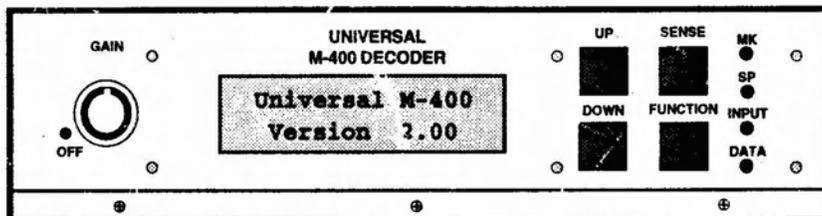


UNIVERSAL M-400

Version 2

Owner's Manual



Universal Radio, Inc.
6830 Americana Pkwy.
Reynoldsburg, Ohio 43068

UNIVERSAL M-400

Version 2

Owner's Manual

By

Digital Electronic Systems, Inc.

&

Universal Radio Research

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Reynoldsburg, Ohio

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1. INTRODUCTION

You are now the owner of the Universal M-400v2 Decoder. The M-400v2 features new modes and capabilities never offered in a "reader" before.

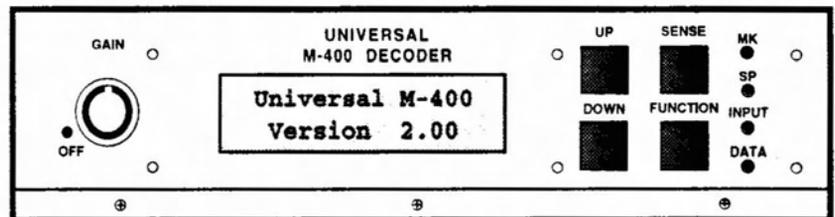
Shortwave reception modes include:

- Baudot 45, 50, 57, 75 and 100 baud.
- ASCII 75, 110 and 150 baud.
- SITOR A & B automatically selected by AUTOR.
- FEC-A 96 and 144 baud.
- SWED-ARQ S, M and L lengths.
- FAX (to printer port) 120 LPM 576 IOC

For the VHF-UHF enthusiasts, the following capabilities are featured:

- ACARS Aviation message/telemetry mode.
- POCSAG Digital pager mode.
- GOLAY Digital pager mode.
- CTCSS (PL) Decoding 41 standard frequencies
- DCS (DPL) Decoding 104 standard codes
- DTMF Decoding 16 digits.

This manual will start with installation and general features. Then shortwave modes will be discussed. Next "scanner" modes and features will be reviewed. Finally specialized programming will be examined. A careful review of this manual is required to understand and operate this device.



◆ **Important Note:** Listeners are reminded that the unauthorized interception and/or divulgence of private, non-broadcast, communications may violate federal and/or state laws.

2. INSTALLATION

The M-400 should be located in a convenient location close to your radio receiver and / or scanner. Do not place the unit on top of, or close to sources of heat such as radiators, heat ducts, etc. The Liquid Crystal Display (LCD) screen on the M-400 provides the best contrast and clearest display when viewed perpendicular to the sloped front panel or from a level below this line. Do not locate the M-400 where it may be exposed to water or excessive moisture.

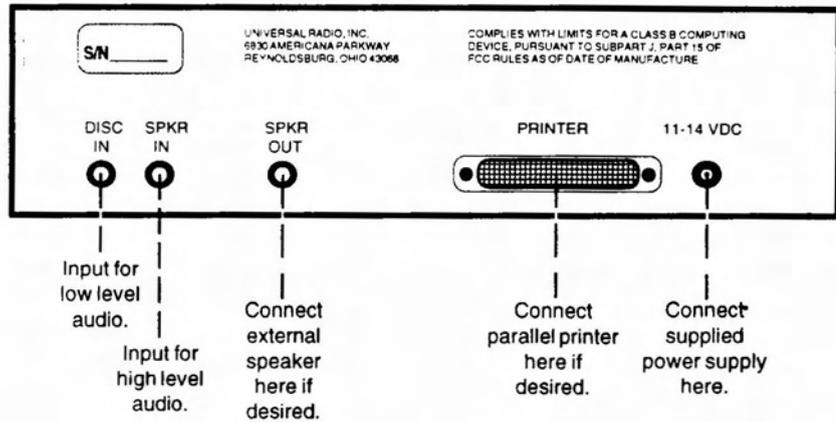
Reminder ...
Before operating, plug the power cord into the M-400, then plug the power adapter into the wall.



■ POWER CONNECTION

WARNING! Please read *before* plugging unit into the wall ...

First, insert the coaxial plug of the wall-mounted power adapter into the hole of the rear panel of the M-400 marked "11-14 VDC". **Then**, plug the power adapter into the 110 volt AC wall outlet. Please do this to avoid electrical shock and/or damage to the M-400. Do NOT insert or remove the power connector *while* the AC power adapter is plugged into the wall. Do not use extension cords or any other type of extenders or adapters.



■ RECEIVER CONNECTION

The receiver audio output may be connected to the M-400 by one of two methods, depending upon the type of audio output being used.

1. Speaker Audio

Plug one end of a suitable audio patch cord into the speaker output of your receiver and the other end into the rear panel jack of the M-400 marked "SPKR IN". With most receivers, making the connection to the speaker output will switch off the receiver's internal speaker. The M-400 accommodates this by providing an output to drive an external speaker. Refer to your receiver's instruction manual for information on selecting an external speaker. Follow the receiver manufacturer's recommendations — the speaker that you connect to the M-400 will actually be driven directly by your receiver's output. Connect the external speaker to the rear panel jack of the M-400 labeled "SPKR OUT".

2. Low-Level Audio

Connect the low-level audio output (discriminator, detector, or recorder output) of your receiver to the M-400 rear panel connector marked "DISC IN". Connections to the low-level receiver outputs do not normally affect the speaker output of most receivers. If the low-level audio input is used the "SPKR IN" and "SPKR OUT" jacks may still be used to *switch* a remote speaker with the M-400. The "SPKR" jacks are disconnected from the internal demodulator circuits when a plug is inserted into the "DISC IN" jack. Therefore you cannot use the SPKR IN and DISC IN at the same time.

Note: Some receivers will not provide enough volume from their record output jacks. In such a case, you may have to use the receiver's speaker output.

■ PRINTER CONNECTION

You may connect a Centronics parallel interface compatible printer to the M-400 using a standard "PC" printer cable. Connect the 25 pin "D" end of the cable to the M-400 "PRINTER" jack and the 36 pin end to the printer. Always turn the M-400 on first ... *then* power-up the printer. Use of the printer is optional for operation of the M-400 in all modes except FAX. The M-400 FAX output is available only at the printer output. For proper operation in the FAX mode, the printer must be compatible with the Epson 8 pin or 24 pin bit-mapped graphics modes. Universal Radio maintains a list of known-compatible printers. Please check this source prior to investing in a printer which may not suit your needs.

Reminder ...

If a plug is inserted into the DISC IN, then the SPKR IN will be disabled.

Note ...

For more information on connecting the M-400 to a scanner, please see **Appendices F & G**.



Warning ...
The printer must be turned OFF when power is applied to the Universal M-400.

3. FUNCTIONAL MODES

We are now ready to turn the M-400 on. To do this turn the **GAIN** control clockwise. The display will briefly show:

Universal M-400
Version 2.00

Reminder:
When corresponding with the factory or your dealer, please specify your version number.

The display next display the "default mode" (to be explained later) and then will go blank. The M-400 is **now** ready to operate. (You must **wait for the display to clear** before starting).

Pressing the **FUNCTION** button steps the display through the following functional modes:

Mode	Typical M-400 Display				
● <i>Operating Mode Select</i>	<table border="0" style="width: 100%;"> <tr> <td style="width: 70%;">BAUDOT</td> <td style="text-align: right;">75</td> </tr> <tr> <td>NOR</td> <td style="text-align: right;">170</td> </tr> </table>	BAUDOT	75	NOR	170
BAUDOT	75				
NOR	170				
● <i>Programming Access</i>	<p>Press "SENSE" for Program Mode Menu</p>				
● <i>Auxiliary Controls 1</i>	<p>Speaker MAN = OFF Scroll Rate = 5.0 S</p>				
● <i>Auxiliary Controls 2</i>	<p>U.O.S. = OFF</p>				
● <i>Text Receive</i>					

¹ blank, or recently received text.

We are initially going to be concerned with the *Operating Mode Select* and *Text Receive* modes. These modes are most closely associated with the reception of shortwave RTTY and FAX.

Notes:

- Whenever the M-400 is operating, and the display would otherwise be blank, a blinking asterisk (*) will appear in the upper right hand corner of the LCD display.
- As mentioned on the previous page ... If you are using a printer, be sure to turn the M-400 on first, **then** turn the printer on.
- When browsing through these alternate display modes, reception in the currently selected mode will continue. Output to the printer will not be interrupted and received data (string or burst formats) will be held in queue until the unit is returned to the *Text Receive* mode. If a new operating mode is selected, the new mode does not take effect until the unit is switched from the *Operating Mode Select* to *Text Receive* operation.

4. OPERATING MODE SELECT

After the M-400 is turned on, and the screen has cleared, you may then press the **FUNCTION** key to see the currently selected reception mode. Pressing the **UP** and **DOWN** buttons will step through the other reception modes:

BAUDOT, ASCII, AUTOR, FEC-A, SWED-ARQ, CTCSS, DCS, DTMF, POCSAG, Super POCSAG, GOLAY, ACARS, FAX

■ SELECTING A RECEPTION MODE

Simply continue to press the **UP** or **DOWN** key until the desired mode appears.

■ SELECTING NORMAL / REVERSE

If the indicated mode requires manual setting of the demodulator sense (normal or reverse) then either NOR or REV will appear on the screen below the mode. For example, the BAUDOT mode may be set for normal or reverse, therefore the display could show:

BAUDOT NOR

Pressing the **SENSE** button will toggle between **NOR**mal and **RE**verse demodulator sense **if** the sense function is applicable to the currently selected mode. (If the displayed mode is SWED-ARQ then the **SENSE** button will select **Short**, **Medium** or **Long** character groups).

It is not absolutely necessary to set the proper sense at this point. The **SENSE** button operates exactly as described above when the M-400 is in the **TEXT RECEIVE** mode, except there is no on-screen indication of the selected setting to refer to. In other words, you can change the sense, "on the fly" while you are receiving the signal.

If no button, other than **FUNCTION** is pressed, then the next press of the **FUNCTION** button will advance to the **PROGRAMMING ACCESS** display screen. If any button, other than **FUNCTION** is pressed prior to pressing the **FUNCTION** button, then a different sequence of events will occur as described below. In any event, if another key is pressed prior to **FUNCTION**, the unit will return to the **Text Receive** mode at the end of the **MODE SELECTION** sequence.

The mode of operation which is displayed on the screen when the **FUNCTION** button is pressed will be the new operating mode. If there are no user-selectable parameters associated with the new mode (other than received sense) operation will immediately begin in the new operating mode.

These 'fixed-parameter' modes include:

AUTOR, CTCSS, DCS, DTMF, POCSAG,
Super POCSAG, GOLAY, ACARS and FAX

If the new mode of operation is *not* one of these 'fixed' modes, the screen will display the current demodulator shift value. Pressing either the **UP** or **DOWN** buttons will step through the fixed shifts of:

170, 425 and 850

Variable (i.e. non-standard) shifts can also be selected in the range of 100 to 1000 Hz. To do this press either **UP** or **DOWN** buttons while holding down the **SENSE** button. This will vary the shift in 5 Hz steps (at a rate of 4 steps per second) as long as both buttons are pressed.

NOTE: Press and hold the **SENSE** button before pressing either **UP** or **DOWN** and do not release the **SENSE** button until after releasing **UP** and **DOWN** buttons.

Observing the MK and SP LEDs will assist in setting the unit to the proper shift. The goal is to get the **MK** (mark) and **SP** (space) LEDs to flash with equal brightness. When the desired shift has been selected, press the **FUNCTION** button again.

If the selected mode is SWED-ARQ, then operation will commence in the new mode. If the selected mode is BAUDOT, ASCII or FEC-A, the screen will display the default (or current) speed setting. Pressing the **UP** and **DOWN** buttons will step through the available standard speeds of the selected mode. When the desired speed is indicated on the screen, press the **FUNCTION** button again and operation at the newly selected mode will begin.

Note:

If you have your printer on-line during mode selection, the printer will perform a line feed when the **FUNCTION** button is pressed to select a new mode. This is normal.

5. INDICATORS

The M-400 has four light emitting diodes (LED's). Their functions are:

MK Indicates reception of a *mark* tone (1275 Hz).

