The Model 305 Level Converter performs the translation of RS-232 level computer signals to TTL compatible levels as required by many transceivers. Employing a MAX232 Intergrated Circuit Level Converter, the Model 305 converts +12/-12 volt RS-232 to 0/+5v TTL levels. The Model 305 contains a 25 pin D-Sub connector for connections to a personal computer. Also provided are 5 connectors for interfacing to TTL compatible serial devices such as TEN-TEC Models 535/536 HF transceivers. Power connection is via a 2.1mm power connector. An 8-15 volt power source is required for operation. A power cable with 2.1mm connector attached is supplied with the Model 305. Also provided is a TTL serial interface cable for connection between the Model 305 and TEN-TEC Models 535/536 transceivers.

1.1 CONNECTING THE MODEL 305 LEVEL CONVERTER TO A PERSONAL COMPUTER

In order to place the Model 305 in operation, the unit must be attached to personal computer, a transceiver and a power source (see Fig. 1). To connect a power source, use the 2.1mm cable/connector combination supplied with the Model 305. To make connection from the Model 305 to a transceiver, use the shielded cable with 1/8" phone connectors provided in the Model 305 packing kit. Connecting the Model 305 to a personal computer requires a standard RS-232 serial cable (not supplied) that provides the proper connectors for the Model 305 and the personal computer. The Model 305 Level Converter requires a 25 pin male D-Sub connector. The Computer end of the cable requires a connector that mates with the RS-232 port of the personal computer. While hand built RS-232 cables could be used (see Fig. 2), inexpensive cables are available from computer and electronic dealers which will simplify installation of the unit. Also, commercially manufactured computer cables may provide additional shielding that may keep RF from interfering with proper operation of the transceiver.

1.2 THEORY OF OPERATION

RS-232 logic levels, as found on most personal computers, must be converted to TTL levels before interfacing to TEN-TEC transceivers. The Model 305 performs the RS-232 (+12/-12) to TTL (0/+5) translation with a MAX232 Integrated Circuit ,U1. Inductors L1-L4 and capacitors C1,C2,C8 are used to suppress RF interference and voltage surges that may interfere with proper operation of the level converter. IC U2, a 5 Volt regulator, regulates 8-16 volts to the 5 volts required by the unit. Power input is via connector J6, a 2.1mm power connector. RS-232 levels enter and exit via connector J7, a 25 pin D-Sub connector. TTL level signals enter and exit via connectors J1-J5 which allows up to 5 TTL serial devices to be connected to a single Model 305 Level Converter via 1/8" Phone plugs.

TEN-TEC INC.
1185 Dolly Parton Parkway
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Printed March 1994

