



**CROMCO
ELECTRONICS**

A Division of Cromack Industries, Inc.

OPERATORS MANUAL

REVISION L

CEC-10, CEC-10D, and CEC-10E UNIVERSAL AUDIO GENERATOR

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Cromack Industries, Inc.
Cromco Electronics Division
22 Rockland Road
Greenfield, Massachusetts 01301
(413) 774-6500

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HISTORY OF FIRMWARE REVISIONS

VERSION	DESCRIPTION OF CHANGES
B2	Correct Parity Error in Golay Format Affecting GSC Display Paging and Digital Coded Squelch.
B3(2.3)	Low Noise Version of B2, change version designation i.e. Version 2.3 is the same as Version B3.
3.0	Modifications to POCSAG so that all two million addresses can be encoded. This Mod. also affects the operation of the NEC digital paging. Modification to Tone Control Function for Motorola PURC (Analog Mode) station control (D and E) Options. Add a new feature to the Universal Function for PURC (Binary Mode) station control (E Option Only).
3.1	HSC Radiopaging Format added to 5/6 Tone Function.
3.2	Fix Function Code Error in POCSAG
3.3	Modify POCSAG for NEC D4 Pagers
3.4	Fix frequency error on DTMF "*" low tone (941 Hz)
3.5	Modify POCSAG for Motorola Bravo Pager Problem. Add Register 5 to Universal Function to allow user control of Gap Time for Motorola PURC, binary mode, base station control.
3.6	Add high speed, i.e. 1200 b/s, POCSAG as Universal Mode 5.
3.7	Change data entry format on Motorola GSC paging (Universal mode 2). Also, add New Universal mode 6 for the NEC Scanning Pager.
3.8	Add 2400 b/s POCSAG
4.0	Add Alphanumeric and Tone-Only feature to all POCSAG modes (i.e. modes 4 - 7).

CEC-10 PREPROGRAMMED PARAMETERS

FUNCTION	DESCRIPTION	REGISTER	VALUE	UNITS
DTMF	Mode Number	0	0	
	Tone On Time	1	100	ms
	Tone Off Time	2	100	ms
	MF Custom Frequencies	3-A	0.0	ms
MTS	Frequency-1	1	600.0	Hz
	Frequency-2	2	1500.0	Hz
	Dial Pulse Width	3	100	ms
	Interdigit Time	4	500	ms
IMTS	Mode Number	0	0	
	Idle Tone Frequency	1	2000.0	Hz
	Seize Tone Frequency	2	1800.0	Hz
	Dial Pulse-Break Time	3	50	ms
	Dial Pulse-Make Time	4	50	ms
	Interdigit Time	5	250	ms
	Delay Before ANI	6	500	ms
SINGLE	Tone Frequency	1	2805.0	Hz
	Dial Pulse-Break Time	2	50	ms
	Dial Pulse-Make Time	3	50	ms
	Interdigit Time	4	250	ms
UNIVERSAL	Mode Number (0 - 4)	0	0	
	Data Polarity, 0=Normal	1	0	
	Data Repeat, 1=Repeat	2	0	
	Modem: Mark Frequency	3	1200.0	Hz
	Modem: Space Frequency	4	2200.0	Hz
2-TONE	Number of 2-Tone Cycles	0	1	
	First Tone Frequency	1	1000.0	Hz
	Second Tone Frequency	2	500.0	Hz
	First Tone On Time	3	1000	ms
	Intertone Gap Time	4	250	ms
	Second Tone On Time	5	2500	ms
	Repeat Delay Time	6	2000	ms

