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CROMCO ELECTRONICS
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OPERATION MANUAL

CEC-10A Code Synthesizer II

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SAFETY FIRST: TO ALL OPERATIONS AND SERVICE PERSONNEL

REFER ALL SERVICING OF UNIT TO QUALIFIED TECHNICAL PERSONNEL.

CASE, COVER OR PANEL REMOVAL

Removing protective covers, casings or panels from this unit exposes the operator to electrical hazards that can result in electrical shock or equipment damage. Do not operate this unit with the case, cover or panels removed.

SAFETY IDENTIFICATION IN TECHNICAL MANUAL

This manual uses the following terms to draw attention to possible safety hazards, that may exist when operating or servicing this equipment.

CAUTION: THIS TERM IDENTIFIES CONDITIONS OR ACTIVITIES THAT, IF IGNORED, CAN RESULT IN EQUIPMENT OR PROPERTY DAMAGE (e.g., FIRE).

WARNING: THIS TERM IDENTIFIES CONDITIONS OR ACTIVITIES THAT, IF IGNORED, CAN RESULT IN PERSONAL INJURY OR DEATH.

EQUIPMENT GROUNDING PRECAUTION

Improper grounding of equipment can result in electrical shock.

USE OF PROBES

Check the specifications for the maximum voltage, current and power ratings of any connector on the unit before connecting it with a probe from a terminal device. Be sure the terminal device performs within these specifications before using it for measurement, to prevent electrical shock or damage to the equipment.

POWER CORDS

Power cords must not be frayed or broken nor expose bare wiring when operating this equipment.

USE RECOMMENDED FUSES ONLY

Use only fuses specifically recommended for the equipment at the specified current and voltage ratings.

CAUTION: SIGNAL GENERATORS CAN BE A SOURCE OF ELECTROMAGNETIC INTERFERENCE (EMI) TO COMMUNICATION RECEIVERS. SOME TRANSMITTED SIGNALS CAN CAUSE DISRUPTION AND INTERFERENCE TO COMMUNICATION SERVICES OUT TO A DISTANCE OF SEVERAL MILES. USERS OF THIS EQUIPMENT SHOULD SCRUTINIZE ANY OPERATION THAT RESULTS IN RADIATION OF A SIGNAL (DIRECTLY OR INDIRECTLY) AND SHOULD TAKE NECESSARY PRECAUTIONS TO AVOID POTENTIAL COMMUNICATION INTERFERENCE PROBLEMS.

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1 Getting Acquainted - A Quick Look

1.1 Introduction

The CEC-10A Code Synthesizer II is a microcomputer and Digital Signal Processor (DSP) controlled audio and data synthesizer capable of generating the tone and data formats used for selective signaling over voice grade communications channels.The most common tone signaling formats are easily selected by the front panel function switch. Each function or sequence is generated according to a pre-programming set of frequency and timing parameters stored in the CEC-10A's memory. The user may send a sequence using the preprogramming parameters or change the parameters for special purpose signaling requirements. Data generation capabilities are provided in the DIGITAL function mode. In this function the user may select one of several formats by first entering the appropriate mode number.

The CEC-10A utilizes a *terse* user interface which may, at first, appear difficult to use. In particular, the requirement to memorize a few of the different registers numbers, and their associated function, may give the user the initial impression that the CEC-10A is going to be cumbersome instrument to use. The alternative is a menu driven user interface which leads the user by the hand for each step of data entry and setup. However, the CEC-10A user interface was designed for maximum operator speed where the instrument is used anywhere from tens to hundreds of times per day. Under these circumstances a menu driven user interface would be slower than allowing the user to directly *tell* the instrument what to do. For this reason, the reader is encouraged to pay particular attention to the use of “registers” as explained in section 2 of this manual.

This manual is divided into five sections. Section 1 provides basic information about the CEC-10A. The purpose of this section is to introduce the user to the features of the CEC-10A while, at the same time, performing the initial power up test and checkout. Section 2 describes, in detail, the use of the keyboard function keys and how register contents can be made to control the operation of the instrument. Section 3 describes how to use the CEC-10A for each of the several encode and function modes except the Digital function which is covered in section 4. Finally, Section 5 provides some useful miscellaneous information.

1.2 Power Up

It is recommended that the instructions in this section be followed when the CEC-10A is first unpacked or when a problem is suspected, otherwise skip over this section. To test the CEC-10A first make sure the function switch is set to one of the eight functions available i.e. "DTMF" through "TONE CONTROL".

Then turn the OFF/ON switch (located on the rear panel) to the ON position and observe that the display first shows the sign-on message for the front panel microprocessor. This message has the format **`FP VER x.y`** where (x.y) is the firmware version for the front panel processor. Next, after about 2 seconds, the display shows the sign-on message for the main processor. This message has the format **`C10Ax y.z`** where “x” indicates the options (if any) that are installed, and (y.z) is the firmware version for the main processor. Then, after another few seconds the CEC-10A displays the text message indicating the function that is currently selected by the front panel switch.

Note that the Digital function is a special case in that when the function switch is in this position, the display indicated which one of the digital formats has been selected by the user. See Section 4 on page 10 for a complete description of the Digital formats available.

Note: If the CEC-10A only displays the front panel sign-on message then the main processor failed to run correctly. If the front panel displays the message **`BADMAGIC`** then the main processor is attempting to run a software version not compatible with the hardware.

