The HAL System II RTTY/Morse Communications Terminal (CT-2100 Terminal, KB-2100 Keyboard, and Video Monitor)

BY JOHN J. SCHULTZ*, W4FA

HAL COMMUNICATIONS CORP.
BOX 365
URBANA, ILLINOIS 61801

CQ Reviews:

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Although I have been around radioteletype equipment for many years in my professional engineering life, I could never warm up to the equipment as a radio amateur. Everything about RTTY seemed to impress me as being a mechanical engineer's delight and an electrical engineer's nightmare. Well, of course, all that has changed drastically. RTTY is now finally electronic thanks to equipment such as that pioneered by HAL Communications. The purpose of this article is to review a very sophisticated RTTY/Morse communications terminal composed of HAL components, but to approach the subject from the viewpoint of the average amateur in terms of system description, while giving some meaningful subjective and objective equipment comments useful to those already "into" RTTY. For the amateur who enjoys c.w. and who might have been toying with the idea of getting into RTTY, I suggest that electronic RTTY will pose the same pleasant surprise to him as many of us encountered years ago when manual keys gave way to electronic keyers.

But, first, a short digression on an important definition. In RTTY, the word "terminal" has conventionally meant the device that prints or displays the received signals, while perhaps also allowing one to type or otherwise send a transmitted message. Terminals could be either receive only or send/receive, such as the famous, old mechanical monsters: the Teletype Corp. Model 15 and 28 machines. However, I suggest that a newer definition be used, in that the "terminal" designate the entire electronic "ball of wax" that is needed to interface with a transceiver or a separate receiver/transmitter to provide electronic RTTY/Morse operation. Many amateurs seem to be almost unconsciously adopting this definition in conversation anyway. As shown in fig. 1, a terminal could then be as simple as possible or as elaborate as one wants to make it. For basic receive-only operation, a demodulator and a video monitor or page printer would suffice. For send/receive operation, at least a keyboard also has to be added. As one wants to make a terminal more elaborate, one could add features such as electronic message storage or even a computer for complete programmed control of the terminal.

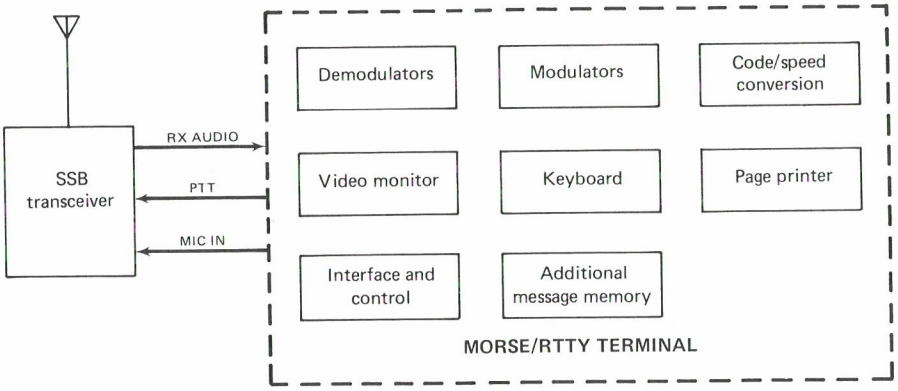


Fig. 1– Some of the functional blocks that might go into a modern-day Morse-RTTY communications terminal.

The HAL System II RTTY/Morse Communications Terminal basically consists of three units: the Model CT-2100 Communications Terminal, the Model KB-2100 Keyboard, and the Model ESM-914 Video Monitor. These three units are sufficient to provide complete send/receive operation for RTTY and Morse and contain some very sophisticated features.

The heart of the system is the CT-2100 Communications Terminal. Although labeled a terminal, it is more aptly looked at as a microprocessor-controlled package that demodulates and converts various transmission modes, generates various transmission codes, provides for interface with various external display and input devices, provides send/receive control, and provides audio monitoring of the signals coming into or leaving the unit.

Table I lists the specifications for the unit. They will tell quite a bit to those already involved in RTTY operation, but they may seem a bit overwhelming to others. So, rather than comment on all of the specifications, first a description will be given of how the CT-2100 can be placed into operation for various modes of operation. After understanding this, one can then go back to the specifications to get a better feel for the advanced capabilities of the unit.

The basic interface wiring for the CT-2100 with a transceiver is shown in fig. 2. All of the connectors on the CT-2100, except to the keyboard, utilize standard phono connectors. If one wanted to visualize the CT-2100 being put into operation for receive-only purposes for the moment, the keyboard connection and those to the c.w. key, Microphone In, and PTT can mentally be eliminated, the point being to emphasize that although the CT-2100 has a host of interconnection possibilities, only a few basic ones are necessary to get the unit operating.