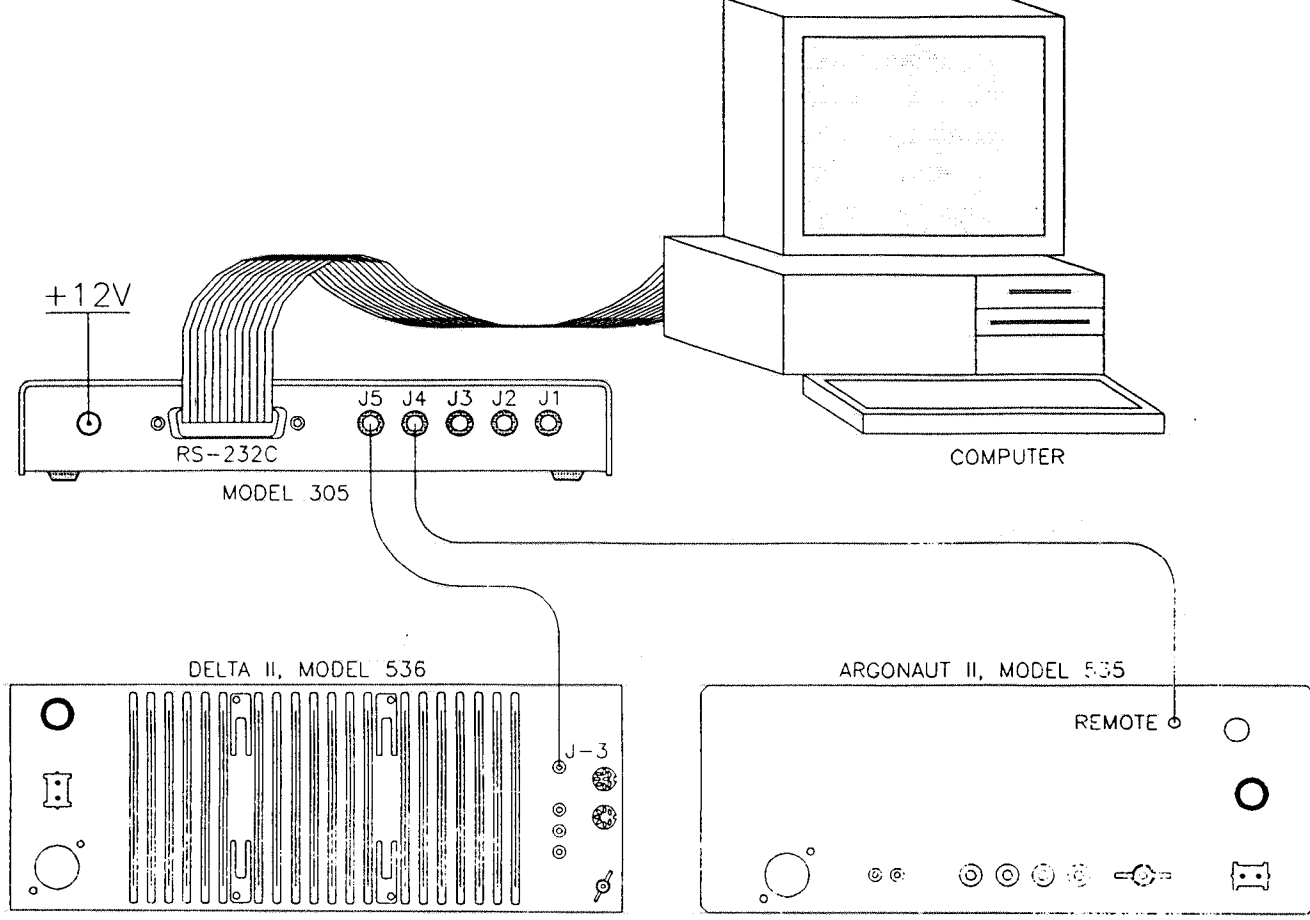


FIGURE 1: MODEL 305 CONNECTIONS TO COMPUTER AND TRANSCEIVER

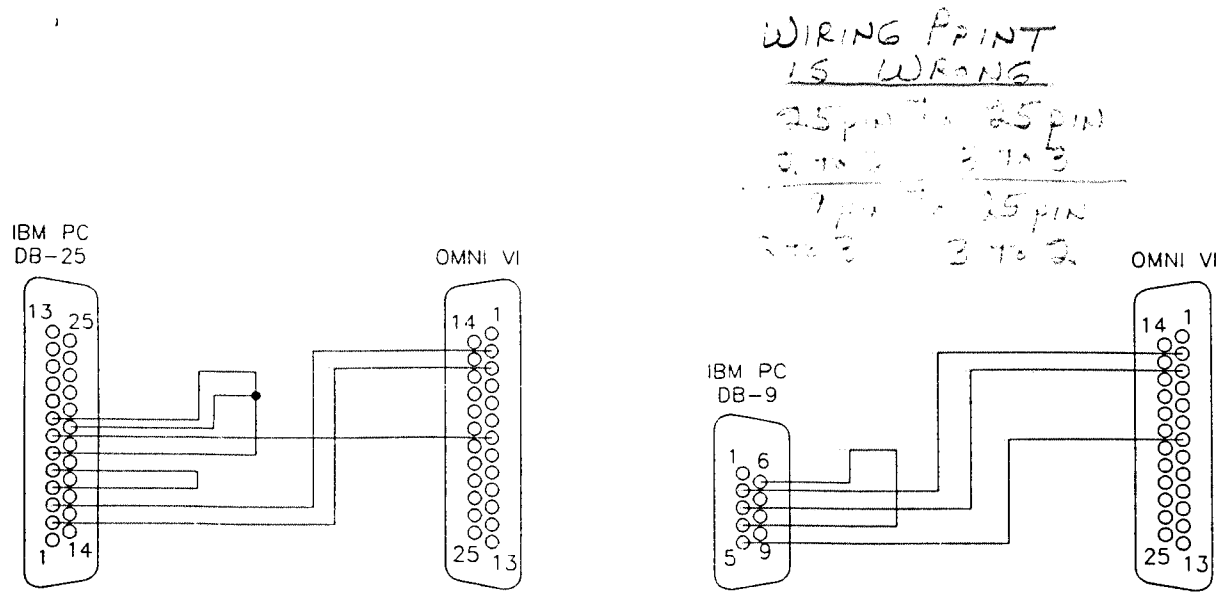


FIGURE 2: RS-232 CABLE WIRING CONNECTIONS

2.1 COMMAND/CONTROL OPERATIONS OF TEN-TEC TRANSCEIVERS

When connected to a personal computer, many transceiver operations can be controlled and/or queried remotely. Operating frequency,modes and memory selections can be controlled. There are many software packages available to control a transceiver while providing LOGGING and DATABASE features. Many of these programs are excellent and choosing one will be the quickest way to take advantage of remote transceiver operations.

The following information is supplied as reference if you choose to write your own transceiver control program. Once RS-232 levels are converted to TTL compatible levels as required by the transceiver, commands must be sent in a form that the transceiver will understand and can act upon. To communicate with TEN-TEC Models 535/536 , the personal computer must first be set-up properly. The computer's RS-232 port must be configured for 1200 baud, NO parity, 8 data bits and 1 stop bit. Since several TTL serial devices may be connected to a single serial line, each transceiver connected must have a unique identifier. If you are using a TEN-TEC Model 535/536 , this unique identifier may be set from the key pad on the radio (see your radio instruction manual). This identifier is a two digit number and the transceiver 'ADDRESS'as its called, must match the transceiver address in any software program.

2.2 COMMAND/DATA FORMATS - COMPUTER TO TRANSCEIVER

Commands and data traveling from a host computer to a transceiver or vice versa must be properly encoded if the interface is to operate properly. The commands and data are sent as strings of numbers and/ or characters that represent specific operations to a transceiver. Generally, operation involves sending a command to the transceiver and then waiting for the transceiver to respond. Depending on the command, the transceiver may respond with a string of characters indicating 'OK', meaning that the requested command has been processed. Alternately, the transceiver may respond with a string of characters indicating 'NO GOOD' to the computer, meaning that the transceiver was unable to process the request. Some commands, may result in the transceiver returning some operational information from the radio such as current frequency or mode. If a transceiver responds with a NO GOOD code, it was either because the command was not in the proper format or because the requested operation was not available on that transceiver.

The structure of the commands and responses is designed to limit the amount of data to be sent or received via the serial interface. This allows the interface to operate quickly. The general format of a command is shown below (sent left to right). Notice, that numeric codes are encoded in Hexadecimal format.

