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TECHNICAL PAPER No.29

Mnemotype
Timber Grading Machine Deflection Reading
Storage Unit

by

D.J. Grant

Wood Technology & Forest Research Division

FORESTRY COMMISSION OF N.S.W.
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FOREWORD

Research carried out by the Forestry Commission of N.S.W. and other research establishments in various parts of the world has shown that there is a close relationship between stiffness and the ultimate bending strength of timber, whether it contains defects or not. It has also been shown that stiffness measured by loading the timber as a plank can be used as a non destructive strength indicator for timber to be loaded as a joist.

This relationship offered an improved method, to that of visual grading, of sorting timber for strength by using stiffness as a strength indicator. As a result of this in 1963 the Wood Technology Division, now Wood Technology and Forest Research Division, Forestry Commission of N.S.W., developed two commercial type machines to grade timber for strength based on the above principle. They are the "MICROSTRESS" and the "COMPUTERMATIC" for which the Forestry Commission of N.S.W. holds Patent rights in most of the English speaking countries of the world.

The "COMPUTERMATIC" timber grading machine, which is now manufactured under licence to the Commission by Plessey Australia Ltd., makes use of this principle to predict the strength of a piece of timber as a joist by evaluating its stiffness as a plank. The current model, the Plessey COMPUTERMATIC Mk. PIVa, is of a highly advanced design and has been exported to many countries.

Continuous developments in the field of mechanical grading of timber and intensive research into the industrial operation of the COMPUTERMATIC Mk. PIVa necessitated the development of peripheral equipment to perform sophisticated investigations. The MNEMOTYPE as described in this publication has been developed for recording the deflection readings taken by the grading machine.

This facility enables the rapid evaluation of modulus of elasticity along the length of the timber and may be used to verify the correct operation of the COMPUTERMATIC timber grading machine. It can also be used to facilitate proper setting of the Computermatic's controls, check its reliability or in any other study of the various parameters that affect the performance of the "COMPUTERMATIC Mk. PIVa".

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Summary

This paper describes a unit for use in conjunction with the Computermatic Mk PIVa timber grading machine and a digital printer for the purpose of recording the deflection readings taken by the grading machine.

General Description

The Mnemotype unit is used as a fast intermediate storage buffer between the Computermatic Mk PIVa† timber grading machine and a digital printer, model 2010A manufactured by the John Fluke company of Seattle, Washington, U.S.A. The unit stores the deflection readings taken by the grading machine for later retrieval by the printer. The retrieval and printing of all measured points is carried out automatically after the tested timber clears the machine. A sample printout is shown below.

	01	019	
	02	018	
	03	018	
	04	020	
	05	025	
	06	024	
	07	029	
deflection reading serial number →	08	039	← deflection reading in units
	09	042	
	10	035	
	11	024	
	12	022	
	13	021	
	14	021	

The unit is connected directly to the Computermatic's socket S9 which is situated next to the machine's power supply panel and to the digital printer via a special plug. Plate 1 shows the prototype Mnemotype, power supply and printer next to a Computermatic machine. Plate 2 shows the inside of the prototype Mnemotype.

An added feature of the unit is its facility for automatically printing a space after the last reading has been printed.

Specification

Maximum permissible grader speed	:	6.10 metres per second
Maximum storage capacity	:	256 deflection readings
Printout rate	:	2.56 deflection readings per second.
Power supply	:	240V 50HZ and rechargeable batteries

The rechargeable batteries are optional but may be useful if the unit is operated in an electrically noisy environment.

† See note opposite

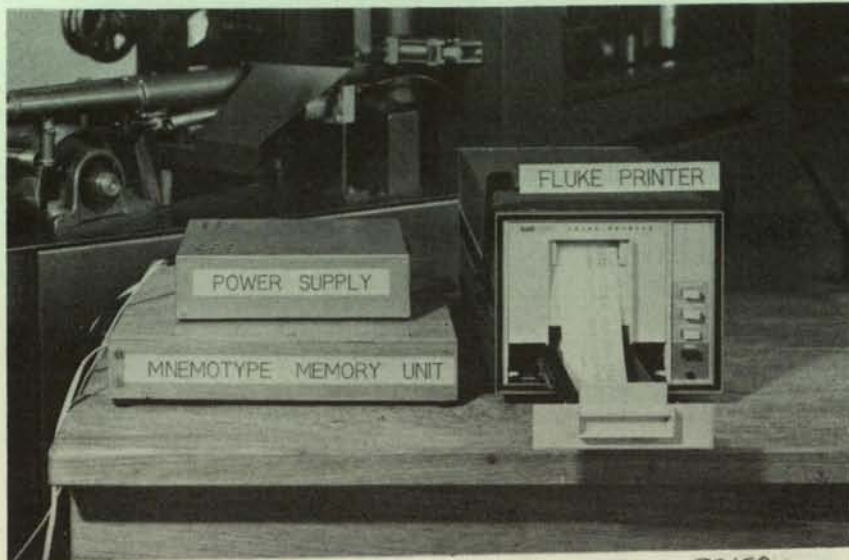


PLATE 1
Prototype Mnemotype, power supply and printer
with a Computermatic machine in the background.