C.W. Operation

Looking at the front panel of the CT-2100, one can see that the push buttons are grouped into functional areas, such as for Data, Display, TX/RX Control, etc. Once all of the buttons have been preset, there is not much one has to do in operation. For instance, once the unit has been set up for c.w. operation, one would see appearing on the video monitor a status line that among other things displays "**MORSE.**" When tuning-in a c.w.

*c/o CQ Magazine

The HAL System II gear being put through its paces at DJ0AT (W4FA).

signal, one adjusts the receiver tuning so the c.w. LED in the **Tuning Indicator** block on the CT-2100 flashes in sync with the desired c.w. signal. The CT-2100 uses a heterodyne phase-lock-loop detection circuit for c.w. which has a center frequency of 800 Hz and will lock on to a keyed tone of that frequency and track it over about a ± 100 Hz range.

The center frequency can be internally adjusted from 600 to 1200 Hz, and adjustment might be needed with some transceivers when using very sharp c.w. i.f. filters, such that, for example, a 700 Hz tone only instead of an 800 Hz tone is produced during c.w. reception. One can check that lock is achieved by using the input/output button in the **Monitor** block of the unit. Selecting "input" one hears the received signal, and selecting "output" one hears the regenerated c.w. signal from the CT-2100. There are no speed adjustments on receive since the unit automatically tracks from 1 to 100 w.p.m. speeds and recognizes all letters and numbers in Continental Morse plus all common punctuation signs and groupings such as AR, BT, KN, etc. The tuning is fairly sharp, and it does require practice to tune-in a c.w. station quickly, but it can be done. However, for extremely short c.w. transmissions one will usually find that the decoder we have programmed in our brains will react much faster.

Once the signal is tuned in, the decoded characters will appear on the video monitor starting at the bottom of the screen. Each line of received text as it is completed scrolls smoothly upward to make space for the next new line. It's really quite nice to see a good c.w. signal displayed, but on the other hand, a sloppy fist will produce a more than sloppy looking copy on the screen. This is because the computer in the CT-2100 "prints 'em as it hears 'em." The computer will sense longer than normal pauses between letters as spaces and put a space on the screen, and if a station runs words together, the unit will display them as one word. At slow c.w. speeds one's brain can decode Morse faster than the CT-2100, but as speed increases, it is a completely different story. The CT-2100 will merrily run along and decode high-speed c.w. that is an aural blur to one's ears.

