

INSTRUCTION MANUAL

MODEL 1200

FSK DEMODULATOR

FREDERICK ELECTRONICS CORPORATION
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Frederick, Maryland 21701

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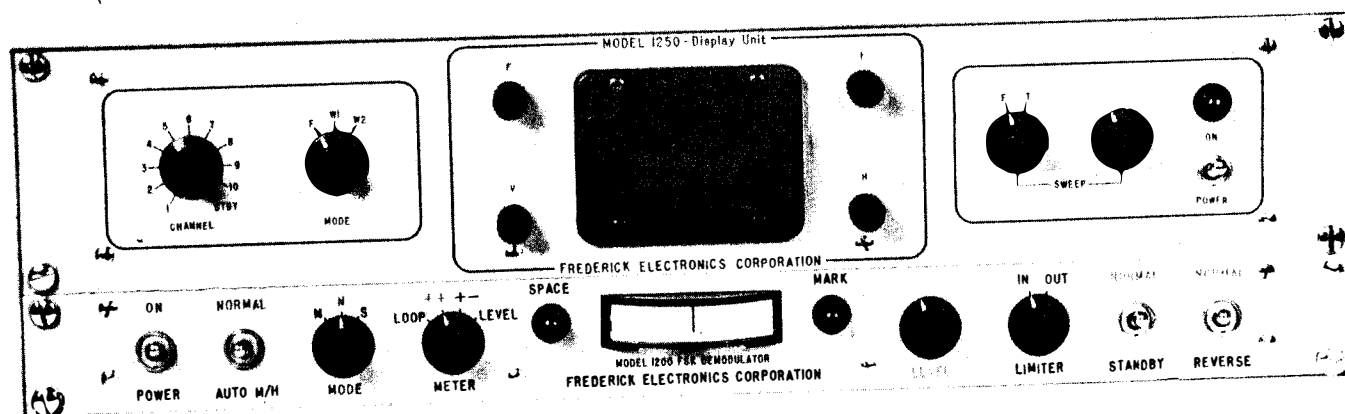



Figure 1-1. Model 1200 FSK Demodulator and Optional Tuning Indicator



SECTION I
INTRODUCTION

1.1 PURPOSE OF EQUIPMENT

The Model 1200 FSK Demodulator is designed to provide optimum detection of frequency shift keying signals with shifts between 170 and 2000 Hz, and with keying rates from 30 to 300 baud. The Model 1200 accepts audio signals from a communications receiver, demodulates these signals, and uses the resultant output for keying a standard neutral telegraph loop. The effects of frequency selective fading are minimized in the Demodulator through the use of variable decision threshold techniques. This function is performed by a patented Decision Threshold Computer (DTC), which varies the threshold or transition point between marks and spaces in accordance with receiving conditions.

Additional outputs are provided on the rear panel of the Model 1200 for diversity operation, and for visual tuning with an optional data tuning and display monitor. Chassis space is also provided for an optional 130-volt internal loop power supply.

1.2 PHYSICAL DESCRIPTION

The Model 1200 FSK Demodulator contains plug-in Filter and Detector cards, a plug-in power supply and optional loop supply, a tuning meter, and associated front panel controls and switches, all conveniently packaged for mounting in a standard 19-inch equipment rack. The required rack space is 1-3/4 inches.

1.3 ELECTRICAL SPECIFICATIONS

Electrical specifications for the Model 1200 FSK Demodulator are shown in Table 1-1.

Table 1-1. Electrical Specifications, Model 1200

Standard Model	Ranges Available On Special Order	
<u>INPUT</u>		
Impedance	Balanced 500 ohm	
Signal	0 dbm audio: 2125 Hz Mark frequency; 2975 Hz Space fre- quency	400 to 3500 Hz
Baud	45.5 baud (60 wpm) or 74.2 baud (100 wpm)	30 to 300 baud
Frequency Shift	850 Hz	170 to 2000 Hz
<u>MARK AND SPACE FILTERS.</u>	200 Hz bandwidth	85 to 500 Hz
<u>OUTPUT</u>		
Current	0 to 60 ma., neu- tral	
POWER REQUIREMENTS.	115/230 vac, 50/60 Hz, at ap- proximately 15 watts	

NOTE

Frequency shift and baud rates are determined by the predetection and postdetection filters. Predetection filters consist of the input band-pass filter and the mark and space channel filters. The post-detection filter consists of the detector output filter. All four filters are mounted on a single plug-in card. This feature not only increases the versatility of the Demodulator in adapting itself to a variety of signal requirements, but also reduces in-the-field change-over to the simple and brief operation of removing one card and plugging in another.

SECTION II
INSTALLATION

2.1 UNPACKING AND INSPECTION

Carefully unpack and remove the Model 1200 FSK Demodulator from its shipping container. Inspect the unit for damage. If any damage is found, file a written claim with the shipping agency. Send a copy of this claim to Frederick Electronics Corporation.

2.2 POWER REQUIREMENTS

The required input power for the Model 1200 FSK Demodulator is 115 volts, ac, 60 Hz. Satisfactory operation is possible with line voltages between 105 and 130 volts, ac, and with frequencies from 47 to 63 Hz.

2.3 INSTALLATION

2.3.1 MOUNTING

The Model 1200 FSK Demodulator is designed to mount in a standard 19-inch equipment rack. A vertical rack space of 1-3/4 inches is required. Low power consumption permits operation over a temperature range of 0° to 50° C.

2.3.2 TERMINAL BOARD WIRING

Figure 2-1 shows the rear panel terminal board connections for a typical demodulator installation with an external 130-volt loop power supply. Figure 2-2 shows a typical installation with the optional 130-volt internal loop power supply installed and connected. Figure 2-3 shows a typical installation for diversity operation.