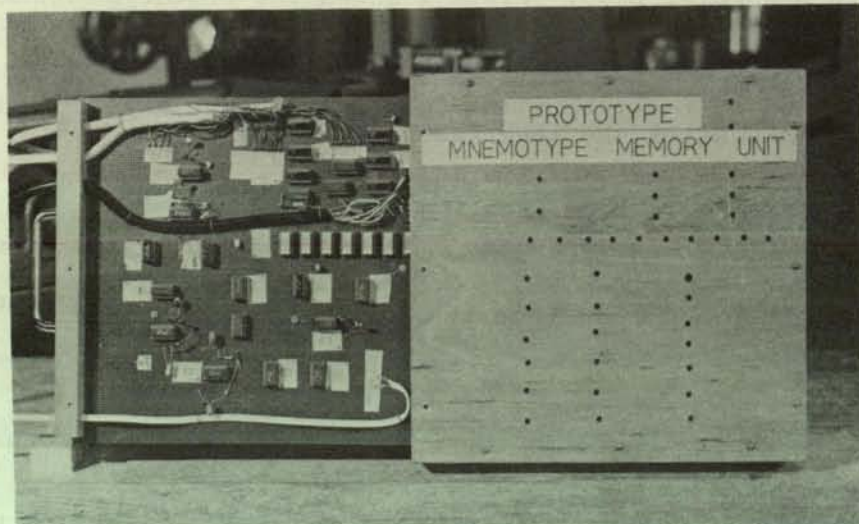


PLATE 2
Inside the prototype Mnemotype.

Operating Procedure

- 1) Connect the 15 pin Cannon plug from the Mnemotype to socket S9 of the Computermatic (see Computermatic manual Fig. 3.2).
- 2) Connect the 100 pin plug from the Mnemotype to the digital printer (see printer manual).
- 3) Ensure that the printer's 'Stand By' button is pressed in.
- 4) Connect the power (240V) to the Mnemotype (or alternatively switch to internal batteries) and switch it on.
- 5) Connect the power to the printer and switch it on.
- 6) Switch on the Computermatic machine.
- 7) For automatic printing release the 'Stand By' button on the printer before passing the timber. If grading occurs with the 'Stand By' button depressed and retrieval of the readings is required, simply release the 'Stand By' button and press the 'Manual Print' button and the stored information will be printed.

Maintenance

For maintenance information on the printer please refer to its manual. The Mnemotype unit requires no regular maintenance.

Detailed Circuit Description

(see sheets 1,1A,2A,2B,2C,3)

Operation Stage 1 - Initialization

A piece of timber enters the Computermatic machine and progressively interrupts the light beam of the three photo-electric cells. A '0' (commence grading) pulse is generated at machine terminal S9-9 when the third cell is cut. This pulse causes the following to occur:

- 1) Logic '0' appears at the write enable terminals of the random access memories (RAM), ME1 to ME7 via AND gate G1.
- 2) Logic '0' appears at the print inhibit terminal of the Fluke digital printer (FL-13) via NOR gate G3.
- 3) Triggering of monostable MO3 occurs and the master reset terminals of the counters CO1 and CO2 receive a logic '1' pulse for 1.7 mS after a 1.7 mS delay. This resets them to zero.

The commence grading pulse continues until the trailing end of the timber clears the first photocell.

Operation Stage 2 - Storage of deflection readings

A logic '0' (master clock) pulse is generated at machine terminal S9-7 just after the initiation of the commence grading pulse. One of these pulses is generated for each six inch of travel of the timber through the machine. Each pulse lasts for 15 mS and during this time the calculated deflection in binary code is generated at the output terminals S9-1,2,3, 4,5,6 and 8 of the Computermatic. These terminals are connected directly to the data inputs of the RAM's ME1 to ME7. The trailing edge of the first master clock pulse causes the following to occur:

- 1) The counters are stepped one unit up.

- 2) Triggering of monostable MO2 occurs via AND gate G6. MO2 generates a 4.5 mS pulse delayed by 4.5 mS which is used to trigger the chip select inputs of the RAM's via AND gate G5. This causes the deflection readings presented to the RAM's to be stored at the address presented by the counters CO1 and CO2.

All master clock pulses that occur as the timber is moving through the machine cause the above two functions to occur.

Operation Stage 3 - Retrieval and printing of deflection readings

When the timber clears the first photocell the commence grading pulse ends. This pulse edge causes the following to occur:

