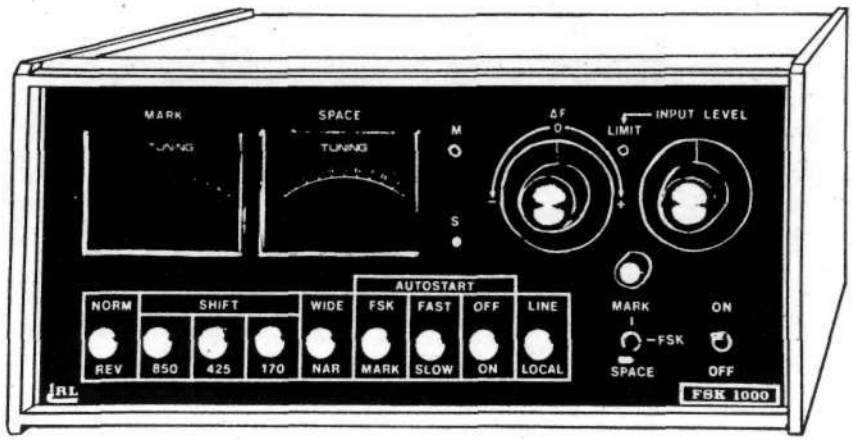
FOR COMPLETE APPRECIATION OF THE FSK-1000,
READ THE MANUAL FIRST.

FSK-1000 T.M.



CONTENTS

WARNING: The FSK-1000 has 110 or 220 volt AC and 170 volt DC voltages present on the circuit board and at some rear panel connectors. Persons unfamiliar with or unqualified to service or operate equipment of this type should refer to a qualified electronics technician.

IRL T.M.

700 TAYLOR ROAD
COLUMBUS, OHIO 43230
(614) 864-2464

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If difficulty is experienced with the operation or interconnection of your demodulator, iRL Engineers are available for limited technical consultation by telephone or correspondence, at no extra charge. For repair work performed outside of the iRL limited warranty, iRL charges a fee of Twenty Dollars ($20.00) per hour plus the cost of any parts which may be required. (Most minor repairs to demodulators are accomplished in one hour or less.)

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I. SPECIFICATIONS

MODE:	limiterless (am) or hard limiting (fm)
SHIFT: RECV:	continuously tunable, 85 to 1000 Hz.
TONES: XMT:	"high tones" - Mark=2125, Space=2295, 2550, 2975 "low tones" - Mark=1275, Space=1445, 1700, 2125 (Optional)
AUDIO INPUT:	600 ohm, unbalanced nominal minimum signal, 1 mv. maximum signal, 17 volts (continuous)
OUTPUTS:	60 ma. 170 volt loop supply (adjustable) RS-232 compatible "Data Out", strappable for TTL levels of either logic sense AFSK Out (on units with FSK-1020 keyer) PTT "push to talk" switch output (open collector); positive voltage only
KEY BOARD INPUT:	Keyboards or Distributors +170 volt loop. Serial input for RS-232 signals, "dry" contacts, or TTL levels. Either logic sense may be selected by Internal Jumper. (Mark=low voltage or closed contact, Space=high voltage or open contact) Maximum voltage, +12v. See Section VI, "Strapping of Serial-In and Data Out Jacks".
AUTOSTART:	Dual mode (mark only or FSK). Selectable 1 second or 4 second attack time. Printer drop-out in approximately 4 seconds. Mark-Hold is immediate upon mark signal falling below threshold set by front panel threshold control.
POWER MAINS:	117 VAC 50 or 60 Hertz, optional 220 VAC
DIMENSIONS:	5.22 inches high x 11.37 inches wide x 10 inches deep
WARRANTY:	1 year against parts and workmanship

II. INTRODUCTION AND BACKGROUND

Amateur radio has experienced tremendous growth in recent years and radioteleprinter (RTTY) communications is one of the fastest growing aspects of the amateur radio service. The overall growth of the amateur ranks has been exciting in that it has been accompanied by significant technological advances which have provided hams with more sophisticated equipment and alternative modes of communication than ever before; however, with this growth has come an ever increasing congestion of powerful signals on the HF bands which makes solid communication over long distances heavily dependent upon highly selective receiving equipment that is capable of rejecting strong adjacent channel interference.

Although ideal demodulator characteristics, based on modern communication theory, have been described in the RTTY literature for years, the actual demodulators available to commercial and amateur radio operators have usually fallen considerably short of these ideals because a variety of technological or cost limitations often conspire to force compromises upon the actual design.

In the past, demodulators designed for commercial or government use have not had to deal with the problem of severe crowding ("QRM"), that is unique to amateur and MARS frequencies. Consequently, designer's concerns over selectivity were not addressed to the present day ham bands.

A concensus of the RTTY literature seems to suggest that the following are highly desirable features for an FSK demodulator.

(a) Limiterless operation; necessitating stable, independent bandpass filters for each channel, wide dynamic range, and some form of decision level correction for optimum performance.

(b) Matched characteristics of the bandpass filters for proper transient responses and noise cancellation.

(c) Selectable bandwidth to accommodate different QRM conditions or higher baud rates such as is encountered with the use of 110 baud ASCII code instead of 45.45 Baudot code.

(d) Tunable receive shifts, thereby accommodating signals whose shifts are slightly off or completely nonstandard.

Many demodulators, including phase locked loop types, use hard limiting front ends -- a technique which eliminates the requirements of (a) above and a host of other circuitry. The result is usually a simplified, easy-to-use demodulator which will function quite nicely on strong signals which are "in the clear" and not suffering from selective fading. Appropriately, limiter-type demodulators are fine for clear-channel signals such as one encounters on VHF or many commercial frequencies.

The price paid for using a limiter is that the ultimate selectivity of the demodulator is not as good as a limiterless design can attain, and the unit is subject to capture by the strongest input, be it the desired information or QRM. Also, selective fading (a relatively common occurrence on the HF bands) can cause the limiter to be captured by atmospheric noise (QRN) or QRM and produce printing errors.

The serious HF operator needs a limiterless demodulator, such as the FSK-1000.

The simultaneous achievement of items (b), (c) and (d) above has been one of the greatest challenges facing demodulator designers. The advent of active filters made it possible to mass produce highly selective filters with identical bandwidths and gains for any two specific frequencies; however, as with their passive forerunners, these filters did not allow independent tuning of parameters. Consequently, if the designer tried to change the filters' center frequency to achieve item (d), this adversely affected the filter's bandwidth and gain. Similarly, if he tried to change only the bandwidth to achieve item (c), he would simultaneously and unintentionally shift the center frequency and gain beyond acceptable limits. The cascading of more than one filter stage to achieve steeper skirt selectivity only intensified the existing problem.

One approach to satisfying (b) and (d) is to use two matched filters whose parameters are fixed. The incoming signals are then combined with a beat frequency oscillator in a mixer stage which shifts the incoming tones down to the fixed filter's center frequency. Thus, item (d) is achieved not by tuning the filter across the spectrum, but by changing the frequency of the oscillator.

There are two immediate drawbacks to this approach. First, the mixer stage produces sum and difference tones which can result in audio image interference which allows strong adjacent channel QRM to foul the desired signal. The effect can be to reduce the ultimate selectivity of the unit, in spite of using selective filters. The second drawback is that this approach ignores item (c) altogether.