CONTINUED ON NEXT PAGE

FUNCTION	DESCRIPTION	REGISTER	VALUE	UNITS
5/6 TONE	Digit 0 Frequency	0	600.0	Hz
	Digit 1 Frequency	1	741.0	Hz
	Digit 2 Frequency	2	882.0	Hz
	Digit 3 Frequency	3	1023.0	Hz
	Digit 4 Frequency	4	1164.0	Hz
	Digit 5 Frequency	5	1305.0	Hz
	Digit 6 Frequency	6	1446.0	Hz
	Digit 7 Frequency	7	1587.0	Hz
	Digit 8 Frequency	8	1728.0	Hz
	Digit 9 Frequency	9	1869.0	Hz
	Preamble On Time	A	690	ms
	Preamble Tone Frequency	B	600.0	Hz
	Digits 0-9 On Time	C	33	ms
	Dual Address Tone Frequency	D	2010.0	Hz
	Repeat Tone Frequency	E(*)	459.0	Hz
	Service Block Code (HSC)	F(#)	1	
TONE CONTROL	Guard Tone Frequency	1	2175.0	Hz
	Function Tone Frequency	2	1950.0	Hz
	High Level Guard On Time	3	125	ms
	Function Tone On Time	4	40	ms
	Aux. Tone Frequency	5	1750.0	Hz
	Aux Tone On Time	6	0	ms

GETTING ACQUAINTED - A Quick Look

Introduction

The CEC-10 Universal Audio Generator is a microcomputer controlled audio 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 preprogrammed set of frequency and timing parameters stored in the CEC-10's memory. The user may send a sequence using the preprogrammed parameters or change the parameters for special purpose signaling requirements. Data generation capabilities are provided in the UNIVERSAL function mode. In this function the user may select one of several formats by first entering the appropriate mode number.

This manual is divided into three sections. Section 1 provides basic information about the CEC-10. The purpose of this section is to introduce the user to the features of the CEC-10 while, at the same time, performing the initial power up test and check out. Section 2 describes in detail the use of the keyboard function keys. Section 3 describes how to use the CEC-10 for each of the several function modes.

Power Up

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

NOTE: The function switch will rotate clockwise past the tone control function. This is for selecting test functions used by the factory.

Then turn the OFF/ON control switch clockwise to the ON position and observe "CEC-10" followed by an "E" if the unit contains E option, and then followed by a two digit number indicating the software version. If nothing appears check the 1/4 amp fuse in the rear panel fuse holder. If the fuse is good then consult the factory for further instructions.

Next rotate the function switch to a different function (any function). The display should now show only a single zero i.e. "0". Verify that all of the keyboard keys are operational by performing the following tests:

- 1) Enter the digits "1" through "8" by pressing each of the corresponding digit keys on the keyboard,
- 2) Press the [CLR] key to clear the display and note that the display again shows a single zero,
- 3) 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 keys second function) followed by the

- corresponding digit key for each DTMF digit. The display should now read "90AbCd",
- 4) Enter the DTMF characters "*" and "#" by pressing the [*/2nd] key two times, for the "*" character and then the [*/2nd] key followed by the [#/.] key for the "#" character. NOTE: the "*" and the "#" characters are displayed as "E" and "F" respectively. The display should now read "90AbCdEF",
 - 5) 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.

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

KEYBOARD BASICS

Error Messages

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

- 1) Attempt to store [STO] to or recall [RCL] from a function register that does not exist,
- 2) Sending [SND] a sequence before the cap-code or dialed digit information has been entered (for 5/6 tone and IMTS mode 2 and UNIVERSAL modes 1 - 4),
- 3) Storing [STO] a number that is larger than that allowed for frequency and timing parameters.

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

Dual Function Keys

The front panel keyboard contains 16 function keys. However, to fully utilize the power of the CEC-10 it is necessary to be able to enter 22 different functions, either data or commands. Therefore, 6 keys must perform more than one function. The 6 dual function keys are listed below.

DUAL FUNCTION KEYS	FIRST FUNCTION	SECOND FUNCTION
[A/STO]	[STO]-Store Display Data in a Register	Enter "A" Character
[B/RCL]	[RCL]-Recall Register contents	Enter "B" Character
[C/CLR]	[CLR]-Clear Display	Enter "C" Character
[D/SND]	[SND]-Send Sequence	Enter "D" Character
[*/2nd]	Select 2nd Function for next key pressed	Enter "*" Character
[#/.]	Enter Decimal Point	Enter "#" Character

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".

Preprogrammed Frequency & Timing Parameters

Each function the CEC-10 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, B, C, D, or the characters * or #. NOTE: the characters * & # are displayed as E & F respectively. The registers hold frequency and timing information which is used by the particular function selected when a sequence is generated. Each time the CEC-10 is turned on all of the registers are preprogrammed with the frequency and timing parameters most often used with each function. Table-1 is a list of each function and the registers associated with them along with the preprogrammed value of each parameter.