- 1) Monostable MO1 is triggered and its inverted output goes to logic '0' for 16 mS. This pulse is connected to the write enable terminals of the RAM's via AND gate G1. This pulse ensures that the last reading taken by the Computermatic is stored in the appropriate memory position. After 16 mS the write enable terminals go to logic '1' so that the stored data can be retrieved.
- 2) Logic '0' appears at terminal 1 of OR gate G2 via inverter I1.
- 3) Logic '0' appears at terminal 2 of G3 thus enabling the printer.
- 4) Monostable MO5 is triggered and it generates a 4.5 mS long pulse delayed by 25 mS. This delayed pulse is used to perform the following functions:
 - (a) Pulse the chip select inputs of the RAM's via AND gate G5. This causes the information recorded in the particular counter address presented to the RAM's to be presented at the output of the RAM's for the 4.5 mS duration of the pulse.
 - (b) Monostable MO6 is triggered and generates a 2 mS pulse. This pulse is linked to the enable inputs of the latches L1 and L2 and causes the information at the data outputs of the RAM's to be stored by the latches and thus presented to the binary to BCD (binary coded decimal) converter and then, after conversion, to the digital printer.
 - (c) The trailing edge of the 4.5 mS pulse triggers the printer through OR gate G4 and it commences to print. At the instant the printer commences to print each line a data update flag pulse is generated by the printer at terminal FL-15. This pulse is of 4 μ S duration and its trailing edge causes the following to occur:
 - (i) The counters CO1 and CO2 are counted down by 1 step via inverter I2 and OR gate G2.
 - (ii) Monostable MO2 is triggered via inverter I2, OR gate G2 and AND gate G6 and generates a 4.5 mS pulse delayed by 4.5 mS. This pulse triggers the chip select inputs of the RAM's via AND gate G5 thus causing the information in the particular counter address presented to the RAM's to be presented at the data outputs of the RAM's for the 4.5 mS duration of the pulse. The 4.5 mS pulse triggers monostable MO6 which generates a 2 mS pulse which is connected to the enable inputs of the latches L1 and L2 and causes the information at the data outputs of the RAM's to be stored by the latches and thus presented to the binary to BCD converter and then, after conversion, to the digital printer.

The output of the counters CO1 and CO2 is converted continuously from binary to BCD by C1, C2 and C3 and is thus always ready for printing.

When the printer commences to print each line a logic '1' (busy signal) occurs at FL-10 and lasts for 375 mS. The trailing edge of this pulse is connected to the print command terminal (FL-6) of the printer via OR gate G4 thus causing the generation of the next print line. This continues until all the measured points have been printed out, or rather until the output of the counters is zero. Detection of zero on the counters is carried out by the comparators COM1 and COM2 which, if this is so, inhibit the printer through FL-13 via NOR gate G3.

Each time the counters go to zero the A>B terminal of COM1 goes to logic '0'. This signal triggers monostable MO4 via latch L3 when L3 is enabled via I1. When MO4 is triggered it generates a 700 mS pulse delayed by 500 mS. This pulse triggers the 'paper advance' terminal FL-17 of the printer and thus advances the paper in the printer.

General Manufacturing Advice

- (a) Cross milled double sided Veroboard or plain double sided Veroboard are useful for connecting up most of the components.
- (b) Vcc and ground leads to the integrated circuits should be short enough and of low enough resistance to cause as little drop in supply voltage as possible throughout the unit.
- (c) Ground loops should be avoided and power supply decoupling capacitors should be used on each printed circuit card used, with a minimum of one for each monostable (MO1 to MO6). They should be good quality RF capacitors of from 0.01 to 0.1 μ F with short leads located 25 - 50 mm from the monostables. In addition a 2 to 20 μ F tantalum capacitor should be included on each card. Keep monostable timing components close to the packages and away from high transient voltage or current carrying conductors.
- (d) Good ventilation must be given to the components of the unit and power supply and this can be achieved by allowing a relatively large free space in the case and/or plenty of ventilation holes. Heat sinks must be used on the 2N5871 transistor and the 7805 micro-circuit in the power supply. A suitable heat sink is the FK202 for 2N5871, the 7805 can be connected directly to the case. The power supply should be shielded from the Mnemotype or it should be contained in a separate case. The Mnemotype itself should be assembled into a metal case.
- (e) If an alternative power supply is used it should meet the following specification:

5 V \pm 0.25 V DC @ 1.5 ampere
with ripple less than 5% and regulation less than 5%.

Parts List

MO1, MO6	integrated circuit	9601	x2
MO2, MO3, MO4, MO5	integrated circuit	9602	x4
G1, G5, G6	integrated circuit	7408	x1
I1, I2	integrated circuit	7404	x1
G3	integrated circuit	7402	x1
G2, G4	integrated circuit	7432	x1
L1, L2, L3	integrated circuit	93L14	x3
COM1, COM2	integrated circuit	9324	x2
CO1, CO2	integrated circuit	9366	x2
C1 - C6	integrated circuit	74185A	x6