SP Indicates reception of a *space* tone.

INPUT Indicates adequate level of audio is present at the input and the *GAIN* control is set high enough.

DATA Indicates the unit is receiving data from the demodulator section. In Baudot RTTY this merely indicates the transition from Mark to Space. In FEC-A this indicates received data or idle.

6. DISPLAY METHODS

The LCD (Liquid Crystal Display) on the M-400 front panel is composed of two lines of twenty characters each using a 5x7 dot matrix for each character. This display is used to assist in setting the mode and other operating parameters and functions. Under normal operation, the display serves to show the received text or other decoded information.

In this display function, there are four distinct formats used to present the received information depending upon the current operating mode: String, Burst, Direct and None. **The M-400 automatically selects the appropriate display method!** The following explanation of each display method is provided for those desiring a deeper understanding of how the M-400 works.

● String Display Method

The string format is used to display text in modes where the data is received at a relatively constant rate which is slow enough that it can be read and understood in "real time" conditions by the average individual. Characters are displayed, from left to right, on the lower LCD line. When the lower line is filled, its contents are moved to the top line (over-writing any text which was on the top line) and the bottom line is cleared to make ready for the next line of text. This is commonly referred to as "scrolling". Any partial words which were not completed at the end of the line when the display is scrolled are transferred to the beginning of the new line. This prevents the break-up or hyphenation of displayed words.

If some of the received text is missed or needs to be reviewed, the **UP** and **DOWN** buttons may be used to scroll back through previously received text. This is described in detail on the next page under "Manual Text Scrolling".

String display mode is used for: BAUDOT, ASCII, AUTOR (SITOR A/B), FEC-A, SWED and DTMF.

● Burst Display Method

The burst format is used to display text in modes where the received data occurs at very high instantaneous rates but only for relatively short durations at any given time. If these types of modes were displayed in "real time" as in the string mode, the user would be able to read only the last two lines of each 'burst' of data; the rest of the burst would scroll past the display in a blur. Since the average data rate of these burst modes is usually within the reading speed of the average person, the burst format simply spreads the received bursts over a longer period of time.

The burst format separates the received text into individual lines and then scrolls one line onto the display at a time. The rate at which the new lines are presented is controlled by the user by specifying the minimum time interval between successive new lines. The procedures for doing this will be described in detail later on. The scrolling rate should be selected to be slow enough for comfortable reading, but not so slow as to allow the averaging buffer to become full. The M-400 will retain up to 8,000 received text characters in its buffer.

If some of the received text or data is missed or needs to be reviewed, use the **UP** and **DOWN** buttons to scroll back through previously received text. This is described in greater detail at the end of this section.

Burst display mode used for: POCSAG, Super POCSAG, GOLAY & ACARS.

● Direct Display Method

The direct format is used to display the results of non-text decoded information. This format is used only when operating in the CTCSS and DCS sub-audible signaling modes. The left side of the top LCD line is used to display the 3 or 4 digit value of the received signal. When these signals are keyed, the same pattern is repeated over and over until the transmission stops. For this reason, the M-400 simply displays the decoded value as long as it is present. When the signal stops, or becomes too weak or distorted to properly decode, the LCD display segment is blanked.

The M-400 has the capability of comparing the decoded CTCSS or DCS pattern with user-programmed values and turning on the speaker output during the time when a match exists. This feature will be described in greater detail later.

Direct display mode is used for: CTCSS and DCS

● "None" Display Method

While the M-400 is operating in the FAX mode, the LCD display will simply show the word FACSIMILE. As the name 'none' implies, no received information is presented on the display. The FAX image is strictly routed to the parallel printer port.

FACSIMILE

Reminder:

After scrolling, you must press **UP** and **DOWN** simultaneously to resume displaying incoming text.

MANUAL TEXT SCROLLING

Text (or other information) which is received and displayed in either the String or Burst display formats is stored in the 4,000 character text buffer. With either of these formats, as new information is received and displayed, the oldest displayed text is scrolled off the top line of the LCD and disappears.

This 'lost' information may be retrieved for review with the use of the **UP** and **DOWN** buttons. Each press of one of these buttons will cause the display to scroll up or down, one line at a time through the data stored in the text buffer. Pressing **DOWN** repeatedly will bring you to the *top* of the text buffer. To help visualize this, think of the buffer as a sheet of paper and the LCD as a *fixed* window. The paper gets moved up or down behind the fixed window.

When either **UP** or **DOWN** button is first pressed, the automatic display operation will be suspended. **In order to restore normal operation** of the display, press and release both **UP** and **DOWN** buttons simultaneously. The LCD screen will be cleared and normal text display will then resume. This procedure does *not* flush (erase) the stored text. It just moves the LCD "window" down beyond the last line. This is a very important paragraph to understand.

7. BAUDOT

In *Chapter 4* we spoke generally about selecting a mode, and then selecting the speed, sense and shift. Now we are going to review this procedure as it applies to specific modes.

We are going to start with the oldest teletype mode, Baudot. Many Baudot stations have recently changed to newer more reliable modes such as SITOR and FEC-A. However, there remains a number of weather and press stations using this mode. There is also a large population of encrypted Baudot stations which cannot be decoded. It is therefore advisable to seek *known* Baudot stations as listed in various books, newsletters and directories. This will dramatically improve your chances of obtaining a readable signal. Especially as a beginner, you should practice on a strong reliable station such as *CFH Weather* (see sample Baudot station list on next page).

To select the Baudot mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until the screen displays:

BAUDOT	
NOR	

Press the **FUNCTION** button. The screen will now display:

BAUDOT	
NOR	170

The 170 indicates that the demodulator is set for a shift of 170 Hz. Use the **UP** and **DOWN** buttons to select the proper shift for the received signal. When correctly tuned, the MK and SP will flash with equal brilliance. This will show you are physically tuned to the tones of the signal (mark and space). It does *not* indicate whether you have the correct mode, speed, or sense selected!

Press the **FUNCTION** button. The screen will now display:

BAUDOT	75
NOR	170

The 75 indicates that the unit is set to decode a Baudot signal of 75 baud. Use the **UP** and **DOWN** buttons to select the proper baud rate (speed) for the signal to be received. Available speeds are 45, 50, 57, 75 and 100 baud.

Press the **FUNCTION** button. The M-400 is now in the Text Receive mode for Baudot. You *may* be properly receiving text at this time. If not you can press the **SENSE** button. This will toggle you from **NOR**mal to **RE**Verse (or *visa versa*). There will be no specific indication of this as such (other than possibly the result of this action ... which *may* be readable text).

The following is a brief tutorial on radioteletype for beginners ...

RTTY, which stands for Radio TeleTYpe, is a term used to cover a wide variety of radio communications codes. What they all have in common is that they are based on teletype operation. Tele (far away, or remote) type (typing, or printing) originally used wires to connect the teletyping machines together.

This on and off keying is called a binary, or two state code. On shortwave the two states (on and off) are represented by two distinct tones, or frequencies, called the *Mark* and the *Space*. This separation between the mark and space frequencies is referred to as the *shift*. Common shifts include 170, 425 and 850 Hz. It is the responsibility of the shortwave receiver to convert these radio frequency signals down to audio tones. Any instability or drift in the short-wave receiver will degrade of performance of the M-400. The receiver must also be capable of providing a *complete* signal to be demodulated. While narrow filters may be desirable in certain cases, in other instances they can prevent both needed portions of the signal (Mark and Space), from reaching the M-400. For 170 Hz shift use at least a 500 Hz filter, for 425 Hz use at least a 1000 Hz filter, and for 850 Hz use at least a 2000 Hz (2 kHz) filter.

The objective in tuning a RTTY signal is to match the mark and space tones coming from the receiver to the same frequencies as the *Mark* and *Space* filters in the M-400's demodulator. In order to match these tones, the receiver must be capable of tuning in very fine increments. If the main tuning of the receiver is not capable of varying the frequency by 10 Hz. or less, then the RIT, BFO or similar fine-tuning control must be used to tune RTTY signals.

We **strongly** suggest you initially try for *published* RTTY stations on *known* frequencies, transmitting with *known* baud rates and shifts. Randomly tuning around, trying different, modes and speeds will be unproductive. To tune a typical Baudot RTTY signal you would:

1. Set the M-400 for the correct baud rate (usually 50 or 75 baud).
2. Set the M-400 for the correct shift (usually 170 Hz. in the ham bands, 425 or 850 Hz. outside the ham bands).
3. Slowly tune the receiver around the signal until both the *Mark (MK)* and *Space (SP)* LEDs flash with equal brightness.
4. If readable copy does not follow, then press the **SENSE** button to change the sense (or polarity) of the signal.

A few general reminders ...

- If you can't get *both* the *MK* & *SP* to light, try a different shift.
- If you *still* can't *both* *MK* & *SP* check your filter selection on the receiver.
- You must always try both senses (NOR and REV).
- In order to get readable Baudot RTTY you must have all of the following correct:
 - Speed, • Sense and • Shift (*some* copy is possible with wrong shift).
- The station must be active (not idling) to copy.
- There are many 75 baud Baudot signals on shortwave that are encrypted in *content*. The apparent "garbage" you are getting *is* what is being sent.
- Many RTTY frequencies are seasonal in nature.
- Many RTTY stations only transmit on an as-needed basis.
- Many RTTY stations transmit in a directional pattern and therefore may not be audible in your area.
- Propagation may not permit reception at a given time.
- Some stations only transmit on certain days or with reduced weekend schedules.
- Learn the easier RTTY modes like Baudot and SITOR, before exploring the more advanced modes.
- When looking for a specific RTTY station always try the listed frequency plus or minus 3 kHz.

UNSHIFT ON SPACE FEATURE

The Unshift On Space (UOS) capability is a fairly subtle feature that only applies to the Baudot-based modes (Baudot, SITOR A/B, FEC-A and SWED-ARQ). You do not need to fully understand this feature to monitor these modes.

Baudot is a five data bit per character code, providing 32 possible bit combinations. This does not provide enough unique characters for the 26 letters, 10 digits, and punctuation used in the English language, so Baudot uses two sets of letters, or cases. One case (letters or LTRS) contains the letters of the alphabet, while the other case (figures or FIGS) holds the numbers and punctuation. Normally, the control codes to select a case are only sent when there is actually a change in the case of the transmitted text, or, in some services, at the end of every line. Normal text contains mostly lower case characters. If an error occurs in the reception of a character, there is a chance that the resulting error will cause an improper shift into the upper case. If this occurs, the upper case representation (i.e. incorrect representation!) of all the following text will be displayed (numbers, punctuation, bells, etc.), until the sending station again sends the lower case (LTRS) control code.

If the M-400's UOS feature is left on it will quickly correct this condition. UOS will force the M-400 into the lower (LTRS) case each time the **space character** is received. At the end of every word, then, the lower case operation is restored, and the most that would be lost to gibberish in the event of a false FIGS shift, is one word.

The M-400 provides this function on a user-selected basis. Please refer to page 36 to program this feature on or off. Why would we want to turn off such a marvelous invention? Certain stations, particularly weather transmissions, send columns of numbers. With the UOS on, each time a space is received to place the numbers (FIGS) in column form the unit will switch to LTRS and you will see a column of numbers followed by several columns of letters that make no sense at all.

As an example; the date of MARCH 12, 1987 would appear as MARCH 12, QOIU if the UOS were enabled.

Most users prefer to leave the U.O.S. "on" except during the reception of RTTY weather transmissions. This way when the Baudot code inadvertently falls into the wrong case it is quickly restored to the proper case.