FE FE	RECEIVER ADDRESS	SENDER ADDRESS	COMMAND CODE	SUB COMMAND	DATA	FD

The FE FE at the beginning of the string is the two byte code that tells the transceiver a command is to follow. The transceiver will prepare itself to check the command to determine if it contains its address, which tells the transceiver that it is to process the command that will follow. If the RECEIVER address in the command string, does not match the transceiver's address, the command is ignored by the transceiver. (There are a few exceptions to this rule to be discussed later). The SENDER address is a code that represents the address of the computer that is sending the command. This address will be used later by the transceiver when it responds to the command request. Because the serial interface allows multiple computers to be used as well as multiple transceivers, each computer must have a unique address just as each transceiver is required to have a unique address. The default computer address used most is E0 Hex. The COMMAND CODE tells the transceiver which operation to perform. All command codes are in Hexadecimal format. Some commands contain additional Sub Commands that further clarify to the transceiver the specific operation that is to be performed. Specific codes may be found in the following pages.

The DATA portion of the command string is required by some commands. It will contain frequency or mode information if such commands are issued. The FD Hex. at the end of the command string, informs the transceiver that the end of the command has been reached. After a transceiver receives a complete command string, it will process the command.

2.3 RESPONSE STRINGS - RADIO TO COMPUTER

After a transceiver has processed a command sent from a computer, it will send a response back to the computer that originated the command. This insures that the computer knows how the transceiver handled the command and also provides a method of pacing the commands because the computer knows not to send additional commands until it has received a response from the transceiver concerning the last command sent. If a computer sends a command to a transceiver that is not a status requesting command (a command that requests data to be sent back) the transceiver will respond either with a code indicating OK (FB Hex.) or or NO GOOD (FA Hex.). The returned string will have the following format. The same general structure as described above is maintained but the transceiver is now the sender and the computer is now the receiver.

FEh FEh	RECEIVER ADDRESS	SENDER ADDRESS	FAh or FBh	FDh

2.4 DATA FORMATS

When a computer sends frequency or mode setting commands to a transceiver, the command string will necessarily contain the requested frequency data or mode code. Frequency data must be encoded as a string of BCD digits in the order shown below. Each Hexadecimal number contains 2 BCD digits and must be properly encoded for the transceiver to process them. When frequency data is requested from a transceiver, it will also be in this format.

1st byte	2nd byte	3rd byte	4th byte
10Hz 1Hz	1Khz 100hz	100Khz 10Khz	10Mhz 1Mhz

FOR EXAMPLE: The frequency 14.03567 Mhz would be encoded as follows:
70 56 03 14

Since the TEN-TEC Models 535/536 have a tuning resolution of 10 Hz, and an upper frequency limit of 30 Mhz, the 1Hz digit is ignored and attempting to go beyond 30 Mhz will generate a 'NO GOOD' response from the transceiver.

When a mode selection command is sent, the mode must be encoded according to the following table:

LSB	00
USB	01
AM	02
CW	03
FM	05

When a transceiver returns its current operating mode to a computer,it will also be encoded in this format.

2.4 COMMANDS

Specific transceiver control commands can be found on the following pages. In use, each command must adhere to the structure discussed earlier. Included with the commands is a brief discussion of the possible transceiver response.

03h QUERY TRANSCEIVER FREQUENCY

This command sends the transceiver's current operating frequency to the requesting computer.

The frequency data is returned as a string of BCD digits encoded as discussed previously.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh RA SA 03h FDh

FEh FEh	Command Prefix
RA	Receiver Address (transceiver's address)
SA	Sender Address (computer E0h)
03h	Command code for frequency query
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER:

The transceiver will respond by sending a return string that contains a data segment with the transceiver's frequency encoded in BCD format. The returned frequency represent the frequency of the currently active VFO.

FEh FEh RA SA DATA FDh

FEh FEh	Command Prefix
RA	Receiver Address (computer E0h)
SA	Sender Address (Transceiver's address)
DATA	Transceiver's frequency in BCD format
FDh	Command string terminator

04h QUERY TRANSCEIVER MODE

This command sends the transceiver's current operating mode to the requesting computer.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh RA SA 04h FDh

FEh FEh.	Command Prefix
RA	Receiver Address (transceiver's address)
SA	Sender Address (computer E0h)
04h	Command code for mode query
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER:

The transceiver will respond by sending a return string that contains a data segment with the transceiver's mode encoded. The mode returned is from the displayed VFO.