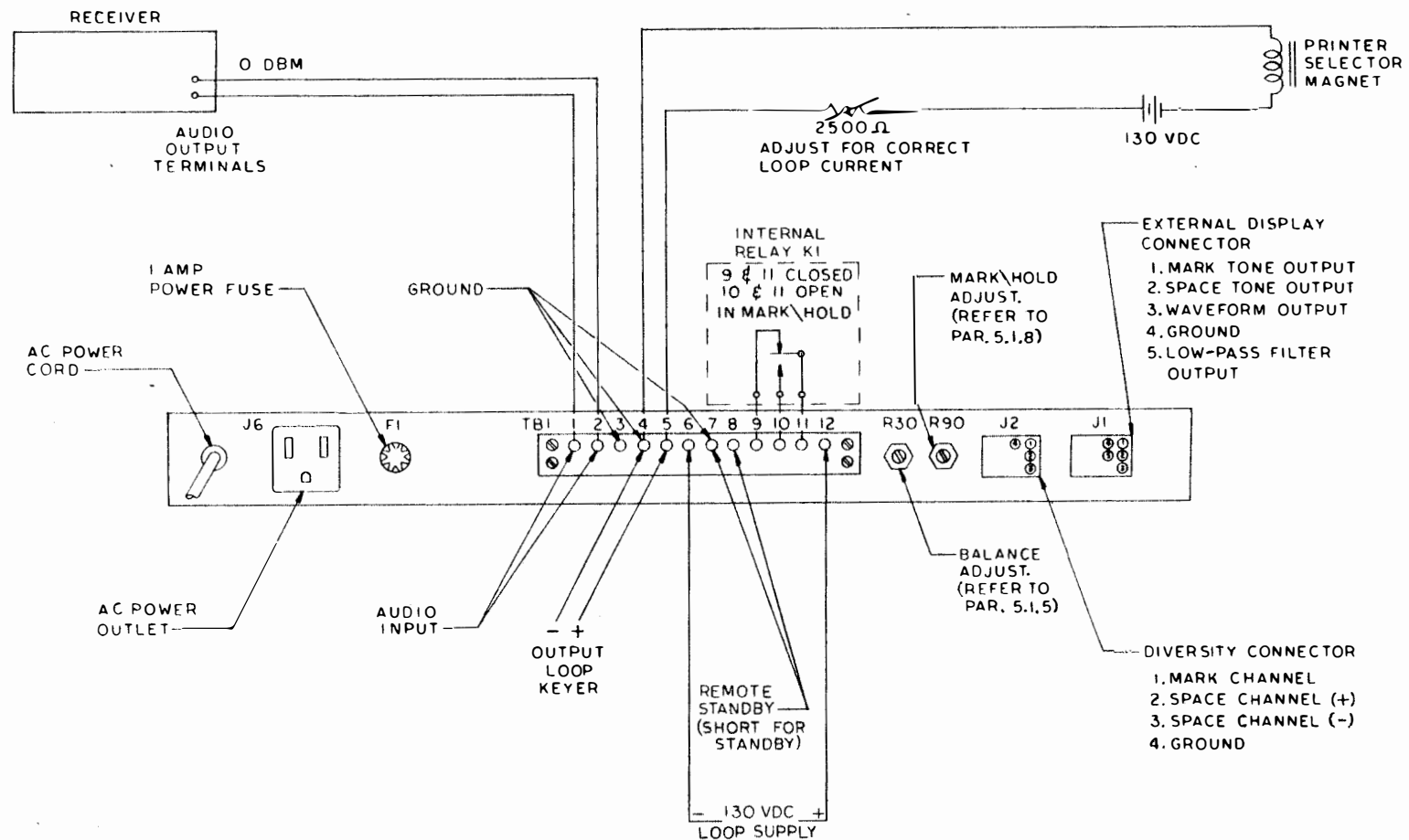
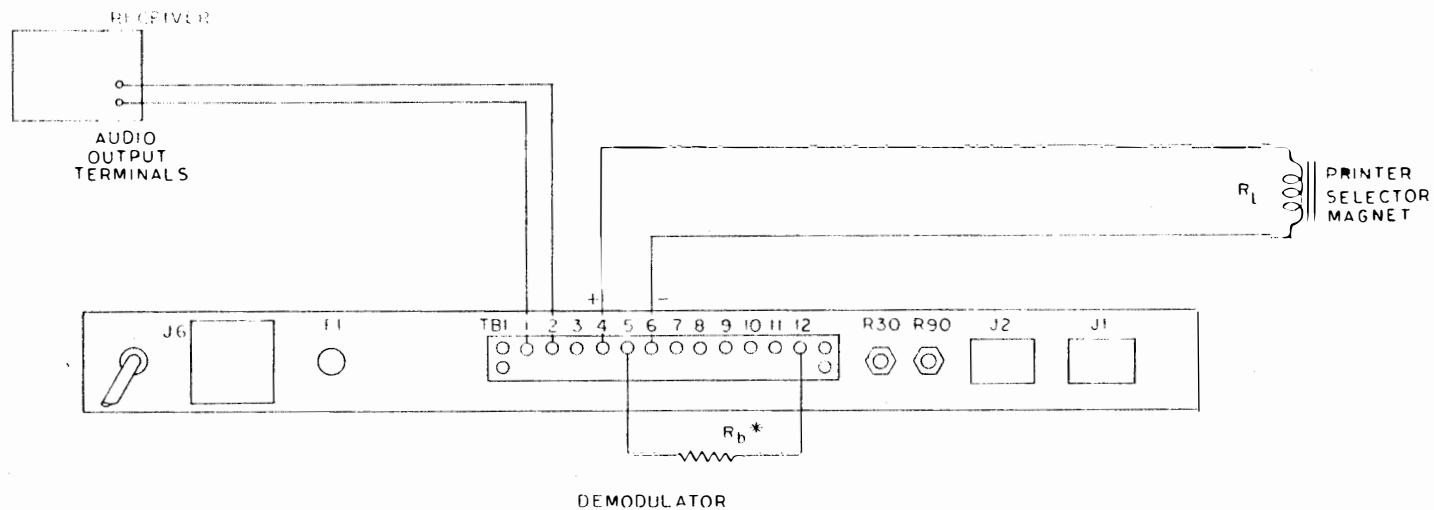


Figure 2-1. Typical Demodulator Installation
(C0857D)



* NOTE:
 FOR 60 MA LOOP
 $R_b = 2000 \Omega - R_l$
 MINIMUM 10 WATT RATING

Figure 2-2. Typical Demodulator Installation
 with Optional 130-Volt Loop Supply
 (C0996A)

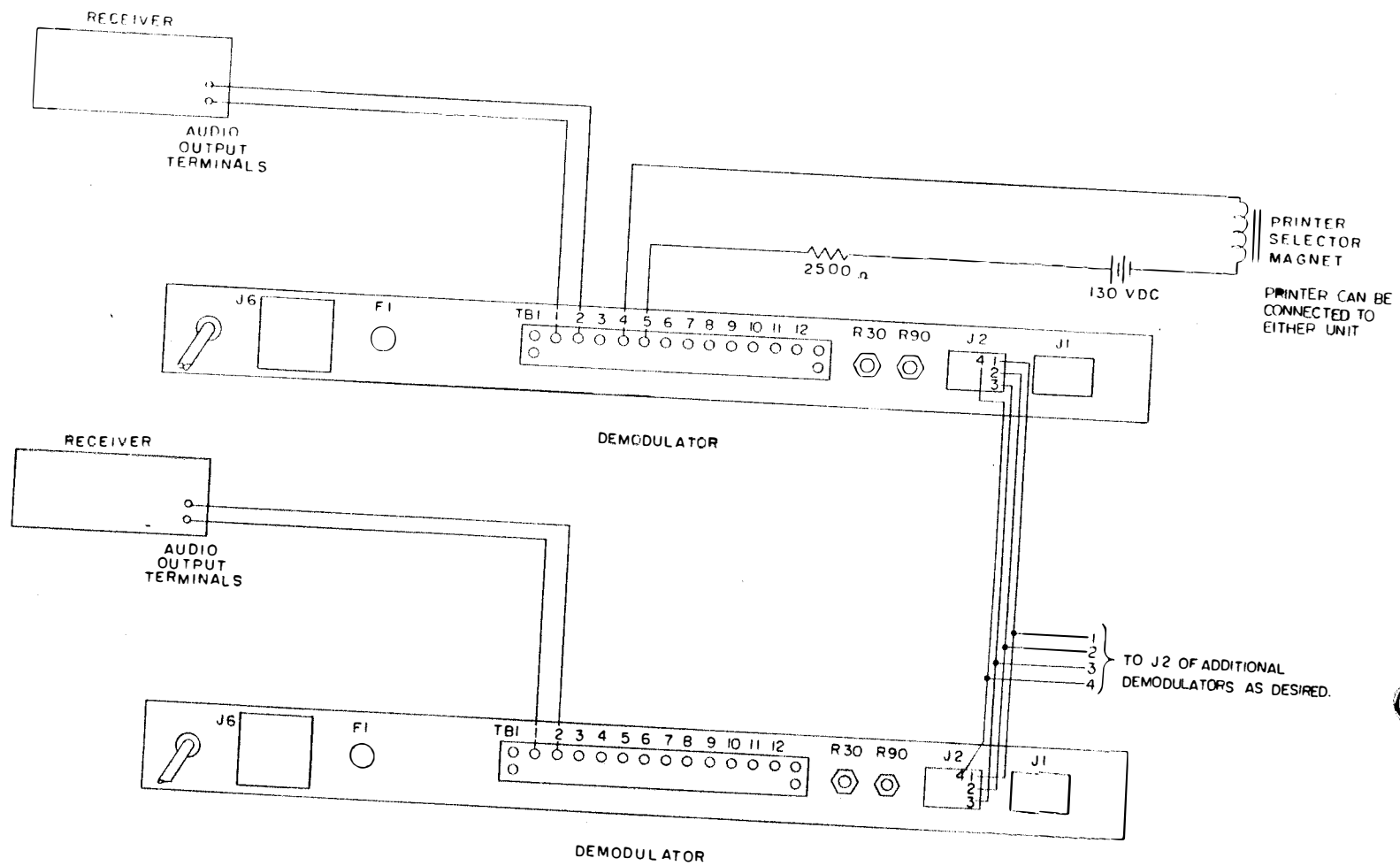


Figure 2-3. Typical Demodulator Installation for Diversity Operation (C0951)

SECTION III
OPERATION

3.1 GENERAL

To obtain optimum performance from the Model 1200 FSK Demodulator, it is essential that the operator thoroughly understand: (1) how the Demodulator works; (2) the function of each control and indicator; (3) how to tune the associated receiver to an FSK signal. Item (1) is covered in Section IV of this manual. Items (2) and (3) are presented in this section.

3.2 CONTROLS AND INDICATORS

Table 3-1 lists all front panel controls and indicators on the Model 1200. Notice that an asterisk (*) appears after one position or function of certain controls. The asterisk indicates that the control function is engraved in red on the front panel. The red engraving identifies normally-used positions and provides a "home-base" or departure point for various operating situations. Thus, if the operator experiences any difficulty or confusion in operation, he can return these controls to the red position until he determines the correct operating procedure.