The FSK-1000 meets all four of the listed criteria through the use of a limiterless design, and a modern, sixth order active filter arrangement which permits independent adjustment of the filter parameters to achieve (b), (c) and (d) without trading off the ultimate selectivity.

The FSK-1000 was designed from inception to function as a limiterless ("linear" or "AM") demodulator, eliminating errors which result from FM-type capture problems associated with hard limiting or "FM" demodulators. In the past, some demodulators have offered an "AM" mode which, while switching out the hard limiting front end, did not provide the operator with a positive indication that true linear operation was being achieved. Depending on the output levels of the receiver, internal gains of the demodulator and dynamic range, it was often the case that high level received signals were being "soft" limited ("clipped") by operational amplifier stages driven into saturation. As a result, it was quite possible that many operators who thought they were operating in a limiterless mode, were actually suffering errors resulting from a type of limiter action.

The FSK-1000 is equipped with a front panel input level control and a dynamic range indicator LED which gives positive indication to the operator when the linear range is exceeded. This permits adjustment for true limiterless operation, "controlled clipping" or hard limiting if desired.

It is a common phenomenon on the HF bands for the mark and space tones of an FSK signal to exhibit independent fading, as if coming from two separate sources. This selective fading results from multipath propagation and can momentarily cause one of the tones to take a deep fade or disappear entirely. Selective fading can spell disaster for hard limiting demodulators since, in the absence of the desired tone, QRM or QRN will "capture" the limiter and produce a random output.

It takes a limiterless demodulator with some form of decision level correction to copy correctly with only one tone present. The FSK-1000 has automatic decision level correction which does not require the operator to switch correction in or out manually.

The FSK-1000 offers three switch-selectable standard shifts of 170, 425, and 850 Hz, while the front panel ΔF tuning allows continuous shift coverage from 85 to 1000 Hz in three ranges. The active filters in the FSK-1000 are computer designed for matched characteristics and optimum response at the standard shifts. The shift adjustments are by actually tuning a multipole bandpass filter of constant bandwith, rather than using audio frequency mixers in a heterodyning process. This assures complete freedom from audio images, spurious responses, or other problems associated with mixing techniques.

Selectable bandwidth filters for each tone allows the operator to select either 100 Hz "wide" channel filters for normal operation up to 110 baud, or 55 Hz ultra-narrow channel filters, designed specifically to slice through the tough QRM on the crowded HF amateur bands. The two bandpass filters utilize twenty FET operational amplifiers in a stable, modern topology.

The result is a demodulator which not only provides the HF operator with superior selectivity, but also maintains the flexibility one expects from a "deluxe" demodulator.

III. CONTROL AND INPUT/OUTPUT DESCRIPTIONS

FRONT PANEL CONTROLS

ON/OFF: The ON/OFF switch applies power to the FSK-1000, including the AUTOSTART AC outlet on the rear panel.

INPUT LEVEL: This control is adjusted while observing the LIMIT LED to select the optimum signal level for copying FSK signals. It has a full clockwise switch detent for the hard limiting mode.

NORMAL/REV: (Receive only) In the NORMAL position (out), the mark frequency is the lower of the two tones. The REV position (in) reverses the incoming information so that the higher tone is used as the mark. (This switch also reverses the function of the MARK/FSK/SPACE switch.)

SHIFT 850-425-170: These interlocking pushbuttons are used in conjunction with the Δ F control to select the desired shift range. With the Δ F set to its zero position and the 170 button depressed, the demodulator is set for 170 Hz operation. Rotation of the Δ F control permits adjustment of shift from about 50 Hz to 270 Hz by tuning the space filter. With the 425 pushbutton depressed and the Δ F centered at zero the demodulator is set for 425 Hz operation. Rotation of the Δ F control now permits adjustment of shift over the range of 260 to 640 Hz. Similarly, in the 850 shift position, the range of adjustment is from 590 Hz to 1000 Hz shift. The FSK-1000 equipped with the "high tones" has "170", "425" and "850" Δ F ranges of 100-250, 235-550 and 540-1000 Hz respectively. Please note that the Δ F control does not affect the transmitted shift as selected by the 850-425-170 pushbuttons.

WIDE/NARROW: With the switch in the WIDE position (out), the bandwidth of the tone channels is 100 Hz nominal. With the switch in the NARROW position (in), the bandwidth is 55 Hz nominal.

THRESHOLD: This small control is located on the front panel just below the Input level and Δ F controls. This control serves as the means of setting the Threshold for the internal "Mark-Hold function" and also serves as the Autostart Threshold adjust. Thus, it may be thought of as an "RTTY Squelch" control. Maximum sensitivity is achieved when the control is in the full counterclockwise position. As this control is rotated clockwise a point is reached where the printer goes into a "Mark-Hold" condition, thereby "squelching" the input. If a signal is being copied which is approximately equal to the Threshold level it is quite possible the printer may print "hits". When experiencing difficulty in copying a station, always check to see that the Threshold control is set far counterclockwise. Mark-Hold is immediate upon the Mark signal falling below the Threshold. Autostart drop-out occurs approximately five seconds af-

ter Mark-Hold occurs. Copy on "space-only" is possible only with the Threshold control completely counterclockwise.

SETTING YOUR THRESHOLD CONTROL: It is generally desirable for the operator to have a visual indication of the relationship between the incoming signal and the Threshold level. This is easily accomplished if the Threshold control is set by use of the procedure in the following example.

1) Set Threshold control to full counterclockwise position.

2) Tune in any strong RTTY station (preferably one which is "in-the-clear") as described in section IV under OPERATION.

3) Now, reduce the Audio Input (through use of the INPUT LEVEL control or receiver's AF Gain) until the FSK-1000's tuning meters indicate, say, 2 on the tuning scale.

4) Now rotate the THRESHOLD control clockwise slowly until the FSK-1000 "locks up" in a Mark-Hold condition (printing will, of course, stop).

5) You may now increase your input audio (again through use of either INPUT LEVEL or receiver AF Gain) to the level it was in Step 2.

You have just set your THRESHOLD level to "2". Anytime your received signals fall below a 2 on the meter the demodulator will not print them. If the signals are above a 2, normal printing will occur.

The above procedure once understood, will only take 1 or 2 seconds and need not be repeated each time a station is tuned in.

Notice that if the Audio level in Step 3 had been adjusted for a reading of 5 instead of 2 on the meters, then the procedure would have resulted in a THRESHOLD setting of 5. In this case, signals which read above a 5 would be copied and signals below a 5 would not.

LINE/LOCAL: With the switch in the LINE position (out), the demodulator is in its normal mode for receive and transmit operation. With the switch in the LOCAL position (in) the PTT Output and the optional FSK-1020 AFSK keyer are disabled so that the operator may type on his keyboard and observe local copy without keying his transmitter. The tuning meters will continue to actively indicate the receiver's audio signals, yet the demodulator will not print.

LIMIT: This LED illuminates when the audio input level has reached the point where limiting begins in the demodulator. This indicator enables the operator to adjust for the optimum signal level in the limiterless or "linear" range.

TUNING METERS: These meters indicate the relative signal strengths of the two-tone channels and are viewed by the operator when tuning in an RTTY station. The MARK TUNING meter indicates the strength of the lower FSK tone, while the SPACE TUNING meter indicates the strength of the higher tone. If the

reverse button (REV) is pushed, then the signal displays are reversed. (These meters are not connected to the transmitting circuitry.)