FEh FEh RA SA DATA FDh

FEh FEh	Command Prefix
RA	Receiver Address (computer E0h)
SA	Sender Address (Transceiver's address)
DATA	Transceiver's mode encoded
FDh	Command String Terminator

05h SET TRANSCEIVER FREQUENCY

This command updates the frequency of the currently selected VFO to data contained in the command string. Frequency data must be encoded.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh RA SA 05h DATA FDh

FEh FEh	Command Prefix

RA	Receiver Address (transceiver's address)
SA	Sender Address (computer E0h)
05h	Command code for mode query
DATA	BCD encoded frequency data
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER:

The transceiver will send a string that contains either the OK code (FBh) or a NO GOOD code if the operation failed. The operation will fail if the frequency data indicates a frequency that is beyond the capabilities of the transceiver.

FEh FEh RA SA FAh or FBh FDh

FEh FEh	Command Prefix
RA	Receiver Address (computer E0h)
SA	Sender Address (Transceiver's address)
FAh or FBh	NO GOOD CODE or OK CODE
FDh	Command String Terminator

06h SET TRANSCEIVER MODE

This command changes the mode of the currently selected VFO to data contained in the command string. Mode data must be encoded.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh RA SA 06h DATA FDh

FEh FEh	Command Prefix
RA	Receiver Address (transceiver's address)
SA	Sender Address (computer E0h) 06h = Command code for mode query
DATA	Desired mode encoded
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER:

The transceiver will respond by sending a string containing either the OK code (FBh) if the operation was performed, or a NO GOOD (FAh) code if the operation failed. The operation will fail if the requested mode is not available on the transceiver.

FEh FEh RA SA FAh or FBh FDh

FEh FEh	Command Prefix
RA	Receiver Address (computer E0h)
SA	Sender Address (Transceiver's address)
FAh or FBh	NO GOOD CODE or OK CODE.
FDh	Command String Terminator

07h VFO SELECTION

This command provides for selection of a particular VFO. Besides the VFO selection code 07h, a sub command must be specified that indicates which VFO operation to perform.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh RA SA 07h SC FDh

FEh FEh	Command Prefix
RA	Receiver Address (transceiver's address)

SA		Sender Address (computer E0h)
07h		Command code for mode query
SC		Sub-Command:
	00h	Select VFO A
	01h	Select VFO B
	A0h	Copies selected VFO to other VFO. ie VFO A = VFO B.
B0h		Swaps VFO contents. ie VFO A to VFO B and VFO B to VFO A.
FDh		Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER:

The transceiver responds by sending a string containing either the OK code (FBh) if the operation was performed, or a NO GOOD code if the operation failed. The operation will fail if the requested mode is not available on the transceiver.

FEh FEh RA SA FAh or FBh FDh

FEh FEh	Command Prefix
RA	Receiver Address (computer E0h)
SA	Sender Address (Transceiver's address)
FAh or FBh	NO GOOD CODE or OK CODE.
FDh	Command String Terminator

08h SELECT MEMORY CHANNEL

This command informs the transceiver which memory channel is to be used for subsequent memory operations. The memory channel number, in BCD format, must be within the memory channel limits of the transceiver or a NO GOOD will be returned.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh RA SA 08h MC FDh

FEh FEh	Command Prefix
RA	Receiver Address (transceiver's address)
SA	Sender Address (computer E0h)
08h	Command code for mode query
MC	Memory channel number in BCD format
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER:

The transceiver responds by sending a string containing either the OK code (FBh) if the operation was performed, or a NO GOOD code if the operation failed. The operation will fail if the memory channel is not available on the transceiver.