ME1 - ME7	integrated circuit	93410	x7
Power supply	integrated circuit	7805	x1
Power supply	transistor	2N5871	x1
Power supply	diodes	BY 126/50	x2
	resistor ½ W	5.6K ohms	x3
	resistor ½ W	6.8K ohms	x2
	resistor ½ W	10K ohms	x3
	resistor ½ W	22K ohms	x1
	resistor ½ W	39K ohms	x1
	resistor ½ W	3.0 ohms	x1
6Vmin	tantalum capacitor	0.1 µF	x6
24Vmin	tantalum capacitor	0.33 µF	x1
6Vmin	tantalum capacitor	1 µF	x3
6Vmin	tantalum capacitor	2.2 µF	x6
6Vmin	tantalum capacitor	3.3 µF	x1
6Vmin	tantalum capacitor	4.7 µF	x1
6Vmin	tantalum capacitor	33 µF	x1
6Vmin	tantalum capacitor	47 µF	x2
25VW	electrolytic capacitor	4700 µF	x1
Switch	2PST	2 amps @ 240VAC	x1
Switch	4PST	4 amps @ 240VAC	x1
Transformer	15v CT	40 VA (Ferguson PL15/40)	x1
Fuse	150 mA	+ holder	x1
Fuse	2 amp	+ holder	x1