Verify that all of the keyboard keys are operational by performing the following tests:

- Enter the digits "1" through "8" by pressing each of the corresponding digit keys on the keyboard,
- Press the [CLR] key momentarily and observe that only the right most digit is deleted from the display. Then press and hold the [CLR] key to clear the entire display.
- Enter the digits "9" and "0" by pressing the corresponding keys and then enter the DTMF digits "A", "B", "C" and "D" by first pressing the 2nd key (to select the key's second function) followed by the corresponding digit key for each DTMF digit. The display should now read **90ABCD** .
- Enter the DTMF characters * and # by: (1) pressing the [*/2nd] key two times, for the * character and then the [*/2nd] key followed by the [#/.] key for the # character. The display should now read **90ABCD*#**.
- Again press the [CLR] key to clear the display followed by the [#/.] key to enter a decimal point and observe that only a single decimal point is being displayed.
- Press any key on the keypad to enter a single digit after the decimal point. Note that the CEC-10A will not accept more than one digit beyond the decimal point - try it!

This completes the initial power up check. If the CEC-10A did not perform as indicated consult the factory.

2 Keyboard Basics

2.1 Error Messages

The error message "Error x" indicates that one of the following types of invalid keyboard operations was performed by the user, where x indicates the specific error.

Error Code	Description of the Error
1	General keyboard entry error, e.g. entering [STO] followed by [STO], which is invalid.
2	Attempt to store to or recall from a function register that does not exist
3	Attempt to store a Floating-Point number (e.g. frequency value) into a register which only holds integer values
4	Pressing the [SND] key to Send a sequence of digits, or Cap-Code, with the incorrect number of digits entered for the Cap-Code
5	Range Error - the value of the Cap-Code entered is not within the required range for the format and mode selected

If the error message should be displayed press the [CLR] key to clear the display and then enter the correct information.

2.2 Dual Function Keys

The front panel keyboard contains 16 function keys. However, to fully utilize the power of the CEC-10A it is necessary to be able to enter 32 different functions, either data or commands. Therefore, all keys have a dual (or shift) function.

The Secondary, or shift, characters associated with a key are printed in blue while the primary function is printed in black.

To use the first function associated with a key - just press the key. To use the second function just press the [*/2nd] key followed by the key corresponding to the function desired.

EXAMPLE: Enter a "D" character.

This requires 2 keyboard entries i.e. the [*/2nd] key followed by the [D/SND] key. In the future this operation will be denoted "Enter 2nd D".

2.3 Preprogrammed Frequency & Timing Parameters

Each function the CEC-10A is capable of generating has from 1 to 16 memory locations associated with it. Each memory location or register is designated by a number from 0 to 9 or the letters A to F. The registers hold frequency and timing information which is used by the particular function selected when a sequence is generated. Each time the CEC-10A is turned on all of the registers are preprogrammed with the frequency and timing parameters most often used with each function.

2.3.1 Displaying Parameters - Recall [RCL] Key

To display the register contents for a particular function first switch the function selector to the appropriate function desired. Then using the register table shown for that function determine the register number for the desired parameter. To display the value of the parameter press the [RCL] key (for recall register) followed by the key corresponding to the register number. The display will now show the register number, in the left most digit, followed by the value stored in that register. If the register holds frequency information a decimal point will also be displayed, otherwise the register holds timing or miscellaneous setup information.

All frequency information is displayed in units of hertz (Hz) with a resolution of 0.1 Hz. All timing information is displayed in units of milliseconds (ms) with a resolution of 1 ms. Therefore, 1 second would be displayed as "R 1000" where R is the register number.

EXAMPLE:

Determine what frequency would be sent when the SINGLE function is first selected.

STEP 1. Rotate the function selector to SINGLE.

STEP 2. The table in the Single Tone section indicates that 1000.0 Hz is the preprogrammed frequency for this function and is stored in register 1 (R1). This may be verified by pressing the [RCL] key followed by the [1] key to recall the information stored in R1. This display should now read `1 1000.0`.

2.3.2 Modifying Register Information - Store [STO] Key

Any of the parameters may be modified by the following procedure:

STEP 1. Select the particular function desired with the front panel function switch.

STEP 2. Enter the new value of the parameter using the keyboard. If necessary, use the [CLR] key to clear mistakes and then enter the correct information.

NOTE: The contents of a register can only be modified by the store [STO] operation. The effect of the clear [CLR] key is to clear the display only, not the contents of the register.

With the desired information to be stored now displayed, press the store [STO] key followed by the key corresponding to the desired register. The left most digit of the display will now indicate the register to which the information was stored.

The following rules apply to storing data in registers:

- If an attempt is made to store data in a register that doesn't exist for the function selected the error message will be displayed (See section on Error Messages).
- Frequency information may not exceed 6500.0 Hz while timing information may not exceed 65000 i.e. 65 seconds.
- Frequency information may be programmed with a resolution of 0.1 Hz. If a decimal point is not entered it will be assumed to be located to the right of the last digit entered. If a decimal point is entered than only one additional digit will be accepted.

EXAMPLE: (cont.)

The previous recall operation indicated that the SINGLE function was programmed to generate a tone on the frequency of 1000.0 Hz. However, it is desired to generate a 67.0 Hz CTCSS tone using this function. This may be done by entering [6] and then [7] followed by the two keys [STO] and [1]. The display should now read `1 67.0` and the CEC-10A should now be generating a 67.0 Hz tone.

2.4 Dialed Digit Outpulsing

Dialed digits may be outpulsed in a group, of from 1 to 8 digits, or outpulsed individually, one at a time, for: DTMF, MTS, IMTS, and SINGLE functions.