FEh FEh RA SA FAh or FBh FDh

FEh FEh	Receiver Address (computer E0h)
SA	Sender Address (Transceiver's address)
FAh	NO GOOD CODE or OK CODE.
FDh	Command String Terminator

09h TRANSFER ACTIVE VFO TO MEMORY CHANNEL

This command transfers contents of the active VFO to the pre-specified memory channel. The memory channel should have been previously set using command 08h. If not, the last accessed

memory channel will be used for the operation.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh RA SA 09h FDh

FEh FEh	Command Prefix
RA	Receiver Address (transceiver's address)
SA	Sender Address (computer E0h)
09h	Command code for mode query
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER:

The transceiver responds by sending a string containing either the OK code (FBh) if the operation was performed, or a NO GOOD code if the operation failed.

FEh FEh RA SA FAh or FBh FDh

FEh FEh	Command Prefix
RA	Receiver Address (computer E0h)
SA	Sender Address (Transceiver's address)
FAh	NO GOOD CODE or OK CODE.
FDh	Command String Terminator

0Ah COPY MEMORY CHANNEL TO ACTIVE VFO

Transceiver to copy data from the pre-specified memory channel into the currently active VFO. The memory channel should have been previously set using command 08h. If not, the last accessed memory channel will be used for the operation.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh RA SA 0Ah FDh

FEh FEh	Command Prefix
RA	Receiver Address (transceiver's address)
SA	Sender Address (computer E0h)
0Ah	Command code for mode query
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER:

Transceiver responds by sending a string containing either the OK code (FBh) if the operation was performed, or a NO GOOD code if the operation failed.

FEh FEh RA SA FAh or FBh FDh

FEh FEh	Command Prefix
RA	Receiver Address (computer E0h)
SA	Sender Address (Transceiver's address)
FAh	NO GOOD CODE or Ok CODE.
FDh	Command String Terminator

0Fh SET/CANCEL SPLIT OPERATION

This command activates or cancels split operation of the transceiver. In addition to the SET/ CLEAR SPLIT command code 0Fh, a sub command must be specified to indicate which operation to perform.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh RA SA 0Fh SC FDh

FEh FEh	Command Prefix
RA	Receiver Address (transceiver's address)
SA	Sender Address (computer E0h)
0Fh	Command code for mode query
SC	Sub-command:
	00h = cancel split operation
	01h = Set split operation
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER:

Transceiver responds by sending a string containing either the OK code (FBh) if the operation was performed, or a NO GOOD code if the operation failed.

FDh FDh RA SA FAh or FBh FDh

FD FD	Command Prefix
RA	Receiver Address (computer E0h)
SA	Sender Address (Transceiver's address)
FAh	NO GOOD CODE or OK CODE.
FD	Command String Terminator

SPECIALIZED COMMAND MODES:

Some transceivers, such as TEN-TEC models 563, 535 and 536 provide an additional mode referred to as MATRIX MODE. MATRIX MODE allows a transceiver to operate as a controller for other transceivers connected to the serial interface. When the transceiver is placed in MATRIX MODE it will generate and accept MATRIX MODE COMMANDS. These commands are sent from any transceiver placed in MATRIX MODE and are in a format unique to MATRIX MODE. Other MATRIX MODE transceivers will accept the matrix mode commands but will not generate response. MATRIX MODE commands are generated from a MATRIX MODE transceiver when ever its operating status is changed (ie frequency or mode). By sending MATRIX MODE commands that contain this information, other MATRIX MODE transceivers will automatically track the transceiver that generated the commands. To activate MATRIX MODE on Models 535/536: press "SHIFT" and "SPLIT". "M.Lock" will appear in display. To activate MATRIX mode on Model 563: in USER'S MENU, turn CdE "ON".

00h MATRIX MODE COMMAND
TRANSFER CURRENT OPERATING FREQUENCY TO ALL TRANSCEIVERS IN MATRIX MODE

This command, generated by a transceiver in MATRIX MODE, causes any other MATRIX MODE transceiver to mimic the operation of the transceiver that generated this command.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh 00h SA 00h DATA FDh

FEh FEh	Command Prefix
RA	00h Receiver Address that any MATRIX MODE transceiver will accept.
SA	Sender Address (transceiver address)
00h	Command code for mode query 00h
DATA	Transceiver frequency, encoded in BCD format
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER: No transceiver responds to this transceiver generated command.

