CEL Technical Memorandum No. 104

03604-1-M

OPERATOR'S MANUAL

for the

M4 COMMUNICATIONS EXPERIMENT

by

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for

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Contract No. N00014-67-A-0181-0032

Office of Naval Research (Code 468)
Department of the Navy
Washington, D. C. 20360

August 1970

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I. INTRODUCTION

The M4 Communication System is a complete revision of the M3 Communication System as constructed by C. V. Kimball in June 1969. The M4 system operates under the control of CPS (Cooley Programming System) and is designed to be run on the Field-8 computer. The M4 system operates only in a reference mode, i.e., it is not set up to operate in a communication mode. The M4 system is considerably more versatile than the M3 system:

1) it utilizes 8K of memory,

2) it operates under CPS,

3) software support is readily available at CEL.

The transmitter is the LMSG. The reference word transmitted is a 15 digit maximal length pseudo-random sequence. The LMSG can transmit each bit of information, i.e., each digit of the sequence, either in the normal mode (no subsequence) or in a band-spreading mode (each digit of the sequence is characterized by a particular subsequence).

The "receiver" is the Field-8 computer. The program consists basically of two parts, the synchronization procedure and the receiver itself.

Major improvements over the M3 system are:

1) automation of synchronization procedure,

2) conversion to double precision,

3) more detailed computation of system parameters,

4) simplicity of operation (one program only).

II. PURPOSE

The goals of the M4 Communication Experiment are:

1. To calculate P(E) versus S/N.

2. Compare band-spreading with the normal mode of operation.

3. Study effect of exponential weighting in computing the reference.

III. SYSTEM COMPONENTS

Operating the M4 system requires the following system components.

3.1 Field-8 Computer, an 8K DEC PDP-8/L with tape controller modified to operate under CPS. Additional hardware needed for the M4 system and for general purpose signal processing include:

1) external interrupt for timing control from clock (or oscillator),

2) A/D converter for sampling,

3) 2 D/A converters for display purposes,

4) 4 mechanical relays for computer attenuator control.

3.2 Logically Modulated Signal Generator (LMSG), a function generator (designed and built by P. Nuspl of CEL) used to generate periodic sequence transmissions. It is capable of transmitting the reference word (the 15 bit periodic sequence) in either the normal mode or in the bandspreading mode.

3.3 Mimi Preprocessor, an analog unit which contains a line-to-line transformer, a bandpass filter (140 Hz about 420 Hz) and a 3 dB per step attenuator. The attenuator has a built-in gain of 40 dB and can be controlled either manually at the unit or remotely by the Field-8 mechanical relays.

3.4 Precision Oscillator, the source for maintaining a

coherent reference. A 1680 Hz, 5 volt square wave is required.

3.5 RMS Voltmeter, for monitoring input voltage level to A/D converter.

3.6 x,y Oscilloscope, for observing synch display and receiver reference.

3.7 8K-CPS Tapes, operating system tapes which contain the binary versions of the M4 system. There are currently two operating versions. The binary file COMS4 contains the program for the "simple" version. The binary file COMM4 contains the program for the "Markov" version (or the version which exponentially weights the reference).

IV. CONNECTION OF COMPONENTS

Figure 1 illustrates the setup for laboratory simulation of the M4 Communication Experiment. Figure 2 shows the connections used in the experiment of July, 1970 for the Mimi channel, Miami to Bimini. Figures 3 and 4 depict the proper settings for the LMSG and MIMI preprocessor, respectively.