Table 3-1. Controls and Indicators, Model 1200 FSK Demodulator

NAME	REFERENCE NUMBER	FUNCTION
POWER-ON* switch	S1	Controls ac power to FSK Demodulator.
AUTO M/H-NORMAL* switch (functions only when MODE M-N*-S switch is in the N* position, and LIMITER switch is in the IN position).	S3	<u>AUTO M/H position</u> : In the absence of an input signal, places output of Demodulator in mark-hold. <u>NORMAL* position</u> : mark-hold circuit is inoperative.
MODE M-N*-S switch	S4	<u>N* position</u> : Selects both mark and space signals. <u>M position</u> : Selects mark signal only. <u>S position</u> : Selects space signal only.

Table 3-1. Controls and Indicators, Model 1200 FSK Demodulator (cont.)

NAME	REFERENCE NUMBER	FUNCTION
METER switch: LOOP, ++*, +-, LEVEL	S7	<p><u>LOOP position</u>: Monitors current in teleprinter circuit; has markings at 20 ma and 60 ma (full scale).</p> <p><u>++* position</u>: Used in tuning receiver to an FSK signal. Receiver is properly tuned when Meter needle has maximum deflection and minimum oscillation.</p> <p><u>+ - position</u>: Indicates presence of mark and space signals by deflecting to right for mark, and to left for space.</p> <p><u>LEVEL position</u>: Monitors level of input signals; normal indication is 0 DBM.</p>
SPACE indicator	DS1	Glows when Demodulator output is spacing.
MARK indicator	DS2	Glows when Demodulator output is marking.
LEVEL* control	R91	Adjusts input level of audio signal to Demodulator.
LIMITER IN-OUT switch	S5	<p><u>IN position</u>: Activates Limiter circuit.</p> <p><u>OUT position</u>: Deactivates limiter circuit.</p>
NORMAL*-STANDBY switch	S6	<p><u>NORMAL* position</u>: Permits normal Demodulator output.</p> <p><u>STANDBY position</u>: Places Demodulator output in steady mark.</p>
NORMAL*-REVERSE switch	S2	Reverses mark and space at output.

3.3 OPERATING AIDS

3.3.1 RECEIVER

The performance of the FSK Demodulator depends to a large extent upon the type of receiver used, and upon careful tuning. For best results, use a single-sideband receiver with good frequency stability, variable IF bandwidth selectivity, a product detector, slow AVC, and passband tuning. The operator should read the instruction manual for the receiver, and thoroughly familiarize himself with its operation.

3.3.1.1 Frequency Stability. Receiver frequency stability is important in the reception of FSK signals. Frequency stability becomes extremely important with the narrower shifts. Any slow frequency drift, even with 850 Hz shift, can quickly interrupt copy from the strongest of signals.

3.3.1.2 Selectivity. The normal AM broadcast receiver passes a band of frequencies five kHz or more in width. If such bandwidths were used in receiving FSK signals, background noise and adjacent-channel interference could ruin reception. Narrow IF bandwidths are thus desirable, since they can reduce and even eliminate much of this interference. Good single-sideband receivers will normally have two or more switch-selectable IF bandwidths. The proper IF bandwidth to use in a particular application depends upon the frequency shift of the received signal. In practice, always use the next widest receiver bandwidth than the bandwidth of the shift frequency. For example, with 850 Hz shift, the bandwidth should be greater than 850 Hz.

3.3.1.3 Product Detector. A product detector in the receiver will improve the performance of the FSK Demodulator. This type of detector greatly reduces both intermodulation and harmonic distortion, thereby providing a cleaner signal from the receiver. Since automatic volume control can be used with the product detector, a more constant output will be obtained even during fading signal conditions.

3.3.1.4 Automatic Volume Control. Some receivers provide slow and fast automatic volume control (AVC). Slow AVC should be used in receiving FSK signals, since a fast attack and a slow release are necessary. Slow AVC introduces the proper amount of delay in release to suppress noise during momentary absences of either signal frequency. With fast AVC, the receiver sensitivity recovers too quickly, thereby permitting excessive noise to appear.

3.3.1.5 Beat Frequency Oscillator. Positioning of the mark and space frequencies in the IF passband of the receiver is critical for good performance. The two frequencies must be positioned so that they straddle the center point with equal amplitude. Failure to do this, especially with a very narrow bandpass, can result in a loss of the mark or space frequency. If the receiver Beat Frequency

Oscillator (BFO) is varied to produce the mark and space frequencies the operator must also know whether the BFO is tuned higher or lower than the received signals. This is illustrated in Figure 3-1. If the BFO is set higher in frequency than the received signals, the mark will be the lower frequency and the space will be the higher. This is the correct position for the mark and space signals. If the BFO is set too high, the space signal will be shifted outside the receiver passband, and the mark signal will approach the original position of the space signal.

Figure 3-2 shows the resultant signal relationship when the BFO is set to a frequency below that of the received signals. The mark and space signals have now changed places. Space is the low frequency and mark is the high frequency. If the BFO is set too low the mark signal will be shifted outside the receiver passband, and the space signal will approach the original position of the mark signal.

All is not lost if the operator tunes the BFO to the wrong side of the signal frequency, provided that the mark and space signals still straddle the center point as shown in Figures 3-1 and 3-2. A wrong choice can be corrected by means of the NORMAL*-REVERSE switch on the FSK Demodulator. This switch reverses the mark and space signals at the output of the detector, thereby permitting the printer to function with the normal mark-space relationship.

To adjust a variable BFO, the receiver is tuned to noise only (i.e., a no-signal frequency), the METER switch on the Demodulator is placed in the +- position, and the BFO control is set for a zero reading (center scale) on the meter. This operation balances the noise in the mark and space channels, thereby insuring equal amplitude signals when the receiver is properly tuned to keying.

3.3.1.6 Passband Tuning. Passband tuning in a receiver permits the IF to be shifted a few kHz above and below its normal frequency. The shift is effected without altering the shape of the passband. This is particularly useful with interfering signals, since the passband can often be tuned to eliminate the unwanted signal. If the receiver has a passband tuning control, this control is substituted for the BFO control. The tuning procedure is the same.

3.3.2 DEMODULATOR

3.3.2.1 MODE M-N*-S Switch. The MODE M-N*-S switch permits the operator to select mark signals only (M position), mark and space signals together (N* position), or space signals only (S position). This switch is usually placed in the N* position.

3.3.2.2 METER Switch. This switch has four positions. The LOOP position of the METER switch is used to adjust and monitor the loop current in the external teleprinter circuit. The meter scale has readings at 20 MA and at 60 MA (full scale).