BAUDOT SAMPLE FREQUENCIES

TIME (GMT)	kHz.	Baud	Shift	Station
0000	6848	50	425	PAP press also 11497
0030	7806	50	400	TANJUG English press
0100	11065	75	475	XINHUA English press
0114	7996	50	400	TANJUG English press
0300	4004	50	425	TELAM press also 7428
0400-0415	11478	50	425	KCNA English press
0500	16135	75	425	APN press
0600	17468	50	425	MTI English press
0700	9830	50	425	SPK English press
0801	9133	50	425	ATA English press
0945	14568	50	425	KCNA press also 10580
1000	15632	50	230	KCNA English press
1120	13440	50	425	TANJUG press
1120	17470	75	425	XINHUA English press
1220	18039	50	850	AA press also 19040
1300	13371	50	425	INA English press
1330	13113	75	365	XINHUA English press
1340	14800	50	600	TAP French Press
1400	18220	50	425	MAP English press
1400	18055	75	425	MFA/TANJUG Press
1400	14373	50	425	INA English press
1400	13648	50	425	CTK English press
1400	7695	50	850	CNA press also 9090
1400	5097	50	425	JIFI press also 8175
1430	16117	50	425	PANA English press
1500	5195	50	425	ADN press
1500-	9430	50	425	ATA English press
1500	7800	50	425	IRNA English press
1500	9395	50	425	KCNA press also 10580
1500	9331	50	425	VNA press also 10599
1500	19980	50	600	IRNA English press
1500	24102	75	400	TANJUG English press
1520	21860	75	425	TANJUG English press
1530	14910	75	400	TANJUG English press
1540	14764	75	350	GNA English press
1200/1500	20085	50	425	ANSA English press
1600	20560	50	425	JANA English press
1630	19087	50	425	CLP Spanish press
1800	8020	50	425	KCNA press
1900	13440	50	425	TANJUG English press
1900	14928	50	425	PL Press
2100	11430	50	250	KCNA French press
	6496	75	850	CFH Weather (also FAX)
	10535	75	850	CFH Weather (also FAX)
	13510	75	850	CFH Weather (also FAX)
	14356	50	425	GFL24 Weather
	18230	50	425	GFL25 Weather

8. ASCII

ASCII stands for *American Standard Code for Information Interchange*. The ASCII code is similar to the Baudot code except its character is composed of 7 data bits instead of 5. ASCII is **not** a popular radio mode.

To select the ASCII mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until the screen displays:

ASCII NOR

Note: The screen may indicate REV rather than NOR.

Press the **FUNCTION** button. The screen will now display:

ASCII NOR	170
--------------	-----

The 170 indicates that the demodulator is set for a shift of 170 Hz. Use the **UP** and **DOWN** buttons to select the proper shift for the received signal (refer to the section on DEMODULATOR TUNING). When the signal is correctly tuned, but not decoding; try changing the sense from NOR to REV.

Press the **FUNCTION** button. The screen will now display:

ASCII	110
NOR	170

The 110 indicates that the unit is set to decode an ASCII signal of 110 baud. Use the **UP** and **DOWN** buttons to select the proper baud rate (speed) for the signal to be received. Available speed are 75, 110 and 150 baud.

Press the **FUNCTION** button. The M-400 is now in the Text Receive mode for ASCII. As always, tune the radio to get both the *MK* and *SPLEDs* to blink.

Reminder:

ASCII signals are currently very scarce on short-wave (HF).

ASCII is **not** generally used on the HF bands except by *W1AW*, a few amateurs, and then usually at 110 Baud. *W1AW* is the master station of the *American Radio Relay League* located in Newington, CT. They transmit bulletins daily for radio amateurs in Baudot 45, ASCII 110 and SITOR. Their schedule (in UTC) is:

DAILY	MON-FRI
0100, 0400, 2200	1500
3625, 7095, 14095, 21095 & 28095 kHz	

9. AUTOR (SITOR A & B)

The Simplex Telex Over Radio (SITOR) code is used extensively in maritime and diplomatic communications. SITOR A and B are popular shortwave modes. The SITOR signals are always sent at 100 baud and usually 170 Hz. shift. SITOR A is one of the easiest RTTY modes to find and tune. It is easy to find because of the unique *chirp, chirp, chirp* sound of two stations interchanging data.

Using the frequency chart below, listen for the distinctive *chirp, chirp* sound. Once again, the idea will be to tune the radio receiver in such a manner as to get both the MK and SP LEDs to flicker on the M-400. Now that you have both Mark and Space you may or may not be getting text on your screen. When you tune to a SITOR A station, the chirps you hear may be the three character groups being sent, or they may be nothing more than the acknowledgment pulses from the receiving station (or in "computer" terms ... you may be merely listening to the "handshaking"). The sound is quite similar. However, in time you will be able to tell the difference by "ear". Until then, be patient. Understand that when the receiving station is done receiving he will probably start transmitting text back to the original transmitting station.

DAYS

12465 - 13070 kHz.
16860 - 17225 kHz.
22315 - 22555 kHz.

EVENINGS

6325 - 6490 kHz.
8435 - 8700 kHz.
12465 - 13070 kHz.

To select the SITOR A mode set the M-400 to the "AUTOR" mode. To do this press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until AUTOR appears on the screen. Press the **FUNCTION** button. The unit is now operating in the AUTOR mode. As always, tune the radio to get both the *MK* and *SP* LEDs to blink with equal brilliance. Enough audio level must be available to light the *INPUT* LED to full brilliance (otherwise the *MK* and *SP* LEDs may not light).

SITOR B consists of a continuous data stream of 100 baud data bits characterized by its "singing" sound. It does not have the distinctive "chirp-chirp" sound of mode A, and is not as commonly used. Mode B is generally used as a broadcast mode to ships by coastal maritime stations. Here are some frequencies to try:

DAYS

12630 - 12715 kHz.
16860 - 17025 kHz.
19680 - 19710 kHz.
22375 - 22445 kHz.

EVENINGS

4210 - 4270 kHz.
6314 - 6345 kHz.
8415 - 8435 kHz.
12630 - 12715 kHz.

SITOR-B may also be used for the reception of the NAVTEX signal at 518 kHz.

◆ Note:

If the M-400 is set in the AUTOR mode it will also copy SITOR-B. Even if the transmitting station suddenly changes from SITOR A to SITOR B, copy will continue as long as you are in the AUTOR mode.

When trying to copy SITOR you do **not** have to worry about sense (NOR/REV), speed or shift!

10. FEC-A

FEC-A is a popular European press and diplomatic mode. To select the FEC-A mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until the screen displays FEC-A.

Press the **FUNCTION** button. The screen will now display:

FEC-A	170
-------	-----

The 170 indicates that the demodulator is set for a shift of 170 Hz. Use the **UP** and **DOWN** buttons to select the proper shift for the received signal (refer to the section on DEMODULATOR TUNING).

Press the **FUNCTION** button. The screen will now display:

FEC-A	96
	170

The 96 indicates that the unit is set to decode a FEC-A signal of 96 baud. Use the **UP** and **DOWN** buttons to select the proper baud rate (speed) for the signal to be received. The available speeds are 96 and 144 baud.

Press the **FUNCTION** button. The M-400 is now in the Text Receive mode for FEC-A. Tune for *MK & SP*. FEC-A signals take several seconds to "sync".

FEC-A SAMPLE FREQUENCIES

Baud	Shift	kHz	Call	Location
96	850	123	DCF42	Bonn, Germany
96	425	10217	9VF59	Singapore (Bonn relay)
144		10802	DZFG	Belgrade, Yugoslavia
96	140	11123	DFI26	Bonn, Germany
144		11483		Paris, France
144		13417	TAD	Ankara, Turkey
144	368	13427		Belgrade, Yugoslavia
144	378	13539		Moscow, Russia (Fr.Emb.)
96	403	13570		Bonn, Germany
144		13833	TAD	Ankara, Turkey
96	425	13927	DFN92	Bonn, Germany
144	812	13982	TAD	Ankara, Turkey
144		15794	TAD	Ankara, Turkey
144		18184	TAD	Ankara, Turkey
144	820	18864	TAD	Ankara, Turkey
96		19535	9VC91	Singapore (Bonn relay)
96	425	19644		Lagos, Nigeria
96	425	20022	DFU23	Bonn, Germany
96	400	20500		Bonn, Germany
96	425	23545	DFX54	Bonn, Germany
96	425	23697	DFX69H6	Bonn, Germany
96	395	25320	DFZ32	Bonn, Germany
96	425	26441	DFZ64	Bonn, Germany

11. SWED-ARQ

As you might suspect from the name, SWED-ARQ is a diplomatic mode used by the Swedish. To select the SWED-ARQ mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until the screen displays:

```
SWED-ARQ
M
```

Note: The screen may indicate S or L rather than M.

Press the **FUNCTION** button. The screen will now display:

```
SWED-ARQ
M          170
```

The 170 indicates that the demodulator is set for a shift of 170 Hz. Use the **UP** and **DOWN** buttons to select the proper shift for the received signal. Press the **FUNCTION** button. The M-400 is now in the Text Receive mode for SWED-ARQ. As always, tune the radio to get both the **MK** and **SP** LEDs to blink.

When operating in the SWED-ARQ mode, the **SENSE** button selects either short, medium or long character block sizes. The M-400 must be set to the same size as that being received in order to obtain synchronization. The only time that the M-400 indicates the current setting of the block size is on the Mode screen display. The simplest way to set the M-400 is while actually receiving a SWED-ARQ signal. Press the **SENSE** button and then wait three or four transmission cycles. If the **DATA** LED does not turn on, then press the **SENSE** button again. While three presses of the **SENSE** button will cover all three possible group sizes, you may need to repeat this process several times as the sending station may change block sizes while you are trying to manually sync. Once the M-400 locks on to the SWED-ARQ transmission, it will track further block size changes automatically so you should not press the **SENSE** button again unless the **DATA** LED turns off.

SWED-ARQ SAMPLE FREQUENCIES

Baud	Shift	kHz.	Call	Location
100	170	12103	SAM	Stockholm, Sweden
100	425	13862	SAM	Stockholm, Sweden
100	170	14406	SAM	Stockholm, Sweden
100	370	14523	SAM	Stockholm, Sweden
100	425	14814	SAM	Stockholm, Sweden
100	400	14878	SAM	Stockholm, Sweden
100	385	14970	SAM	Stockholm, Sweden
100	425	18033		
100	170	18810	SAM	Stockholm, Sweden
100		18947	SAM	Stockholm, Sweden
100	395	20699	SAM	Lisbon, Portugal
100	170	20960	SAM	Stockholm, Sweden
100	425	20986	SAM	Stockholm, Sweden
100		23505	SAM	Stockholm, Sweden
100	400	23547	SAM	Stockholm, Sweden
100	450	23586		Harare, Zimbabwe
100	400	23593	SAM	Stockholm, Sweden

12. FAX

Facsimile (FAX) mode is used on shortwave to transmit wire photos, weather charts, maps and other documents. The M-400 can decode such transmissions and print them to a standard dot matrix parallel printer (not supplied). The printer must be Epson graphics compatible (98% of today's PC printers are.). The M-400 does not support laser printers.

If your dot matrix printer has an 8 or 9 pin print head, you may proceed directly. If your dot matrix printer has a 24 pin print head, you must first go to the Programming section (*Chapter 21*) of this manual, and set the M-400 printer port for 24 pin output.

To select the FAX mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until the screen displays:

FAX	120
POS	576

Note: The screen may indicate NEG rather than POS.

Press the **FUNCTION** button. The M-400 will now wait for the beginning of the next FAX image to start.

Waiting for the start of the image to occur will insure the image is properly framed. However, you may begin to print an image "mid-stream" if you wish. Simply press the **UP** button to manually start (or stop) FAX decoding. You will see the DATA LED light.

If you begin to print an image mid-stream (or miss the framing header) your image will not be properly centered. For example, the left border might run down the center of the page. You can manually re-frame the image "on the fly" by pressing **DOWN** button one or more times. Each press of the **DOWN** button will move the image left by 1/2 inch.

If the image starts to appear as a "negative" on the printer you can press the **SENSE** button. This will change the polarity of the printed image. Black lines or areas will become white and white lines or areas will become black. This can also be done during reception ("on the fly").

The M-400 receives frequency modulated FAX at a fixed speed of 120 LPM and a fixed IOC of 576. This speed IOC combination will decode 95% of the available shortwave FAX imagery.

Tuning FAX is more of an art than a science. The M-400 is fairly forgiving when tuning FAX. Trial and error is the key here. Simply watch the printer, and make *minor* adjustments to your receiver's tuning knob to enhance the image.

In order to get a *good* FAX image, you must have a *strong* signal.