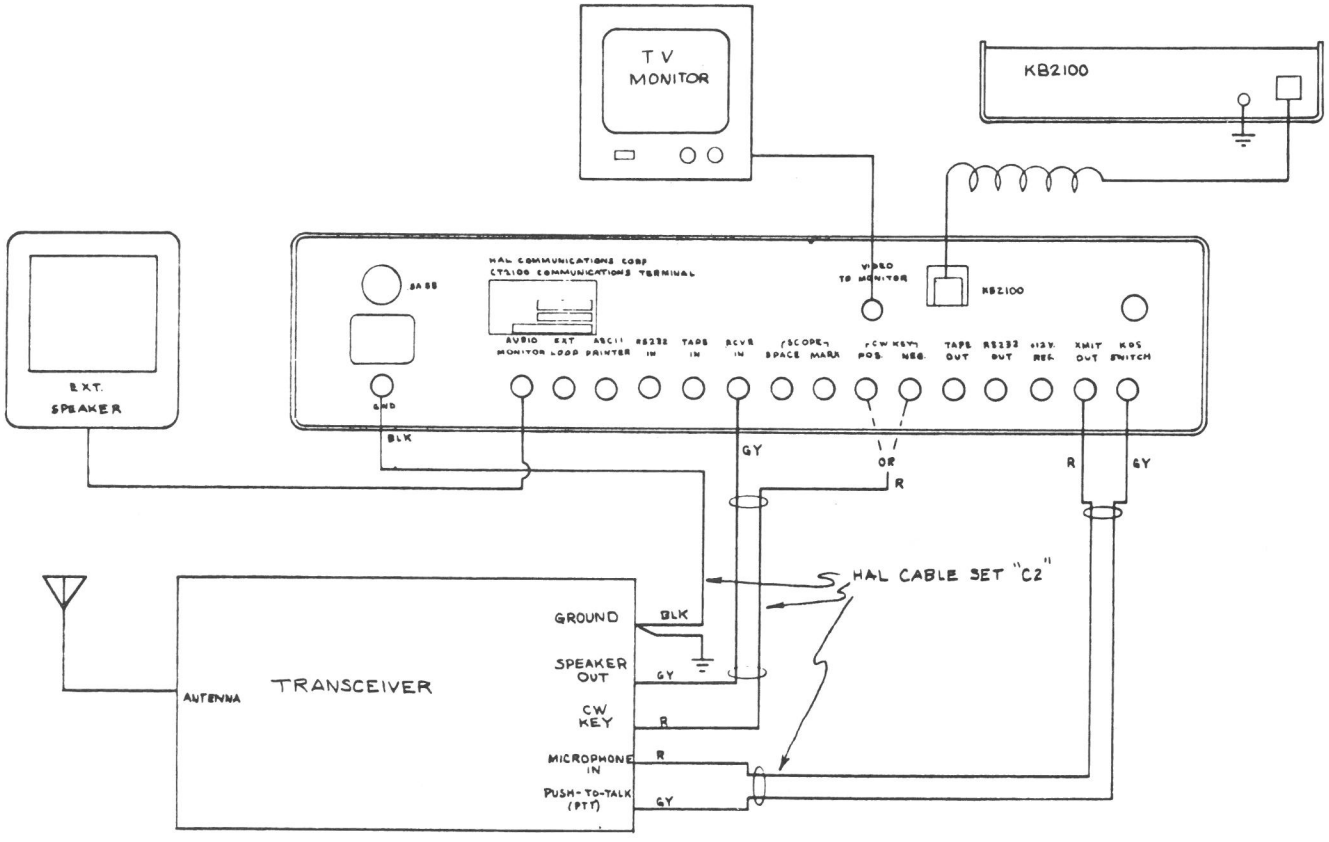


Fig. 2– Basic interface wiring of CT-2100 for use with a transceiver.

INPUT/OUTPUT:

Audio Input:	0.5 V p–p, 4–600 ohm audio 800 Hz for Morse receive 1000–3000 Hz for RTTY
Audio Output:	XMIT OUT = −32 dBm (20 mV nom), 600 ohms (adj.) TAPE OUT = −32 dBm (20 mV nom), 600 ohms (adj.) MON OUT = adj. to 2 Watts, 4–8 ohms All harmonics below 9th are attenuated >30 dB
RS232 I/O:	Standard RS232 data interface levels; Mark = −5 to −15 VDC Space = +5 to +15 VDC
Loop I/O:	Standard current loop; Voltage = 200 VDC maximum Current = 18 to 120 mA Mark = Loop current on Space = Loop current off Loop referenced to chassis ground at the CT-2100; External loop power supply required; data may be transmitted from external loop device.
ASCII Printer:	Serial, RS232-C, 300 baud ASCII printer output; all received and transmitted text may be printed on the ASCII printer, regardless of code, up to the data rate of the printer itself.
Video to Monitor:	RS170 standard composite video output; 1.0 V p–p, 72 ohms, 6.1 MHz bandwidth.

DATA CODES AND RATES:

Baudot Code:	U.S. Standard 5-level International Telegraphic Alphabet No. 2 Baudot Code with 1 unit start and 1.5 unit stop bit. (Interchange of BELL and ' available on export units for CCITT 2.)
ASCII Code:	American National Standard Code for Information Interchange (ASCII) as defined by ANSI Standard X3.4–1968. 8 unit code with 1 unit start pulse; 2 unit stop pulse for 110 baud and lower rates; one unit stop pulse for 150 baud and higher rates. Full 128 character set may be transmitted and received; 8th data bit ("parity bit") set to space condition.
RTTY Data Rates:	Baudot or ASCII codes may be transmitted and received at 45, 50, 57, 74, 100, 110, 150, 300, 600, and 1200 baud.
Morse Code:	Continental Morse Code including all letters, numbers, period, comma, colon, semi-colon, dash, apostrophe, parenthesis, quote, question mark, and AA, AR, AS, BT, KN, SK, and error prosigns. Receive speed automatically tracks from 1 to 100 w.p.m. speeds; transmit speed may be set for 1 to 100 w.p.m. in 1 w.p.m. increments.
103 Modem:	Mark = 1270 Hz Space = 1070 Hz C.W. ID = 1370 Hz
202 Modem:	Mark = 1200 Hz Space = 2200 Hz C.W. ID = 1100 Hz

DISPLAY

Video:	Standard RS170, 1.0 V p–p, 72 ohm composite video; 6.1 MHz (72 character lines) or 3 MHz BW (36 character lines).
Screen:	24 lines of 72 or 36 characters per line; top line may be used to display terminal status or for programming of HERE IS messages; vertical tuning bar in upper left margin indicates RTTY tuning.
Page Memory:	48 lines of 72 characters per line (2 pages); or 96 lines of 36 characters per line (4 pages).
Split Screen:	Bottom 12 lines of page 2 (page 4 in 36 character line mode) devoted to pre-typing of transmit text. Cursor may be repositioned in four directions for full editing. Available only when KB-2100 is used; text may be typed while receiving.
Characters:	Full upper and lower case letters, all numbers and punctuation of the ASCII character set, special graphic symbols for ASCII control codes; 5×7 dot matrix with half-dot shift; full lower case descenders.