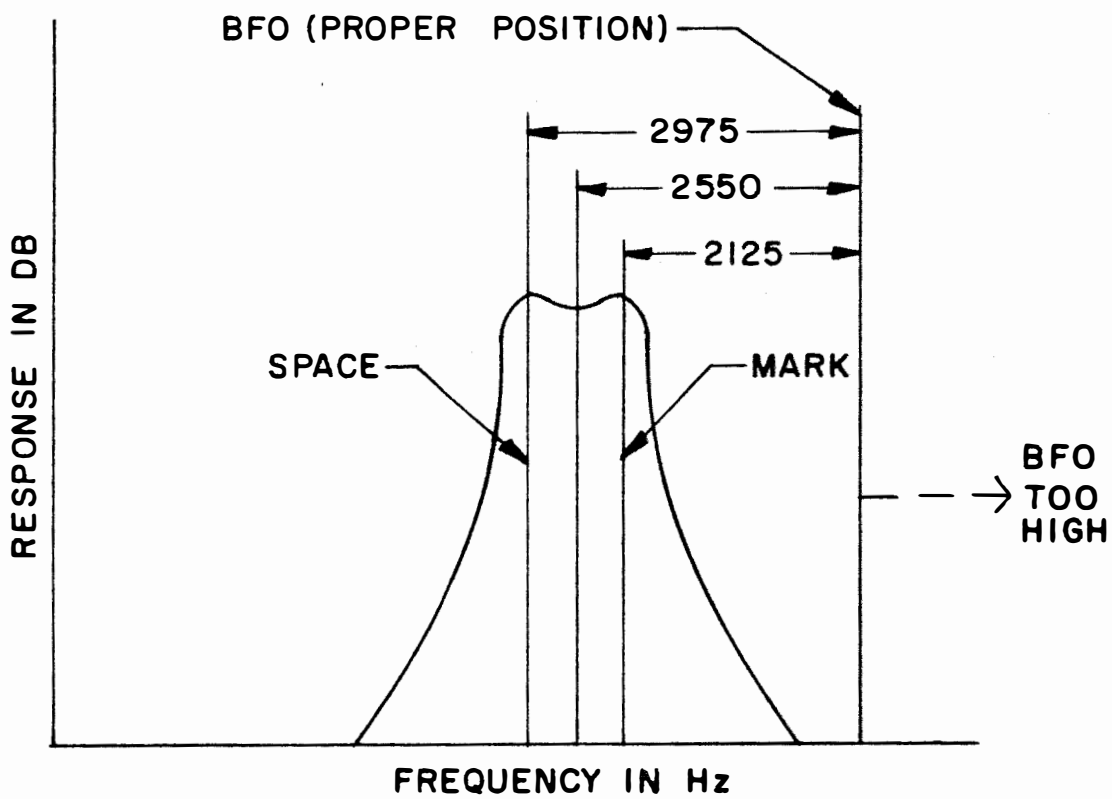


Figure 3-1. BFO Frequency Higher Than Signal Frequency

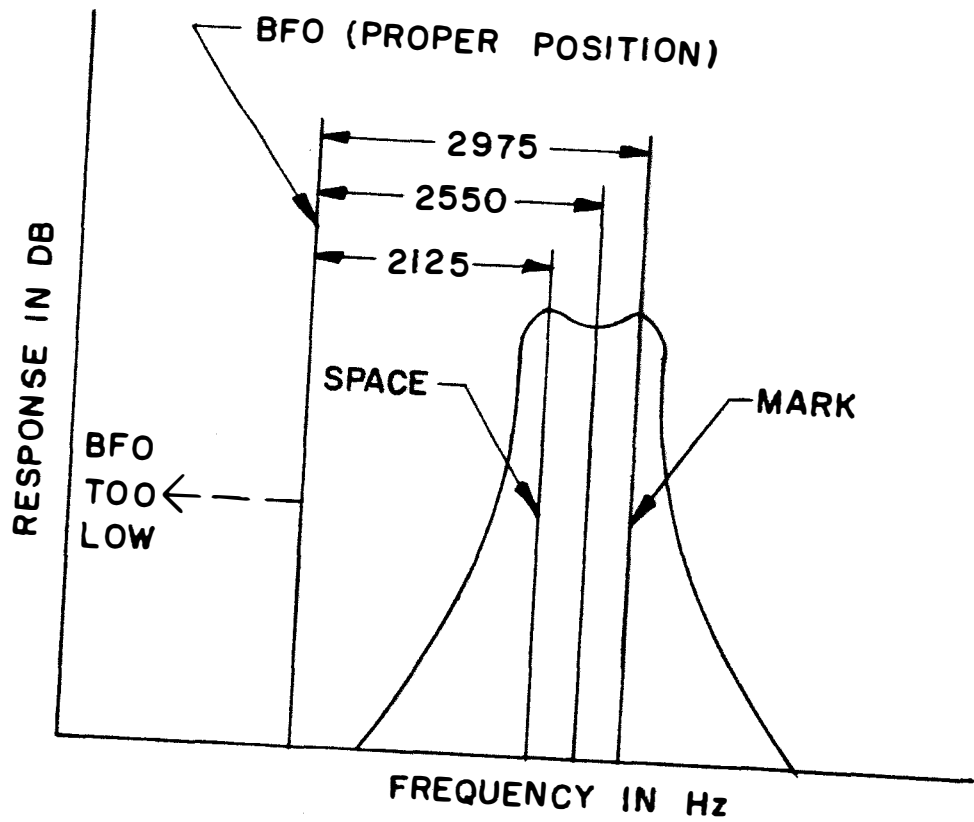



Figure 3-2. BFO Frequency Lower Than Signal Frequency



The **+++** position of the **METER** switch is used in tuning the receiver to an FSK signal. If **only** a carrier is present (no keying), the receiver is tuned for **maximum** needle deflection with the **MARK** indicator on. If keying is present, the receiver is tuned for **maximum** deflection and **minimum** oscillation of the meter needle. Both the **MARK** and **SPACE** indicators will flicker during keying.

The **+ -** position of the **METER** switch is used to obtain equal amplitude response (noise balance) from the mark and space channels. This response is obtained by first tuning the receiver to noise only and then by adjusting either the **BFO** or **passband** control until the needle rests at 0 (center scale). When the receiver is tuned to an FSK signal, deflection of the needle to the right indicates reception on the mark channel, and deflection to the left indicates reception on the space channel.

The **LEVEL** position is used to adjust and monitor the amplitude of the audio input to the Demodulator. The input level is properly set when adjustment of the receiver audio gain control or the Demodulator **LEVEL** control positions the meter needle to 0 **DBM**.

3.3.2.3 MARK and SPACE Indicators. The **MARK** and **SPACE** indicators flicker when signals are being received on the mark and space channels. These indicators will also flicker when the receiver is tuned to noise only, thus providing a rough indication of noise balance in the mark and space channels.

3.3.2.4 LEVEL* Control. The **LEVEL*** control is used to adjust the audio input to the Demodulator. This control is adjusted with the **METER** switch in the **LEVEL** position. The meter will read 0 **DBM** when the **LEVEL*** control is properly set.

3.3.2.5 LIMITER IN-OUT Switch. The **LIMITER IN-OUT** switch inserts or removes the limiter from the Demodulator circuit. During receiver tuning, this switch is placed in the **IN** position. Afterwards, use of the limiter depends upon receiving conditions. Generally, the **LIMITER** switch should remain in the **OUT** position. For receiving conditions which include noise and/or fading, the operator must recognize the type of noise and fading in order to determine the best position of the **LIMITER** switch.

3.3.2.5.1 NOISE. As far as the operator is concerned, noise is any undesired disturbance within the frequency range to which the receiver is tuned. This noise can be both atmospheric and man-made. Atmospheric noise (static) is caused by electrical storms, magnetic storms, etc. Man-made noise is caused by electrical appliances, automobile ignition systems, etc. Perhaps the worst type of noise that the operator will encounter is common to both the atmospheric and man-made categories. This noise is impulse noise. It is caused by such things as lightning discharges in the atmosphere, and arcing in automobile ignitions systems. Impulse noise is characterized by high amplitude and short duration bursts of energy. To counteract it, the **LIMITER** switch must be placed in the **IN** position.

3.3.2.5.2 FADING. Fading is any variation in signal strength at the receiver. The operator will most probably experience the following types of fading: frequency selective fading, flutter fading, and back scatter fading.

Frequency selective fading is a phenomenon in which signals of slightly different frequencies are not propagated with the same amplitude and phase they had at the transmitter. The mark and space signals will thus vary independently with this type of fading. To counteract frequency selective fading, the full effect of the Decision Threshold Computer (DTC) must be realized. The LIMITER switch is therefore placed in the OUT position.

Flutter fading is a very rapid type of fading produced by an unstable propagation medium. Since the rate of fading is too fast for the time constants of the DTC circuit, optimum operation is obtained by placing the LIMITER switch in the IN position.

Back Scatter is a phenomenon produced when the transmitted signal passes beyond the receiving zone, returns to earth, and is then reflected backwards into the receiving zone. Signals propagated in this manner are usually weak, and are recognized by a rapid fade or flutter. To counteract this type of fading, the LIMITER switch is placed in the IN position.

NOTE

A good general rule to follow in using the LIMITER switch is:

When in doubt,
Leave it out.

3.3.2.6 NORMAL*-STANDBY Switch. This switch controls the output circuit. In the NORMAL* position, the Demodulator output keys the output circuit. In the STANDBY position, the Demodulator output is held in steady mark. This latter position is used during tuning.

3.3.2.7 NORMAL*-REVERSE Switch. This switch is used to reverse the mark and space signals at the output of the detector, thereby permitting the output to function with the proper mark-space relationship. The NORMAL* position is used when the marks and spaces are properly positioned both at the transmitter and at the receiver. The REVERSE position is used when the marks and spaces either are transmitted "upside down" or are tuned improperly at the receiver.

3.3.2.8 AUTO M/H-NORMAL* Switch. This switch inserts or removes an automatic mark/hold (auto-start) circuit at the output loop of the Demodulator. The mark/hold circuit will function only when the AUTO M/H-NORMAL* switch is in the AUTO M/H position, the LIMITER switch is in the IN position, and the MODE M-N*-S switch is in the N* position. Generally, the AUTO M/H-NORMAL* switch is placed in the NORMAL* position.

SECTION IV

THEORY OF OPERATION

4.1 FUNCTIONAL DESCRIPTION

A functional block diagram of the Model 1200 FSK Demodulator is shown in Figure 4-1. An external communications receiver supplies frequency shift keying audio signals at zero dbm to the Demodulator. The input signals are initially connected to an input band-pass filter. Output signals from the filter are then applied to an amplifier/limiter circuit.