To outpulse digits individually first clear the display and then press the [SND] key and wait for the dash "-" to be displayed. Then enter the digit to be outpulsed. A dash will again be displayed when the outpulsing of the single digit has been completed. As soon as the dash reappears the CEC-10A is ready to accept another digit for outpulsing.

To outpulse a group of digits first clear the display and then enter the group of digits, the first digit to be outpulsed is entered first. Then press the [SND] key to start the outpulsing, starting with the left most digit in the display. The dash will again be displayed when all of the digits in the group have been outpulsed. Once the dash has been displayed the user may enter individual digits as before. Also, when the dash is being displayed the user may press the [RCL] key (DO NOT ENTER A REGISTER NUMBER) to recall the last group of digits outpulsed. The entire group may again be outpulsed by pressing the [SND] key.

2.5 Sleep Mode

The CEC-10A provides a feature known as *sleep-mode* which enables the operator to turn off the audio or data output (from the front panel BNC jack), but otherwise keep the encoder running internally. The digital encoder portion of the CEC-10A is designed to run continuously and queues pages for transmission when the operator presses the SND key. However, even though the paging queue is empty (i.e. no pages to send) the CEC-10A encoder continues to generate output. This feature is know in the radio paging industry as batching and very closely emulates the operation of an actual over-the-air paging system. Because the CEC-10A contains a batching encoder, it will be possible for future software releases to test advanced features of both Pocsag and Flex pagers, e.g. Roaming. These tests would not be possible with an encoder that only generates short burst of data. Additionally, since the Flex paging system is synchronous, it is desirable to provide continuous forward channel data transmission so that the pagers can receive channel control (overhead) information any time they are turned on.

However, at the same time, the presence of a continuous encoder output may interfere with other radio frequency (R.F.) tests being performed with the RF signal generator. Therefore, the best of all worlds is to keep the batching encoder feature, but provide a mechanism to mute the output. The solution to this problem is *sleep-mode*.

2.5.1 Sleep Mode ON

To enable *sleep-mode* press the [STO] key followed by the [2nd] key. The CEC-10A will display the message **SLEEP ON** and the audio or data output will be muted. When *sleep-mode* is turned on the CEC-10A stores any Cap-Code information that may be displayed on the front panel. Also, the data encoder continues to operate internally which is important for Flex systems.

2.5.2 Sleep Mode OFF

When the [RCL] key followed by the [2nd] keys are pressed the CEC-10A does the following:

- Re-enables the front panel output.
- Restores the contents of the front panel display, typically a pager Cap-Code
- Allows the operator to pick-up where he or she left off as if sleep mode had never been invoked.

Note that if sleep mode has not been entered, i.e. Sleep On, then pressing [RCL] [2nd] will display the **Error 1** message.

3 Using The CEC-10A Functions

3.1 DTMF FUNCTION

The DTMF function is used to generate any of the standard tone pairs associated with the 16 DTMF digits. There are 3 registers associated with the DTMF function. The registers are preprogrammed with parameters on power up and are listed below along with their preprogrammed values.

REGISTER	DESCRIPTION	Preprogrammed Value (Units)
0	DTMF MODE REGISTER	0 (Reserved for Future Use)
1	Tone ON Time	100 (ms)
2	Tone OFF Time	100 (ms)

The DTMF digits may be sent (outpulsed) as a group or individually. The rate at which the digits are sent depends on the information stored in R1 and R2. Each time a digit is outpulsed the tone pair corresponding to the digit entered is generated for the amount of time specified in R1 followed by a gap, of no tone, for the amount of time specified in R2

3.2 MTS FUNCTION

The MTS function is used to generate Mobile Telephone Service (MTS) 600/1500 Hz signaling at 10 pps. However, in this function the CEC-10A is not limited to generating only the standard frequencies and timing associated with MTS. The user may change the two frequencies used as well as the outpulsing rate. MTS digits may be outpulsed in a group or individually. The following is a list of the 4 registers associated with MTS signaling and their preprogrammed values:

REGISTER	DESCRIPTION	Preprogrammed Value (Units)
0	MTS MODE REGISTER	0 (Reserved for Future Use)
1	Dial Pulse Width	100 (ms)
2	Interdigit Time	500 (ms)

In the MTS function, pressing the [SND] key causes a clearing pulse to be generated before the digits in the display are outpulsed. The clearing pulse consists of 710 ms of 600.0 Hz tone followed by 710 ms of 1500.0 Hz tone. Each digit is separated by the interdigit space determined by the value stored in R2. Pressing the [CLR] key causes a reset pulse to be generated followed by the removal of tone after 500 ms has elapsed. The digits are outpulsed at a rate determined by the value stored in R1 (where 100 ms = 10 pps).

3.3 IMTS FUNCTION

The IMTS (Improved Mobile Telephone System) function is used to generate base to mobile signaling for testing IMTS mobile units. This function uses 4 registers and they are listed below.

REGISTER	DESCRIPTION	Preprogrammed Value (Units)
0	IMTS MODE REGISTER	0 (Reserved for Future Use)
1	Dial-Pulse Make Time	50 (ms)
2	Dial Pulse Break Time	50 (ms)
3	Interdigit Time	250 (ms)

To signal an IMTS mobile enter the mobile units 8 digit ANI and then press the [SND] key. After the CEC-10A has sent all 8 digits the display will then shows a single dash. AT this point three options are available.

- To dial additional digits, enter them one at a time while the dash is displayed. As soon as the entire digit has been outpulsed the dash will return to the display.
- Press the [RCL] key to recall the last 8 digit ANI and then press [SND] to send it again.
- Press the [CLR] key to stop sending digits and return to generating 2000.0 Hz idle tone. At this point another ANI can be entered and outpulsed.