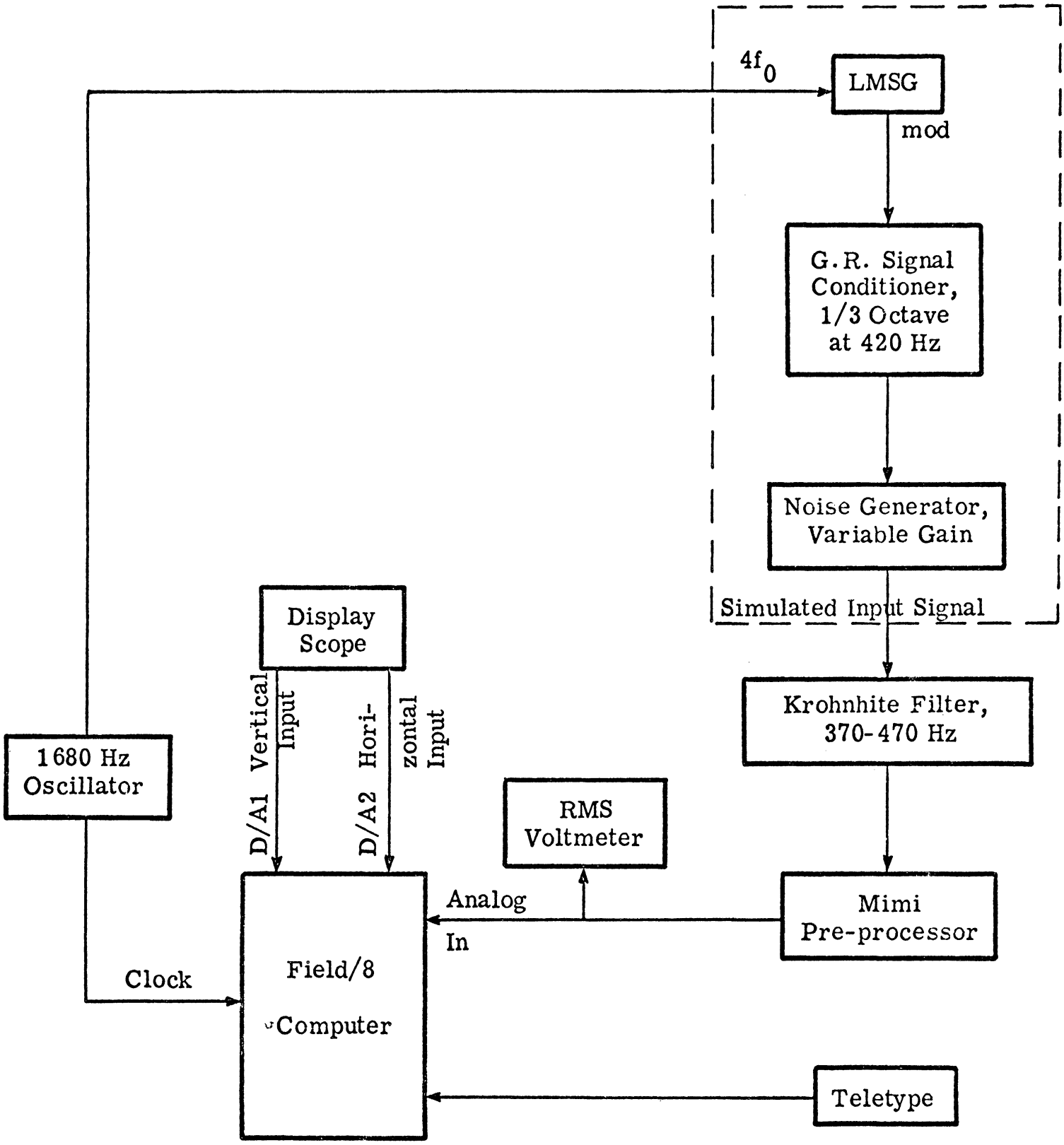


Fig. 