The amplifier/limiter circuit provides either amplification or limiting as required for optimum performance of the Demodulator. A front panel switch permits insertion or removal of the limiter. The limited (or unlimited) output is then routed to the channel band-pass filters.

The channel band-pass filters separate the audio signal into its mark and space components. Each channel filter has a narrow band-pass, designed for aiding the detectors in achieving optimum signal detection. The filter outputs are detected individually, summed, and then applied to a post-detection low-pass filter. After post-detection filtering, the resultant signal is connected to a Decision Threshold Computer.

The Decision Threshold Computer (DTC) is a variable threshold device which automatically determines the half-way or transition point between the mark and space signals. The DTC is particularly advantageous with fading signal conditions. If one channel should fade during keying, the signal would remain centered about the decision level. If the keyed signal should rest in a steady state (mark condition), the DTC would maintain a steady mark output. This latter operation provides maximum discrimination against impulse noise and sudden fades on the mark channel in the absence of keying. Output signals from the DTC are connected to a loop keyer for operating an external teleprinter.

An additional output from each channel detector is used to control an automatic mark/hold circuit (AUTO M/H). This circuit functions as an auto-start system, and returns the Demodulator output to the mark state when the received signal drops below the noise level, or when non-FSK signals such as Morse Code or noise are present.

A front panel meter permits four circuit functions to be adjusted and monitored. These circuit functions are selected by a four-position METER switch labeled: LOOP, +*, +-, and LEVEL. In the LOOP position, the meter monitors the current in the teleprinter circuit. In the +* position, the meter is used to tune the receiver to an FSK signal. In the +- position, the meter is used to obtain equal amplitude response (noise balance) from the mark and space channels. In the LEVEL position, the meter reads the audio input level from the receiver.

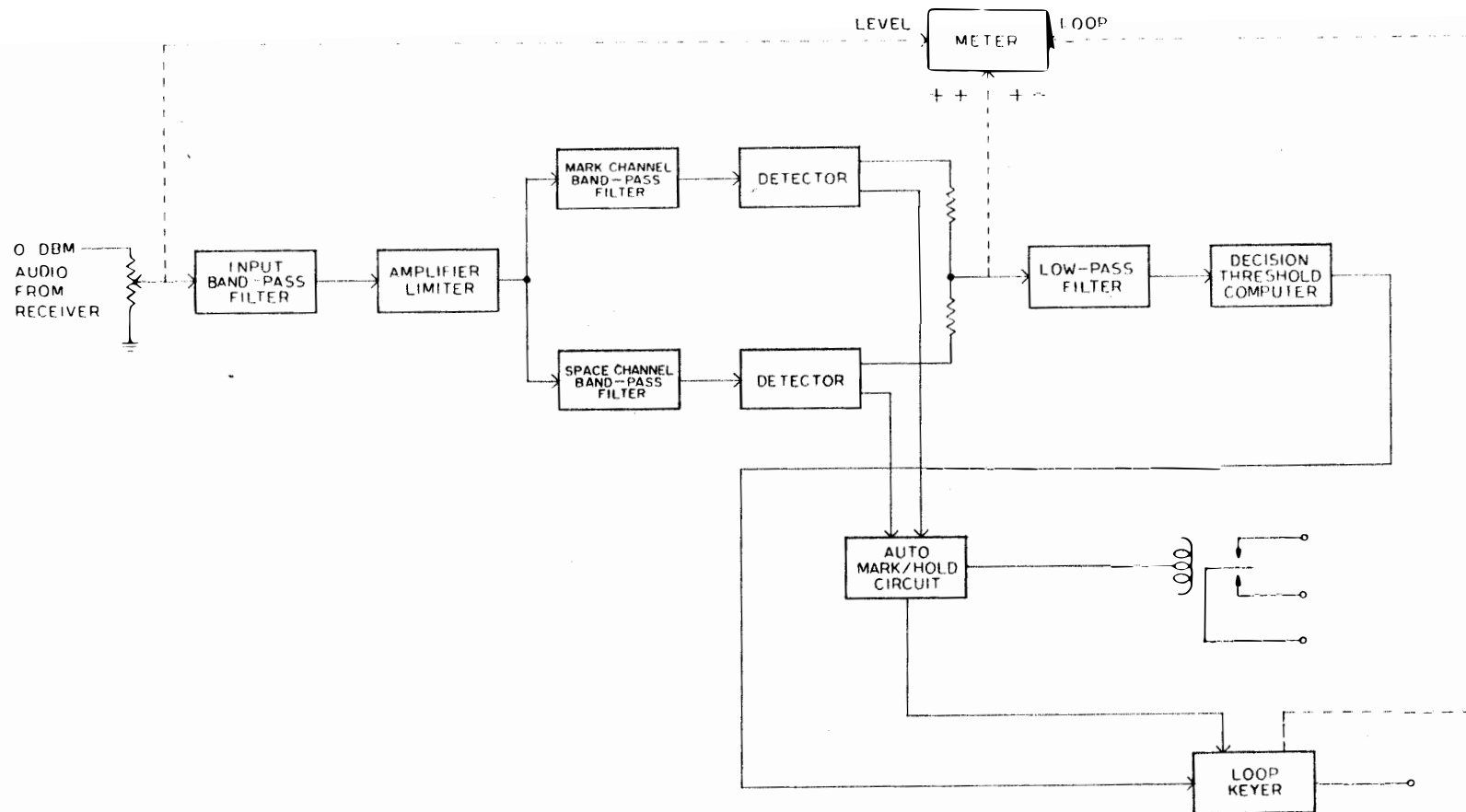
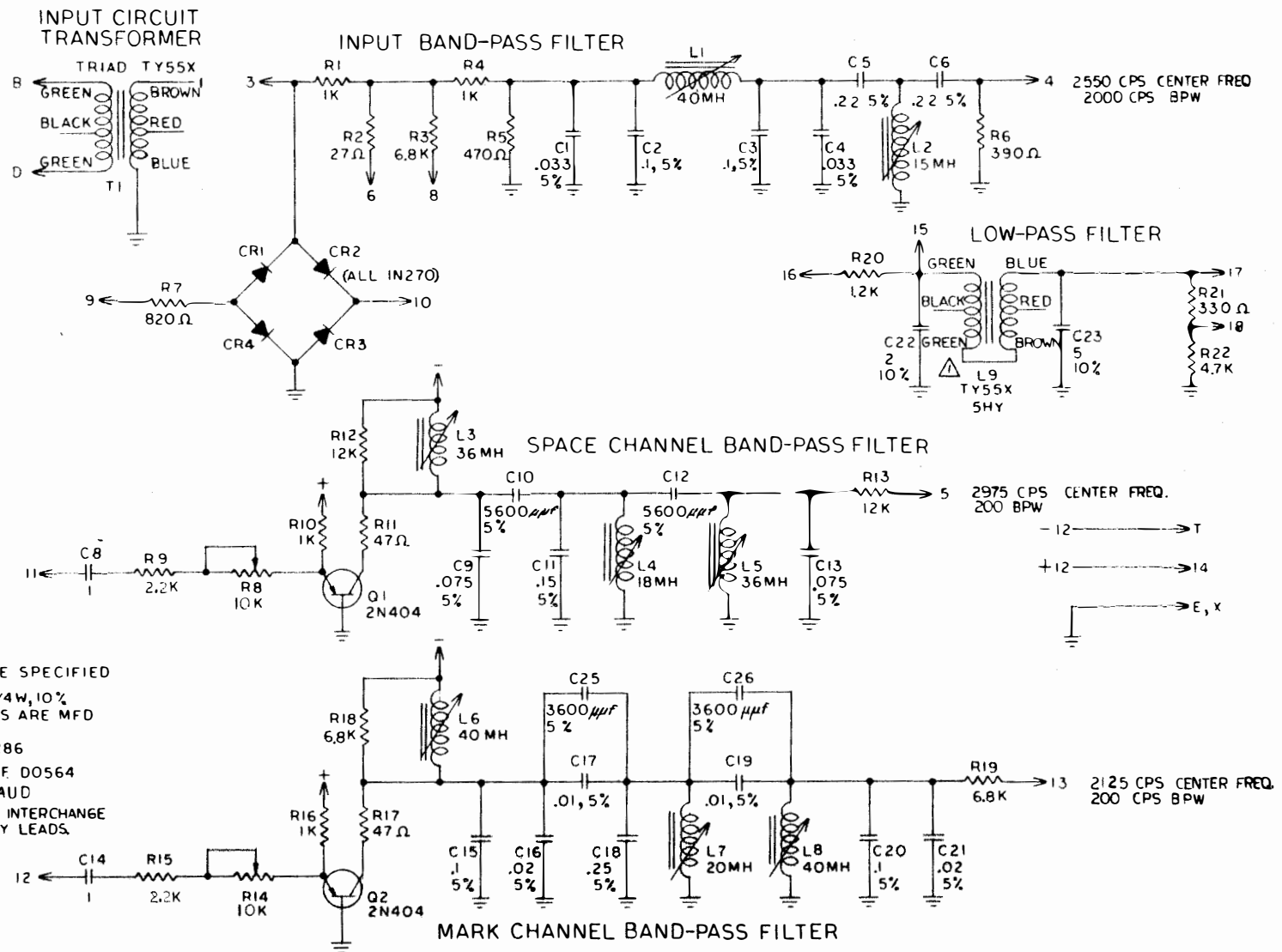