3.4 SINGLE TONE FUNCTION

The SINGLE tone function is used for generating single tones e.g. CTCSS tones as well as single tone interrupted signaling. Single tone interrupted digits may be outpulsed in a group or individually. There are 7 registers associated with the SINGLE tone function and they are listed below along with their pre-programmed values.

REGISTER	DESCRIPTION	Preprogrammed Value (Units)
0	Mode Register	0
1	Tone Frequency	1000.0 (Hz)
2	Dial Pulse - Break Time	50 (ms)
3	Dial Pulse - Make Time	50 (ms)
4	Interdigit Time	250 (ms)
5	CTCSS Reverse Burst Time	500 (ms)
6	Rev. Burst Phase: 0 = 180, 1 = 120	0

3.4.1 Single Tone - Continuous or Dial Pulsed (Mode 0)

Storing a “0” in the mode register (R0) will select the Single Tone Continuous (and optionally Dial Pulsed) mode. The CEC-10A display will show the word **SINGLE**. As soon as this mode is selected the tone frequency stored in R1 is generated. To change the frequency, first clear the display and then enter

the new tone frequency and then press the [STO] [1] keys. The CEC-10A will now be generating the new frequency being displayed.

3.4.2 CTCSS with Reverse Phase Burst (Mode 1)

The CEC-10A also provides another method to generate CTCSS tones using mode "1" of the Single tone function. This function also provides a synchronization signal at the rear BNC connector. This mode is selected by storing a "1" in R0 and the display reads **CTCSS**. To send a CTCSS tone enter the desired CTCSS frequency using the front panel keypad. Then press the [SND] key to start tone generation. To halt tone generation press the [CLR] key. Note that pressing the [CLR] key will delete the right most digit of the tone frequency - so if you want to send the same frequency burst again you must enter this digit again.

When tone generation begins (when the [SND] key is pressed) the Data Sync. output goes to a logic high and remains high until the [CLR] key is pressed. When the [CLR] key is pressed the Data Sync. output goes low and the CEC-10A generates a reverse burst tone for the length of time programmed into R5. The reverse burst tone is at the same frequency as the original tone, but the phase is changed by either 180 degrees (default) if R6 = 0, or 120 degrees is R6 ≥ 1.

3.5 2-TONE FUNCTION

The 2-TONE function is used to generate 2-Tone sequential signaling. There are 6 registers associated with the 2-TONE function and they are listed below along with their preprogrammed values.

REGISTER	DESCRIPTION	Preprogrammed Value (Units)
0	2-TONE MODE REGISTER	0 (Reserved for Future Use)
1	1st Tone Frequency	1000.0 (Hz)
2	2nd Tone Frequency	500.0 (Hz)
3	1st Tone ON Time	1000 (ms)
4	Intertone Gap Time	250 (ms)
5	2nd Tone ON Tome	2500 (ms)

To send a 2-TONE sequence, first, store the desired first and second tone frequencies in R1 and R2 respectively. Pressing the [SND] key will cause the tone sequence to be generated according to the timing parameters stored in R3 - R5.

While the first tone is being generated the display will read **1** followed by **1-** during the intertone gap followed by **1-2** during the generation of the second tone.

3.6 5/6 TONE FUNCTION

The 5/6 TONE function is capable of generating eight (8) different multi-tone sequential signaling formats. The actual format generated depends on the number stored in Register-0 (i.e. R0). By default a zero is stored in R0 on power-up which causes the US 5/6 Tone function to be enabled. Seven other similar functions may be selected by storing a different number in R0. The following table summarizes what other multi-tone sequential formats are available.

R0 VALUE	5/6 TONE FUNCTION	DISPLAY TEXT
0	US (EIA) Type 5/6 Tone	5/6 TONE
1	ZVEI-1	ZVEI-1
2	ZVEI-2	ZVEI-2
3	ZVEI-3/DZVEI	ZVEI-3
4	EURO	EURO
5	CCIR	CCIR
6	CCIT	CCIT
7	EEA	EEA

3.6.1 The US 5/6 Tone Function (Mode 0)

The US 5/6 Tone function is capable of generating Selective Call signaling to US-EIA type 5/6 tone pagers with or without preamble and dual address tones. If a pager requires a preamble tone then it will, in general, have a 6 digit address. The following procedures show how to signal the different types of 5/6 tone pagers:

If the pager contains only a 5 digit address, enter these numbers using the keypad. When the display matches the pager address (also called the Cap-Code) just press the [SND] key. To signal the pager's 2nd (Dual) address (if it has one) use the keypad to append the letter "D" to the display, then press the [SND] key. To return to the primary pager Cap-Code use the [CLR] key to clear the "D" digit and again press [SND] to signal the pager.

If the pager contains a 6 digit Cap-Code then enter these 6 digits (without any punctuation, e.g. dashes or slashes). Then just press the [SND] key to signal the pager's primary address, or follow the procedure above to signal the pager's 2nd address.

3.6.2 European Multi-Tone Sequential Formats (Modes 1-7)

Modes 1-7 of the 5/6 Tone Function are used to generate multi-tone sequential signaling. The length of the selective call (SelCall) address can be from 1 to 20 digits. Note that only the right most eight digits will be shown on the CEC-10A LED display. Each digit of the SelCall address can range from 0-9 and A-E. Note that digit "E" is the Repeat digit and is automatically inserted by the CEC-10A. Therefore, for example, if the user enters a SelCall address of 12334 the CEC-10A will send the tones for the digits 123E4. The following table summarizes the tone frequencies used by the eight (8) formats available.