Displaying Parameters - [RCL] Key

To display the register contents for a particular function first switch the function selector to the appropriate function desired. Then using Table-1 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. 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 " 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: Table 1 indicates that 2805.0 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 2805.0".

Modifying Register Information - [STO] Key

Any of the parameters listed in Table 1 may be modified by the following procedure:

- 1) Select the particular function desired,
- 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.

- 3) 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:

- 1) 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.
- 2) Frequency information may not exceed 3275 Hz while timing information may not exceed 64000 i.e. 64 seconds.
- 3) 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 unction was programmed to generate a tone on the frequency of 2805.0 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-10 should now be generating a 67.0 Hz tone.

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 the: 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-10 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.

USING THE CEC-10 FUNCTIONS**DTMF FUNCTION**

The DTMF function is used to generate any of the standard tone pairs associated with the 16 DTMF digits using mode 0, as well as custom, user defined mufti-frequency (MF) tone pairs using mode 1. There are 11 registers associated with the DTMF function. The first 3 registers are preprogrammed with parameters on power up and are listed below along with their preprogrammed values. Registers 3 through A (R3-RA) which are used only in mode 1, contain all zeros and must be programmed by the user with row and column frequency information only if custom MF tones are to be generated. (see section 3.1.2)

REG. #	DESCRIPTION	PREPROGRAMMED VALUE
0	Mode Number	0
1	Tone On Time	100 ms
2	Tone Off Time	100 ms

The DTMF/MF digits may be sent (outputted) 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 outputted 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

Standard DTMF Signaling (mode 0)

To select the standard DTMF tone pair frequencies first select mode 0 by storing a zero in R0. Registers 3 through A are not used in mode 0; therefore, the frequency information stored in these registers has no effect on the tone pair frequencies for standard DTMF generation.

Custom MF Signalling (mode 1)

To generate custom MF tone pairs first select mode 1 by storing a 1 in R0 to select the bank of user defined row and column frequencies stored in R3 - RA. Then program the desired custom row frequencies in R3 - R6 and custom column frequencies in R7 - RA. The following figure shows the relationship between the keyboard digits and the custom row and column frequency registers.

R3	7	8	9	A
R4	4	5	6	B
R5	1	2	3	C
R6	*	0	#	D
R7	R8	R9	RA	

The frequency's generated for a particular digit corresponds to the frequency's stored in the two registers (one row and one column) associated with that digit in the above matrix. The largest frequency that may be generated in this mode is 2100.0 Hz.

EXAMPLE:

Generate 2+2 signaling consisting of a 1500/800 Hz tone pair for 1 second followed by a 900/750 Hz tone pair for 1 second.

- STEP 1: Select two digits to be used for the first and second tone pairs. In this example digit "1" will be programmed for the first tone pair and digit "5" will be programmed for the second tone pair.
- STEP 2: Program the frequencies for the first tone pair, using digit "1", by storing 1500.0 in R5 and 800.0 in R7.
- STEP 3: Program the frequencies for the second tone pair, using digit "5", by storing 900.0 in R4 and 750.0 in R8.

STEP 4: Program the digit on times by storing 1000 in R1 and 0 in R2 for no gap between tones.

STEP 5: Generate the tone sequence by entering the digits [1] and [5] and press [SND]. To send the same tone sequence again press [RCL] and [SND].

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-10 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:

REG. #	DESCRIPTION	PREPROGRAMMED VALUE	UNITS
1	Frequency 1	600.0	Hz
2	Frequency 2	1500.0	Hz
3	Dial Pulse Width (10 pps)	100	ms
4	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 frequency 1 followed by 710 ms of frequency 2. Each digit is separated by the interdigit space determined by the value stored in R4. Pressing the [CLR] key causes a reset pulse to be generated followed by the removal of tone after 500 ms has elapsed.

IMTS FUNCTION

The IMTS function is used to generate IMTS base to mobile, mobile to base, and general purpose FSK signaling. The type of signaling generated depends on the information stored in the 7 registers associated with the IMTS function. The following is a list of the 7 registers and their preprogrammed values.