FACSIMILE SAMPLE FREQUENCIES

TIME (GMT)	kHz.	LPM	IOC	Station	
evenings	3357	120	576	NAM Norfolk, VA	WX
evenings	4296	120	576	NOJ Kodiak, AK	WX
evenings	4704	120	576	AOK Rota, Spain	WX
evenings	4853	120	576	NPM Pearl Harbor, HI	WX
	5768	120	576	JBK3 Tokyo, Japan	Press
1000	5807	120	576	ZKLF Auckland, NZ	WX
evenings	6496	120	576	CFH Halifax, NS	WX
evenings	6850	120	576	WLO Mobile, AL	WX
	6900	120	576	SMA6 Norrköping, Sw.	WX
evenings	6944	120	576	CKN Vancouver, BC	WX
	7530	120	576	NMF Boston, MA	WX
	7993	120	576	NPM Pearl Harbor, HI	WX
	7710	120	576	VFF Frobisher Bay	WX
2300	7931	60	188	AZG902 B.Aires, Arg.	Press
	8000	120	576	GXH Thurso, Greenl.	WX
24 hours	8080	120	576	NAM Norfolk, VA	WX
evenings	8185	120	576	FPI88 Paris, France	WX
2300	8167	60	188	B.Aires, Arg.	Press
evenings	8459	120	576	NOJ Kodiak, AK	WX
	8492	120	576	NPM Pearl Harbor, HI	WX
	8646	120	576	WWD LaJolla, CA	WX
	8682	120	576	NMC San Fran., CA	WX
	9157	120	576	WLO Mobile, AL	WX
	9318	120	576	Iceland	WX
	9383	120	576	NPN Apra, Guam	WX
	9395	120	576	NPM Pearl Harbor, HI	WX
	9438	120	576	JMJ3 Tokyo, Japan	WX
1000	9456	120	576	ZKLF Auckland, NZ	WX
	10220	120	576	RWD76 Khabarovsk, Rus	WX
	10535	120	576	CFH Halifax, NS	WX
	10555	120	576	AX134 Darwin, Aus.	WX
24 hours	10863	120	576	NAM Norfolk, VA	WX
2100	11480	60	188	AZG641 B.Aires, Arg.	Press
	12728	120	576	USN Point Reyes, CA	WX
1000	13340	120	576	ZKLF Auckland, NZ	WX
1000	13550	120	576	ZKLF Auckland, NZ	WX
	13751	120	576	London, UK	Press
	14828	120	576	NPM Pearl Harbor, HI	WX
days	16410	120	576	NAM Norfolk, VA	WX
	17151	120	576	NMC San Fran., CA	WX
	17405	120	576	WWD LaJolla, CA	WX
	17585	120	576	AOK Rota, Spain	WX
	18060	120	576	AX136 Darwin, Aus.	WX
	18130	120	576	JMJ5 Tokyo, Japan	WX
	18245	120	576	GXH Thurso, Greenl.	WX
mornings	19862	120	576	NPN Apra Harbor, Guam	WX
	21037	120	576	NPM Pearl Harbor, HI	WX
	22542	120	576	JJC Tokyo, Japan	Press
	22940	120	576	JJC Tokyo, Japan	Press
mornings	23882	120	576	NPN Apra Harbor, Guam	WX

13. ACARS

ACARS stands for *Aircraft Communications Addressing and Reporting System*. It was developed a few years ago to cut down on the flight crew workload by using computers on the ground and in the aircraft to exchange many routine reports and messages that will enhance the safety and efficiency of modern air travel.

ACARS is a transmission mode, somewhat like Packet radio, which is sent in short bursts at 2400 baud (bits per second). A typical ACARS transmission lasts well under 1/2 of a second. ACARS uses AM (amplitude modulated) aircraft radios. ACARS transmissions may be heard on (MHz):

131.550 Primary USA/Canada	131.725 Primary Europe
130.025 Secondary USA/Canada	131.450 Primary Japan
129.125 Tertiary USA/Canada	131.475 Private <i>Air Canada</i>

These VHF communications are generally "line of sight" where one of the radio antennas (usually the one on the airplane) is several thousand feet high. Unless you are located fairly near to a major airport it is not likely that you will receive any ACARS traffic other than transmissions from aircraft.

The ACARS system has fairly sophisticated error detecting capabilities with positive control over message integrity. The receiving station will respond with a signal indicating whether or not each transmission was received correctly. If a message is found to contain errors the receiving station demands a repetition of the same transmission until it is correctly received.

In the full ACARS implementation there are three distinct levels of detecting a reception error: at the individual bit level, the character level and the message level. When absolute accuracy is essential (on an airliner) an error at any level will cause the received message to be scrapped and will trigger a request for repetition. The M-400 tests for errors at the bit level and will decode and display the ACARS message until either a bit error is detected or the message is completed. This format permits you to monitor the greatest amount of ACARS traffic with the least amount of displayed garble. You will note that some ACARS messages will not be displayed in their entirety. You will also find that the unit will occasionally print a line of gibberish (not that a correctly received ACARS transmission is ever 'plain text'). The system that the M-400 uses is the best compromise in terms of percentage of valid data presented. It would be very nice for us (and you) if the M-400 could request a repetition when an error was detected, but this feature would likely upset the major air carriers!

The extremely high data rate of the ACARS transmission requires the use of the Burst text display mode. The DATA LED will illuminate during the reception of an ACARS transmission. As indicated above, however, these transmissions are very brief and so the illumination of the DATA LED is sometimes merely a flicker.

To select the ACARS mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until ACARS appears on the screen. Press the **FUNCTION** button. The unit is now operating in the ACARS mode.

ACARS transmissions are usually very cryptic and highly abbreviated. They will, at first glance, seem indecipherable, even to those with an understanding of aviation. Over thirty ACARS message types are utilized. A typical message is shown below with an analysis of its meaning.

OUT/FUEL REPORT (QA)

The "QA" or OUT/FUEL report, indicates total fuel boarded (in pounds) and total fuel on board as the plane leaves the gate. (Not fuel at takeoff).

N150UA QA
3903UA0807SFO2124406313084)

Tail Number N150UA
Message Type QA
Time 2124Z
Fuel Boarded 4063 Lbs.
Fuel Quantity 13084 Lbs.

Origin San Francisco
Flight Number United 0807
Transmission time 3903 in minutes and seconds after the hour. In this case 39 mins and 3 seconds after 21:00Z.

Contact Universal Radio for further reference material on ACARS. Digital Electronic Systems and Universal Radio wish to thank Ed Flynn for his assistance with the ACARS mode.

14. PAGER MODES

Pagers have been developed using a variety of different signal decoding methods. Some of these include two-tone sequential and DTMF. These signals could simply cause the pager to beep, or they could then be followed by a voice message which would be heard only on the pager whose code had been sent. This allowed a large number of customers to be placed on the same frequency without interfering with one another.

While tone only and voice pagers are still in common use, the trend is toward digital pager signaling and message delivery. The M-400 is capable of decoding two of the most widely used digital paging codes: POCSAG and GOLAY. These codes do not use tones to signal the pager, but rather transmit digital data which directly modulates the RF carrier. These codes can be used to address a specific pager to simply beep, to enable the transmission of a voice message, or to directly enter a message into the pager which may then be read by the user. These digital messages fall into two categories, numeric only and alpha-numeric. The numeric-only messages require considerably less data, hence air-time, than do the alpha-numeric messages. The alpha-numeric can actually spell out a message to the pager, while the numeric only is limited to sending a series of digits (usually the telephone number the paged person is to call). Both digital pager formats have the capability of simply signaling the pager to beep, with no data message at all, or in conjunction with an audio voice message.

Every pager has a unique address which identifies it from other pagers sharing a common frequency. This address is digitized and transmitted to the pager. The address that the M-400 displays is a representation of this digitized information and not the address as would be entered on a paging terminal. This address information is presented as incidental information for the listener to analyze repetitions of a signal to a specific pager. It is not intended to be a means of determining the identity of the paged individual, or for any other investigative purpose.

Many of the paging services in operation today use a combination of several different signaling formats. It is not unusual to hear a two-tone sequential voice page followed by a GOLAY signal followed by a DTMF and then a POCSAG page. The M-400 will process only those pages which are in the format that the mode is set to.

The interception of pager modes *by private individuals* may be forbidden in certain areas. Check with your local authorities. The misuse, recording or publication of such traffic would certainly be prohibited anywhere.

The vast majority of digital paging messages consist of telephone numbers. Some of these will appear in the standard "555-1234" format, but there are many variations on this. Sometimes the hyphen is left out ("18005554578") or an extension number is added ("5557382-438"). A limited number of alpha characters are included in the 'numeric only' pager formats. This allows for a designation of an urgent message or call by adding an R or UR after the phone number. Other times the extension will be used to indicate priority ("555-4821 911"). Not all pages are composed of telephone numbers. The digital page may also be used to send authorization codes, part numbers or any other type of numerical message.

15. POCSAG

A POCSAG page signal is displayed on the screen by showing the six digit address indicator followed by an equal sign (=) and then a letter indicating the type of page:

- B** indicates a beep only
- #** indicates a numeric message
- A** indicates an alpha-numeric message

In the case of the numeric and alpha-numeric pages, the type indicator is followed by the page information. It is possible to have a data page with the information fields empty.

To select the POCSAG mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until the screen displays:

POCSAG NOR

Note: The screen may indicate REV rather than NOR.

Press the **FUNCTION** button. The unit is now operating in POCSAG mode.

The polarity of the pager signal is also of critical importance. As a result, the **SENSE** key is used to invert the digital signal, if necessary. The setting of this function to NOR or REV is a function of the sending station's equipment and the receiver's discriminator and audio circuits. If the sense is incorrect there will be no output. The **DATA LED** indicates valid data. Don't overdrive it.

16. Super POCSAG

While standard POCSAG mode transmits at a rate of 512 bits per second (bps), Super POCSAG is sent at 1200 bps. In all other respects the specifications of the two modes are identical. The Super POCSAG signals, therefore, have a similar sound and rhythm to standard POCSAG, but the cadence is faster and "tones" appear higher in frequency.

In addition to the higher data rate, it has been noted that services which use Super POCSAG tend to pack a greater number of pager signals into each transmission. As a result of this increased traffic density, the average throughput on a Super POCSAG station is generally greater than the increase in data speed would indicate. In spite of the large buffers in the M-400, the tremendous amount of data traffic possible on a Super POCSAG channel can quickly over-run the LCD display buffer and rapidly out-pace even a high-speed dot matrix line printer. Just as in any other mode, or with any other device, an over-run of the available buffer(s) will result in lost data.

To select the Super POCSAG mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until the screen displays:

SUPOCS
NOR

Note: The screen may indicate REV rather than NOR.

Press the **FUNCTION** button. The unit is now operating in the Super POCSAG mode.

The polarity of the pager signal is also of critical importance. As a result, the **SENSE** key is used to invert the digital signal, if necessary. The setting of this function to NOR or REV is a function of the sending station's equipment and the receiver's discriminator and audio circuits. If the sense is incorrect there will be no output. The **DATA** LED indicates valid data. Don't overdrive it.

17. GOLAY

The Golay, or more properly Golay sequential code, is another commonly used pager signaling system. The Golay pages are displayed on the screen by printing the eight digit address. If the page is beep only there is no indication other than the address. A numeric page address is followed by an equal sign (=) and then the numeric data. Alpha-numeric page addresses are followed by a colon (;) and then the page information on the following line. Again, it is possible to have a numeric or alpha-numeric page with an empty data field.

To select the GOLAY mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until the screen displays:

GOLAY
NOR

Note: The screen may indicate REV rather than NOR.

Press the **FUNCTION** button. The unit is now operating in the POCSAG mode.

The polarity of the pager signal is also of critical importance. As a result, the **SENSE** key is used to invert the digital signal, if necessary. The setting of this function to NOR or REV is a function of the sending station's equipment and the receiver's discriminator and audio circuits.

18. CTCSS (PL)

Continuous Tone Controlled Squelch System (CTCSS) is sometimes also referred to as Private Line (PL). The "squelch" on a radio is a circuit which turns off the audio to the loudspeaker in the absence of a received signal. This prevents the unwanted noise from being heard by the user. Typical squelch circuits rely on either signal strength or detected noise level measurements to determine when the audio should be switched. With either of these methods, the only requirement to open the squelch is a signal of adequate strength on the receiver's frequency.

As the demand for radio communications increased, transmitters using the same frequency were placed closer together and many users were forced to share frequencies. CTCSS systems were developed so that the users sharing a frequency would not hear messages intended for someone else. This same CTCSS would also minimize the effects of interference from nearby services on the same frequency.

Here is how it works: Along with the voice information, each transmitter sends a continuous sub-audible tone. These tones are not nearly as loud as the voice modulation and are limited to the frequency range of 67 Hz to 257 Hz. Since the voice spectrum occupies mainly the range from 300 to 3000 Hz, these tones can be easily filtered at the receiver and thus not heard. Each receiver in turn is equipped with a decoder which will turn on the speaker audio only if the proper tone is detected. The various users sharing a common frequency are assigned discrete CTCSS tone frequencies and as a result will not hear those transmissions using another CTCSS tone.

In a typical example *Ace Plumbing*, *Bill's Collection Service*, *Larry's Lumber* and *Acme Trucking* will all use the same frequency, or the same radio repeater. All of *Ace Plumbing* trucks, as well as the dispatch radio at the office will be set for 74.4 Hz; *Bill's* will use 82.5 Hz; *Larry's* delivery truck will be set to 91.5 Hz and *Acme* will be at 107.2 Hz.

A similar situation in a neighboring town using the same repeater frequency could set up four users with the tones: 67.0, 77.0, 97.4 and 118.8 (again, just examples). In this case each of the services in the above example can operate on the same frequency in a semi-private fashion without interfering with one another.