TX/RX CONTROL:

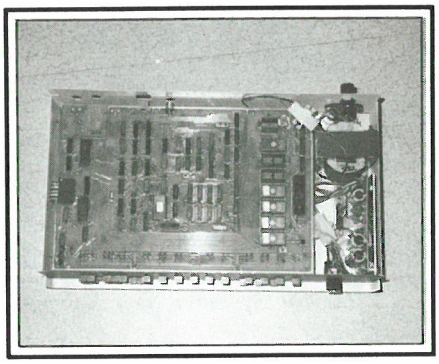
HDX/FDX:	Operate terminal in either half-duplex (HDX) or full-duplex (FDX) modes; HDX gives screen display of typed text and local "echo" as it is transmitted; typed text is not displayed, and there is no local "echo" in FDX mode.
LED:	Six LED indicators show MARK, SPACE, RTTY center tuning (+/+), Morse center tuning (C.W.), audio input overload (OVLD), and KOS on-off status.

MESSAGE STORAGE:

With KB-2100:	Two user-programmable HERE-IS messages, each 32 characters long, volatile.
With KB-2100 and MGS-2100:	2041 character non-volatile EPROM storage may be divided in up to seven 255 character messages, one 192 character message, and two 32 character HERE-IS messages. EPROMs are factory or dealer programmed and are socketed so that several different EPROMs may be interchanged by the user.

Table I– CT-2100 condensed specifications.

The heart of the system is the CT-2100 communications terminal. It measures about 16½" × 4" × 10½".



A look inside the CT-2100. It is a complex but very neatly constructed unit. Basically, there are two large PC boards. The top one, which can be seen, contains some optical message EPROM's on the left.

The **Display** block on the CT-2100 does several interesting things. It allows for the selection of a 72 character per line mode or a 36 character mode. The page in use appears on the status line on the display. When text is received (or typed in from a keyboard), it starts on the high numbered page and works up from the bottom line on the screen. When the bottom line reaches the top of the page, it is dumped over into the bottom line of the next lower numbered page. It moves up again on that page and then is transferred to the next lower page, if one is available, or dumped and lost. By a pushbutton one can recall any page not being displayed. One can also choose reverse video if desired. That is, instead of black characters on the screen, it will produce white characters centered in a black field.

When transmitting c.w., one does have to choose a transmission speed. The **Increase/Decrease** buttons on the CT-2100 allow setting the speed in 1 w.p.m. increments from 1 to 100 w.p.m. The speed selected is shown on the status line on the monitor. This line will also display a notation such as "WT = 4" to indicate the selected weight of the transmitted Morse. Nine different weights can be selected by keyboard commands. Fig. 3 is an interesting display of the selectable weight feature. One can transmit c.w. either using a continuous mode or a word mode. In the continuous mode, characters are immediately transmitted as one types them into the keyboard. In the word mode, a

word is not transmitted until the next word is started (unless one presses a **New Line** key to end a transmission). Thus, one can type several lines of text, and depending upon how fast one types and the transmission speed chosen, one might easily get several lines ahead of the text being transmitted.

The typed characters automatically appear on the screen in reverse video. As the characters are transmitted, a cursor moves across the screen. There is a **Rub Out** key which allows for text editing of untransmitted characters. Each depression of the key backs up the display one character, and one can insert a correction before transmission. One can also use all of the "pages" available to pretype text for later transmission for a total of 48 lines of 72 characters each—a total of 3,456 characters. However, one can only do one thing at a time using the full "page" capacity—either compose keyboard text or receive text on the screen.

A special feature of the CT-2100 is a split-screen display mode. When selected, one half of the screen displays received characters, while simultaneously one can pretype-in characters to be transmitted on the other half of the screen. The received text is in normal video, while the pretyped text is in reverse video, so it is very easy to separate them. An arrow also appears at midscreen. Up to 12 lines can be pretyped (stored for transmission), and, of course, as soon as transmission starts, one can type-in additional characters.

The CT-2100 has transistor switches incorporated which can be used to directly key any positive or negative voltage keying circuit in a transceiver.