Fuse	1.5 amp	+ holder	x1
Cannon DA - 15P plug			x1
Fluke 2010A-7000 General purpose cable			x1
Heat sink type FK 202 for 2N5871 transistor			x1
NiCd battery charger			x1
Eveready NiCd batteries type CH4			x7
Large metal case or smaller metal cases to house completed unit			x1
Double sided Veroboard, tagstrip hardware etc. as required.			
DIP sockets if used.			

References

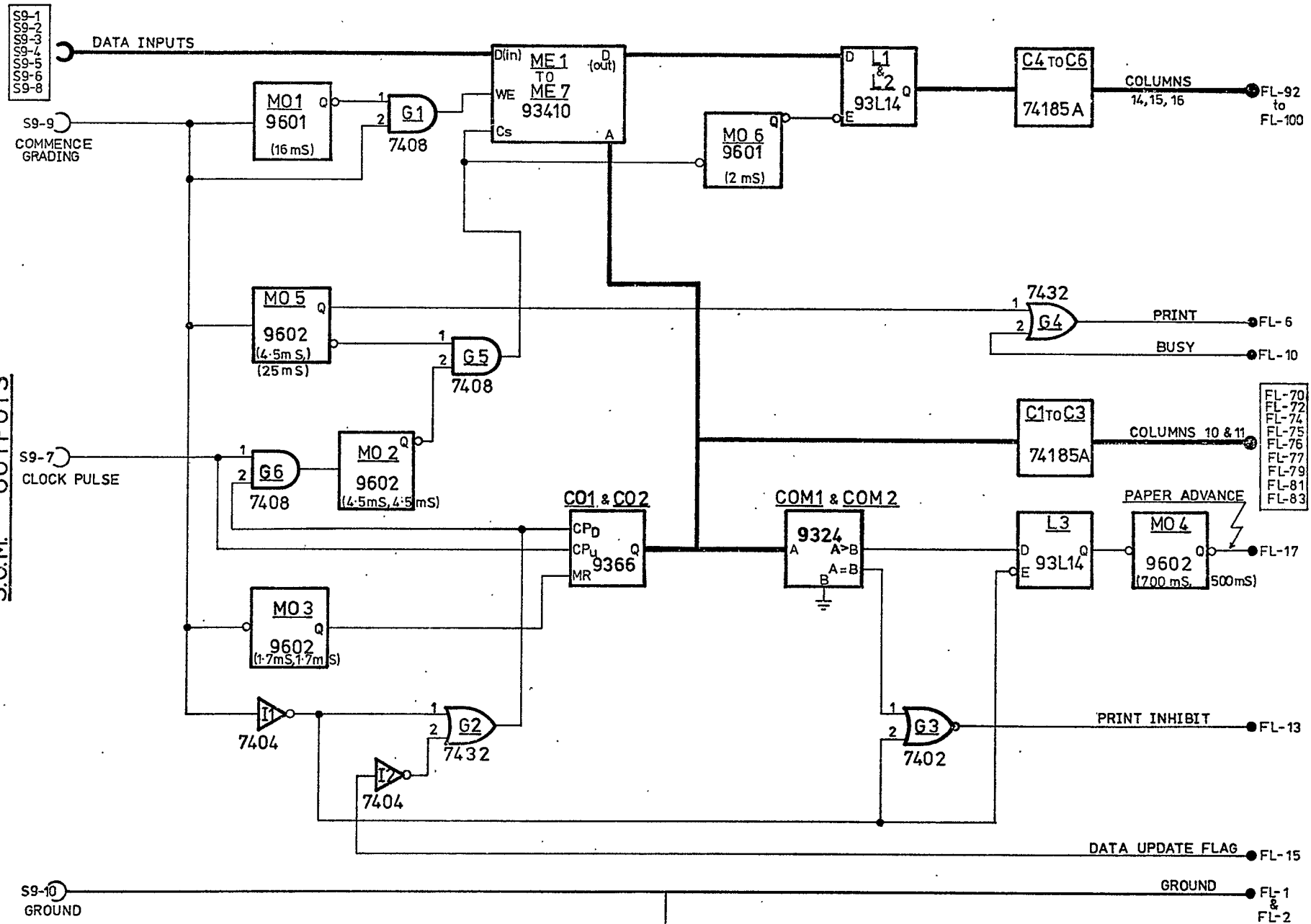
- 1) Fairchild Semiconductor TTL Data Book.
- 2) Fairchild Semiconductor TTL Applications Handbook.
- 3) Plessey Computermatic Mk PIVa Timber Grading Machine Manual.
- 4) "The Grading of Timber into Stress Grades by Mechanical Means".
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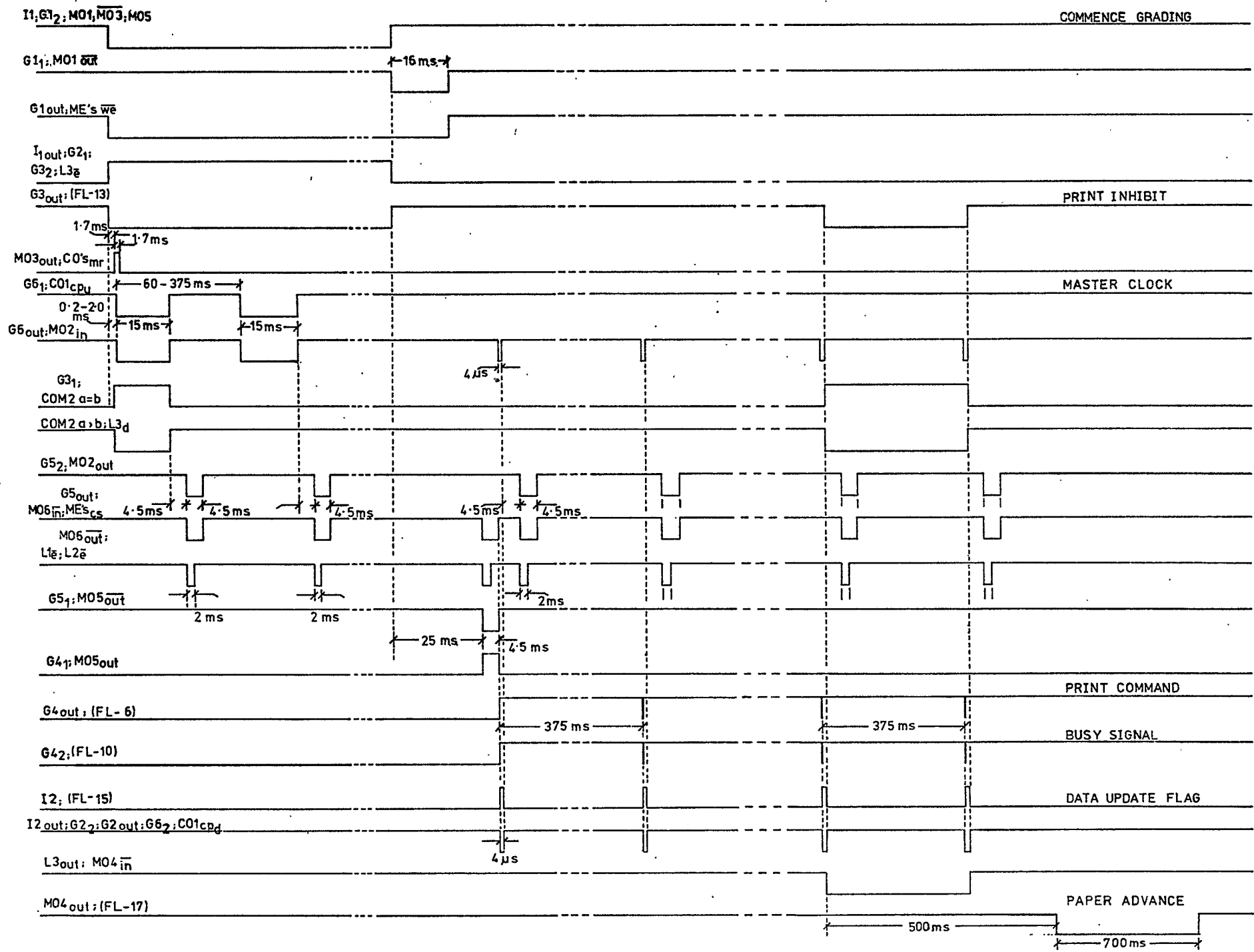
SHEET 1 MNEMOTYPE MEMORY UNIT