1. Test setup at CEL

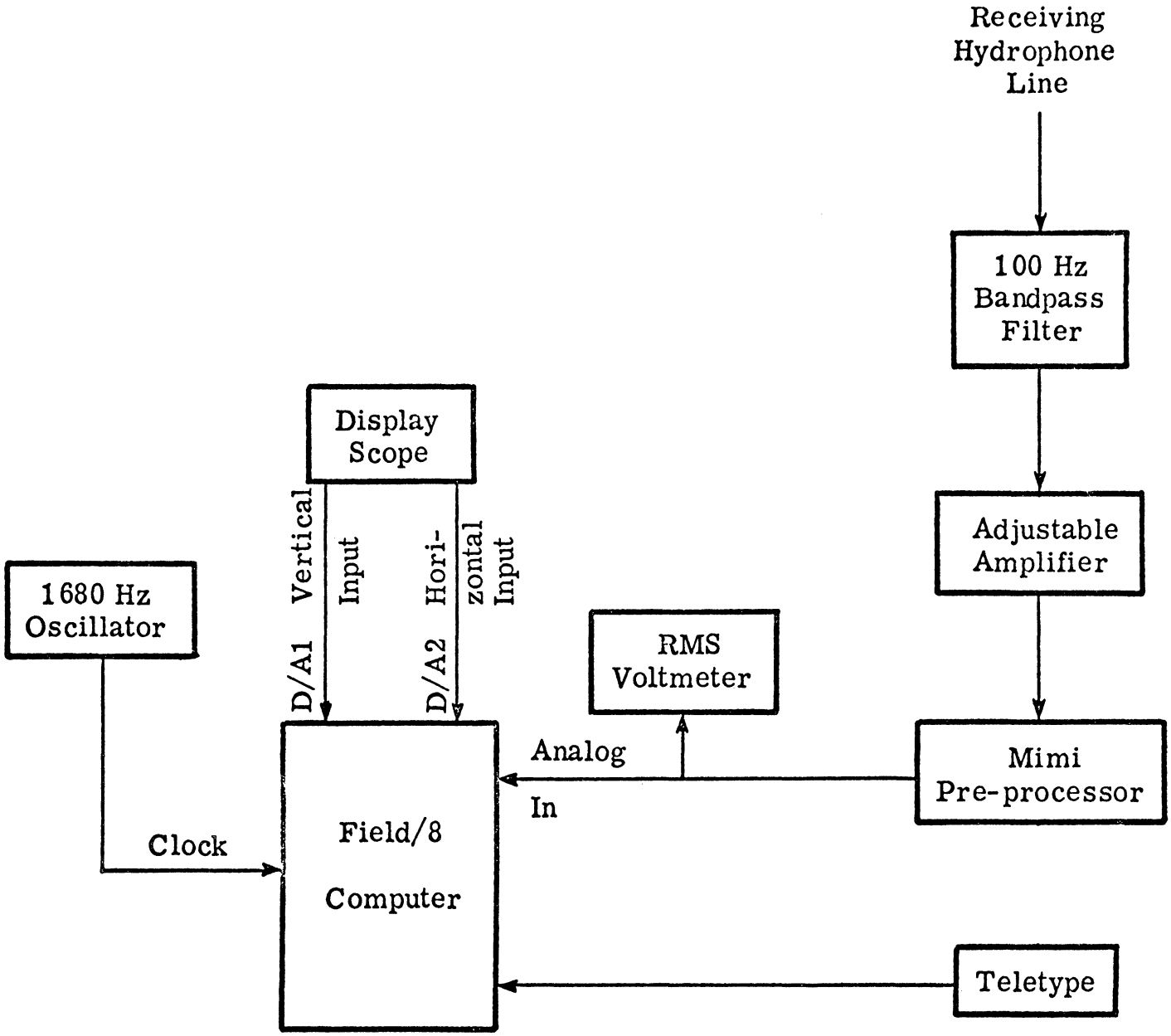