3.6.3 Tone Timing

The length of time each tone is generated in the US (EEA) 5/6 Tone format is fixed according to the specification for the format. However, for the European formats (modes 1-7) the tone duration is controlled by the value stored in Register-1 (i.e. R1) and this value is set by default to 100 ms.

Tone #	US 5/6	ZVEI-1	ZVEI-2	ZVEI-3	EURO	CCIR	CCIT	EEA
0	600.0	2400.0	2400.0	2200.0	980.0	1981.0	400.0	1981.0
1	741.0	1060.0	1060.0	970.0	903.0	1124.0	697.0	1124.0
2	882.0	1160.0	1160.0	1060.0	833.0	1197.0	770.0	1197.0
3	1023.0	1270.0	1270.0	1160.0	767.0	1275.0	852.0	1275.0
4	1164.0	1400.0	1400.0	1270.0	707.0	1358.0	941.0	1358.0
5	1305.0	1530.0	1530.0	1400.0	652.0	1446.0	1209.0	1446.0
6	1446.0	1670.0	1670.0	1530.0	601.0	1540.0	1335.0	1540.0
7	1587.0	1830.0	1830.0	1670.0	554.0	1640.0	1477.0	1640.0
8	1728.0	2000.0	2000.0	1830.0	511.0	1747.0	1633.0	1747.0
9	1869.0	2200.0	2200.0	2000.0	471.0	1860.0	1800.0	1860.0
A	2151.0	2800.0	886.0	2600.0	340.0	2400.0	None[a]	1055.0
B	2435.0	810.0	2800.0	2800.0	400.0	930.0	None	930.0
C	2010.0	970.0	810.0	810.0	1153.0	2247.0	2400.0	2247.0
D	2295.0	886.0	2600.0	886.0	369.0	991.0	None	991.0
E[b]	459.0	2600.0	970.0	2400.0	1063.0	2110.0	2300.0	2110.0

a. Tone Frequencies marked “None” are not defined for the format and generate a 0.0 Hz tone.

b. Tone E is the Repeat Tone

3.7 TONE CONTROL FUNCTION

The TONE CONTROL function is capable of generating tone sequences used in the tone remote control of base station equipment. The preprogrammed TONE CONTROL sequence consists of a burst of 2175 Hz high level guard tone (at 0 dBr) followed by a burst of 1950 Hz function tone (at 0 dBr), followed by low level guard tone (transmit hold tone at -20 dBr). The hold tone is continuously send until the [CLR] key is pressed. Additionally, a user defined auxiliary. burst tone may be sent (at 0 dBr) between the high level guard tone and function tone bursts. To activate this feature simply program the burst time register (R6). There are 7 registers associated with the TONE CONTROL function and they are listed below along with their preprogrammed values.

REGISTER	DESCRIPTION	Preprogrammed Value (Units)
0	Mode Register	0 (Not Used Yet)
1	Guard Tone Frequency	2175.0 (Hz)
2	1st Function Tone Frequency	1950.0 (Hz)
3	High Level Guard Tone - On Time	125 (ms)
4	1st Function Tone - On Time	40 (ms)
5	2nd Function Tone Frequency	1750.0 (Hz)
6	2nd Function Tone - On Time	0 (ms)

To start the tone control sequence press the [SND] key. If R6 is programmed for 0 ms of Auxiliary Tone then the display will read `G` while the high level guard tone is being generated followed by `G1` while the 1st function tone is being generated followed by `G1L` while the low level guard tone is being generated. Low level guard tone will continue to be sent until the [CLR] key is pressed. If the programmed value of R6 > 0 then a "2" will be displayed between the "1" and the "L". Therefore, while low level guard tone is being sent the display will read `G12L`

4 Digital Function

When the Digital function is selected, using the front panel function switch, it is also necessary to further select one of several available digital formats by storing the appropriate number in Register 0 (i.e. R0). As is the case in all of the CEC-10A functions, register 0 is the mode register. Other registers associated with the Digital function control other features such as the type of display message, data polarity and digital page repeat. The following table shows the Digital function registers and their use. Additionally, these registers are programmed with a default value each time the CEC-10A is turned on.

REGISTER	DESCRIPTION	DEFAULT
0	**MODE REGISTER - SEE TABLE BELOW**	4
1	Display Type: 0 = Tone Only, 1 = Numeric, 2 = Alphanumeric	1
2	Data Polarity: 0 = Normal, 1 = Invert	0
3	Repeat Mode: 0 = Off, 1 = ON	0
4	Mail Drop Mode, FLEX ONLY: 0 = Disable, 1 = Enable	0

The following table shows the value that should be stored in the Mode Register (i.e. Register 0 of the Digital Function) to select a specific digital format.

R0 VALUE	DIGITAL FUNCTION	DISPLAY TEXT[a]
0	Setup (Reserved for future Use)	SETUP
1	Digital Private Line (DPL)	DPL
2	Motorola Golay Sequential Code (GSC)	MOT GSC
3	Reserved for Future Use	NOT USED
4	POCSAG 512 Baud	POC 512
5	POCSAG 1200 Baud	POC 1200
6	POCSAG 2400 Baud	POC 2400
7	FLEX 1600 bps, 2-FSK (1600 baud)	FLEX 16/2
8	FLEX 3200 bps, 2-FSK (3200 baud)	FLEX 32/2
9	FLEX 3200 bps, 4-FSK (1600 baud)	FLEX 32/4
A	FLEX 6400 bps, 4-FSK (3200 baud)	FLEX 64/4

a. Note that if the right most decimal point is also displayed next to the above “Display Text”, when a Digital function is selected, than Register 2 (the Polarity register) has a non-zero value stored in it. If R2 > 0 then the data transmitted in modes 1 - A is sent inverted.