S.G.M. OUTPUTS

(FLUKE 2010A)

PRINTER INPUTS

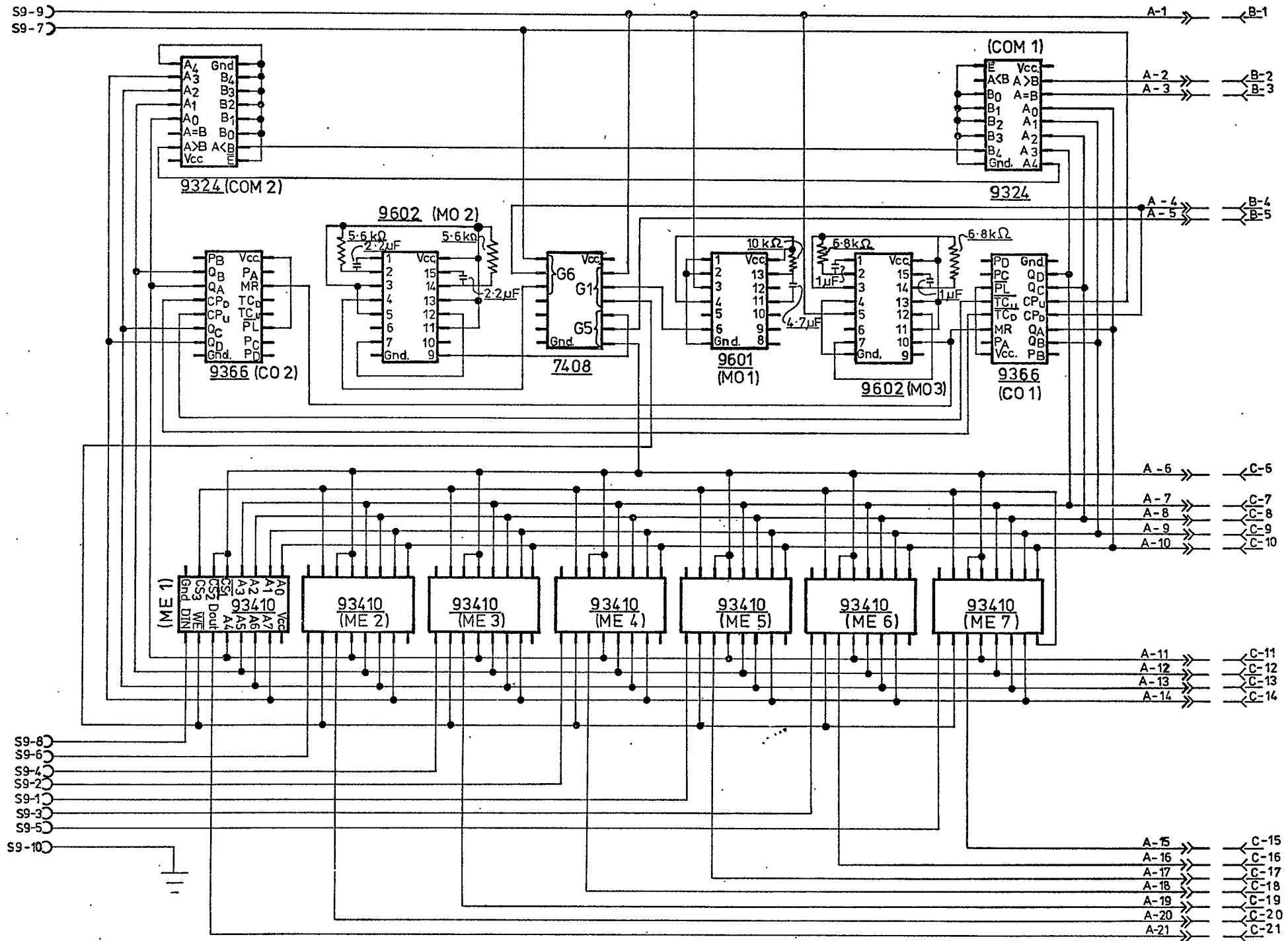


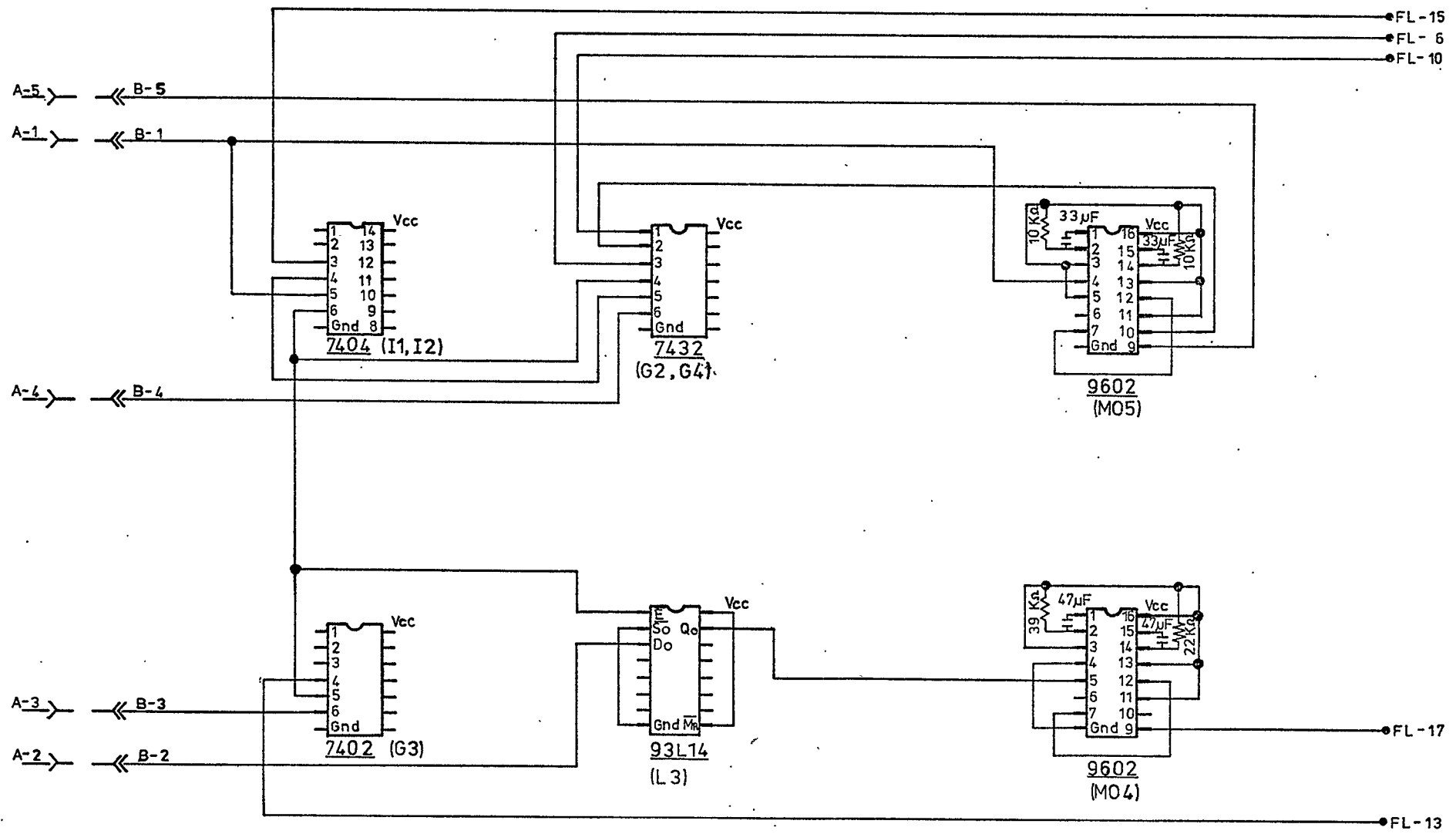