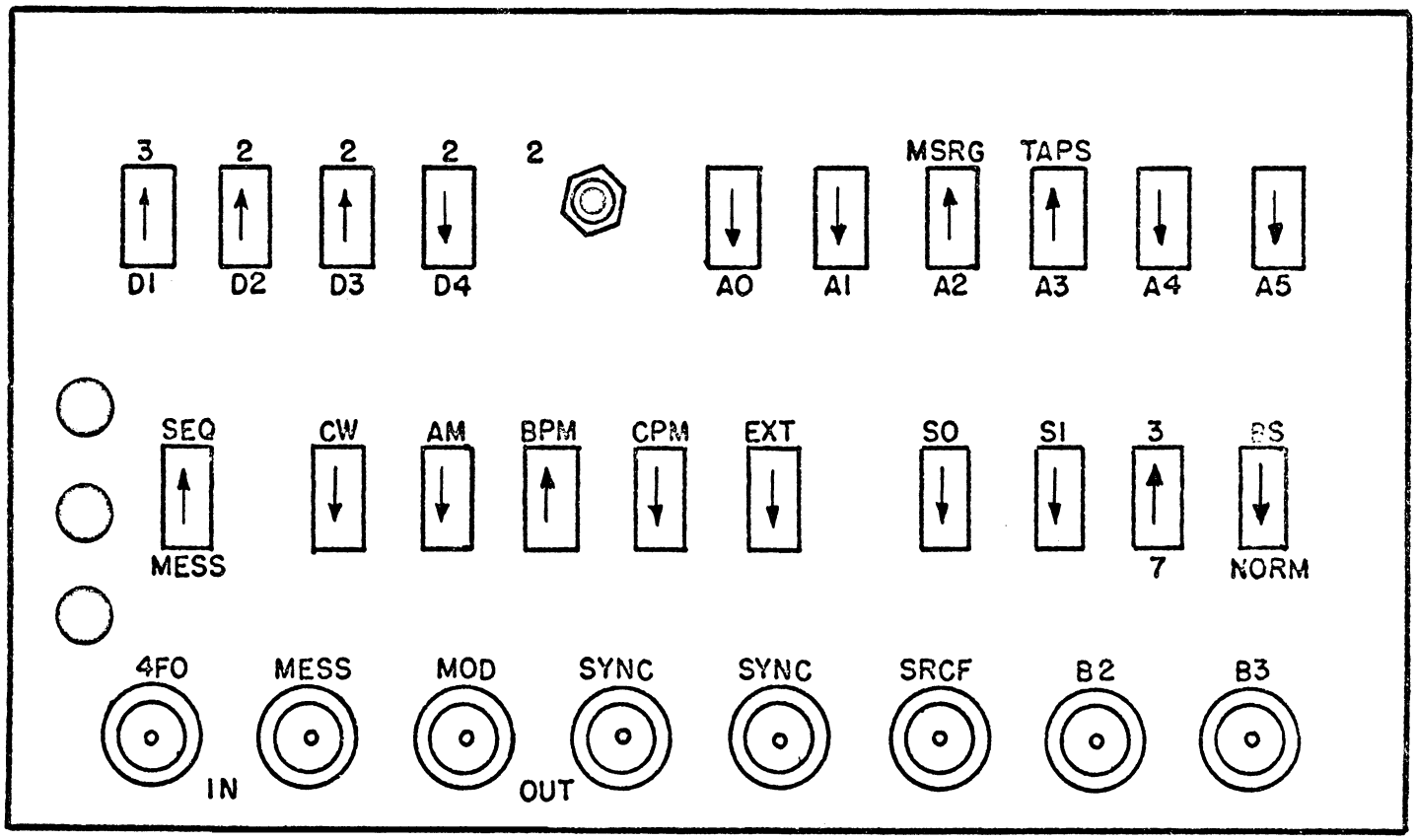