There are often many more than four users sharing a common frequency or repeater, but the principal remains the same. The properly equipped receiver will remain quiet (muted) unless the correct tone is decoded.

DECODING CTCSS CODES

There are 41 standard CTCSS tone frequencies in use. When the M-400 is set to the CTCSS mode, the upper left LCD screen will display the tone being received. This is not a frequency counter mode. You will note that the standard tones are specified to the nearest 1/10 of a Hz. In order to obtain accurate frequency counter readings to 0.1 Hz, the signal must be sampled over a ten second period.

The M-400 uses a digital signal evaluation which will analyze the sub-audible tone frequency and display the standard CTCSS frequency nearest to the detected tone. This digital signal evaluation is capable of resolving the correct CTCSS value within 18 cycles of tone signal. Depending upon the actual tone frequency, this time can range from 70 to 250 milliseconds.

While this system is very reliable and accurate (it has been used successfully for many years in commercial radio-telephone equipment), the CTCSS display should not be used to set or align CTCSS tone generators.

Chapter 21 Programming, describes how you can store up to ten individual CTCSS tones in the decoder memory. If this is done and the speaker mute is set to AUTomatic, then the M-400 can turn off the speaker relay unless one of the programmed tones is detected.

To select the CTCSS mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until CTCSS appears on the screen. Press the **FUNCTION** button. The unit is now operating in the CTCSS display mode.

If a printer is connected a printed report of detected codes will be produced. It will be 13 columns wide. The decoded value will print every time it is detected. A typical report (with two PL's in use) would look like:

```
203.5 203.5 203.5 203.5 203.5 203.5 203.5 179.9 179.9 179.9 179.9 179.9 179.9
179.9 203.5 203.5 203.5 203.5 203.5 179.9 179.9 203.5 203.5 203.5 203.5 179.9
179.9 203.5 203.5 203.5 203.5 179.9 179.9 203.5 203.5 203.5 203.5 179.9 179.9
```

Note: Due to the varying low frequency roll-off characteristics of various receivers, you may not obtain valid readings on the lower frequency tones. If the radio won't pass it (to the record/speaker jack), the M-400 cannot read it.

19. DCS (DPL)

Digital Coded Squelch (DCS) is sometimes also referred to as Digital Private Line (DPL). DCS is implemented in radio systems for the exact same purpose as the CTCSS system described in the preceding section. The implementation of DCS is also very similar to CTCSS in that they are both sub-audible signals. Rather than using a separate tone for each user, the DCS system uses a synchronous 23 bit digital code word which is directly modulated on the radio carrier at a 135 baud rate. This equates to a maximum data tone of around 68 Hz, well below the voice frequency band and like the CTCSS signal, at a modulation level well below the voice signal.

Nine bits of the 23 bit code word are determined by the three octal digits that comprise the DCS code. Three other bits are of a set pattern while the remaining 11 bits are check bits. The three octal digits (nine binary bits) are capable of uniquely describing 512 codes. Due to the nature of the synchronous signal and the combination of data and check bits, virtually every one of the 512 codes has a bit pattern which is identical to at least one of the other 511 codes. This happens when you begin to decode at different points on the continuous bit stream and is referred to as aliasing.

Some of the DCS bit patterns have as many as four aliases. There are a few DCS codes which have been found to be unreliable because their bit patterns contain frequency components which are below the response limits of most receivers. (A long string of bits of the same polarity starts to become DC.) After eliminating the superfluous aliases and otherwise unusable codes from the original 512 patterns we are left with 104 'standard' DCS codes. These are listed in *Appendix C*. The M-400 evaluates the incoming sub-audible bit pattern for a match with one of the DCS codes listed in this table. Aliases (i.e. DCS codes other than those listed in *Appendix C*) will be neither decoded nor displayed.

Since the DCS code is a direct binary code, the decoding is dependent upon the polarity of the received signal. The **SENSE** button is used to select the proper polarity for DCS decoding. Many of the DCS codes will convert to another DCS code if the signal is inverted. This is not true in all cases. How do you know if the DCS code you are detecting as 051 is actually 051 normal or 032 reversed? There are two methods of determining the answer to this question. You can ask one of the technical personnel at the service you are receiving and hope that someone will both know and share that information with you. Or you could just toss a coin because it really does not matter. If you want to program a memory to turn on the speaker relay upon detection of a particular DCS code, you can rest assured that a DCS bit pattern which decodes as 051 normal today will decode as 051 normal tomorrow and forever.

The M-400 displays the detected DCS code on the left upper line of the LCD screen. When the code is no longer detected either due to noise, distortion or loss of signal, this display will be cleared. *Chapter 21 Programming*, describes how you can store up to ten individual DCS tones in the decoder memory. If this is done and the speaker mute is set to AUTOMATIC, then the M-400 can turn off the speaker relay unless one of the programmed DCS codes is detected.

To select the DCS mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until the screen displays:

DCS
NOR

Note: The screen may indicate REV rather than NOR.

Press the **FUNCTION** button. The unit is now operating in the DCS display mode.

Just like with CTCSS, if a printer is connected, a printed report of detected codes will be produced. It will be 13 columns wide. The decoded value will print every time it is detected.

20. DTMF

Dual Tone Multi Frequency (DTMF) is a signaling method developed to replace the pulse (rotary) dialing system in telephone applications. Instead of each digit of a telephone number being represented by a series of current pulses, digits are converted into a pair of tones. DTMF uses eight discrete tones which are divided into two groups of four frequencies. Four of the tones correspond to the row and four to the columns of a 4x4 (16 digit) array. The simultaneous transmission of a pair of these tones uniquely identifies the row and column location of a single digit in the array.

The application of DTMF signaling (also called Touch Tone) has expanded from telephone applications to a variety of other communication systems including telemetry, two-way radio and pager systems. While most telephones only support 12 (3x4) of the DTMF digits, many of these other systems utilize the all 16 digits of the DTMF array. (The additional four digits, referred to as the 'fourth column' are A, B, C and D.) The M-400 will decode all 16 DTMF digits.

DTMF signaling is normally sent as a string of DTMF digits spaced fairly close together. The M-400 will display a group of digits together on one display line as long as the time between digits does not exceed 1000 milliseconds (1 second). If there is a pause between successive digits in excess of 1 second, then subsequent digit(s) will be displayed on a new line. In order for the M-400 to match a decoded string of digits with a programmed DTMF memory all of the digits must be spaced no more than 1 second apart.

Note: Typical automated DTMF signaling is sent at a rate of ten digits per second: 50 millisecond tone + 50 millisecond pause per digit.

The DATA LED will illuminate whenever a DTMF digit is being decoded. This LED will stay on as long as the two tones corresponding to a digit are detected. This LED can be used to as an indicator when setting the LEVEL control: The DATA LED should blink whenever a string of DTMF digits is being received.

Chapter 21 Programming, describes how you can store up to ten individual DTMF digit sequences in the decoder memory. If this is done and the speaker mute is set to AUTOMATIC, then the M-400 can turn off the speaker relay until one of the programmed digit sequences is detected. The speaker relay may then be turned off automatically at the end of a specific time period or manually by pressing the **SENSE** button.

To select the DTMF mode, press the **FUNCTION** button. The currently selected mode of operation should appear at the upper left of the LCD screen. Use the **UP** or **DOWN** buttons to step through the various operating modes until DTMF appears on the screen. Press the **FUNCTION** button. The unit is now operating in the DTMF display mode.

21. PROGRAMMING

■ PROGRAMMING MODE MENU

To perform special programming for the M-400 the programming menu must be accessed. While the unit is in the normal (text) mode, press the **FUNCTION** button two times. The LCD will show:

Press "SENSE" for
Program Mode Menu

Press the **SENSE** button, the screen will display the opening programming menu selection:

Default Mode

Note: While the Programming Mode is being accessed, all data reception and decoding is halted.

Pressing the **UP** and **DOWN** buttons will step through the various programming menu major selections of:

Default Mode
Default Scroll
Mute Timer
CTCSS Codes
DCS Codes
DTMF Codes
FAX Printer
Default Mode

Any time one of these major menu headings (without any other text on screen) is displayed, pressing the **FUNCTION** button will return the M-400 to the **TEXT DISPLAY** mode. In order to access a function under any of these headings you must press the **SENSE** button. When the **SENSE** button is pressed the lower line of the screen will become active. When the activity of the selected menu option is complete, the bottom line of the screen will become blank again. When the lower line is blank, pressing the **FUNCTION** button returns to **TEXT DISPLAY**.

■ PROGRAMMING THE DEFAULT MODE AT POWER UP

This menu selection determines the mode of operation that the unit will operate in when it is *first* turned on. In order to do this, first set the M-400 to the desired mode of operation. (Yes, you must first exit the Programming Mode to do this.) Starting from power-on you would press **FUNCTION** once to get into the Mode Select. Using the **UP** and **DOWN** buttons, select the desired mode. Also remember to set the proper speed, shift, and sense. Then press **FUNCTION** two times until you see:

```
Press "SENSE" for
Program Mode Menu
```

Press the **SENSE** button, the screen will display:

```
Default Mode
```

Now simply press the **SENSE** button again. The screen will indicate:

```
Default Mode
*** Stored ***
```

After a few seconds the screen will automatically return to the TEXT DISPLAY mode.

Please note that storing the default mode also saves the setting of the speaker control (on/off auto/manual) and the UOS feature. If you would like a particular speaker control or UOS setting at power-on, set these features prior to storing the default mode.

■ PROGRAMMING THE DEFAULT SCROLL

Pressing the **SENSE** button under this selection provides a screen display like that in the AUXILIARY CONTROLS on page 36. This operation, however, is capable of storing the selected scroll rate in non-volatile memory. If this is done, the setting will be restored when the unit is turned on.

The **UP** and **DOWN** buttons select the desired default scroll rate.

When the desired scroll rate is displayed you may either:

Press the **SENSE** button to store the new value in temporary memory only (value will be valid *until* power is turned off) (This has the same effect as setting the temporary scroll rate in the AUXILIARY CONTROLS section).

- or -

Press the **FUNCTION** button to store this value in non-volatile memory (value will be permanent until re-programmed).

■ PROGRAMMING THE MUTE TIMER

When the speaker is set to the AUTO mode, the relay can be actuated upon the decoding of a selected CTCSS, DCS or DTMF code. In the case of the CTCSS or DCS code, the speaker relay can be deactivated when the code is no longer present. The detection of a DTMF sequence, however, must be latched. The M-400 allows the relay to turn off automatically at the end of a predetermined length of time. The setting of the mute timer determines that period.

Use the **UP** and **DOWN** buttons to adjust the time in one second steps from 0 to 99 seconds. A setting of 0 disables the timer and requires manual resetting of the speaker relay. Any other setting will determine how long the speaker relay will be active following the detection of a programmed DTMF sequence. If a second programmed DTMF sequence is detected while the relay is still active, the timer will be re-loaded with the selected time value.

The setting of this option has no effect on any mode operation other than the detection of a DTMF sequence.

When the desired time (in seconds) is displayed you may either:

Press the **SENSE** button to store the new value in temporary memory only (value will be valid *until* power is turned off)

- or -

Press the **FUNCTION** button to store this value in non-volatile memory (value will be permanent until re-programmed).

■ PROGRAMMING THE MEMORIES (Generic)

The following three menu items (CTCSS, DCS and DTMF) allow you to view and program a variety of codes in very similar fashion. The basic operation of these menu selections described here applies to all three of the menu items. The variations and specific operations will follow this generic programming description.

In order to view or program the code memories, press the **SENSE** button when the desired code type is displayed. The lower line will appear as:

```
#0 =
```

The number immediately following the (#) indicates the memory number (0-9) which is being viewed. If the selected memory has not been programmed, or was programmed but was subsequently erased, the screen to the right of the (=) will be blank. Otherwise, the value programmed into that memory will be displayed to the right of the (=). The format of the particular value will depend upon the type of code being viewed and will be described in the sections below.

Pressing the **UP** and **DOWN** buttons will step through the ten memories (0-9) allocated to each type of code. The value stored in each of those memories, in turn, will also be displayed.

If all that was desired was to browse the memories for their currently programmed values, then the **FUNCTION** button may be pressed at any point in the sequence so far to complete the current menu item operation.

In order to program a new value into a memory, first use the **UP** or **DOWN** buttons to display the memory number to be programmed and then press the **SENSE** button. When the **SENSE** button is pressed the word 'Select' will appear at the right side of the bottom line of the LCD and the area to the right of the (=) will be cleared. This indicates that the displayed memory number is ready to be programmed with a new value.