MARK/FSK/SPACE: (Receive only)

This three position toggle switch is normally set to the middle position which is for full FSK operation. Throwing the switch up to the MARK position removes the signal from the space channel completely to allow for Mark-only copy. Setting the switch down to the SPACE position, removes the signal from the mark channel to allow for space-only operation. Space-only operation is possible only with the Threshold control set completely counter-clockwise.

AUTOSTART ON/OFF:

With this switch in the OFF position (out) the autostart function is disabled and power is constantly applied to the rear panel autostart power outlet, controlled by the power ON/OFF switch. With the switch in the ON position (in), the autostart function is enabled.

AUTOSTART FSK/MARK:

With the switch in the FSK position (out), the autostart responds to incoming FSK signals (both tones must be shifting) which are above the autostart threshold, and will not trigger on a constant tone in either channel. With the switch in the MARK position (in), the autostart will trigger on a mark tone signal and shifting FSK tones are not required. The autostart threshold is adjusted by use of the threshold control mounted on the front panel just below the input level and ΔF controls.

AUTOSTART FAST/SLOW:

With the switch in the FAST position (out), the attack time is approximately one second. With the switch in the SLOW position (in), the attack time is approximately four seconds. The attack times may be changed by installation of new resistors on the circuit board. The resistors (R122 and R123) are labeled "ASTRT ATTACK RC" on the schematic diagram.

REAR PANEL JACKS

FUSE:

This 5 amp slow blow fuse protects the entire FSK-1000 and also fuses the equipment plugged into the A.C. outlet on the rear panel. There is an additional fuse (3/8 amp regular) located on the circuit board which protects the (+) and (-) 12 volt supply and main circuit board.

AUDIO IN:

This phono jack receives audio from the receiver. The input impedance is nominally 600 ohms, unbalanced. Although some receivers provide 500-600 ohm outputs, a common practice is to simply connect across the receiver's low impedance speaker terminals. Audio gain may be increased by removal of resistor R1. (Input $\mathbb{Z}$ is then 5K ohms nominal.)

SERIAL IN:

This phono jack input is for connection of a serial output keyboard or tape reader. The keyboard output may consist of "dry contacts" (such as from a mechanical keyboard or tape distributor ("TD") without loop current), or RS-232 voltages (mark = -12V max, space = +12V max) or TTL levels (mark =

0V, space = +5V). THIS JACK DOES NOT ACCEPT HIGH VOLTAGE (greater than ± 12V) LOOP SUPPLIES. This input does, however, drive the 170 volt LOOP OUTPUT in the FSK-1000, so that local copy can be observed on a mechanical teleprinter even though the keyboard is not actually in the high voltage loop. This was done so that a variety of keyboard inputs such as RS-232 could be converted to a high voltage loop output. Dry contacts should be closed for mark and open for space. IF THE SERIAL-IN IS NOT TO BE USED, THEN A SHORTING-TYPE PHONO PLUG JUMPER IS REQUIRED IN THIS JACK. Otherwise, the demodulator will not function. This input may be "strapped" (by movement of internal jumpers labeled "X1") for "TTL, Mark High (Mark = +5V)" in which case a jumper in the Serial In is not required.

+170 POLARIZED LOOP:

This one-quarter-inch three-conductor phone jack provides a high voltage, 60 mA loop current output for driving mechanical teleprinters. The output information is either the demodulated receiver audio or that information which is inputted to the SERIAL IN jack. The tip of the three-conductor phone plug is (+) and the ring (center conductor) of the plug is the (-). The sleeve of the plug is chassis ground and may be used for connecting a shield, if a shielded, twisted pair loop cable is used. The loop current may be adjusted for 20 mA operation. This may be accomplished by adjusting the slide on the large power resistor (R301) located at the right of the rear panel. The slide should be moved to the left to lower the current. The loop current should be measured by an ammeter placed in series with the loop. POWER SHOULD BE REMOVED BEFORE ADJUSTING THE SLIDE. THE SLIDE IS CONNECTED TO 170 VOLTS DC AND PRESENTS A SHOCK HAZARD. A two-conductor phone plug will not function in this jack. The three-conductor jack was used to lessen the likelihood of electrical shock at the LOOP OUT.

DATA OUT:

This phono jack provides a RS-232 compatible output (mark = -11V nom., space = +11V nom.). The output information is either the demodulated receiver audio, information from a keyboard or TD in the high voltage loop or information inputted to the SERIAL-IN jack. Thus, this jack outputs the same information as the LOOP OUT and may be used simultaneously with the LOOP OUT. For instance, the DATA OUT jack may be used to drive a computer or video character generator while the LOOP OUT drives a tape punch or "hard copy" terminal. The DATA OUT jack may be strapped for TTL compatible outputs (mark = 0V, space = 5V, or mark = +5V, space = 0V). Connector jumpers labeled X2 invert the voltage sense. Connector jumper X3 connects a 5 volt Zener diode to limit output level for TTL levels.

PTT OUT:

This phono jack is for use with the "push-to-talk" lines of many transmitters. The output consists of an open-collector transistor output which is driven "on" (pulled low) by the keyboard activated switch in the FSK-1000. Upon depressing a character on the keyboard (or closing a hand key connected to KEY IN), the transistor turns on, effectively grounding the PTT line. The transistor has a rated maximum of +40 volts and 60 mA. Users should determine if the push-

to-talk voltage in their transmitter exceeds this rating. If so, an external relay may be required to isolate this output. This jack may not be required if the transmitter has provision for VOX operation, in which case the audio tones from the AUDIO OUT would key the transmitter. This jack is totally disabled when the FSK-1000 is in the LOCAL mode.

SCOPE OUT MARK, SCOPE OUT SPACE: These two phono jacks provide access to the bandpass filter outputs (output impedance is approximately 100K) for use with an external oscilloscope tuning indicator. The maximum output voltage is 12 volts.

Adventurous operators are encouraged to connect the outputs to a stereo amplifier for driving stereo headphones for use as an audio tuning indicator or highly selective CW filter. (An attenuator would probably be required at the input of the amplifier since the SCOPE outputs are high level.)

KEY IN: This phono jack is for connection of a standard hand key, for narrow-shift CW identification. Normally, when receiving, the key contacts should be open. Closing the key activates the keyboard activated switch and causes a narrow-shift "space" to be sent. When the key is opened again the demodulator goes to the mark condition until the keyboard switch "times out" (approximately seven seconds).

AFSK OUT: This phono jack is for units which have the optional FSK-1020 AFSK keyer installed. The output consists of audio tones for driving the microphone input of a transmitter. The keyer is enabled by the keyboard activated switch and shifts in accordance with the information inputted to the SERIAL IN. The keyer is completely disabled when the demodulator is in the LOCAL position. The keyer is normally supplied for three "full" shifts (170, 425, and 850) and also a narrow shift (nominally 80 Hz) for the CW ID.

REMOTE T/R: This phono jack is located on the rear panel directly below the "Audio In" jack. Grounding the center conductor of this jack will enable the PTT jack for transmit as well as activate the AFSK keyer if installed. If the FSK-1000 is in the LOCAL mode, this function is disabled.