RTTY Operation

In general terms, RTTY reception and transmission are very similar to that described for c.w., but one has to make a few "decisions" before operation can start. The CT-2100 provides for the selection of a very wide range of RTTY shifts, data rates, and audio tone pairs (for feeding into the microphone input of an s.s.b. transmitter). Three shifts are available: 850, 425, and 170 Hz. Data rates or speeds can be selected for 45 baud (60 w.p.m.), 50 baud (66 w.p.m.), 57 baud (75 w.p.m.), 74 baud (100 w.p.m.), etc., on up in steps to 1200 baud! So-called high tones (Mark = 2125 Hz; Space = 2295, 2550, or 2975 Hz) or low tones (Mark = 1275 Hz; Space = 1445, 1700, or 2125 Hz) or "modem" tones (discussed later) can be selected. Of course, all of this versatility should not become confusing. When turned on, the CT-2100 will automatically set itself to 45 baud, and if one then selects 170 Hz shift, normal polarity, and high tones, one is then ready to go for most h.f. RTTY work on the amateur bands. Reception of commercial RTTY stations will usually require trying at least the other shifts and some higher speeds.

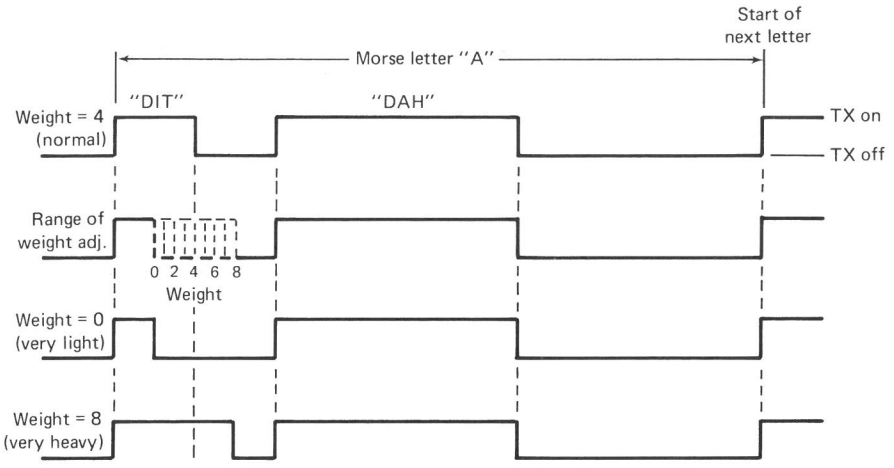


Fig. 3– The CT-2100 allows the "weight" of transmitted Morse to be set with digital precision to any one of eight steps.

The speed to which the CT-2100 is set will be displayed on the status line on the monitor.

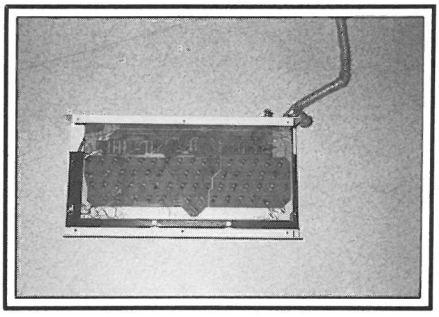
The tuning aids available for RTTY reception include, as for c.w., audio tone comparison between the audio in/out on the CT-2100, so one can hear that mark and space signals are within the filter passbands and are being regenerated. Also, there is a three LED display for Mark, +/+, and Space. When proper tuning is achieved, the +/+ LED glows steadily, while the other two flicker. In addition, there is a tuning bar on the monitor. The vertical length of the tuning bar will vary as one tunes an incoming signal through the mark and space filter. Correct tuning occurs when the length changes little between mark and space conditions. An optional tuning aid can be used if one has an X-Y oscilloscope. The CT-2100 has rear-panel **Mark** and **Space** outputs so one can achieve a crossed ellipse indication on the scope.

Transmission can be direct from the keyboard using the word mode, or one can precompose all available "pages" while not receiving or use the split-screen mode to simultaneously receive while pretyping a half page (various types of memory messages available from the keyboard or externally are discussed later). A word wrap-around feature (also effective on receive) prevents splitting of a word at the end of a line. If one over-types a word, all of that word (back to the last space) is transferred to the next upcoming line.

Two additional features on RTTY are an **Idle** (or "diddle) mode and a **KOS** mode. The Idle feature, when selected, inserts a continuous stream of nonprinting characters during pauses in typing, thus helping the receiving station maintain sync. The KOS (**K**eyboard **O**perated **S**witch) is the RTTY equivalent of s.s.b. VOX to avoid manual transmit-receive switching.

Since current FCC regulations require a c.w. identification before and after RTTY transmission, this feature is also included in the CT-2100. Current regulations also provide only for the use of the 45, 50, 57, and 74 baud rates when the Baudot RTTY code is used.

The KB-2100 keyboard. It plugs directly into the CT-2100.



Looking inside the KB-2100, one notes again the very clean, professional construction typical of the units.