A typical display when ready to program would look something like:

```
CTCSS Codes  
#3 =                Select
```

Now for the variations on this basic programming theme:

• **Programming the CTCSS Codes**

With the 'Select' prompt on screen, use the **UP** and **DOWN** buttons to select the desired CTCSS tone to program into the displayed memory number. You can select any one of the 41 standard tones, or you may choose the blank selection, at the extreme **DOWN** end of the list. A 'blank' memory will not match any decoded tone, in essence, it is turned off.

When the desired tone is displayed, press the **FUNCTION** button to store the tone in the indicated non-volatile memory. Pressing the **FUNCTION** button will erase the 'Select' prompt and the programmed tone frequency will remain displayed.

If you should change your mind or otherwise want to abort the programming operation press the **SENSE** button at any time, prior to pressing the **FUNCTION** button. Pressing the **SENSE** button will erase the 'Select' prompt and re-display the tone stored in the indicated memory.

Once the 'Select' prompt has been cleared, the **UP** and **DOWN** buttons may be used to select, view and program other CTCSS tones or you may press the **FUNCTION** button to return to the Main Select Menu.

• Programming the DCS (DPL) Codes

The DCS codes must be entered as a three digit octal number. Each of the three digits is entered separately as follows: When the **SENSE** button turns on the 'Select' prompt, a period (.) will appear in the first digit position. To clear (erase) a DCS memory, press the **FUNCTION** button at this time (with the period displayed in the first digit position).

Use the **UP** and **DOWN** buttons to select the desired digit (remember these are octal numbers so you only have 0 to 7 to choose from) and press **SENSE** to freeze the first digit. A period (.) will now appear in the second digit position. If you press the **SENSE** button with the period displayed in the first or second digit positions, the period will change to the digit '0'.

Again use the **UP** and **DOWN** buttons to select the second digit and then press the **SENSE** button. The selected second digit will be frozen and a period will appear in the third digit position.

Once again, use the **UP** and **DOWN** buttons to select the third digit. When all three digits have been properly entered, press the **FUNCTION** button to store the selected DCS code into the displayed non-volatile memory number. The 'Select' prompt will be erased and the newly programmed DCS code will remain displayed for the selected memory number. Pressing the **FUNCTION** button with a period in the third digit position will change the period to a '0' and then store the DCS code.

To abort the DCS memory programming operation, press the **SENSE** button during the third digit selection. The 'Select' prompt will be erased and the screen will re-display the DCS code stored in the indicated memory. If you decide to cancel the operation at any time, simply press the **SENSE** button until the 'Select' prompt disappears.

The **FUNCTION** button has no effect on DCS programming except when the period is displayed in the first digit position, or when the third digit has been selected.

It is possible to store any of the 512 three digit octal codes in the DCS memories. The M-400, however, will only decode the 104 'standard' DCS codes listed in *Appendix C*. Storing a code other than one of those on the list will have no effect other than to occupy a memory location. It won't hurt anything, but there will be absolutely no benefit either.

Once the 'Select' prompt has been cleared, the **UP** and **DOWN** buttons may be used to select, view and program other DCS tones or you may press the **FUNCTION** button to return to the Main Select Menu.

• Programming the DTMF Codes

The DTMF decoder can be programmed to recognize a string of DTMF digits up to eight digits long. Programming DTMF codes uses a procedure very similar to that for DCS codes. When the 'Select' prompt turns on a period (.) also appears in the first digit position of the DTMF code.

For any of the eight digit positions, use the UP and DOWN buttons to select the desired DTMF digit for the indicated position. The available digits are:

. 0 1 2 3 4 5 6 7 8 9 A B C D * #

A note now about the (.) When the period is selected as one of the digits in a DTMF code it becomes a "don't care" or "wild card" digit. That is, it will match any DTMF digit received in that position. The "don't care" digit is displayed as a (.) when it is being selected (so you do not lose track of the digit position being selected) but is displayed as a blank space () when displayed in the context of a DTMF digit string. If a DTMF code memory contains all "don't cares" then that memory is disabled.

Again, simply use the **UP** and **DOWN** keys to select the value of the DTMF digit. When the desired digit is displayed, press the **SENSE** button to freeze that digit and the period will appear in the next digit position.

After you have selected the desired value of the last DTMF digit for the selected memory press the **FUNCTION** button to store the displayed DTMF code in non-volatile memory. Remember that the DTMF code can be any number of digits from one to eight. If you inadvertently press the **SENSE** button after the last desired digit, the period will appear in the next digit position. Unless you pressed **SENSE** for the eighth digit (which cancels the operation) simply press the **FUNCTION** button with the period showing. (All unused DTMF digit positions are set to the "don't care" value anyway.)

If you want to cancel the DTMF code programming, press the **SENSE** button when the eighth digit is being selected. (Repeatedly press the **SENSE** button until the 'Select' prompt disappears.)

To 'erase' a DTMF code from a memory, simply press the **FUNCTION** button with the period in the first digit position.

■ PROGRAMMING THE PRINTER PORT

The M-400 is capable of generating the FAX output in a format tailored for Epson compatible printers with either 8 pin (also 9 pin) or 24 pin print heads. This menu item allows you to select the output format which is compatible with your printer.

Pressing either the **UP** or **DOWN** buttons will toggle the selection between 8 and 24 pins. Pressing the **SENSE** button will store your selection in temporary memory only (selection will be lost if power is turned off). Pressing the **FUNCTION** button will save the printer selection in non-volatile memory; it will remain in effect until re-programmed.

22. AUXILIARY CONTROLS

This mode features a screen which displays the setting of the speaker mute relay and Burst format scroll rate. It will look something like this:

```
Speaker MAN = OFF
Scroll Rate = 5.0 S
```

The first line deals with the SPKR OUT jack. Pressing the **SENSE** button will step through the four available speaker relay settings of:

MAN = OFF, MAN = ON, AUT = OFF and AUT = ON

MAN Indicates that the relay will operate manually only. You can set it ON to pass all audio to the SPKR OUT jack. You can set it OFF to disengage the SPKR OUT jack.

AUT Indicates that the relay will operate automatically upon detection of a programmed CTCSS, DCS or DTMF code.

ON Indicates the relay is currently on (passing audio)

OFF Indicates the relay is currently off (not passing audio)

Note: When the relay changes you will hear a distinct *click*. This is normal.

The second line deals with the scroll rate during the Burst display method. Pressing the **UP** or **DOWN** buttons will increase or decrease the scroll rate in 1/2 second steps within the range of 0.0 to 19.5 seconds. A setting of 0.0 eliminates any delay from the Burst display method. The example above indicates a delay of 5 seconds. Any other setting indicates the minimum length of time between successive new line scrolls to the display. The setting of this value has no effect on the display in the Text or Direct formats. The scroll rate setting which is selected here will remain in effect as long as there is uninterrupted power to the M-400. When the unit is turned on a default value is loaded from non-volatile internal memory. This non-volatile default value may be altered in one of the Programming Mode Menus.

After the speaker relay control and scroll rate have been set to the desired values, press the **FUNCTION** button to return the M-400 to the TEXT DISPLAY mode.

The speaker control may be made permanent (non-volatile) by making this setting prior to storing the default mode. See page 30 for details.

```
U.O.S. = OFF
```

Pressing the **SENSE** button will toggle the Unshift On Space feature ON and OFF. When the desired setting is displayed, press the **FUNCTION** button. The UOS control may be made permanent (non-volatile) by setting this to the desired state prior to storing the default settings. See page 30 for details on storing the default settings.

23. MISCELLANEOUS NOTES

◆ While in the Programming mode, you can change settings without making the changes permanent. The **SCROLL RATE**, **MUTE TIMER** and **FAX PRINTER** parameters may be changed on a *temporary* basis for experimentation or for other reasons without making those changes permanent. After the desired value has been selected in accordance with the Programming mode directions, press the **SENSE** button rather than the **FUNCTION** button. The newly selected value will remain in effect until the M-400 is turned off. When the unit is turned back on, the permanent values will be restored.

◆ You can change the speed without changing the mode. Pressing **FUNCTION** twice while in text mode will display the programming mode prompt. In order to alter the mode, speed or shift, some key *other than FUNCTION* must be pressed while the screen is displaying the current mode setting. To change a parameter (shift or speed), without changing modes:

1. Press **FUNCTION** button for mode display
2. Press **SENSE** button twice.¹
3. Press **FUNCTION** button to access shift and speed setting

¹ If the sense is not displayed, then one press of the **SENSE** button will do.

This method allows you to quickly select among the four main screen formats without the need to cycle through every sub-section of each format.

APPENDIX A DTMF FREQUENCIES

	Col 0	Col 1	Col 2	Col 3
Row 0	1	2	3	A
Row 1	4	5	6	B
Row 2	7	8	9	C
Row 3	*	0	#	D

Low Group	High Group
Row 0 = 697 Hz	Column 0 = 1209 Hz
Row 1 = 770 Hz	Column 1 = 1336 Hz
Row 2 = 852 Hz	Column 2 = 1477 Hz
Row 3 = 941 Hz	Column 3 = 1633 Hz

APPENDIX B STANDARD CTCSS CODES

67.0	97.4	136.5	192.8
71.9	100.0	141.3	203.5
74.4	103.5	146.2	206.5
77.0	107.2	151.4	210.7
79.7	110.9	156.7	218.1
82.5	114.8	162.2	225.7
85.4	118.8	167.9	229.2
88.5	123.0	173.8	233.6
91.5	127.3	179.9	241.8
94.8	131.8	186.2	250.3
			256.3

Values shown are audio frequencies in Hz.

APPENDIX C STANDARD DCS CODES

023	114	205	306	411	503	703
025	115	212	311	412	506	712
026	116	223	315	413	516	723
031	122	225	325	423	523	731
032	125	226	331	431	526	732
036	131	243	332	432	532	734
043	132	244	343	445	546	743
047	134	245	346	446	565	754
051	143	246	351	452		
053	145	251	356	454	606	
054	152	252	364	455	612	
065	155	255	365	462	624	
071	156	261	371	464	627	
072	162	263		465	631	
073	165	265		466	632	
074	172	266			654	
	174	271			662	
		274			664	

APPENDIX D ADDITIONAL REFERENCES

GUIDE TO UTILITY STATIONS

By J. Klingenfuss. The very best guide to non-broadcast stations in the world. 19,549 frequencies and 3590 call signs. Aero, maritime, military, diplomatic, research, time stations and more. Covers SSB, CW AM and exhaustive RTTY with new modes. Includes *Guide to World RTTY Stations*. 537 p.

GUIDE TO FACSIMILE STATIONS

By J. Klingenfuss. The best book we have seen on the exciting world of FAX monitoring. It covers equipment, techniques, formats, frequencies, abbreviations and schedules. Very up to date and comprehensive. Also includes many interesting sample facsimile photos. ©Klingenfuss Publications. 392 p.

MODULATION TYPES ON COMPACT DISK

By J. Klingenfuss. Noted author Joerg Klingenfuss has brought forth his 25 years of monitoring experience to produce this audio CD set of 71 emission types. This 2½ hour, two CD set allows rapid access to the typical sound of all conventional and exotic shortwave transmission modes.

AIR & METEO CODE MANUAL

By J. Klingenfuss. Learn to decode content and origination points of the extensive RTTY meteorological broadcasts. Detailed descriptions of WMO GTS message formats with many decoding examples. 10,000 meteorological stations are listed in numerical order. ©Klingenfuss Publications. 374 p.

RADIOTELETYPE CODE MANUAL

By J. Klingenfuss. A technical review of RTTY alphabets including: Arabic, Chinese, Korean, Japanese and Russian Cyrillic. Explains new RTTY transmission modes including ARQ, ARQ-E, FEC, VFT, Sitor, Piccolo plus major CW alphabets. For advanced RTTY enthusiasts. ©Klingenfuss Publications. 144 p.

WORLD PRESS SERVICES FREQUENCY LIST & MANUAL

By Thomas Harrington. Lists English RTTY press stations. Three different master frequency lists: by time, by frequency and by country. Chapters also review antennas, receivers and RTTY equipment. The original world press services book. Includes supplement. Fifth Edition ©1992 Universal Electronics 84 p.

UNDERSTANDING ACARS

By Ed Flynn. ACARS stands for *Aircraft Communications Addressing and Reporting System*. This VHF teletype mode is used to transmit data and messages between commercial aircraft and airport ground stations. This book will help you intercept and understand this interesting traffic. ©1993 Universal Radio Res. 53 p.

THE U.S.S.R. MERCHANT SHIP LIST

By Jason Berri. This book list hundreds of recently monitored Soviet ships by callsign and name. Also provides information on decoding the header, and indicates ship type. An excellent secondary reference for the Soviet RTTY enthusiast. As useful before, as after the U.S.S.R. breakup. ©1991 Universal Radio Res. 72 p.