Fig. 2. Experimental setup at Bimini

The settings given in Fig. 3 are for operating the Communications Experiment in the normal mode. To operate in the band-spreading mode requires that switch D1 be in the down position and the BS/NORM switch should be in the BS position. A word of caution is in order. When changing from the normal mode to the band-spreading mode, the "receiver" must be restarted since synchronization is lost in the switching process.

Fig. 3. LMSG settings for normal mode



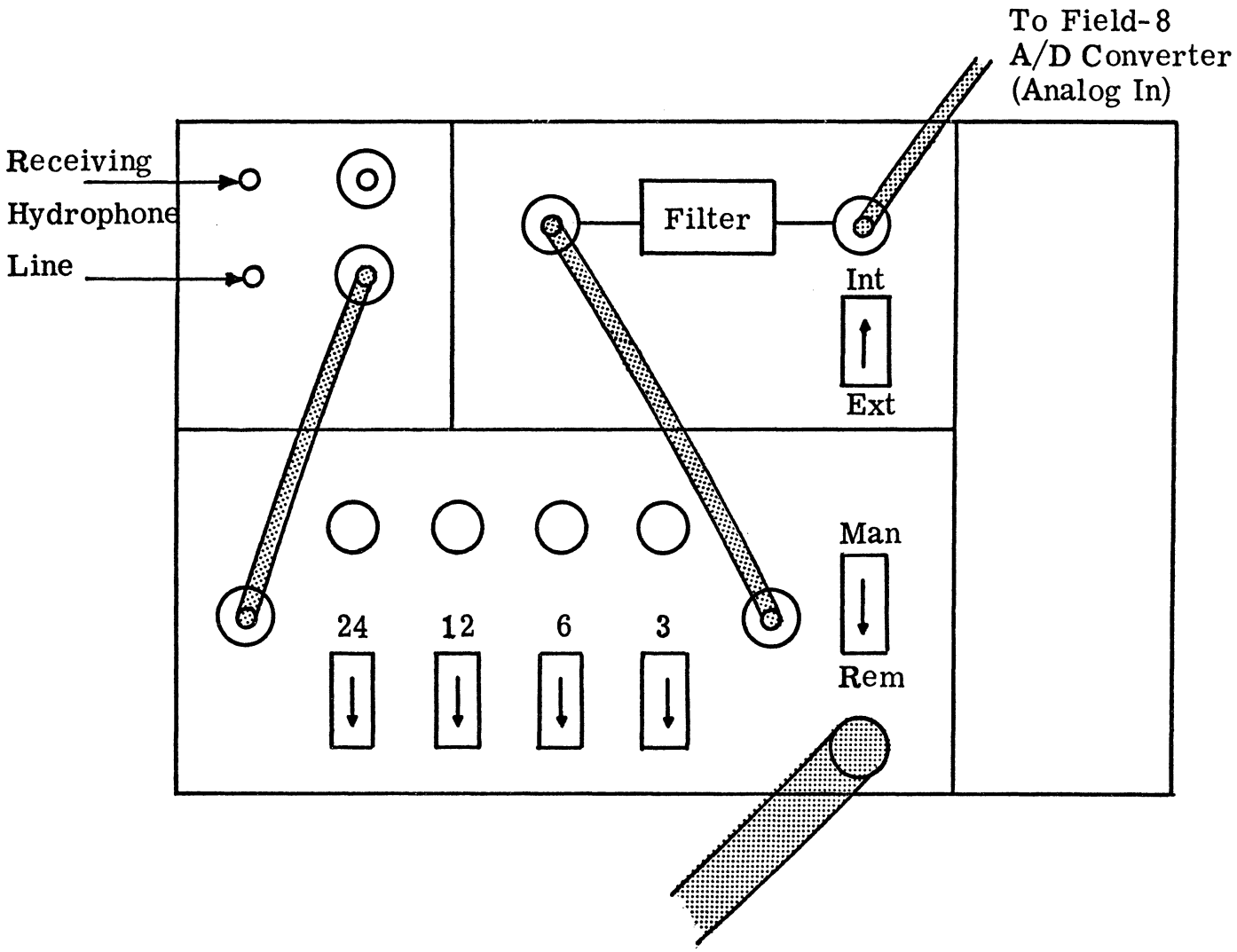


Fig. 4. Mimi - Preprocessor settings

V. SYSTEM OPERATION

5.1 Connect system components.

5.2 Load CPS.

5.3 Type RUN COMS4 or RUN COMS4P [or RUN COMM4] (CR)

(COMS4 computes D1 and D2, COMS4P computes D1 and D3.)

5.4 Adjust amplifier gain so that the input voltage to the A/D converter is approximately .05 volts RMS. [For COMM4 set MAN/REMOTE switch to MAN and adjust gain to .05 volt RMS.]

5.5 Enter data number N , (CR)

Enter group number M , (CR)

[For COMM4 enter weight factor I, (CR).]

5.6 Synch mode: Wait about 2 · n · m seconds for display to appear and the word SYNCHED to be typed. If display is "triangular-like," synchronization is satisfactory. If display is bi-modal (indicative of two distinct paths) or "noise-like," synchronization is doubtful. Wait until conditions improve (path structure changes or SNR increases) or increase averaging times (increase N and/or M) and restart program at loc 200.

A program option in the synch mode is:

1) Type D to view the distribution of energy in the received symbol (it should be "pulse-like"). Type D again to view the original display.

5.7 Receive mode: Type R to enter receive mode if synchronization is deemed satisfactory.

Program options in the receive mode are:

1) Type C to change from computer control of attenuator to manual control or vice versa (only for COMS4).

2) Type P to change from normal printing mode to minimal printing mode or vice versa.

Have patience since these changes will occur only at the end of a block, one at a time.

GOOD LUCK!