Figure 4-1. Block Diagram, Model 1200 FSK Demodulator (C0851)

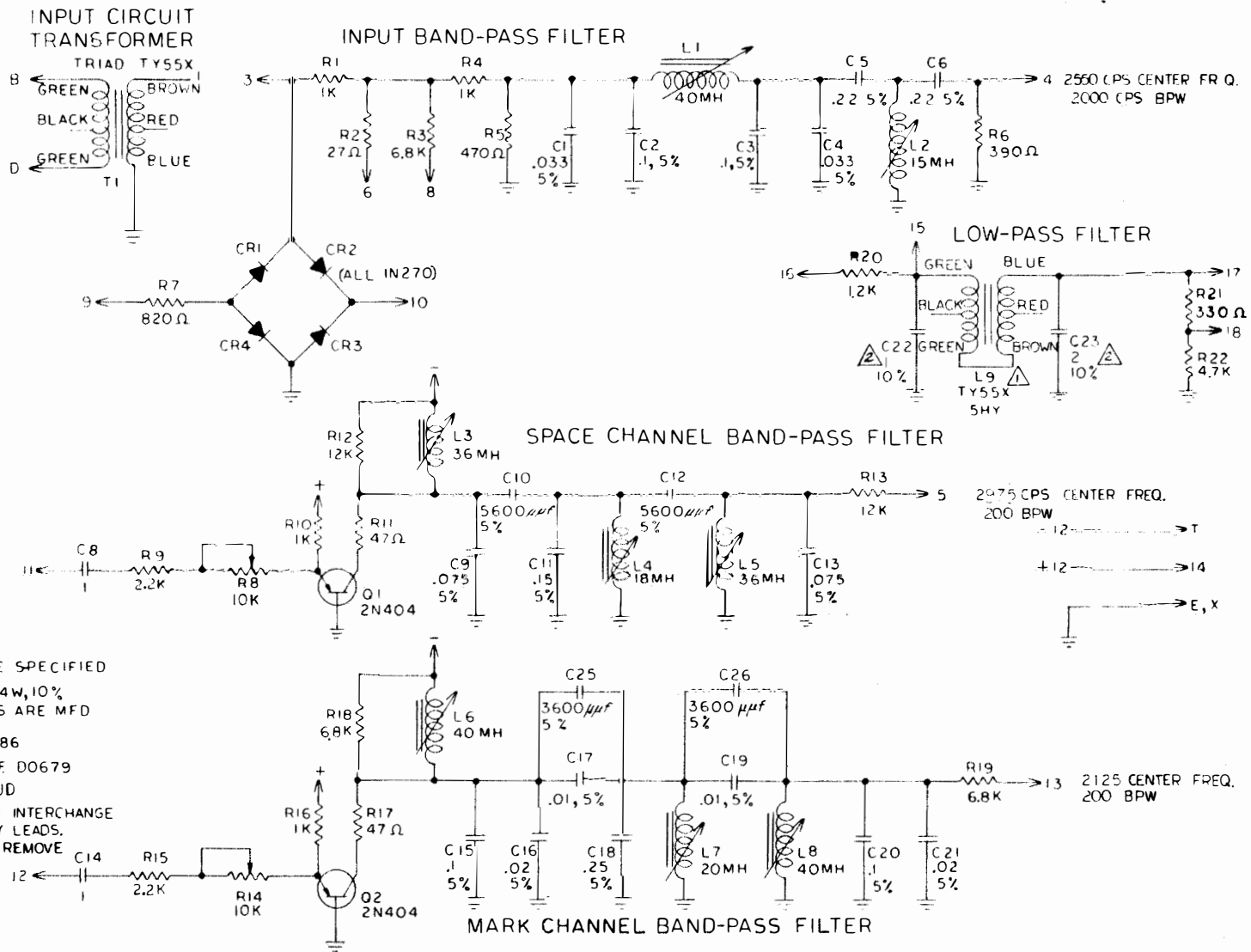


NOTES:
 UNLESS OTHERWISE SPECIFIED
 RESISTORS ARE 1/4W, 10%
 CAPACITOR VALUES ARE MFD

P.C. BOARD REF NO286
 P.C. BOARD ASSY. REF. D0564
 850 ~ SHIFT 45 BAUD

△ WHEN L9 IS TR-263 INTERCHANGE
 THE GREEN PRIMARY LEADS.

Figure 6-2. Schematic, Filter Circuits
 N0286-J4-C0802H



NOTES
 UNLESS OTHERWISE SPECIFIED
 RESISTORS ARE 1/4W, 10%
 CAPACITOR VALUES ARE MFD
 P.C. BOARD REF NO286
 P.C. BOARD ASS'Y. REF D0679
 950 ~ SHIFT 75 BAUD

- ⚠ WHEN L9 IS TR-263 INTERCHANGE THE GREEN PRIMARY LEADS.
- ⚠ FOR 110 BAUD RATE REMOVE C22 CHANGE C23 TO 1MFD. PART NO IP2D HOPKINS,