The circuit board is easily accessed by removing the two screws at the top of the rear panel and sliding the top out. Similarly, the bottom of the circuit board may be accessed by removing the two screws from the bottom of the rear panel and one screw located on the bottom panel. Some care must be exercised when removing the bottom panel as the nuts holding the rubber feet may snag the bottom of the rear panel. Gentle pressure on the bottom panel should free it up. BE SURE TO REMOVE ALL POWER FIRST!

IV. OPERATING AND INTERCONNECTION SUGGESTIONS

INTERCONNECTIONS

The FSK-1000 is somewhat different than most demodulators. In certain circumstances, particularly when QRM is a problem, the FSK-1000 is capable of providing significantly improved copy over that of many demodulators.

With this potential for improved performance, however, goes a requirement for improved operator skills.

The operator is encouraged to experiment with various combinations of control settings on his receiver and demodulator in order to "get the feel" of what the unit can do. Also, the operator should read some of the RTTY literature available from various radio publishing houses, to acquaint himself with the general requirements of an RTTY station. Such things as filter bandwidths, BFO or passband settings, signal speeds and keying techniques are dealt with extensively in these handbooks, as well as suggestions for station interconnections and explanations of many RTTY terms.

Just as the chain is only as strong as its weakest link, an RTTY station requires a good, stable, properly adjusted receiver and transmitter, a good antenna, a reliable teleprinter, and most importantly, an operator who is knowledgeable about how the whole system "plays" together.

The basic receive setup is shown in Figure IV-1 and is quite simple. Please note that normally, a shorting plug is required in the SERIAL IN when nothing is connected to it, if the SERIAL IN is strapped for RS-232 compatible voltages. If the FSK-1000 is strapped for TTL, Mark = +5V, then a jumper is not required. If an RS-232 output level (or TTL level with appropriate straps) is required, the output should be taken from the DATA OUT jack. The basic transmit connections are shown in Figure IV-2 and include connections for demodulators with the FSK-1020 AFSK keyer option installed. For demodulators without a keyer, there is nothing connected to the AUDIO OUT jack, and transmitter keying must be effected through other means. The operator should consult his transmitter operating manual to determine the type of connector and pin connections necessary to input the signal from the AUDIO OUT jack and the PTT OUT jack.

OPERATION

For inital operation of the FSK-1000, the controls should be set to the following positions.

INPUT LEVEL:	Full counterclockwise (minimum)
ON/OFF:	ON
MARK/FSK/SPACE:	FSK (center position)
NORMAL/REV:	NORMAL
ΔF:	Zero (12 o'clock position)
SHIFT:	To anticipated shift; 170, 425, or 850
WIDE/NARROW:	WIDE

AUTOSTART ON/OFF:	OFF (out)
AUTOSTART FAST/SLOW:	FAST (out)
AUTOSTART/FSK/MARK:	FSK (out)
LINE/LOCAL:	LINE
THRESHOLD POT:	Full counterclockwise

Tune the receiver until an FSK signal is heard and adjust the receive audio level for a comfortable listening volume. Next, slowly rotate the INPUT LEVEL control clockwise until a point is reached where the LIMIT indicator light begins to turn ON. (It may "blink" on and off with receiver static if you are set right at the threshold).

The LIMIT indicator lights to signal the operator that the input level is exceeding the limiterless (or linear) range and that limiting of the signal is beginning to take place.

Now, reduce the INPUT LEVEL control slightly just to the point where the LIMIT indicator goes off. At this point the operator has the maximum input level possible for limiterless operation.

Next, tune the receiver up and down SLOWLY through the RTTY frequency until a noticeable peak is observed on BOTH tuning meters. This peak is quite sharp, so tune carefully. If the demodulator is set for the correct shift, both meters will peak simultaneously at about 75 percent of full scale when the signal is properly tuned in. Intelligent copy should now be observed on the teleprinter. If not, it may be that the received tones are reversed (the low tone is the space, and the high tone is the mark).

If this is the case, the situation can be corrected by setting the NORMAL/REV switch to REV (in).

During the course of printing, the RTTY signal may be heard or seen to fade momentarily. It is not usually necessary to readjust the INPUT LEVEL control for this signal as the FSK-1000 is capable of copying signals which barely deflect the meters at all. Also, if the INPUT LEVEL control is increased during a momentary fade, limiting may occur when the signal returns to its previous strength. Normally, "soft clipping" as indicated by sporadic "blinks" of the LIMIT indicator is of little concern. Remember too, that the input level may be adjusted by either the INPUT LEVEL control or the receiver's audio gain control.

Full limiting operation is achieved by rotating the input level control to the full clockwise position until it "clicks" into the switch detent. Although the unit is designed primarily for limiterless operation, sometimes the limiter mode works well on signals which suffer extremely fast QSB, such as can be encountered around 80 meters.

For copying stations in the midst of strong adjacent channel interference (QRM), limiterless operation is a must and the LIMIT indicator should be completely OFF. Also, copy may be significantly improved by switching the WIDE/NARROW pushbutton to the NARROW position.

The NARROW filters are extremely sharp and require that the operator exercise extreme care in tuning. Slight mistuning due to operator judgement or drifting signal can have adverse effects on performance. The NARROW position is generally recommended for use with 60 word-per-minute BAUDOT code (45.45 baud); however, it may prove beneficial in circumstances where QRM is interfering with good signals up to 100 wpm.

On a crowded band, a situation may occur where a strong CW station or off-frequency RTTY station may be transmitting "on top" of either the mark or the space frequency. The only recourse for the operator in this situation is to switch the MARK/FSK/SPACE toggle switch up or down to see if copy can be obtained from one tone only. One-tone-only copying is not possible when limiting is occurring. Also, since in this mode, the operator has literally "thrown out" half of the signal, it generally takes a better than average signal-to-noise ratio in the remaining channel to produce copy. For RTTY work on the HF bands, there is rarely a case for using anything other than the FSK mode. The one-tone modes are included, however, so that the serious operator immersed in a battle with QRM, will not have to throw up his hands in defeat until all possible techniques have been attempted. The one-tone modes will only be effective on 60 wpm BAUDOT copy. For proper use of THRESHOLD control, please see Section III under THRESHOLD.

Mark-only operation can be advantageous on VHF FM, if the FSK-1000 is equipped with the "low tones" and the operator wishes to receive information sent via "high tones". The procedure would be as follows:

1) Set the SHIFT for 850 Hz. This would normally mean that the mark channel is set for 1275 Hz and the space channel for 2125 Hz.

2) Set the NORMAL REV switch to REV for reverse operation. This then places the 2125 Hz signal in the mark channel.

3) Be sure the INPUT LEVEL control and receiver audio are adjusted for limiterless operation.

TRANSMITTING

Transmitting may be accomplished by a key board or tape distributor wired in the high voltage loop, or by an input to the SERIAL IN. A serial keyboard (or tape reader, computer output, etc.) will activate the keyboard activated switch circuitry immediately upon the transmission of a character. The Serial Input overrides the audio input and causes the character to be generated at the LOOP OUT and the DATA OUT jacks. At the same time, the PTT jack goes to ground and the AFSK keyer (if installed) is enabled. Since most transmitters or transceivers require several milliseconds to change over to transmit, the first RTTY character may be lost. Therefore, it is usually a good idea to send one or two "LTRS" characters (or tap the "space" bar) to begin a transmission. Once typing (or tape reading) has ceased, the keyboard activated switch will drop back to the receive mode after approximately seven seconds. This drop out time may be changed by changing R-139.