THE SOVIET MARITIME RTTY DICTIONARY

By Gary Gorka & Fred Osterman. The single largest user of Baudot RTTY on shortwave is the vast Soviet maritime fleet. Their RTTY transmissions can be monitored 24 hours a day! With this book you will be able to find, decode and understand this extensive traffic. ©1988 Universal Radio Research 102 p.

THE RTTY LISTENER RL 1 - 25

By Fred Osterman. This specialized book contains up-to-date, hard-to-find information on advanced RTTY and FAX monitoring techniques and frequencies. Shortwave and satellite topics are explored. An interesting secondary reference for the advanced radioteletype listener. ©1991 Univ. Radio Res. 222 p. 8½" x 11".

SHORTWAVE FACSIMILE FREQUENCY GUIDE

By Balneger & Schaay. A valuable reference for anyone involved in FAX. Includes a good station list organized by frequency. Also many FAX charts and photos are shown. Facsimile equipment is also briefly touched on. The book concludes with addresses for many FAX broadcasters. © Universal Electronics. 66 p.

THE HIDDEN SIGNALS ON SATELLITE TV

By Thomas P. Harrington. There is more than just TV signals coming from the domestic satellites! Read about the secret signals and hidden services on the 4 GHz satellites. For every TVRO owner or hobbyist wanting to learn more about communications satellites. Third Edition. ©1991 Universal Elect. 238 p.

THE RTTY LISTENER RL 26 - 30

Compiles Newsletters 26 to 30. ©1992 Universal Radio Research. 103 pages.

RTTY TODAY

By D. Ingram. Covers the theory and equipment of amateur and SWL radioteletype. ©1984 Univ. Elect 112 p.

TUNE SATELLITE RADIO ON YOUR SATELLITE SYSTEM

By T.P. Harrington. Receive audio programming on the satellites. Includes guide. ©1993 Universal Elect. 150 p.

APPENDIX E SPECIFICATIONS

Modes & Codes:

BAUDOT	45, 50, 57, 75 and 100 Baud.
ASCII	75, 110 and 150 Baud.
SITOR A&B	(automatically selected by AUTOR)
FEC-A	96 & 144 Baud.
SWED-ARQ	100 Baud (S, M & L groups)
FAX	120 LPM 576 IOC (to printer port only)
ACARS	Aviation mode.
POCSAG	Digital pager mode
Super POCSAG	Digital pager mode
GOLAY	Digital pager mode
DTMF	16 digits (includes 4th column).
CTCSS (PL)	41 standard frequencies
DCS (DPL)	104 standard codes

Filter Tones:

Low tone (mark = 1275).
Fixed shifts of 170, 425 and 850 plus variable.
Variable shifts of 100 to 1000 Hz in 5 Hz. steps.

Inputs:

Speaker Input	4-16 Ohms	100 MW. max.
Discriminator Input	10,000 Ohms	.25V max.

Outputs:

Parallel printer port (ASCII 8 bit Centronics standard) DB-25

Rear Panel Jacks:

11-14 VDC, Speaker Input (mini), Discriminator Input (mini),
Speaker Out (mini) and parallel printer (DB-25).

Power Requirements:

11-16 VDC at 200 M.A.

Size:

8.75" wide x 2.5" high x 8" deep.

Weight:

2 Lbs. (5 Lbs. shipping weight with transformer and manual).

APPENDIX F PAGER TUNING LEVEL SETTING

The POCSAG and GOLAY pager codes are direct digital codes (DFSK). The very low characteristic frequency of these data modes results in significant distortion of the signal due to the limited low frequency response at the speaker output of most scanners. As a result, the input level to the data recovery circuit of the M-400 is somewhat critical for proper operation. While optimum level setting will largely be a matter of trial and error, the procedures outlined below will assist in initially setting a level which will be usable.

When listening to the pager signal it is easy to distinguish between the preamble or phasing portion (which is a single tone) and the data segment (resembling a wood-pecker or machine gun). For a given level setting, these two segments of the paging signal have quite a different effect on the input level LED driver circuits.

1. Set the M-400 GAIN control fully clockwise (maximum gain). This should place the GAIN control indicator at the 6:00 position.
2. Set the audio output from your scanner to minimum (the lowest volume setting).
3. While listening to active pager signals, slowly increase the scanner output until the INPUT LED illuminates during the phasing "tones" and just barely flickers during the data portion of the page signal.
4. Set the M-400 GAIN control to the 12:00 position. Do NOT make any further adjustments to the scanner output level. This setting should approximate the correct level for proper pager reception. You may need to make slight adjustments to this setting in order to decode the pager signals. While doing this keep in mind the following:
 - a) If the steps outlined above are followed correctly, optimum level setting of the M-400 GAIN control will be between the 11:00 and 1:00 positions.
 - b) The determination of proper setting should be made by observing the DATA LED. If this LED lights, the M-400 is decoding the pager signal.
 - c) Be sure to try both the NORMAL and REVERSE sense each time you change level settings.

In some cases, improved performance may be realized by disconnecting the speaker from the receiver output. This usually results in somewhat less distortion at the speaker output. The best pager performance is obtained by using the direct detector output as described for CTCSS/DCS operation on page 42.

CTCSS/DCS DECODING

Both CTCSS and DCS occur on an FM carrier as low level (.3 to 1 kHz. deviation), low frequency (67-250 Hz.), signal ALONG WITH VOICE modulation of up to 5 kHz. deviation.

Because the voice modulation can be as much as ten times stronger than the CTCSS/DCS signal to the detector without interference from voice peaks. The M-400 uses 8 poles of low pass filtering in the CTCSS/DCS circuit to prevent voice interference. However, if the receiver's speaker output is used as a source for audio for the M-400, in CTCSS/DCS mode, the components in the speaker audio signal path will cause very great losses in the low frequency range and in effect nullify the abilities of the M-400's low pass circuitry to separate the CTCSS/DCS tones from the voice. This phenomenon is known as talk-off. For this reason the M-400 has been set up so that reliable decoding of the M-400 in the CTCSS/DCS modes will occur only when the audio source is the receiver's detector.

APPENDIX G RECEIVER CONVERSION FOR ACCURATE PL & DCS

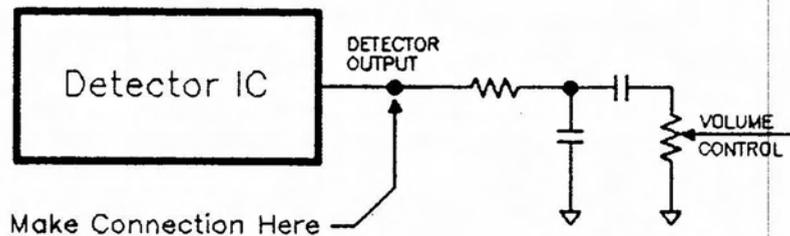
As was previously mentioned, most VHF FM receivers have circuitry that deliberately attenuate the lower audio frequencies (50-250 Hz) before they reach the speaker. This circuitry is the main cause of the M-400's (and other decoders) inability to properly decode CTCSS and DCS tones. The resolution to this problem is simply to tap into the low level audio before the de-emphasis circuit or directly at the detector output.

The modification to your receiver, to access this detector output, is very simple, but should **NOT** be attempted unless you are comfortable working on printed circuit boards. The modification:

1. Obtain the type jack you wish to use. RCA or 1/8" phone jacks (open circuit only) work equally well and will require the same size hole.
2. Disconnect power to the scanner.
3. Open up your scanner and look for the detector IC. Regardless of the brand of scanner, the detector I.C. will probably be labeled with one of the following numbers:

Detector IC	Output pin no.
3357	9
3359	10
3361	9
3362	13
3363	16

The following illustrates a detector IC and its associated de-emphasis circuit.



If you don't know how to determine which pin is which, on an IC, then you should probably not perform the conversion yourself.

4. Locate a clear spot on the rear panel of the scanner that is closest to the detector IC.
5. Drill, or punch a hole on the rear panel, at this location, to fit the selected jack. Invert the radio and shake it to remove any metal particles.
6. Mount the jack on the rear panel and connect a short wire from the detector output to the new jack. This wire does not have to be shielded. If you have difficulty locating the components associated with the de-emphasis circuit for your connection you can, **CAREFULLY**, solder directly to the output pin on the IC with a low wattage soldering iron only.
7. Inspect the scanner for proper connections and then close it up.
8. Connect the new output on the scanner to the "DISC" input on the M-400. Power it up and enjoy.
9. Note: When you are using the detector output of your receiver to drive the M-400, adjustment of the receiver's volume control will have no effect on the drive to the M-400.

APPENDIX H SEMI-CONDUCTOR LIST

IC-1	Zilog 86C93	IC-11	74HC32
IC-2	74HC573	IC-12	74HC02
IC-3	27C128	IC-13	4069
IC-4	43256 (or equiv)	IC-14	4520
IC-5	Sharp LM20A21 display	IC-15	74HC4046
IC-6	75T202	IC-16	74HC163
IC-7	74LS374	IC-17	LM324
IC-8	74HC139	IC-18,19	MF5CN
IC-9	85C82	IC-20	MF6CN50
IC-10	74HC04	IC-21	LM324

APPENDIX I LIMITED WARRANTY

Digital Electronic Systems, Inc. (herein after referred to as "Manufacturer") has tested and found each product to function properly, and within the specifications listed in the product's manual, before being shipped. Any of Manufacturer's product found to be defective in either workmanship or materials, within a period of one year from the date of purchase, by the original owner, will be, at the option of the Manufacturer, repaired, replaced or adjusted and returned to the owner, at no charge, to the original quality standard, if returned to factory by the customer pre-paid.

This warranty term does not apply to semiconductors, or displays which are warranted for 180 days. This warranty does not cover products damaged through abuse, acts of God, operation outside of limits specified in the operating manual, or modifications to the product made without permission from the manufacturer.

All transportation charges, on returned systems, whenever warranty does NOT apply, must be borne by the owner to and from the manufacturer. Transportation charges outside of the continental U.S., whether or not warranty is applicable, must be borne in both directions by the owner.

Upon receipt of equipment, the purchaser is responsible for checking the contents for damage. Any shipping damage should be referred to the carrier. Manufacturer is not responsible for any personal injury, property, or consequential damage, resulting from improper or careless installation or for usage not intended by the manufacturer.