ASCII Operation

The CT-2100 will receive and transmit the full unabridged 128 ASCII code set (upper and lower case, symbols, control codes, etc.) at all of the baud rates previously listed, although 110 baud is commonly used on the h.f. bands. ASCII operation is essentially the same as that described above for regular RTTY, with all the features of word wrap-around, word

mode, pre-loading full pages or split-screen operation, Idle character, and KOS being available when normal half-duplex operation is used. However, full duplex (simultaneous send/receive) is also available in ASCII, and then the preceding features are not available. Characters are transmitted as they are typed and are not displayed. This mode is sometimes used between a terminal and a computer, with the computer providing an echo of the transmitted text (which will appear on the monitor) to verify data acceptance. The CT-2100 may be interfaced to other ASCII equipment through the four available tone pair demodulators/demodulators, "RS232" data interface level in/out connections, and RTTY Loop connections (noted below). An output is also provided for a serial ASCII data printer. All received and transmitted data of the CT-2100 is outputed to the printer regardless of the code or data rate used up to 300 baud. The output provides a code and speed conversion, allowing printing of Morse, Baudot, or ASCII data on the same printer.

Additional Features

The CT-2100 has **Tape In/Out** connections for an audio tape recorder for recording and/or playing back messages in any mode. Messages can be made up from the keyboard or recorded as they are transmitted, and, of course, can be as long as the tape will accommodate. Transmitted tape text is reprocessed by the regenerator circuits in the CT-2100 for a clean output. Recorded received data is also reprocessed for a clean recording.

An **RTTY Loop** connection provides for interface with conventional, mechanical TTY machines. There is no speed or code conversion associated with this output (e.g., if 45 baud is selected for the monitor, the loop output will be 45 baud). Data may also be transmitted from a loop connected device such as a tape reader (TD) unit.

The "modem" tones incorporated (so-called 103 or 202 standard) are the same as those used for phone-line computer data transfer. They will allow transmission of high data rates using v.h.f. AFSK techniques.

Fig. 4 indicates the connection to the CT-2100 if practically all possible external devices were used. Cable salad, anyone?

KB-2100 Keyboard

This keyboard connects to the CT-2100 through a single coiled telephone-type cable. It has 59 keys arranged similar to those on a standard typewriter with extra control keys (colored black). The standard alphabet, numbers, and punctuation keys are used in all modes just as one would use them on a typewriter, except that only ASCII transmission provides for upper and lower case. To type some of the special commands in ASCII such as DLE (**D**ata **L**ink **E**scape), one would type CTRL-P. For RTTY Baudot to send #, one would type SHIFT-3. For Morse, some of the prosigns are not obvious from the keyboard. For instance, to send AR, one depresses the @ key. The keys have an automatic repeat feature. Any key combination held down for more than ½ second will repeat at 7 characters per second.

There is a host of functions associated with the control keys, but only a few highlights will be mentioned. The **IDENT** key will always produce a Morse output which is the same as that programmed into one of the two **HERE IS** keys. These latter keys transmit two different user programmed (by keyboard entry) messages, each being up to 32 characters in length. Using the HERE IS keys, the messages are transmitted in any selected mode. The message storage is volatile unless an optional message EPROM is installed.

The **NEW LINE** key selects the next line for typing for Morse, and generates "carriage return - line feed - letters" for Baudot and "carriage return - line feed" for ASCII, thus saving many individual key depressions in the latter two modes. The **RUB OUT** key, as explained previously, allows editing of errors made while typing. The **BRK** key produces key-down conditions in Morse or a continuous space in Baudot and ASCII. Special use is made of the **CTRL** and **SHIFT-CTRL** keys with the top row of number keys. Just a few examples:

CTRL-1 produces the split-screen option.
CTRL-5 affects the Morse weight options.