REG. #	DESCRIPTION	PREPROGRAMMED VALUE	UNITS
0	Mode Number	1	
1	Idle Tone Frequency	2000.0	Hz
2	Seize Tone Frequency	1800.0	Hz
3	Dial Pulse-Break Time	50	ms
4	Dial Pulse-Make Time	50	ms
5	Interdigit Time	250	ms
6	Delay Time Before ANI	500	ms

The number stored in register 0 (R0), the mode register, determines which type of signaling will be generated. For IMTS base-to-mobile signaling a "1" must be stored in the mode register. Then

registers 2 - 5 determine the frequency and timing of the digits to be outputted. Also, the user can change these parameters to generate custom FSK type signaling. For IMTS mobile-to-base signaling a "2" must be stored in the mode register (R0). Using this mode the user can either originate a call to an IMTS terminal or simulate a mobile's response to a call from an IMTS terminal. Registers 1 - 5 are not used in IMTS mode 2.

Since the CEC-10 doesn't decode signaling from the IMTS terminal it doesn't know when the terminal is ready to accept the mobile's ANI digits. Therefore, to insure that ANI is not sent before the terminal is ready, the sending of ANI is delayed by the amount of time stored in R6.

Base to Mobile Signalling (Mode 1)

In IMTS mode 1 the CEC-10 will initially generate idle tone when the function is selected. To signal an IMTS mobile, enter the mobile's ANI digits (from 1 to 8) and press the [SND] key. The ANI digits will then be outputted according to the timing parameters stored in R3 - R5. After all digits have been outputted a dash will be displayed. The user may then do one of the following:

- 1) Enter additional digits to be outputted, one at a time. (Enter zeros to simulate ringing to the mobile)
- 2) Press the [RCL] key to return to sending idle tone and recall the last ANI sent.
- 3) Press the [CLR] key to return to sending idle tone and clear the display.

Mobile to Base Signaling (Mode 2)

IMTS mode 2 is used for testing the operation of IMTS central office terminal equipment. In this mode the CEC-10 may be used to simulate a call from an IMTS mobile or to simulate the mobile's response to a terminal originated call. In IMTS mode 2, three of the keyboard keys take on a special meaning as described below.

<u>KEYBOARD DIGIT</u>	<u>NEW FUNCTION</u>
2nd *	Send Acknowledge Tone
2nd #	Send Answer Tone
2nd D	Send Disconnect Tones

Mobile Originates the Call

To simulate a mobile originated call to an IMTS terminal, first make sure that a "2" is stored in R0 of the IMTS function. Then enter the mobile units ANI digits (from 1 to 8 digits). While the ANI digits are being displayed press the [SND] key. The CEC-10 will generate a connect sequence, delay for the amount of time stored in R6, and then send the ANI displayed at 20 pps with parity.

When all of the ANI digits have been outputted, a dash will be displayed. At this time the user may simulate IMTS mobile dial pulsing by entering each digit, one at a time. Each time a digit is entered it will be outputted and then a dash will be displayed again to indicate that the CEC-10 is ready to accept the next digit. Also, while the dash is being displayed the user may press the [RCL] key to recall the last ANI sent or enter the 2nd D character to send mobile disconnect signaling. After the disconnect tones are sent the display will automatically be updated with the last ANI sent.

Terminal Originates the Call

To simulate a mobile's response to an IMTS call, first clear the display. As soon as the IMTS terminal completes the base to mobile signaling enter the 2nd * character to send the mobile acknowledgment tone. Then to simulate mobile answer press the 2nd # key. As before, the 2nd D key may be pressed to send disconnect.

SINGLE TONE FUNCTION

The SINGLE function is used for generating single tones e.g. CTCSS tones as well as single tone interrupted signaling. Single tone interrupted digits may be outputted in a group or individually (see section 2.6). There are 4 registers associated with the SINGLE function and they are listed below along with their preprogrammed values.