Narrow-shift manual keying may be accomplished with a standard hand key connected to the KEY IN input. The normal condition of the key should be open. Closing the key will operate the keyboard activated switch, sending the higher tone with the key closed and the lower tone with the key open.

With the LINE/LOCAL switch set to LOCAL, the AFSK keyer and PTT OUT are not enabled by the keyboard activated switch; however, the tuning meters stay active to permit tuning of a received signal.

AUTOSTART OPERATION

The FSK-1000 AUTOSTART may be used to turn a teleprinter or other station accessory "on" automatically by means of the switched AC outlet located on the rear panel. For normal autostart operation the AUTOSTART pushbuttons should be set as follows.

1) AUTOSTART ON/OFF: ON (in)

2) AUTOSTART FAST/SLOW: FAST (out)

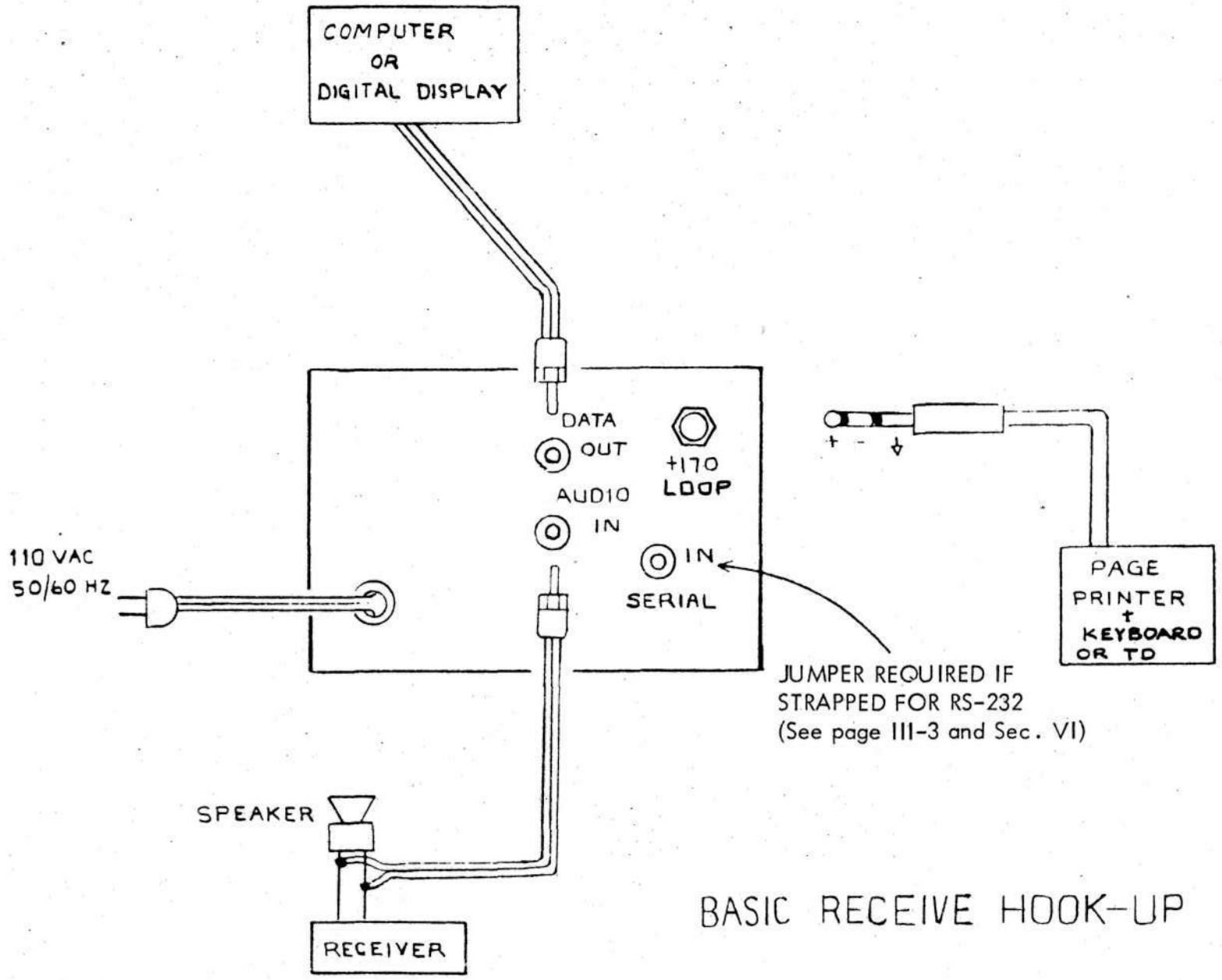
3) AUTOSTART FSK/MARK: FSK (out)

In this mode of operation, it takes an FSK signal which deflects both tuning meters past whatever threshold is set by the Threshold control on the front panel, for approximately one second. The FSK-1000 requires a frequency-shifting signal in both channels and both channels must be above the threshold.* Consequently, the autostart rejects constant CW tones of any amplitude and most random QRM. Once the autostart has turned on, it will stay on until 20 seconds after the RTTY signal has either disappeared or fallen below the threshold.

The user may adjust the threshold by means of the Threshold control located on the front panel. Counterclockwise rotation of this pot lowers the autostart threshold to less than half-scale, and counterclockwise rotation increases the threshold to above half-scale. The operator is encouraged to experiment with various combinations of INPUT LEVEL settings, attack times, as well as threshold settings to achieve the desired autostart response.

Selecting AUTOSTART: SLOW (in) changes the attack time from one second to four seconds. Selecting AUTOSTART: MARK (in) means that a mark signal alone which is above the threshold will turn on the autostart. These attack times may be changed by scaling resistors R 123 (Fast) and R 122 (Slow).

*See Section III under THRESHOLD.