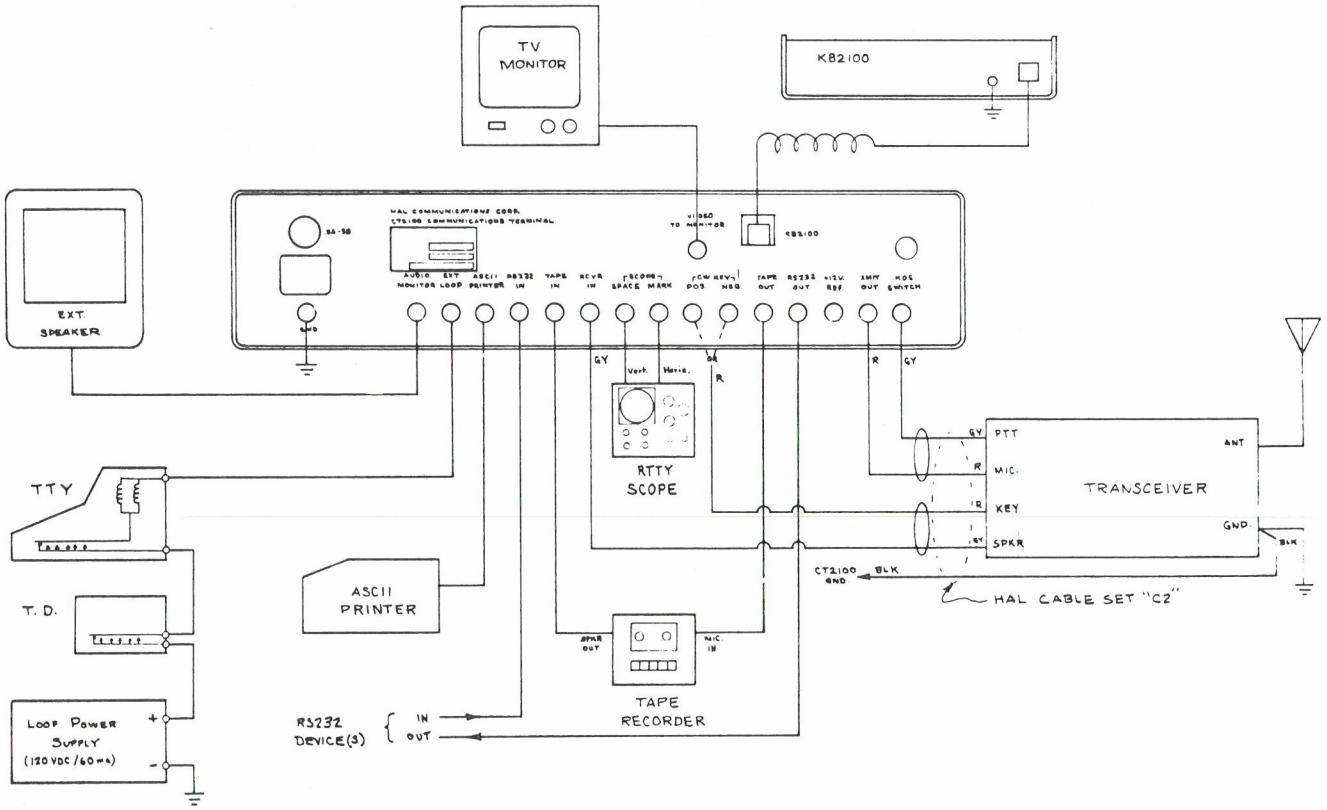


Fig. 4– The extremely versatile interface possibilities for the CT-2100 are shown by this diagram.

CTRL-7 turns the CT-2100 transmit text on/off.
CTRL-8 produces 36 RY's.
CTRL-9 produces the complete THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG'S BACK 0123456789 test message.
CTRL-0 produces a string of four CQ characters.

The sequence SHIFT-CTRL-1 to 8 prepares for transmission one of the eight messages which can be programmed into the optional HAL MSG-2100 message storage EPROM. The ROM (a 2716) can take 256 characters in each of the first seven message blocks and 192 in the eighth block. Blocks can be combined if desired for longer messages. If you buy the EPROM from HAL, they or a dealer will program it for you according to the text you supply (it can also be reprogrammed when desired).

The KB-2100 keyboard, because of the coding used, is the only one that can be used with the CT-2100.

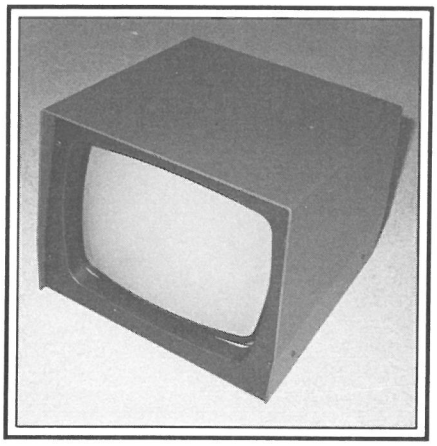
Video Monitor

A high-quality video monitor that has a video bandwidth of at least 8 MHz and preferably 12 MHz should be used with the CT-2100. The green phosper display screens are preferred since they are very easy on the eyes as compared to harsh black-and-white displays. The monitor used for these tests was the Model DV3100, the normal companion monitor for the more expensive HAL DS3100 ASR (supplied by HAL because of the 220 v/50 Hz power I have in Germany). However, the Model KG-12/N monitor is recommended by HAL for use with the CT-2100. This monitor is available from your HAL dealer for several power voltage and frequency combinations (KG-12/NU for 120 v/60 Hz; KG-12/NE for 220 v/50 Hz).