REG. #	DESCRIPTION	PREPROGRAMMED VALUE	UNITS
1	Tone Frequency	2805.0	Hz
2	Dial Pulse-Break Time	50	ms
3	Dial Pulse-Make Time	50	ms
4	Interdigit Time	250	ms

As soon as the SINGLE function 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-10 will now be generating the new frequency being displayed.

2-TONE FUNCTION

The 2-TONE function is used to generate 2-Tone sequential signaling. There are 7 registers associated with the 2-TONE function and they are listed below along with their preprogrammed values.

PREPROGRAMMED			
REG. #	DESCRIPTION	VALUE	UNITS
0	Number of 2-tone cycles	1	
1	First Tone Frequency	1000.0	Hz
2	Second Tone Frequency	500.0	Hz
3	First Tone on Time	1000	ms
4	Intertone Gap Time	250	ms
5	Second Tone On Time	2500	ms
6	Delay Time Before Repeat	2000	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. If more than one sequence is to be generated, store the total number of cycles in R0 and the delay time between sequences in R6. Then press the [SND] key to start the cycle.

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. If the value stored in R6 is greater than "1" the display will read " 1-2-" during the repeat delay period.

5/6 TONE FUNCTION

The 5/6 TONE function is capable of generation sequences of from 1 to 8 tone bursts. There are 15 registers associated with the 5/6 TONE function and they are listed below along with their preprogrammed values. The preprogrammed values are those used in the standard U.S. 5/6 tone format. However, other formats may be generated by entering the decimal digit, dual address and repeat digit tone frequencies and timing in the appropriate registers. Also, by entering the proper control digits this function may be used to generate the HSC Radiopaging Format since it is an extension of the standard 5/6 Tone Format.

PREPROGRAMMED			
REG. #	DESCRIPTION	VALUE	UNITS
0	Digit 0 Frequency	600.0	Hz
1	Digit 1 "	741.0	Hz
2	Digit 2 "	882.0	Hz
3	Digit 3 "	1023.0	Hz
4	Digit 4 "	1164.0	Hz
5	Digit 5 "	1305.0	Hz
6	Digit 6 "	1446.0	Hz
7	Digit 7 "	1587.0	Hz
8	Digit 8 "	1728.0	Hz
9	Digit 9 "	1869.0	Hz
A	Preamble On Time	690	ms
B	Preamble Tone Frequency	600.0	Hz
C	Digit Tone On Time	33	ms
D	Dual Address Tone Frequency	2010.0	Hz
* (E)	Repeat Tone Frequency	459.0	Hz
# (F)	Service Block Code (HSC Only)	1	

In the 5/6 tone code plan each digit in the pager cap-code represents a specific tone frequency. In the CEC-10 these digits 0 - 9, also, correspond to the registers in which the decimal digits frequency is stored. Therefore, the tone frequencies sent are the ones stored in the registers corresponding to the cap-code. However, if the cap-code consists of 2 or more identical digits in a row, the repeat tone frequency stored in r*, is automatically sent in place of the digits entered. To signal a 5 tone pager simply enter the same 5 digit cap-code, as is, and press the [SND] key.

To signal the dual address for the pager, enter the same 5 digit cap-code, followed by 2nd D and press the [SND] key. To send a preamble tone before the address signaling, first press the 2nd B key, then enter the 5 digit cap-code, i.e. the cap-code less the preamble digit, and then press the 2nd D key if the dual address is desired. Then press the [SND] key to send the entire sequence.

NOTE: The B register, i.e. RB, must first be programmed with the preamble frequency corresponding to the preamble digit of the pacers cap-code.

To program the preamble frequency in RB, first, determine from the cap-code, the preamble digit. Then use the CEC-10 to determine the corresponding frequency for this digit by pressing the [RCL] key followed by [P] where P is the preamble digit. Then while the frequency is being displayed press [STO] and 2nd B to program the RB with the preamble frequency.

EXAMPLE:

Send the dual address tone signaling corresponding to the cap- code 6/12344.

- STEP 1: Here the preamble digit is 6 and the frequency corresponding to this digit is found by pressing [RCL] [6].
- STEP 2: The preamble frequency is stored in RB by pressing [STO] 2nd B. The display should now read "b 1446.0".
- STEP 3: Next program the CEC-10 to send the tone sequence for this cap-code by pressing 2nd B followed by 12344, followed by 2nd D. The display should now read " b12344d".
- STEP 4: Press the [SND] key each time the tone sequence is to be generated.