BASIC RECEIVE HOOK-UP

FIGURE IV-1

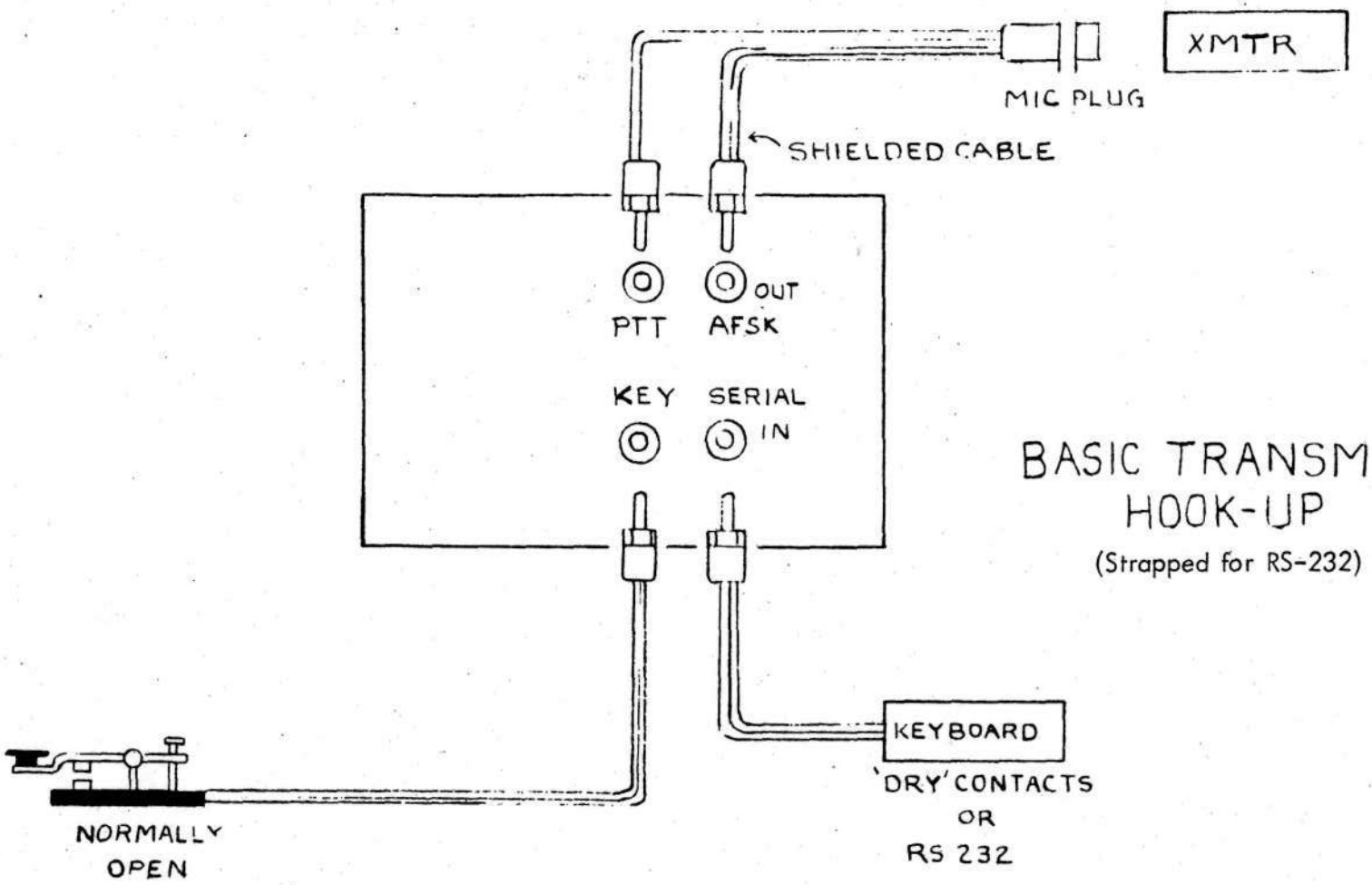

XMTR
MIC PLUG
SHIELDED CABLE
PTT
AFSK
OUT
KEY
SERIAL
IN
BASIC TRANSMIT
HOOK-UP
(Strapped for RS-232)
KEYBOARD
'DRY' CONTACTS
OR
RS 232
NORMALLY
OPEN

FIGURE IV-2

V. CIRCUIT DESCRIPTION

Audio taken from the receiver speaker output of 600-ohm audio output is applied to the input amplifier where the signal level can be attenuated or increased by adjustment of the INPUT LEVEL potentiometer. The LIMIT level detector circuitry samples the output of the input amplifier and the LIMIT indicator lights when this output approaches the saturation point. The limit detector circuitry consists of U23B configured as a comparator and U23A as a unity gain, noninverting amplifier. Transistor Q1 drives the front panel LIMIT LED. LINE/LOCAL switch, S-9, shorts the output of the input amplifier in the LOCAL position to prevent audio signals from producing copy at the output. Center-off toggle switch, S-10, (MARK/FSK/SPACE) selects for mark-only, space-only, or FSK inputs by appropriate grounding of the undesired channel.

The bandpass filters are sixth order transitional Butterworth-Thomson filters. From the schematic, it can be seen that each filter consists of three identical filter sections arranged in a modified cascade form known in the literature as a multiple resonator topology. The individual filters sections are of the bi-quad type and are well known for stability, constant bandwidths, high Q's and ease of tuning.

Switch S-5 (WIDE/NARROW) changes the feedback between sections to select the narrow bandwidth. The filters have a gain of unity.

The SCOPE outputs are taken directly off the bandpass filter outputs, isolated by a 100K resistor.

The outputs of the bandpass filters are envelope-detected by passing the signals through precision rectifiers followed by low-pass filters. The low-pass filtering is that of a fourth order Bessel-type which rolls off at 50 Hz.

The output of the low-pass is applied to the main summer (U19) where it is combined with signals from the decision level correction circuitry.

The keyboard activated switch injects data from the SERIAL IN into the data stream here, through use of FET Q2. A DC offset nulling pot is also summed into U19A to compensate for operational amplifier offsets.

The decision level correction circuitry (DLCC), automatically biases the main summer so that the input decision level, about which the summer's output is driven either positive or negative, is always centered halfway between the peak mark and space amplitudes. It is this circuitry which enables the FSK-1000 to copy RTTY signals when only one tone is present or where selective fading of the tones occur. One-tone-only copy will not be possible at 110 baud.

The tuning meters are driven by voltage followers U15A and U16A which receive their inputs from the DLCC circuitry.

The output of the main summer is applied to U19B, configured as an inverting comparator. The output of the comparator then drives the high voltage loop supply and the DATA OUT driver.

The loop current is adjusted by the large slide potentiometer, R301 for 60 mA operation. CAUTION: THE LOOP SUPPLY POT SHOULD NEVER BE ADJUSTED WITH THE POWER APPLIED TO THE DEMODULATOR, SINCE THE 170 VOLTS PRESENT ON ITS TERMINALS PRESENT A SHOCK HAZARD TO THE INDIVIDUAL. Even after power is removed, time should be allowed (approximately ten seconds) for the 180-volt capacitor to discharge.

The SERIAL IN drives U23A, which is normally wired as a high impedance comparator, whose reference voltage is determined by the voltage divider R137, R138. Keying signals are then routed to the FSK-1020 AFSK keyer via the shift-select pushbuttons and interconnecting cable. Straps are provided at "X1" to invert the input sense.

Autostart voltages are "picked off" at the DLCC stage. When capacitors C54 and C55 both charge to voltages greater than the reference set by the Threshold control, then the output of U20 "snaps" high, charging C58 which ultimately causes the autostart to function. Mark-Hold is accomplished through Diode D36.

Autostart attack times are determined by R123 (FAST) and R122 (SLOW). The autostart dropout time is determined by C56 and R114.

The "Loop Sense" circuitry samples the high voltage loop for keying from a keyboard or TD and feeds this keying back into the Serial Input circuitry via U25A and D39. This means that a closed loop is essential in the external loop; otherwise, the keyboard activated switch circuitry is enabled by the "perceived" space condition. A closed circuit jack is provided for the loop output so that with nothing plugged into the loop jack, the FSK-1000 can receive or transmit normally.

VI. "STRAPPING" OF SERIAL IN AND DATA OUT JACKS

Programming the DATA OUT and SERIAL IN logic levels has been "made easy" by iRL through the use of push on jumpers. None of the Strapping options below effect the loop-out in any way.

CIRCUITRY DESCRIPTION

X2 located in the fron right side of the FSK-1000 determines the Data Out polarity (Mark = High or Mark = Low). X3 allows the Data Out to swing between +11 and -11 (Fig. VI D) or limits it to TTL levels 0 +5V DC (Fig. VI B). For example, if you want to program the Data Output for Mark High you would configure X2 as shown in Fig. VI A. If you also wanted TTL levels you would configure X3 as shown in Fig. VI B.