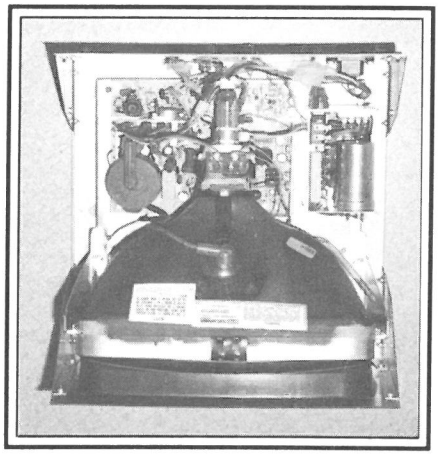
To give a good display of the 72 character lines, a monitor such as the KG-12/NU will provide the sharpest display. But, even as HAL admits in their literature, some good-quality black-and-white TV sets can easily be modified to serve as a video monitor. Some horizontal/vertical size adjustments will probably be necessary so one can see all four corners of the raster, and a means has to be provided to couple the CT-2100 video output to the input of the first video amplifier stage in the set. The literature for the CT-2100 provides details on how to accomplish this.

Construction and the Manual

HAL is a commercial equipment manufacturer, and this is reflected in the construction of their System II units. Rugged steel or aluminum material wrap-around cabinets are used. The lettering on the keys and controls is outstandingly clear and sharp (the CT-2100 has groupings of red and blue buttons with white lettering on a gray background). If one starts to take equipment covers off (see photos), one will find very neatly laid out, double-sided PC boards. There is a generous use of connectors between various boards and between other components so that any board/major component can be removed for servicing. All of the units, by the way, can be internally changed over for 110/220 or 50/60 Hz operation.



The video monitor is housed in a well-shielded cabinet.



A look inside the ESM-914 video monitor. The a.c. supply is on the right, and the rest of the circuitry is on a large PC board.

The manual supplied with the CT-2100 runs some 87 pages, and it is all operation/adjustment information and not servicing data (that is in a separate manual). However, HAL has organized the manual quite realistically. The first main chapter, "Simple Hook-Up for the Eager and Impatient," gives one just enough information to get the units interconnected and on the air. Then, after one gets over the initial fascination or seeing how the units work, one can read detailed chapters which thoroughly explain all the features. Variations in hook-ups are covered, plus how to use a TV set as a monitor, r.f.-induced problems, user adjustable controls, self-programming of an optional 2716 EPROM (if you have the equipment), etc. A one-year warranty applies to the units, subject to the usual conditions of no misuse, abuse, etc., by the owner.

Operational Tests

There was just no way that a bench check could be made of all the shift/tone/speed combinations available in the filters, demodulators, and modulators in the CT-2100. The specialized test equipment necessary was not available. However, what could be checked with regard to levels and the tone frequencies for various shifts was done. The levels all came out to within 5% of those specified, and the tone frequencies to within ±2 Hz (the latter to be expected since they are all crystal derived). The lower baud rates which could be checked were exactly correct (e.g., 45 baud).

On-the-air operation was, of course, the most fun, and the gear performed excellently. It took quite a few hours to get a feel for all the capabilities of the units, and I still feel I have missed learning a few features. Initial operation was on c.w., which ranged in satisfaction from poor (when encountering a very sloppy fist, which made the monitor display alphabet soup) to excellent (when QSO'ing with a station using keyboard generated c.w.). But, operation quickly shifted to RTTY where one could really have a bit of fun using all the automated and message-storage features of the units. The text, displays, and RTTY pictures that one can generate (especially using an ancillary audio tape unit) are up to one's imagination. Many QSO's with excellent reports were had with European amateurs in the 14.075–14.100 MHz range.

ASCII operation was not tried while using the gear in the European area. However, there is no reason why it would not perform perfectly.

I can only advance two cosmetic criticisms. The LED display gets confusing at times. It would help to have the c.w. one blanked out on RTTY and the RTTY ones blanked out on c.w. (I used tape). The "bell" tone burst makes one jump out of a chair. Some will say that such is its purpose, but I'd trade it for a simulated gong-type sound.

General Comments

If you have read this far, it should be apparent that HAL's System II is very sophisticated. It is also not inexpensive. So, if one is interested in this type of equipment, one has to consider the quality, versatility, interface possibilities, expansion capabilities, non-obsolescence features, etc., of such equipment versus a less expensive, simpler approach. It's up to you.

If one has just started to become interested in RTTY and/or ASCII, two free pamphlets from HAL (Box 365, Urbana, Ill. 61801) might be of interest: "Questions About RTTY" and "ASCII, Baudot and the Radio Amateur." Both are excellently written and do not attempt to "promote" HAL gear to the exclusion of just giving the reader a clear idea of what electronic RTTY and data transmission are all about. CQ

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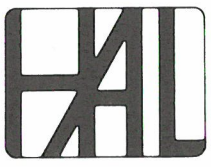

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BOX 365
URBANA, ILLINOIS 61801