Note that the CEC-10A data encoder runs continuously and, therefore, there will always be an signal output from the front panel BNC connector while digital modes 2 through A have been selected. To temporally mute this output see Section 2.5 on page 4 for more about “sleep-mode”.

4.1 Setup (Mode 0) Reserved for Future Use

In the future this mode will be used to make permanent changes the CEC-10A register contents.

4.2 Digital Coded Squelch/Digital Private Line (Mode 1)

Mode 1 of the Digital function provides for the generation of Digital Coded Squelch (also know as Motorola Digital Private Line). This function controls the Data Sync. output jack (located on the rear panel) to provide a synchronization signal to the start and stop of the DPL code. At the start of DPL generation the Data Sync. output goes high and returns low when the [CLR] key is pressed and the generation of turn off code begins.

The following procedure is used to generate Digital Private Line (DPL™) data i.e. a continuous sequence of the 23 bit code word.

STEP 1. Select the DIGITAL function and make sure that a "1" is stored in R0, i.e. to select mode 1. The display should now read **DPL**.

STEP 1. To send the DPL code inverted store a 1 in Register 2. The display will now read **DPL.** where the right most decimal point indicates that the data polarity has been inverted for ALL Digital modes.

STEP 2. Enter the 3 digit octal DCS code number.

STEP 3. Press the [SND] key to start DCS generation.

STEP 4. To halt data generation - press the [CLR] key or select another function. Pressing the [CLR] key will cause the CEC-10A to send a 180 ms burst of 134 Hz turn off code and then halt data generation.

NOTE: The error message indicates that either a digit in the DCS code was larger then 7 or that more or less than 3 digits were entered for the code number.

NOTE: Because of the Buffered nature of the CEC-10A digital encoder the Data Sync. output only provides an approximate reference to the actual events occurring at the output jack. For example, when the [CLR} key is pressed the Data Sync. output will go low, but the encoder will continue to generate DPL until the 23 bit word boundary is encountered at which time the turn off code data will be encoded. When the Data Sync. output is used to trigger an oscilloscope the error between the change of state in the Data Sync. output and the actual events is small enough to capture the CEC-10A output (on one channel) and the decoder under test response (on a 2nd channel).

4.3 Motorola Golay Sequential Code - GSC (Mode 2)

This section describes how to signal Motorola digital pagers using the Golay Sequential Code (GSC) format. For this format each pager is assigned a 6 digit address or Cap-Code For each Cap-Code the pager can be alerted in four different ways. In other words each address has 4 functions or sub-addresses. Note that in ALL cases where the GSC format is to be encoded, the pagers Cap-Code consist of a 6 digit number. However, some later model pagers have a 7 digit address is printed on them. The seventh digit is known as the "Pager Function". To generate the correct signaling enter the first 6 digits (i.e. the pagers address) as is. If the pager function digit is known enter this next, otherwise use the following table to determine the correct 7th digit to enter.

Also, note that for a display pager, the type of message depends on the value stored in Register 1 (i.e. R1). However, the Motorola GSC pager function digit can override this setting in the case of a tone-only page. Therefore, if the 7 digits entered into the CEC-10A were, for example, 1000009 and the value in

R1 was 2 (for Alphanumeric Message) then the pager will alert in tone-only because the pager function digit of “9” overrides the value in R1.

To alert display type pager, first determine whether it is a numeric or alphanumeric type. Then make sure the value stored in R2 matches this type, i.e. 1 = numeric and 2 = alphanumeric. Then enter the 6 digit Cap-Code followed by a pager function digit. Note that for display paging the value of the pager function can only be between 5 and 8.

Function Digit	Type of Page	GSC Function
1	Tone & Voice	1
2	Tone & Voice	2
3	Tone & Voice	3
4	Tone & Voice	4
5	Display	1
6	Display	2
7	Display	3
8	Display	4
9	Tone Only	1
0	Tone Only	2

Follow the steps below to signal Motorola GSC type pagers:

STEP 1. Rotate the selector switch to DIGITAL.

STEP 2. To select the Motorola GSC format store a "2" in the mode register R0 (The CEC-10A will remain in the Motorola GSC mode until another code is stored in R0. Therefore, it is not necessary to repeat this step before each test page.). The display will now show **MOT GSC**. A decimal point displayed to the right of GSC indicates that the polarity has been reversed (register 2 = 1), i.e. **MOT GCS.**

STEP 3. Use the generation of Dotting to set the FM signal generator’s deviation to ±4.5 Khz, if this has not already been done.

STEP 4. Enter the pagers 6 digit cap code (include leading zeros).

STEP 5. Enter the desired pager function digit: (0 - 9) see the above table.

STEP 6. Press the Send [SND] button each time the page is to be transmitted except where R3 has been programmed for repeat page.

The Numeric Display Message is “**123456789-0**”. The Alphanumeric Display message is “**MOTORLA ALPHA - GSC PAGING TEST**”.

4.4 POCSAG PAGING FORMAT (Modes 4 - 6)

To use the Pocsag function, first rotate the selector switch to DIGITAL and then store the appropriate value in R0 (the Mode register) to select the desired Pocsag speed where: 4 = 512 baud, 5 = 1200 baud, and 6 = 2400 baud. As soon as the correct value is stored in R0 the display will briefly display the register number (in this case 0) on the left and the value stored in that register on the right. Then a text message will continuously be displayed which indicates the Pocsag mode selected. For example, **POC 2400** is the text display message for Pocsag 2400 baud. At this point the CEC-10A will start generating continuous Dotting at the selected baud rate. A decimal point displayed to the right of baud rate indicates that the polarity has been reversed (register 2 = 1).