The SERIAL IN logic polarity is determined by X1 strapping. If strapped as in Fig. VI E any level appearing above the serial in is accepted as mark. Conversely any signal below 1.5V is considered a space. (Note, in the absence of an active "high" such as open-collector or no input on the serial input when strapped as in Fig. VI E will default to the Mark input state.

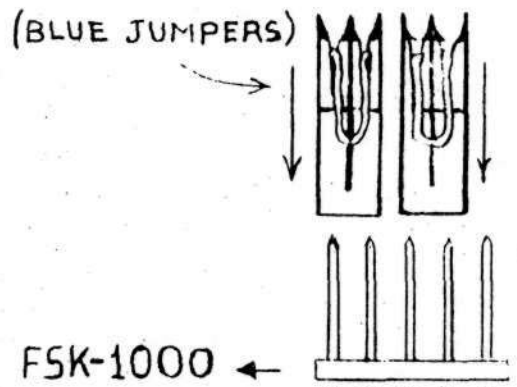
QUICK REFERENCE CHART

	DESIRED INTERFACE	
	RS232 COMPATIBLE	TTL MARK = HIGH
SERIAL IN	Fig. VI F	Fig. VI E
DATA OUT	Fig. VI C Fig. VI D	Fig. VI A Fig. VI B

STRAPPING OPTIONS

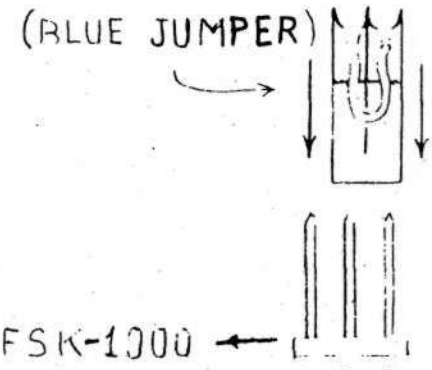
"DATA OUT"

FIG VI A MARK = HIGH (+ VOLTAGE)



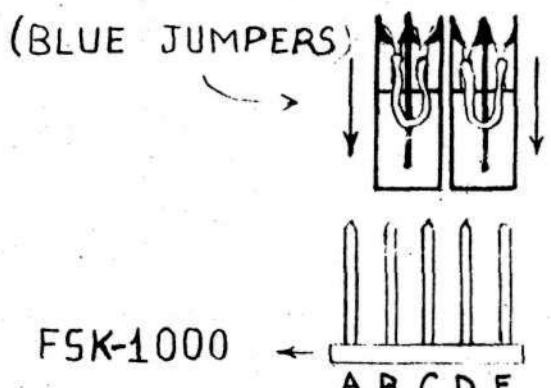
X2

FIG VI B DATA OUT = TTL



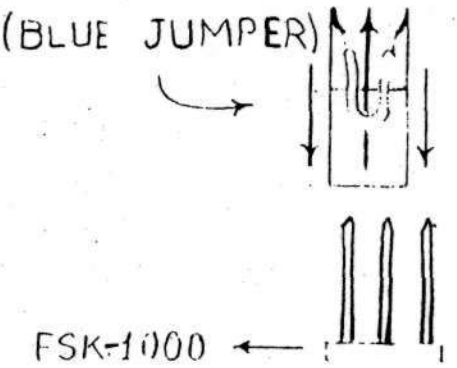
X3

FIG VI C MARK = LOW



X2

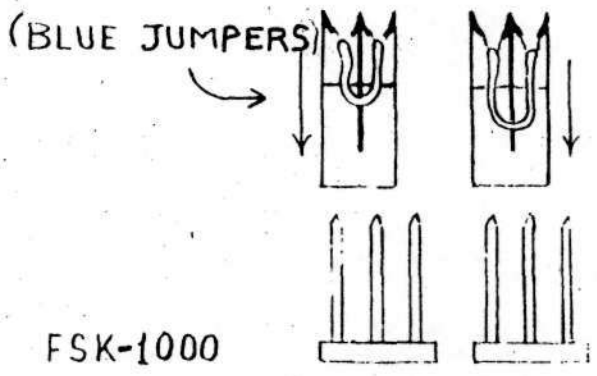
FIG VI D DATA OUT = ± 11 V



X3

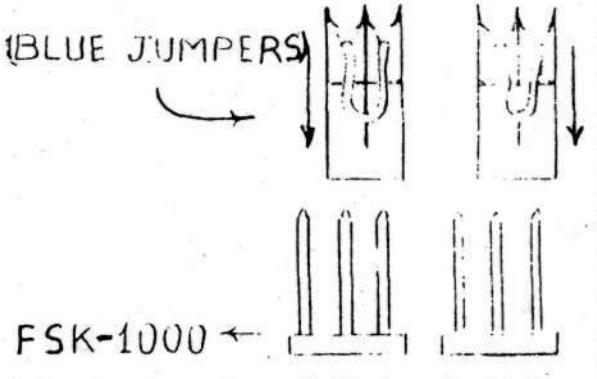
"SERIAL IN"