Figure 6-3. Schematic, Filter Circuits
 N0286-J4-C0892G

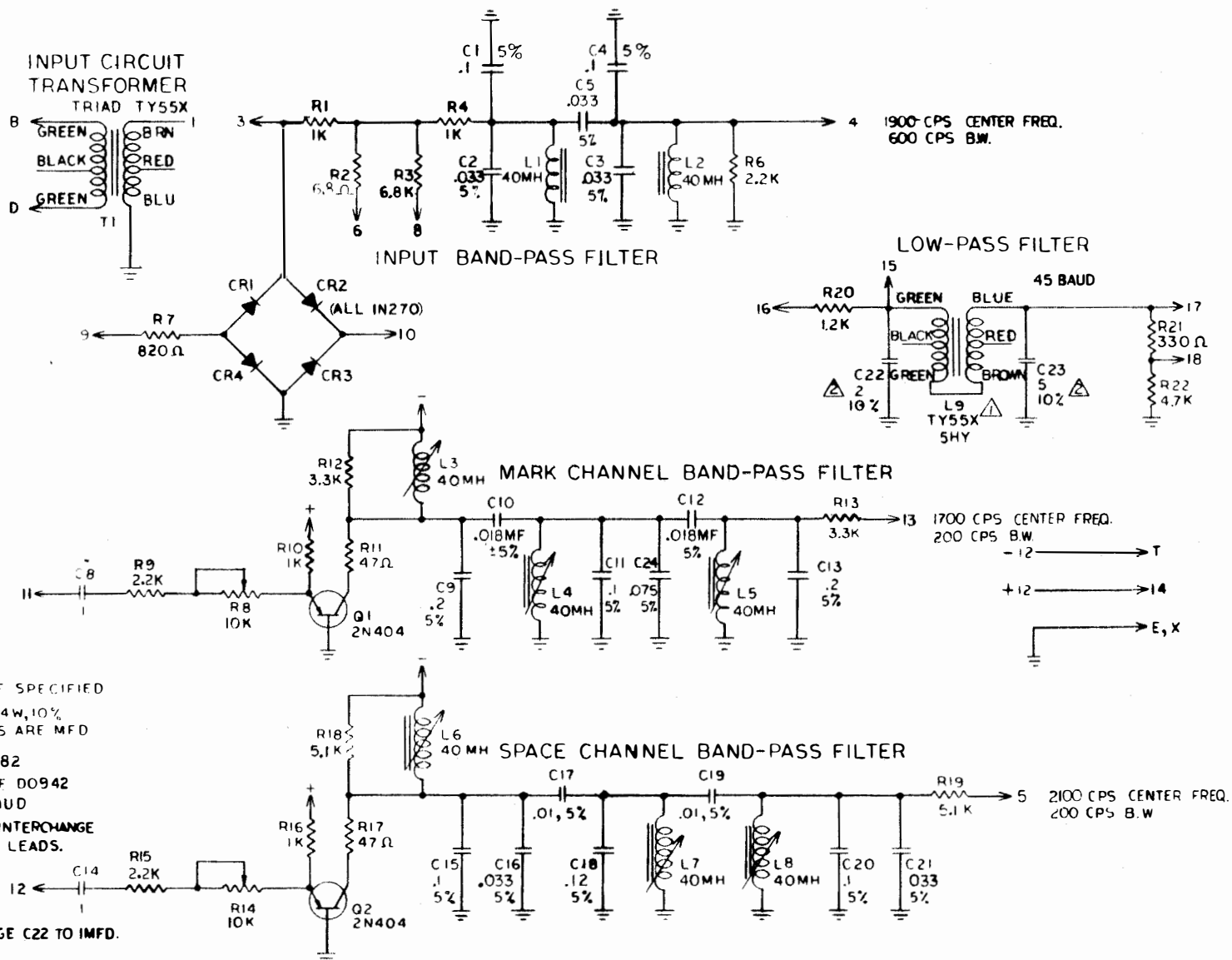
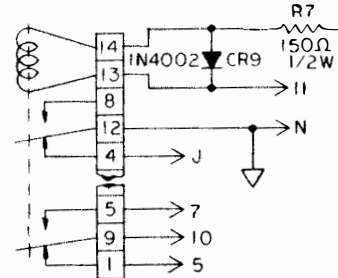
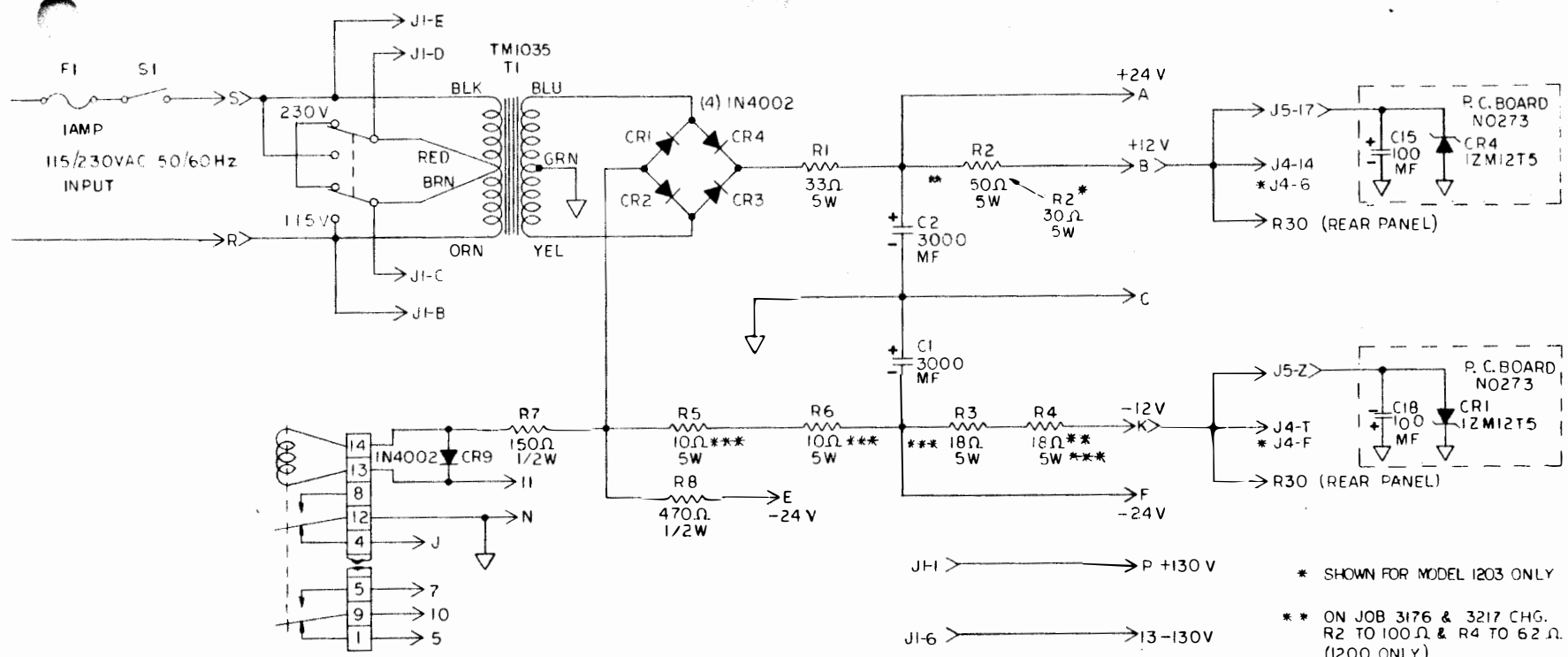


Figure 6-4. Schematic, Filter Circuits
N0382-J4-C1068F



J1-1 → P +130 V * SHOWN FOR MODEL 1203 ONLY
 J1-6 → 13-130V ** ON JOB 3176 & 3217 CHG. R2 TO 100Ω & R4 TO 6.2Ω. (1200 ONLY)
 *** ON JOBS 3304 & UP REMOVE R3 & R5 CHG R2 TO 100Ω, R4 TO 82Ω, & R6 TO 20Ω. (1200 ONLY)

- NOTES
 1. ASS'Y REF: D0884, SHEET 2.
 2. P.C. BOARD ASS'Y REF: D0886, SHEET 2.
 3. P.C. BOARD REF: N0423. FOR 1203 ONLY
 4. P.S. CONN. IS J3.
 5. LOOP SUPPLY CONN. IS J1.
 6. P.C. BOARD REF. N0423A FOR 1200

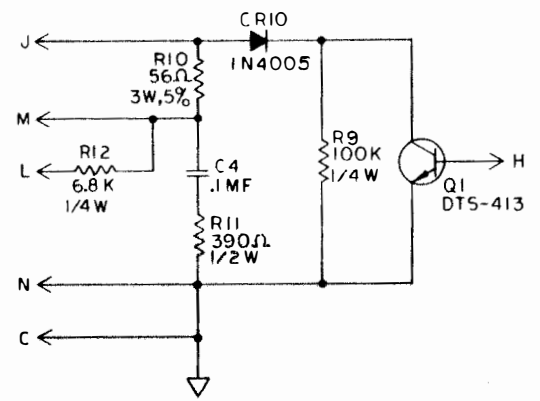
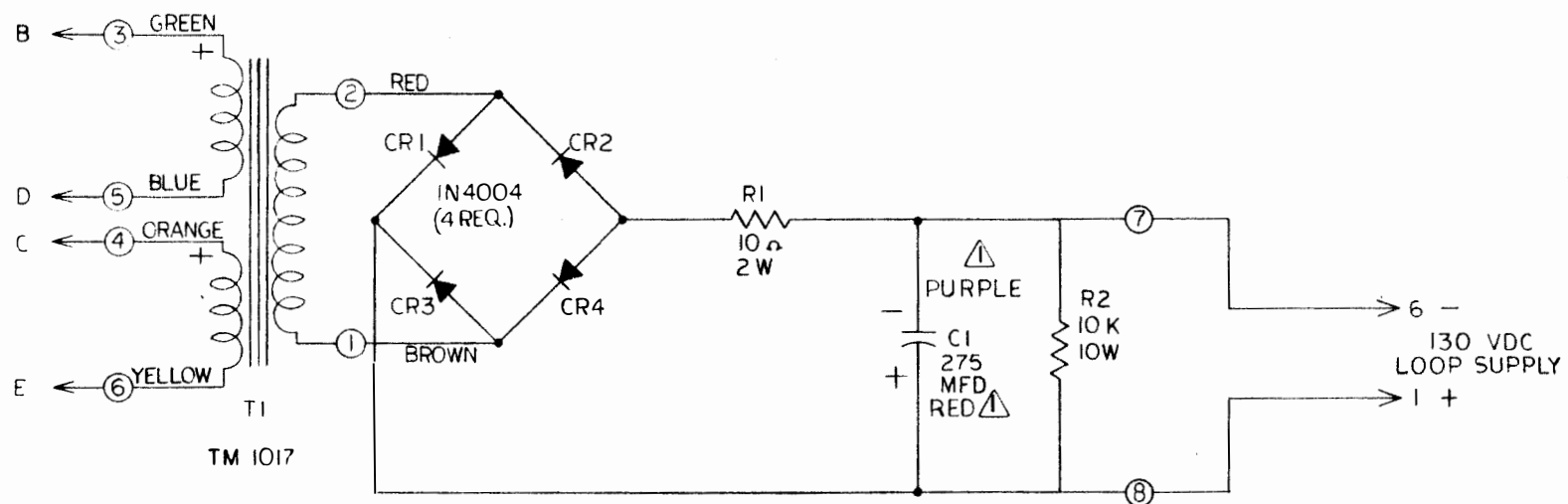


Figure 6-5. Schematic, Power Supply N0423-J3-C1077C



JUMPERS FOR 115VAC OR 230VAC
OPERATION INSTALLED ON MATING
ASSY.