4.4.1 POCSAG Numeric Display Message

To instruct the CEC-10A to send a numeric test message when it sends a Pocsag page, make sure a "1" is stored in register "1" (i.e. R1 = 1). Note that this is the power-on default value for this register. If R1 = 1 then the numeric message sent is **1234567890**. Note that for the pager to correctly receive a numeric display message it must be either: (a) a numeric pager; or (b) an alphanumeric pager with the page sent to Pager Function 1 (see step 3 below).

4.4.2 POCSAG Alphanumeric Display Message

To instruct the CEC-10A to send an alphanumeric test message when it sends a Pocsag page, make sure a "2" is stored in register "1" (i.e. R1 = 2). If this is the case then the message **POCSAG ALPHA TEST** will be sent to the pager. Note that on most Pocsag alphanumeric pagers, Pager Function 1 is reserved for numeric message reception. Therefore, if you attempt to send an alphanumeric function 1 type message to an alphanumeric pager, the pager most likely will not understand the message and display *junk* on its display.

To send a Pocsag page follow the procedure outlined below:

STEP 1. While Dotting is being sent, set the FM deviation if this has not already been done. Note that Dotting is sent whenever: (a) the Text message indicating the format selected is displayed, or (b) the word **DOTTING** is displayed.

STEP 2. Press the [SND] key to put the CEC-10A in batching mode. In this mode a continuous stream of paging data is generated. The CEC-10A displays **BATCHING** while in this mode unless a pager Cap-Code is displayed.

STEP 3. Enter the Pager Function digit (1 - 4) where: 1 = 1 Beep, 2 = 2 beeps, etc.

STEP 4. Enter the 7 digit pager address (include leading zeros). There should now be 8 digits on the display.

STEP 5. Press the [SND] button to start the page sequence. This will queue the page with the address on the display for the next available batch in the transmission sequence.

STEP 6. To send the same page, just press the [SND] key again. To enter a new Cap-Code hold down the [CLR] key to clear the entire display and then go to step 3.

4.5 Using Motorola FLEX Paging (Modes 7 - A)

The CEC-10A supports the generation of FLEX signaling on all four modulation speeds (baud rates). Because FLEX is a synchronous protocol, it is necessary to synchronize the pager to the CEC-10A signaling before a page can be sent. Additionally, it is necessary to accurately set the modulation level before attempting to send a FLEX page. For these reasons several features have been incorporated into the CEC-10A FLEX encoder to facilitate the quick setup of modulation level and synchronization.

4.5.1 FLEX Addressing & Cap-Codes

The addresses used in FLEX paging systems (and other paging systems) are referred to as Cap-Codes. FLEX Cap-Codes can represent either short or long addresses. With short addressing a paging system can support just under two million Cap-Codes. FLEX Cap-Codes can be distinguished from other pager addresses (e.g. Pocsag) by the Alpha characters that make up the Cap-Code. A short address Cap-Code consist of one letter followed by 7 numeric digits. Therefore, A0000001 is a FLEX short address Cap-Code. A long address FLEX Cap-Code consists of one Alpha character followed by 9 numeric digits where the 9 digit number is 2101249 or larger. Therefore, A002101249 is a FLEX long address Cap-Code while A000000001 is *not.*

FLEX Cap-Codes either follow the “Standard Rules” or “Non-Standard Rules”. If the Cap-Code follows the Standard Rules the Alpha character is a letter from A through L. Other letters for the Alpha character signify Non-Standard Rules.

The 8 or 10 character FLEX Cap-Codes may also be preceded by a Cap-Code-Prefix. Thus, for example, 1274A0000001 represents a pager with short addressing, but forced to look for its pages in frame 127 and programmed to use the standard battery cycle of 4.

4.5.2 Non-Standard Cap Codes and Prefixes

Non-Standard Cap code generally contain the letters U, V, W or X preceding the 7 or 9 digit numeric part of the Cap-Code. Additionally, these Cap-Codes may be preceded by frame and battery cycle information (as described above). It is possible to signal these Non-Standard Cap-Codes by making a few minor changes to the data entered into the CEC-10A. First of all, the CEC-10A forward channel signaling instructs *All* Flex pagers to look at every frame so that the 4 digit prefix can be completely ignored. Second, the letters U - X represent Flex multiplex phases just like the standard digits A - D. Therefore, when signaling a pager with U - X as the alpha part of the Cap-Code - replace the alpha part with the letters A - D respectively.

4.5.3 To Send A FLEX Page

To send a FLEX page the following steps should be followed. For display pagers the message sent by the CEC-10A is “**0123456789**” when R1 = 1. Note that in FLEX systems this message can be received by both numeric and alphanumeric pagers so there is no need to alter the contents of R2 unless a Text message is required. For Alphanumeric Display Pagers the display message sent is “**MOTOROLA FLEX ALPHA TEST MESSAGE**” when R1 = 2. Note that numeric pagers can not receive this alphanumeric message.

The CEC-10A can also send a Maildrop type message to a FLEX pager. For this type of message the pager must be capable of alphanumeric message reception as well as Maildrop operation. Additionally, the Maildrop feature must be enabled in the pager for a specific Maildrop Cap-Code. The Maildrop Cap-Code is generally a secondary address for the pager. To send a Maildrop message: (a) program R4 = 1 for Maildrop operation; and (b) remember to enable the pager’s Maildrop audible alert so you can tell when the message is received by the pager. Then follow the steps below, but use the Maildrop Cap-Code.