FIG VI E MARK > 1.5 V

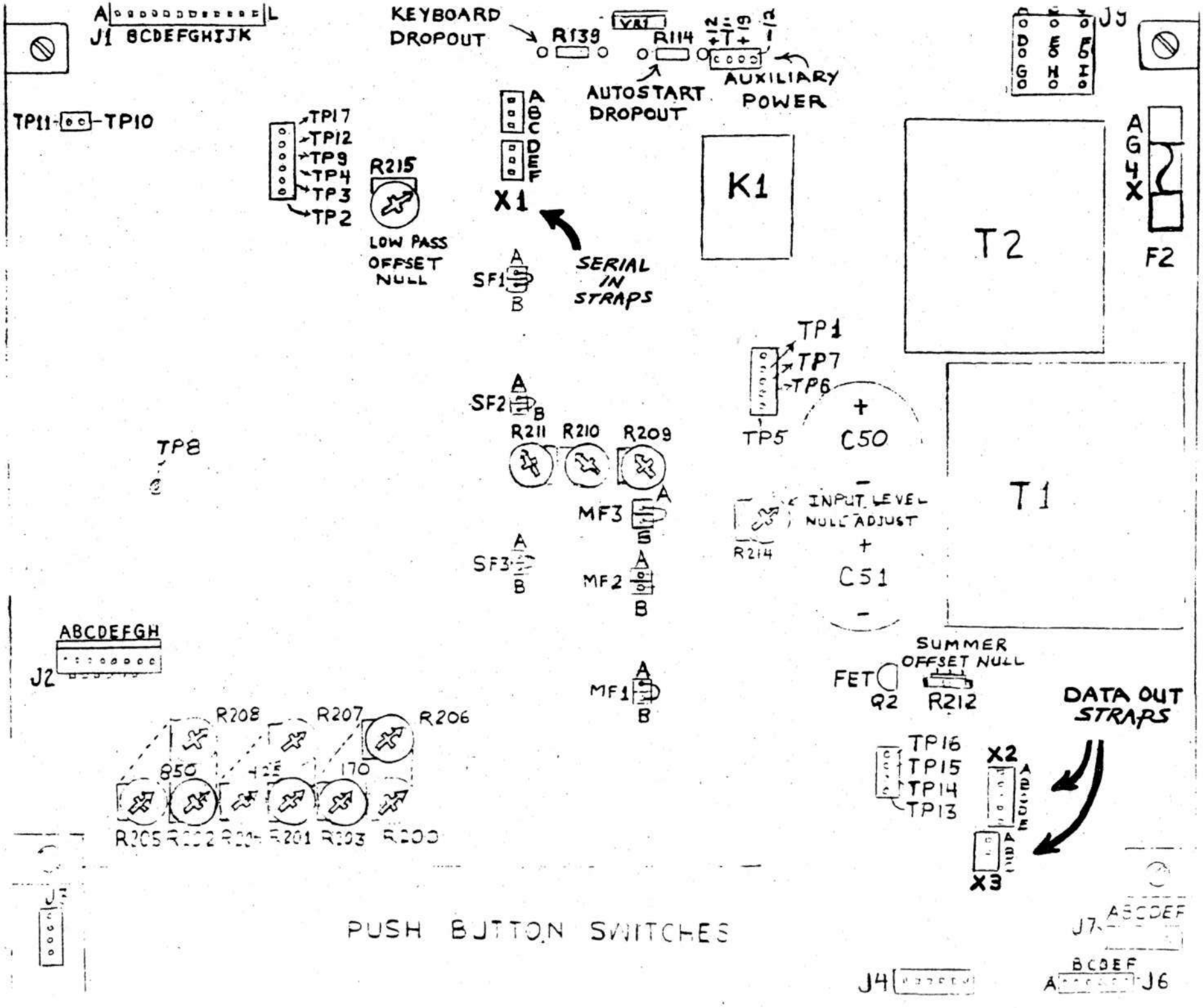


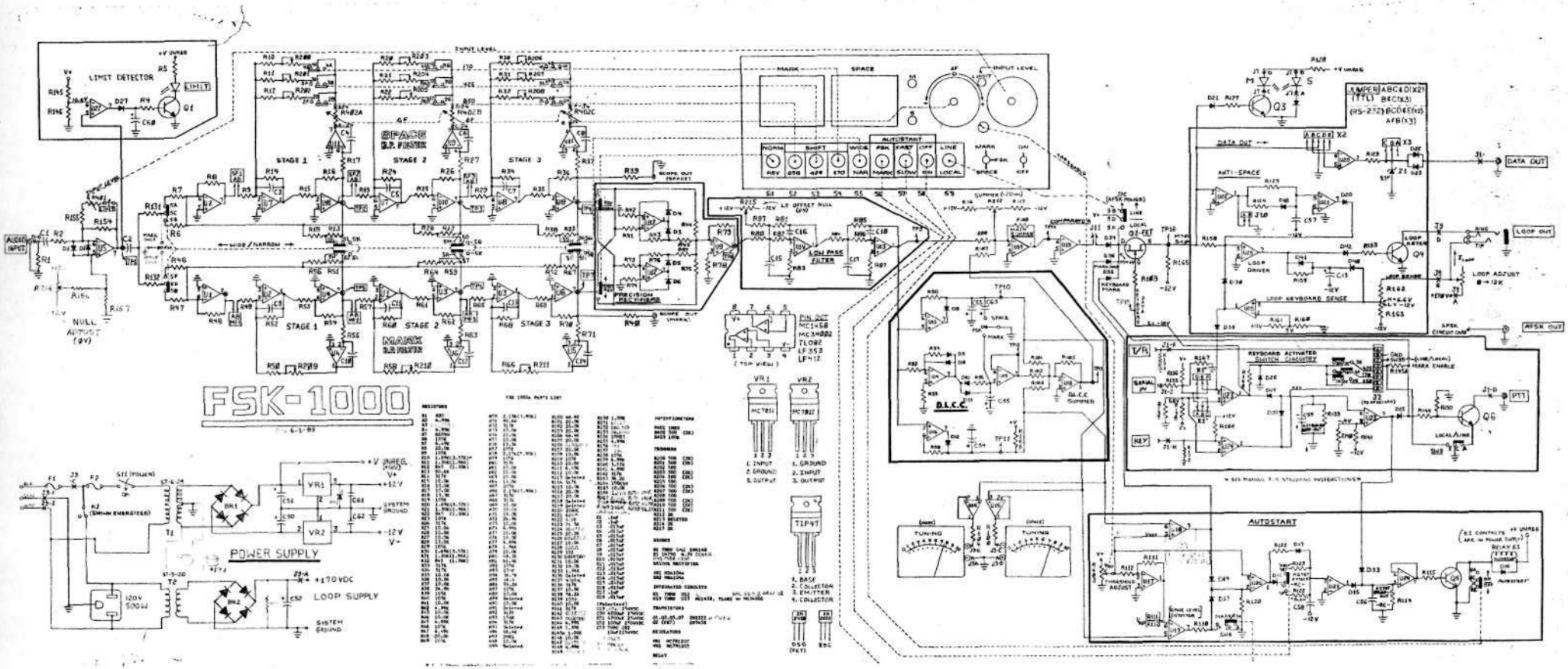
X1

FIG VI F MARK < 1.5 V



X1


A
J1 BCDEFGHIJK
L
KEYBOARD
DROPOUT
R139
VR1
R114
AUTOSTART
DROPOUT
AUXILIARY
POWER
J3
TP11
TP10
TP17
TP12
TP9
TP4
TP3
TP2
R215
LOW PASS
OFFSET
NULL
X1
SF1
SERIAL
IN
STRAPS
K1
T2
X4
F2
TP1
TP7
TP6
TP5
SF2
R211
R210
R209
TP8
C50
INPUT LEVEL
NULL ADJUST
R214
C51
T1
MF3
SF3
MF2
MF1
ABCDEFGH
J2
SUMMER
OFFSET NULL
FET
Q2
R212
DATA OUT
STRAPS
R208
R207
R206
850
425
170
R205
R202
R204
R201
R203
R200
TP16
TP15
TP14
TP13
X2
X3
J7
ABCDEF
J4
BCDEF
J6
PUSH BUTTON SWITCHES


FSK-1000
LIMIT DETECTOR
SPACE
B.P. FILTER
MARK
B.P. FILTER
STAGE 1
STAGE 2
STAGE 3
PRECISION RECTIFIER
LOW PASS FILTER
AUDIO INPUT
NULL ADJUST (8V)
MARK
SPACE
INPUT LEVEL
AUTOSTART
NORM
REV
SHIFT
WIDE
NAR
FSK
MARK
FAST
SLOW
OFF
ON
LINE
LOCAL
DATA OUT
LOOP OUT
LOOP ADJUST
ANTI-SPACE
LOOP DRIVER
LOOP SENSE
LOOP KEYBOARD SENSE
KEYBOARD ACTIVATED SWITCH CIRCUITRY
B.L.C.C.
B.L.C.C. SUMMER
AFSK OUT
PTT
KEY
LOCAL ALINE
TUNING
AUTOSTART
THRESHOLD ADJUST
SINE LEVEL DETECTOR
RELAY K1
PIN OUT
MC1458
MC34082
TL082
LF353
LF412
VR1
MC7815
VR2
MC7812
1. INPUT
2. GROUND
3. OUTPUT
1. GROUND
2. INPUT
3. OUTPUT
T1P41
1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR
POWER SUPPLY
+V UNREG
+12 V
-12 V
SYSTEM GROUND
120V 50/60
+170 VDC
LOOP SUPPLY
SYSTEM GROUND