HSC RADIOPAGING FORMAT

The HSC format operates much the same as the standard 5/6 Tone Format except 2 control digits follow the 5 digit address and are used to alert the CEC-10 that the HSC 5 Tone format is to be generated.

Before entering the pacers cap code determine the service block code for the system the pagers operate on and store this code in register-F of the 5/6 Tone Function. This may be accomplished by first clearing the display, entering the service block digit (0 - 9, preprogrammed for 1) and pressing the [STO] key followed by the 2nd [#] key. The display should now read "F S" where s is the service block digit.

To signal a HSC type pager first enter the pacers 5 digit address followed by the 2nd [#] key. Note, the # character is displayed as a "F". Next enter a mode control digit for the type of test page desired. There should now be 7 digits in the display. The following table describes the meaning of the four mode control digits.

Mode Control Digit	Type of Page Generated
1	Tone Only Page.
2	Tone and Data Message Page The message "12345678" is sent to the pager.
3	Tone and Voice Page, the pagers speaker is unmuted.
4	Voice Reset the pagers speaker is muted.

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.

PREPROGRAMMED			
REG. #	DESCRIPTION	VALUE	UNITS
1	Guard Tone Frequency	2175.0	Hz
2	Function Tone Frequency	1950.0	Hz
3	High Level Guard Tone Burst Time	125	ms
4	Function Tone Burst Time	40	ms
5	Auxiliary Tone Frequency	1750.0	Hz
6	Auxiliary Tone Burst 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 " 1" while the high level guard tone is being generated followed by " 12" while the function tone is being generated followed by " 12-" 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 "d" will be displayed between the "1" and the "2". Therefore, while low level guard tone is being sent the display will read " 1d2-"

UNIVERSAL FUNCTION

When the UNIVERSAL function is selected using the function switch it is also necessary to select one of the eight available digital formats by storing the appropriate number in Register Zero, (i.e. R0 is the mode register. This section of the manual is written for ALL types of CEC-10 firmware options available. However, your CEC-10 may NOT be equipped with the D or E options - and therefore will not encode these functions. To determine what options your firmware included, power-up the unit and look at the sign-on message (see the "Power Up" section of this manual for a description of the sign-on message.

In the standard version of the CEC-10 the UNIVERSAL function allows the user to generate ONLY Digital-Coded-Squelch (DSC) data (mode 0 & 1).

With the D-Option the Universal function is expanded to include encoding capabilities for the Motorola Golay-Sequential-Code (mode 2), the NEC D3 code (mode 3), and four POCSAG formats (modes 4 - 7). The NEC Scanning Pager (mode 6) is a special version of the 512 b/s POCSAG format.

With the E-Option the CEC-10's data generating capabilities (modes 2 - 7) are combined with the Tone Control Function and a NEW Modem Emulation function to produce a composite audio output (from the front panel) capable of keying up a Motorola PURC binary base station and then causing it to send a digital page. The following is a list of the registers used in the Universal Function:

NOTE: The data output for UNIVERSAL modes 0 to 7 is at the BNC connector on the rear panel of the CEC-10.

PREPROGRAMMED			
REGISTER	DESCRIPTION	VALUE	UNITS
0	Mode Register for Format Selection	0	
1	Data Polarity: 0=Normal, 1=Inverted (modes 2-6)	0	
2	Cycle Control: 0=Send Once, 1=Send Repeatedly	0	
3	Modem-Mark Frequency	1200.0	Hz
4	Modem-Space Frequency	2200.0	Hz

The data sequence generated depends on the mode number stored in register 0 (R0) of the UNIVERSAL function. The following digital formats are available:

Mode	Format
0	134 Hz Square Wave Generation
1	Digital Coded Squelch (DCS)
2	Motorola GSC Paging
3	NEC D3 Paging
4	Pocsag standard speed (512 b/s)
5	Pocsag 1200 b/s
6	NEC Scanning Pocsag Pager (512 b/s)
7	Pocsag 2400 b/s

Digital Coded Squelch (DCS)

Both modes "0" and "1" are associated with testing DCS systems such as those made by Motorola, E.F. Johnson, and Ferritronics. Mode 0 generates a test signal useful in setting FM signal generator deviation, if one is used. Mode 1 allows the user to generate the actual 23 bit DCS data by simply entering the 3 digit octal DCS code. The data may be sent non-inverted or inverted.