01h MATRIX MODE COMMAND
TRANSFER CURRENT OPERATING MODE TO ALL TRANSCEIVERS IN MATRIX MODE

This command, generated by a transceiver in MATRIX MODE, causes any other MATRIX MODE transceiver to mimic the operation of the transceiver that generated this command.

COMMAND STRING SENT TO THE TRANSCEIVER:

FEh FEh 00h SA 00h DATA FDh

FEh FEh	Command Prefix
RA	00h Receiver Address that any MATRIX MODE transceiver will accept.
SA	Sender Address (transceiver address)
00h	Command code for mode query
DATA	mode code, encoded in BCD.
FDh	Command String Terminator

RESPONSE STRING SENT TO THE COMPUTER: No transceiver responds to this transceiver generated command.

EXPANDED COMMAND SET FOR OMNI VI, MODEL 563

0C HEX.: READ OFFSET FREQUENCY

This command queries the transceivers current offset frequency.

Transciever's response: The transceiver will respond by returning the current offset frequency in BCD format (2 bytes). Negative offset frequencies are returned in 9's compliment form.

Data: Transceiver's current offset frequency in BCD format.

0D HEX: WRITE OFFSET FREQUENCY

This command sets the transceivers current offset frequency.

Data: Offset frequency in BCD format. For negative values of offset, the format should be 9's compliment.

13 HEX: ANNOUNCE FREQUENCY OF CURRENT VFO (OPTIONAL VOICE BOARD REQUIRED)

This command will activate the optional voice board and announce the frequency of the current VFO.

Transceiver's response: Returns NO GOOD if the voice board is not installed.

16 HEX: SET/CLEAR TRANSMIT MODE

This command and associated sub-commands control the transmitter.

These commands provide remote control of the transmit/receive functions but cannot override local control functions. Thus, if the PTT line is depressed, sending a RETURN TO RECEIVE command cannot overide the PTT action.