NOTE: The Maildrop register (i.e. R4) overrides the Display Message Type Register (i.e. R1) and forces an alphanumeric message to be sent when R4 = 1 regardless of the value stored in R1. Therefore, Maildrop messages can be sent with fewer front panel keystrokes, i.e. just program R4 = 1. When R4 is reset to “0” the value stored in R1 again determined the type of FLEX display message.

To send a FLEX page follow the steps below:

STEP 1. Turn the front panel function switch to the Digital function.

STEP 2. Select the desired signaling speed by storing the appropriate number in R0. Note that the FLEX mode will be displayed (in abbreviated form) on the front panel display). Therefore, **FLEX16/2** is displayed when a 7 is stored in R0.

STEP 3. As soon as the desired signaling speed is selected, the CEC-10A starts generating continuous Dotting. Dotting ALWAYS consists of the alternating one-zero pattern transmitted at 1600 bps regardless of the FLEX baud rate selected. At this point, the generated Dotting pattern can be used to correctly set the FM modulation deviation (level). This level should be set to ±4800 Hz (with an accuracy of ±60 Hz).

STEP 4. Next, press the send [SND] key to put the CEC-10A in batching mode. The front panel displays **BATCHING** to indicate this mode. At this point the CEC-10A will generate a Re-synchronization signal which will sync. the pager to the CEC-10A forward channel data. The CEC-10A is a full batching encoder and, therefore, is capable of generating a continuous forward channel data stream which more closely resembles what a pager *sees* from a paging system than does single *burst* mode paging.

STEP 5. To enter a short address Cap-Code first clear the display. Pressing the Clear [CLR] key momentarily clears a single (right most) digit while shifting all displayed digits to the right. Pressing the [CLR] key for more than 250 ms clears the entire display and shows only a single zero "0" in the right-most digit. Next, use the keyboard to enter the desired Cap-Code. The CEC-10A shift function (2nd key) must be used to select the Alpha characters A through N. Therefore, to enter the Cap-Code "A0000001", first press the [*/2nd] key followed by [A/STO] key. The display should now show the letter "A" in the right-most position. Then enter the remaining 7 digits so that the display shows a total of 8 characters. To send a long address page enter a total of 10 digits where the first digit is A to N. Note that the left most 2 digits will scroll off the display. However, when the [CLR] key is pressed, to delete single display characters, they will scroll back to the right.

STEP 6. To send the displayed address to the pager press the [SND] key. The page is then queued for the NEXT available frame in the forward channel data stream. Note that when the pager was receiving idle frames (during batching) it was instructed to "look" at ALL frames regardless of the "Collapse Cycle" programmed into the pager's code-plug.

STEP 7. To Repeat the page continuously, first clear the display and store a "1" in register 3. The display should now show `3 1` where the left-most digit indicates the register the remaining data was stored to. Then enter a pager Cap-Code and press the [SND] key. The CEC-10A will continuously send the page in all frames until the [CLR] key is pressed. When the display shows less than 8 digits, by pressing the [CLR} key, the CEC-10A will return to sending idle frames (i.e. batching).

5 Additional Digital Encode Features

When in the Digital encode mode the CEC-10A also has the capability of switching between: Dotting, Batching, and Pseudo-Random data generation.

5.1 Switching between Batching and Dotting

When the CEC-10A is in one of the digital paging modes (modes 4 - A) is may be necessary, from time-to-time, to return to sending Dotting. This can be done by clearing the display, and then entering the character "D". Then when the [SND] key is pressed, the CEC-10A will display **DOTTING** and then return to sending the alternating one-zero pattern at 1600 bps. Note that when the encoder is returned to the Dotting mode the FLEX pager looses synchronization. To resume paging operation first clear the display and just press the [SND] key. The CEC-10A displays the word **BATCHING** and paging can resume with step 3 described above.

5.2 Sending Pseudo-Random Data

It may also be desirable to send pseudo-random data at the selected baud rate and the CEC-10A can accommodate this requirement too. Because FLEX forward channel data consists of mainly 1600 bps dotting (regardless of the mode selected) it is difficult to see the data transition between all the symbols (e.g. 4 symbols with 4-FSK) unless it is possible to *capture* just the frame that the specific page was sent in. For this reason the CEC-10A has the capability of generating pseudo-random data at the baud rate selected. Note that with 4-FSK the baud rate is not the same as the bit rate (in bps).

Pseudo-Random data can be generated by: clearing the display, entering a * character, and pressing the [SND] key. The CEC-10A responds by displaying **P-RANDOM** and generates a forward channel data stream of random data symbols. Therefore, for example, if FLEX 6400 bps 4-FSK was the mode selected when pseudo-random data generation started, then the CEC-10A would generate (on average) an equal number of symbols for each of the 4 possible modulation deviation levels at, in this example, 3200 symbols per second (3200 baud).

Additionally, the CEC-10A provides a symbol clock reference signal located on the rear panel. This is a BNC connector labeled “DATA SYNC”.

6 Technical Support

For technical support on this product you may contact us in one of four different ways:

- Call **1-800-603-5140** (inside the US) or 1-413-774-6500: then dial extension 4 for technical support.
- Visit our Internet Web site at **http://www.cromack.com** and go to the technical support page.
- E-mail questions to **sales-info@cromack.com**
- Fax questions to **1-413-774-6291**.