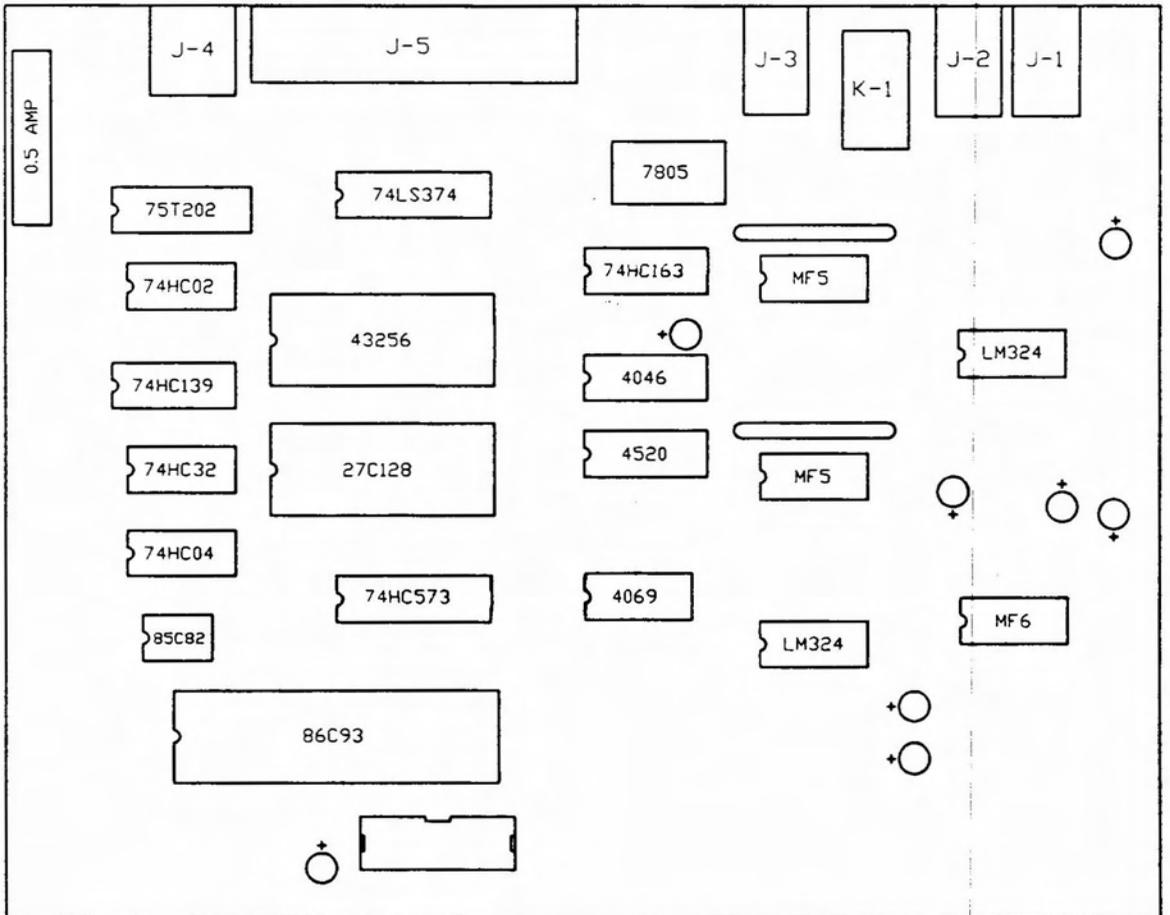
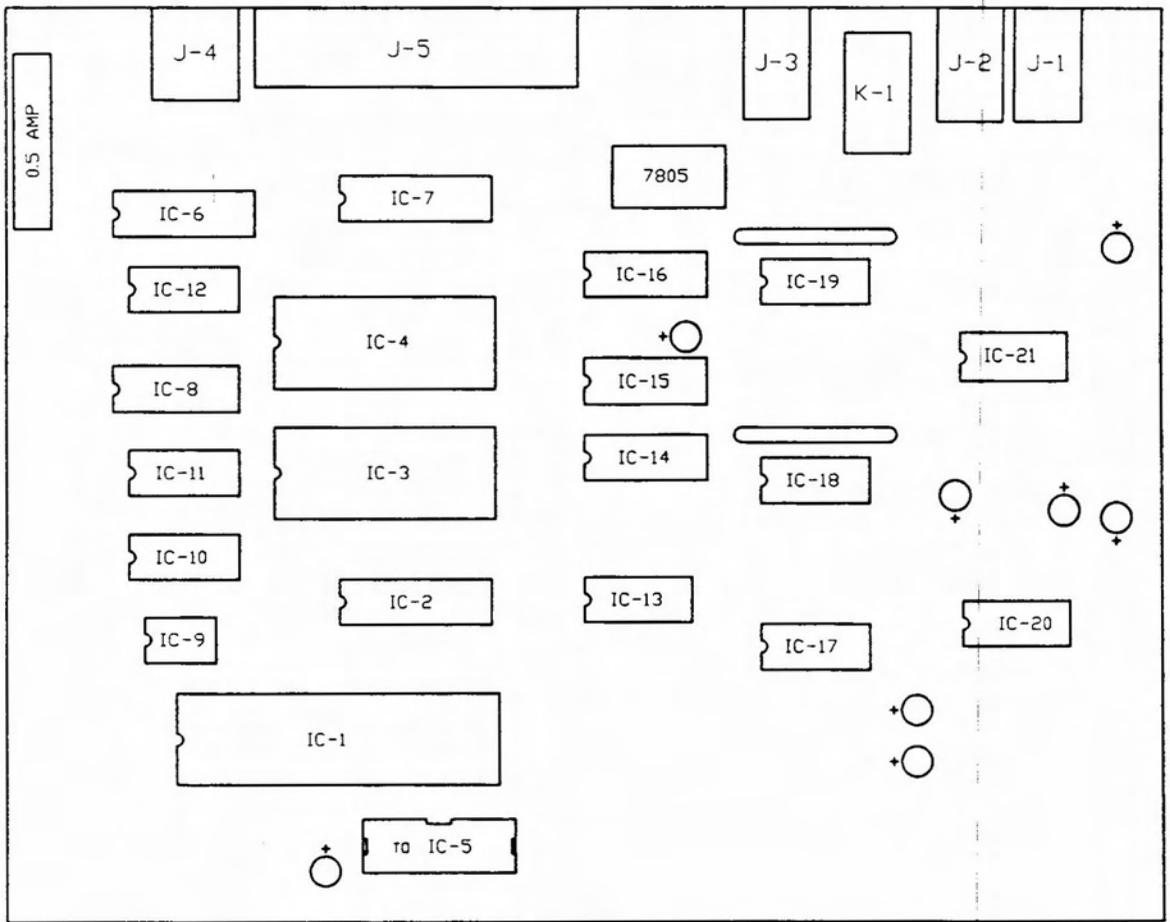
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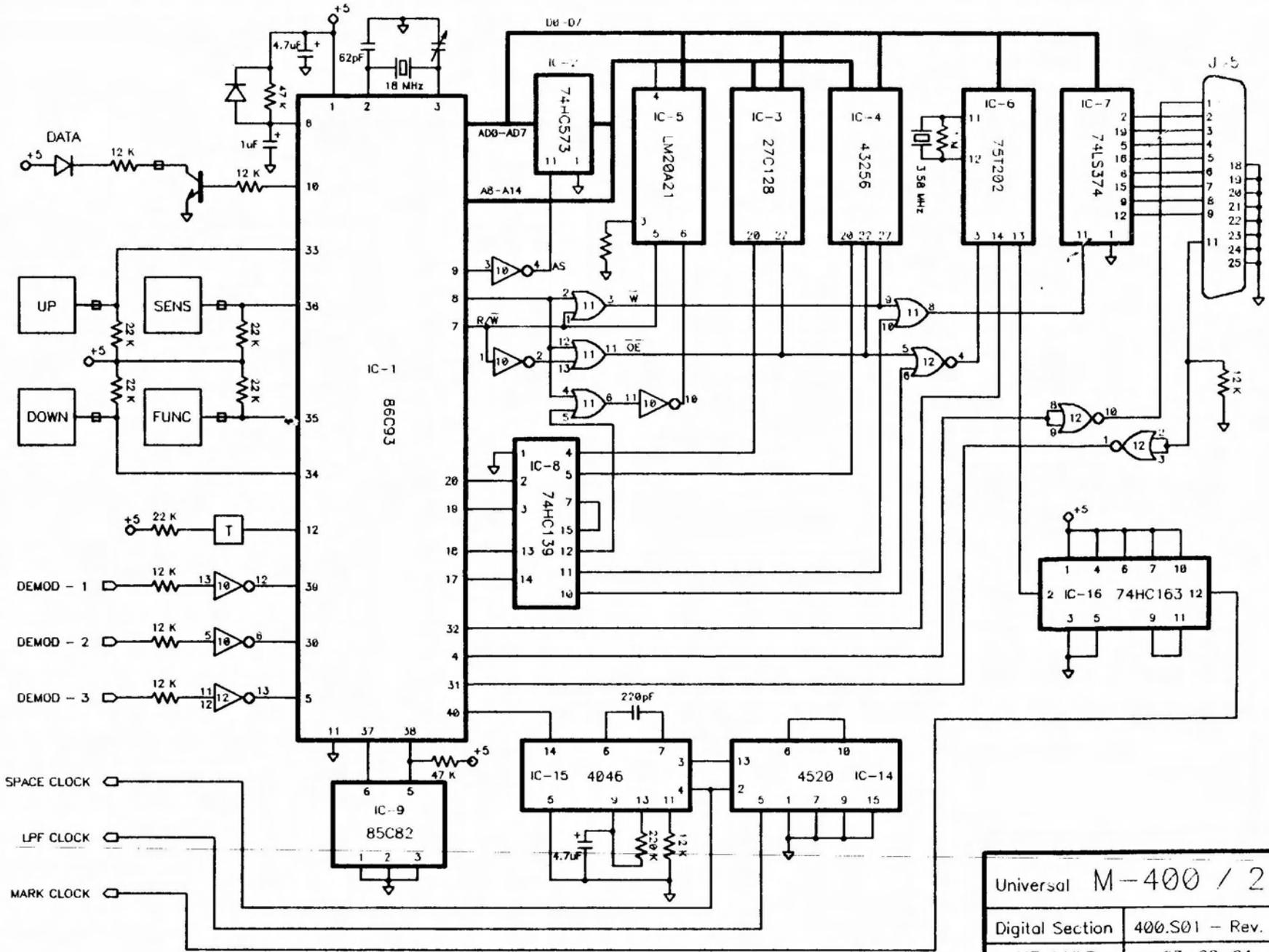
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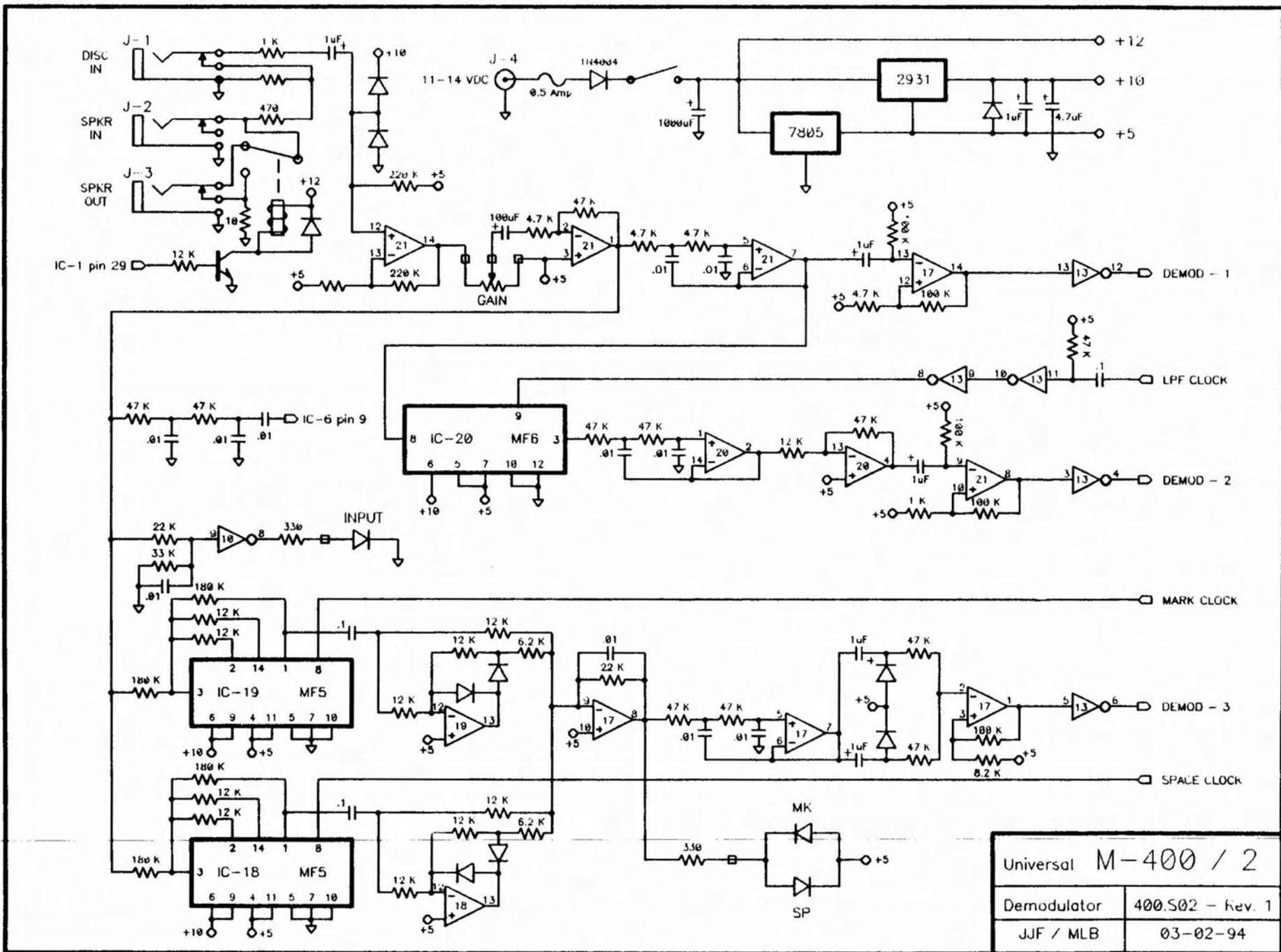
565 Paul Morris Dr.
Englewood, FL 34223
813 474-9518 Phone
813 474-9519 FAX

**APPENDIX J
SCHEMATICS**





Universal M-400 / 2	
Digital Section	400.S01 - Rev. 1
JJF / MLB	03-02-94



Universal M-400 / 2	
Demodulator	400.S02 - Rev. 1
JJF / MLB	03-02-94