SUB-COMMAND 01h	GO TO TRANSMIT
SUB-COMMAND 02h	RETURN TO RECEIVE

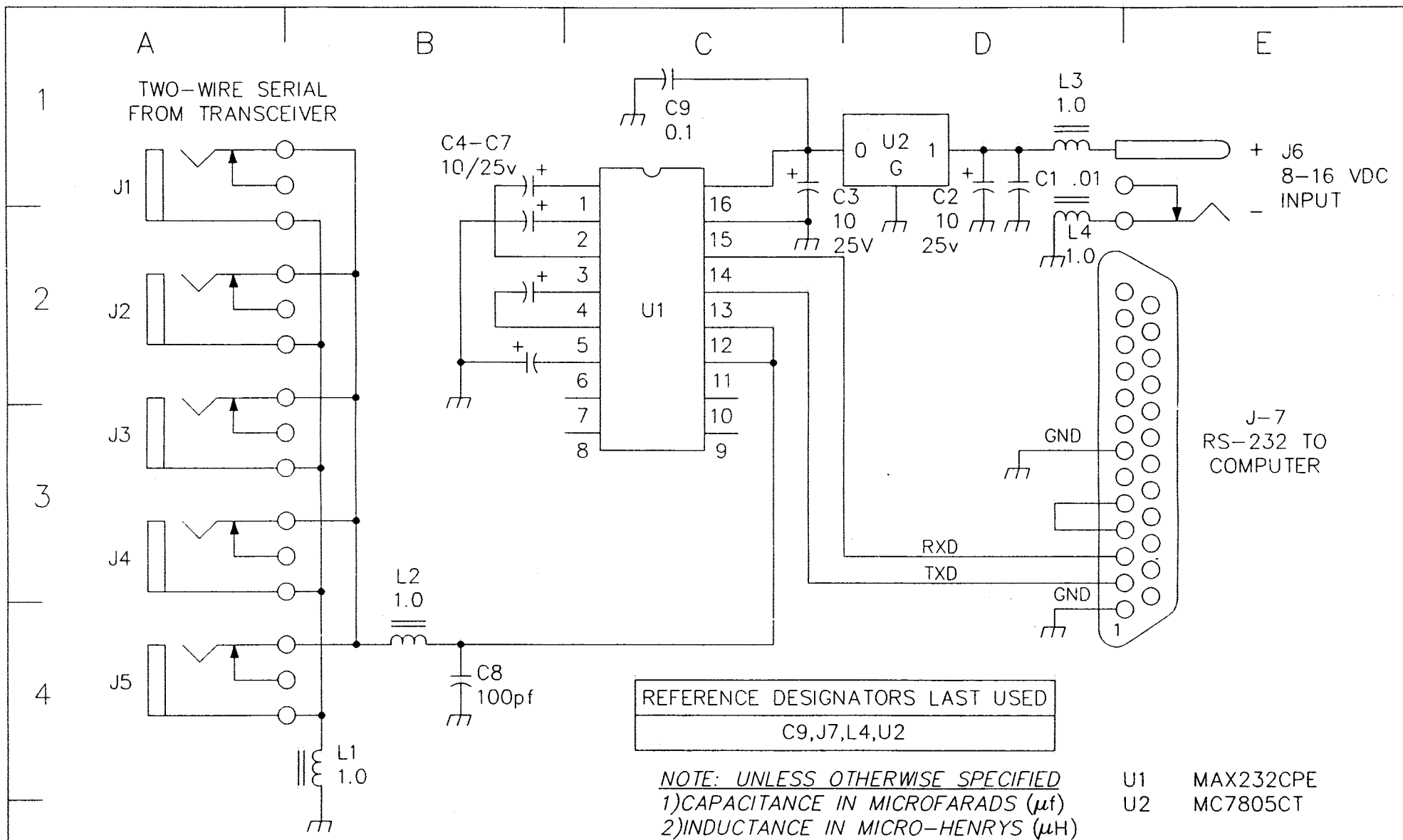
Transceiver's response: If the transceiver was able to perform the indicated operation, it will return the OK code.

COMMAND 17h: RETURN TRANSCEIVER STATUS

This command queries the transceiver's extended status information.

Transceiver's response: The transceiver will return the extended status information encoded in a 1 byte code encoded as listed below.

BIT POSITION		
0	SPLIT STATUS	(0=SPLIT OFF, 1=SPLIT ON)
1	VFO SELECTED	(0=VFO A, 1=VFO B)
2	TX STATUS	(0=RX, 1=TX)
3	RIT STATUS	(0=OFF, 1=ON)
4	XIT STATUS	(0=OFF, 1=ON)
5	VOX STATUS	(0=OFF, 1=ON)
6	LOCK STATUS	(0=OFF, 1=ON)
7	NOT USED	


A
B
C
D
E
1
2
3
4
5
TWO-WIRE SERIAL
FROM TRANSCEIVER
J1
J2
J3
J4
J5
L1
1.0
L2
1.0
C8
100pf
C4-C7
10/25v
C9
0.1
U1
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
U2
0
G
1
C3
10
25V
C2
10
25v
C1 .01
L3
1.0
L4
1.0
+ J6
8-16 VDC
INPUT
J-7
RS-232 TO
COMPUTER
GND
RXD
TXD
GND
1
REFERENCE DESIGNATORS LAST USED
C9,J7,L4,U2
NOTE: UNLESS OTHERWISE SPECIFIED
1)CAPACITANCE IN MICROFARADS (μf)
2)INDUCTANCE IN MICRO-HENRYS (μH)
3)RESISTANCE IN OHMS ±5% 1/4w
U1 MAX232CPE
U2 MC7805CT
LEVEL CONVERTER
81586