SHEET 1A MNEMOTYPE TIMING DIAGRAM (SEE SHEET 1)

8.

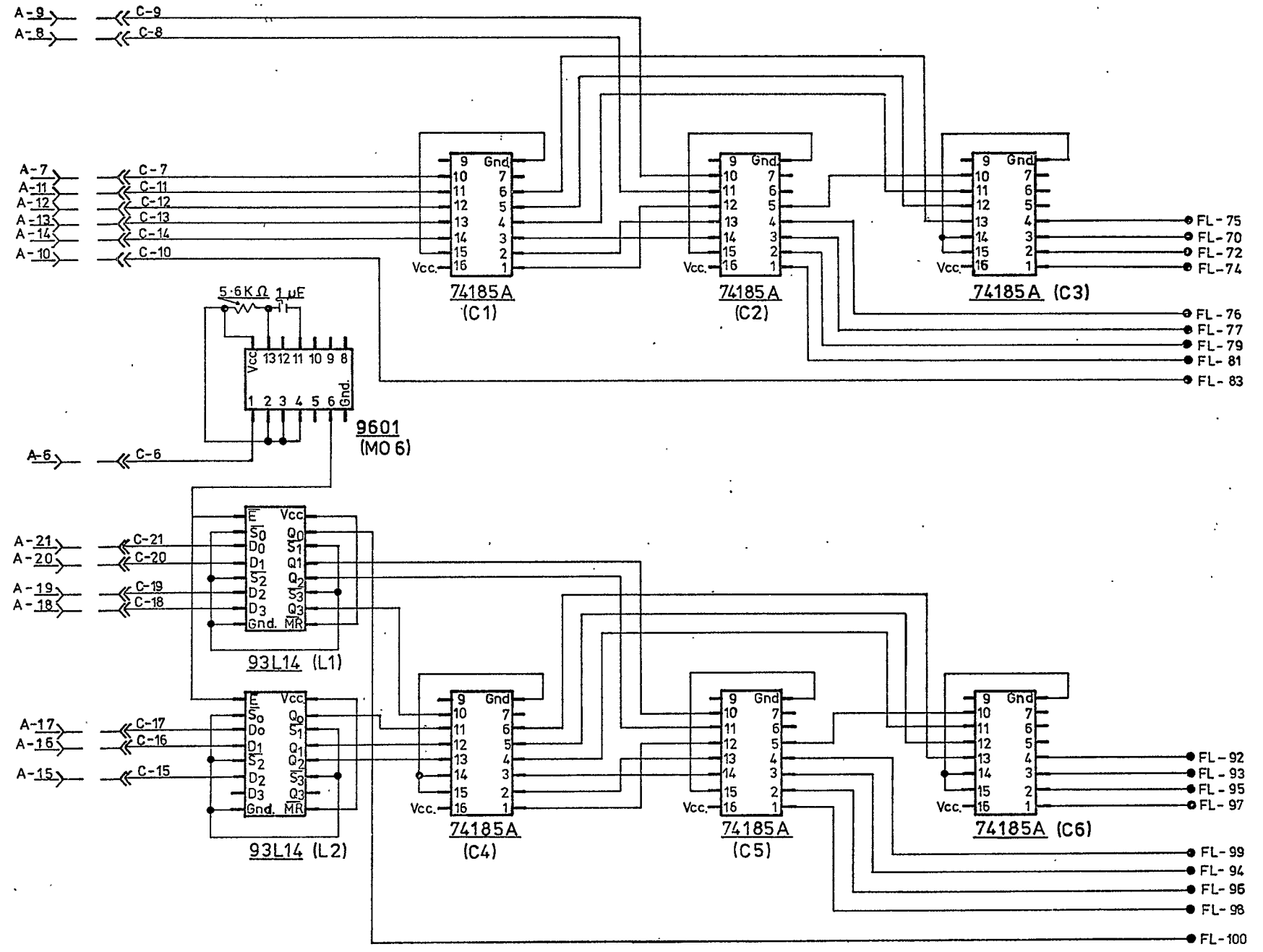
SHEET 2A (MNEMOTYPE)