134 Hz Square Wave Generation (Mode 0)

The digital (NRZ) output may be connected to a FM signal generator or directly connected to the digital input of the DCS board under test. If a signal generator is used, mode 0 must first be used to set the proper FM deviation, otherwise skip to section 3.8.1.2.

The following procedure is used to set the signal generator deviation:

- STEP 1: Select the UNIVERSAL function and make sure that a "0" is stored in R0.
- STEP 2: Press the [SND] key to generate the 134 Hz test signal.
- STEP 3: Adjust the FM deviation from ± 0.5 to ± 1.0 KHz for DCS generation. NOTE: Mode 0 can also be used to set the signal

generator deviation before sending digital pages (modes 2 - 7). If this is the case adjust the FM deviation to ± 4.5 KHz.

STEP 4: Press the [CLR] key to halt generation of the test signal.

NOTE: The keyboard will be locked (except the [CLR] key) while the CEC-10 is generating continuous data sequences. To halt data generation, and unlock the keyboard, either press the [CLR] key or select another function.

DCS Generation (Mode 1)

The following procedure is used to generate DCS data i.e. a continuous sequence of the 23 bit code word.

STEP 1: Select the UNIVERSAL function and make sure that a "1" is stored in R0, i.e. to select mode 1.

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

STEP 3: To send non-inverted data - just press the [SND] key. To send inverted data - first enter a decimal point and then press the [SND] key.

STEP 4: To halt data generation - press the [CLR] key or select another function. Either of these actions will cause the CEC-10 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 than 7 or that more or less than 3 digits were entered for the code number.

D-OPTION SIGNALING (Universal Modes 2-7)

Two additional registers are used for the above digital paging formats. Register 1 (R1) controls the polarity of the TTL output data. Normal data transmission takes place when a "0" is stored in R1. Storing a "1" in R1 causes the digital data to be sent INVERTED. Register 2 (R2) is used to control the number of repeats of the paging sequence. With a "0" stored in R2 the digital page is sent only once each time the Send button is pressed. With a "1" stored in R2, pressing the Send button causes the page to be repeated until the Clear button is pressed. On power up R1 and R2 both contain "0".

Motorola GSC (Mode 2)

The following procedure is used to signal Motorola digital pagers using the GSC format. These pagers include the Model BPR-2000 and the OPTRX. For this format each pager is assigned a 6 digit address or cap-code (The OPTRX may have two cap-codes). 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: In ALL cases where Motorola's Golay-Sequential-Code (GSC) is to be encoded, the pagers cap-code consist of a 6 digit number. However, on some later model pagers, and in particular OPTRX pagers, a 7 digit address is printed on the pager. 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.

EXAMPLE:

A Motorola OPTRX pager has the address "1234568" printed on it. Using the following table, the correct eight digits for the CEC-10 are "12345681" which will cause a Data Display Page to be generated.

MOTOROLA PAGER FUNCTION CODES

MOTOROLA PAGER FUNCTION	OLD CEC-10 MODE DIGITS	TYPE OF PAGE
1	1 - 3	Tone & Voice
2	2 - 3	Tone & Voice
3	3 - 3	Tone & Voice
4	4 - 3	Tone & Voice
5	1 - 2	Data Display
6	2 - 2	Data Display
7	3 - 2	Data Display
8	4 - 2	Data Display
9	1 - 1	Tone Only
0	2 - 1	Tone Only

The following procedure is used to signal Motorola GSC type pagers: Skip to step 3 if the FM modulation level has already been set.