▲ RED WIRE 4 IN. LONG.
PURPLE WIRE 3 1/4 IN. LONG.
BOTH WIRES 22GA, STRIP
1/4 IN BOTH ENDS TIN TIP
ONE END.

Figure 6-6. Schematic, Optional Loop Supply
N0421-J1-B1102A

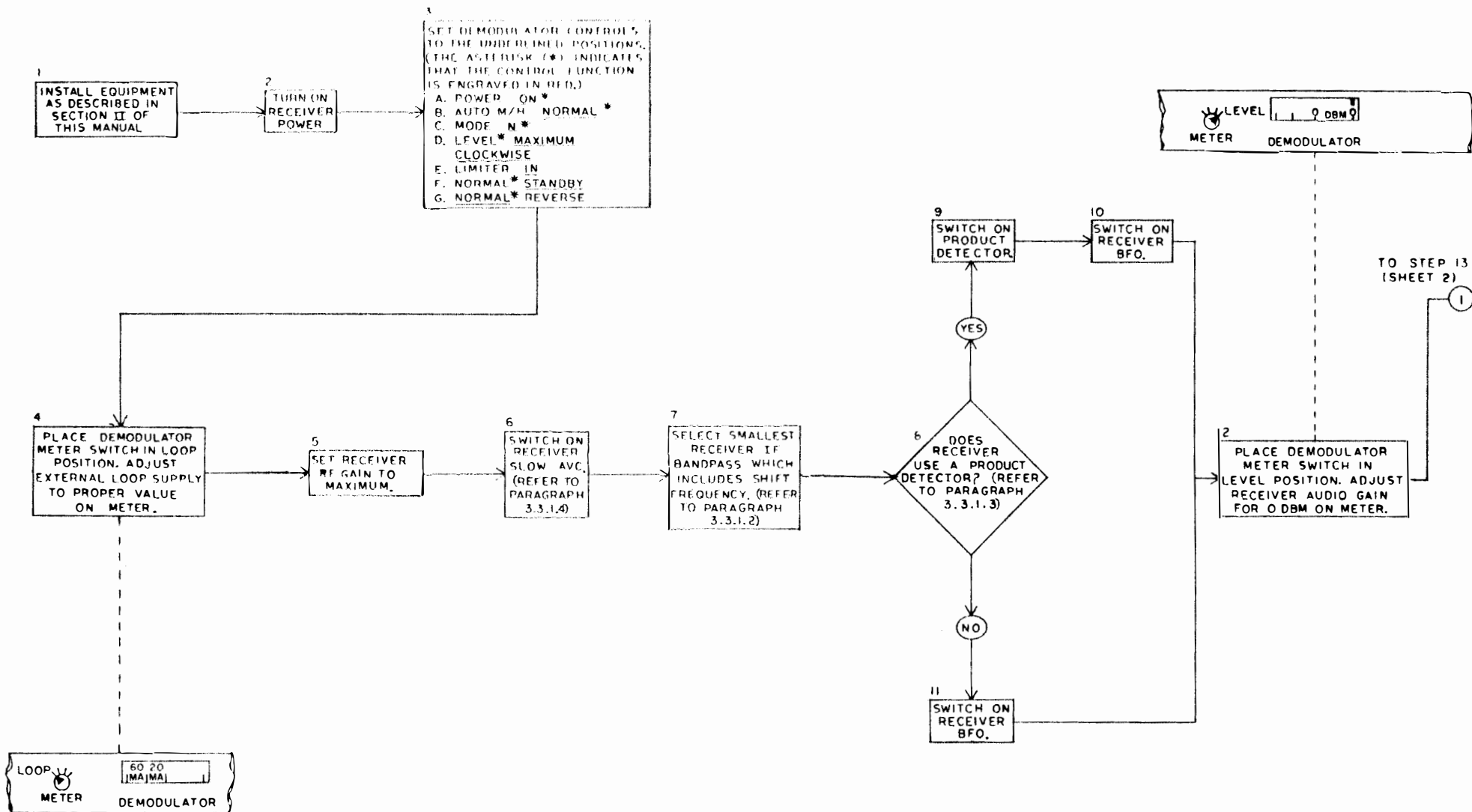


Figure 3-3. Flow Chart Operation of FSK Demodulator (Sheet 1 of 2)

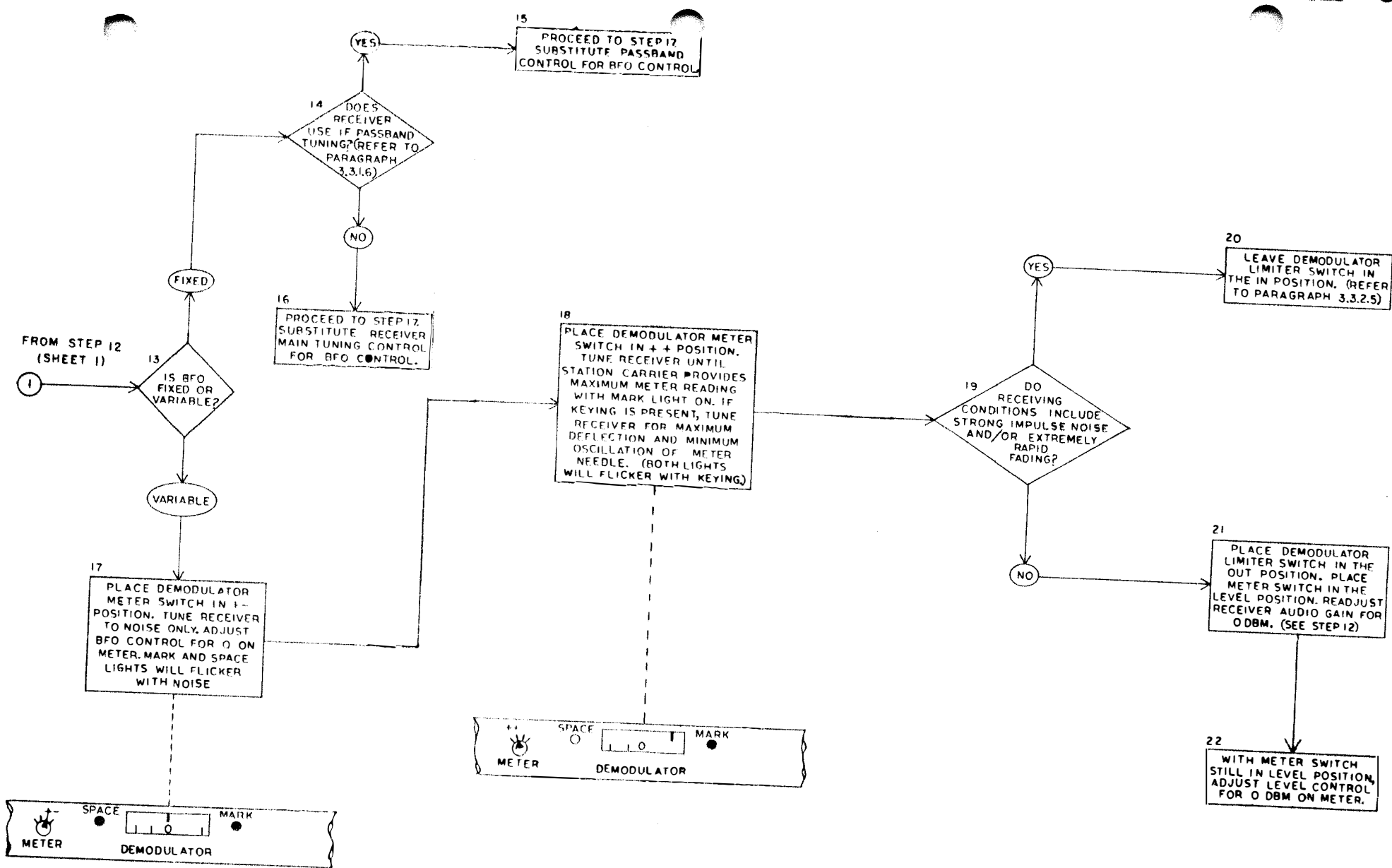


Figure 3-3. Flow Chart Operation of FSK Demodulator
(Sheet 2 of 2)