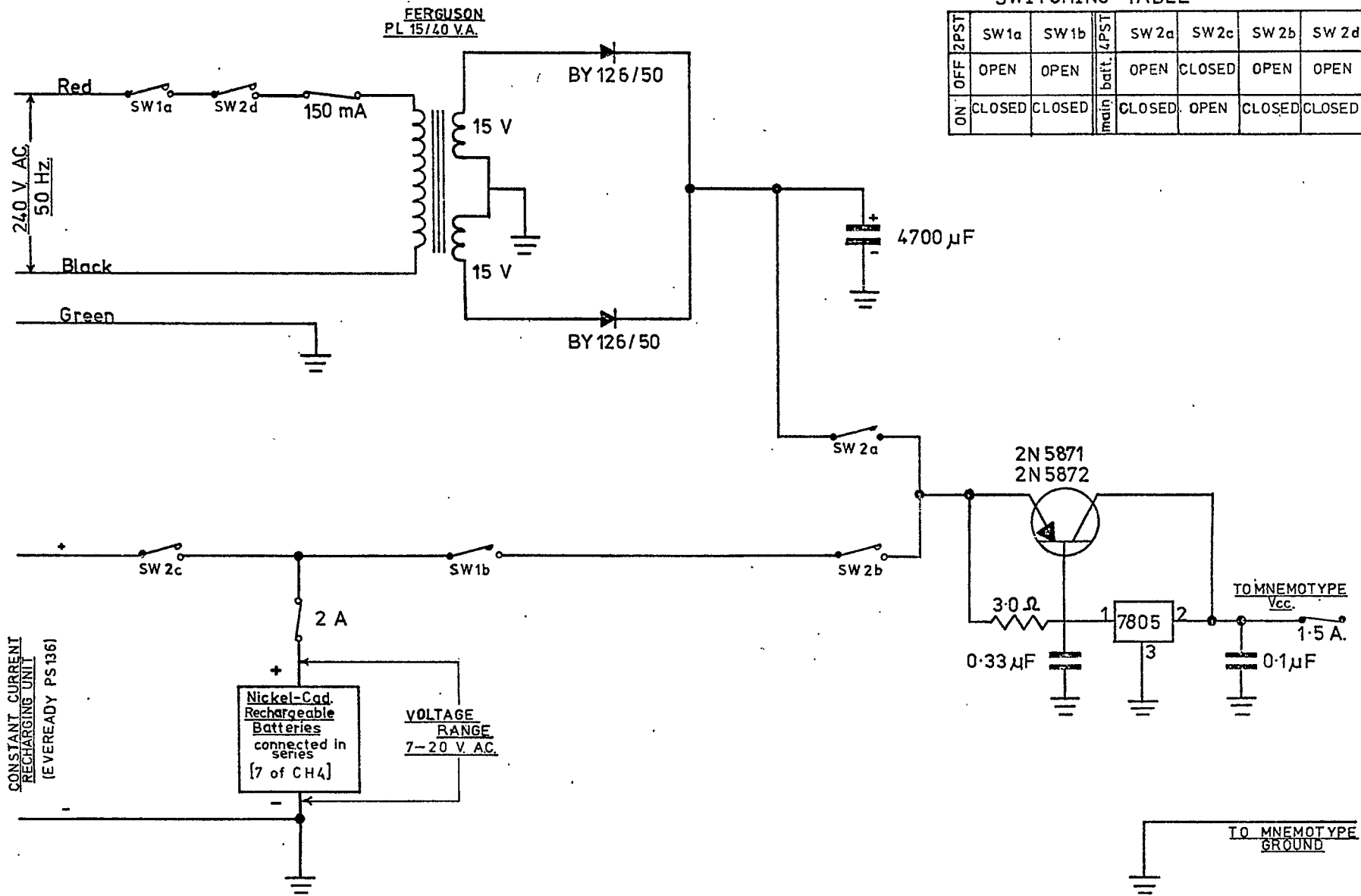




SHEET 2B MNEMOTYPE

SHEET 2C MNEMOTYPE





SWITCHING TABLE

	SW1a	SW1b	4PST	SW2a	SW2c	SW2b	SW2d
ON	CLOSED	CLOSED	main	CLOSED	OPEN	CLOSED	CLOSED
OFF	OPEN	OPEN	batt.	OPEN	CLOSED	OPEN	OPEN

SHEET 3 MNEMOTYPE POWER SUPPLY