- STEP 1: Rotate the selector switch to UNIVERSAL, *00000051*
- STEP 2: Use Mode-0 to set the proper FM deviation to ± 4.5 KHz if this has not already been done, *123856*
- STEP 3: To select the Motorola GSC format store a "2" in the mode register R0 (The CEC-10 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.),
- 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: Enter the display mode digit (1 digit) as follows:
 Enter a "0" for Tone-Only and Numeric pagers
 Enter a "1" for Alphanumeric pagers.
 There should now be eight digits in the display.

STEP 7: Press the Send (SND) button each time the page is to be transmitted except where R2 has been programmed for repeat page.

The Numeric Display Message is **123456789-0**

The Alphanumeric Display message consists of three lines as follows:

**MOTOROLA
ALPHA - GSC
PAGING TEST**

NEC D3 DISPLAY (Mode 3)

- STEP 1: Rotate the function selector to UNIVERSAL, ship to step 3 if the FM modulation level has already been set.
- STEP 2: Use mode 0 to set the proper FM deviation if this has not already been done,
- STEP 3: Store a 3 in R0 to select Mode 3 (The CEC-10 will remain in the NEC mode until another code is stored in R0.),
- STEP 4: Enter the one digit Synchronization code i.e. 1,2,3 or 4. This code is pager dependent, however, most systems use sync. code "1".
- STEP 5: Enter a "0" followed by the 6 digit pager address. There should now be a total of 8 digits in the display.
- STEP 6: Press SND to start the page. The prestored display message is **1234567890**.

POCSAG PAGING FORMAT (Modes 4 - 7)

- STEP 1: Rotate the selector switch to UNIVERSAL, ship to step 3 if the FM modulation level has already been set.
- STEP 2: Use mode 0 to set the FM deviation if this has not already been done,
- STEP 3: Store the POCSAG format number (4 to 7) in R0 to select the speed and type of POCSAG desired (**See List on Page 14**).
- STEP 4: Enter the desired function code 0, 1, 2, 3 or 4.

NOTE: Function code "0" selects a Tone-Only page (using pager function 4 - i.e. 4 beeps) while function codes 1 to 4 are for display pagers. Both numeric and alphanumeric pagers will decode a numeric type message on function 1 - this is defined by the POCSAG international specification. However, when display paging has been selected (by entering

a 1 to 4 for the function code) the CEC-10 will generate a numeric message for functions 1 to 3 and an alphanumeric message for function 4. See the table for the type of message displayed.

STEP 5: Enter the 7 digit pager address (include leading zeros).
There should now be 8 digits in the display,

STEP 6: Press the SND button to start the page sequence.

FUNCTION CODE	DISPLAY MESSAGE	
	NUMERIC PAGER	ALPHANUMERIC PAGER
0	Tone-Only	Tone-Only
1	12345	12345
2	12345	Not Available
3	12345	Not Available
4	U2720	KN

E-OPTION SIGNALING

The E-Option enables the user to combine the features of the TONE CONTROL function, which facilitates base station keying, with the digital paging feature of the UNIVERSAL function and a new modem emulation feature. With or without this option the TONE CONTROL function would allow the user to key a Motorola PURC base station in the Analog Mode. However, with the E-Option and while the CEC-10 is in the UNIVERSAL function it is possible to simultaneously generate TTL data from the rear BNC connector and Composite Tone Control/Modem/Digital Paging signaling from the front panel jack which will key the PURC station in the Binary Mode. Since the front panel output is 600 ohms balanced it can be connected directly to the telephone line input of the PURC base station.

To use the E-Option first turn the function selector to the Tone Control function. The programming of these registers will also be used when the PURC base station is key in the binary mode via the E-Option. Next rotate the function switch back to the Universal function and follow the procedures for encoding a digital page, either Motorola, NEC or POCSAG. When the SND button is pressed the sequence of tones from the front panel will consist of bursts of tone control information to key the PURC base station followed by 150 ms of no tones followed by modem tones modulated with the data that appears at the rear BNC connector. NOTE: make sure that the data INVERT feature (i.e., a 1 stored in R1) has not been programmed or the data will be sent to the base station inverted. The 150 ms pause followed by modem tones causes the PURC station to key in the binary Mode and transmit the digital display page.

The CEC-10 has been preprogrammed for the Modem MARK and SPACE frequencies of 1200 and 2200 Hz using UNIVERSAL registers 3 and 4 respectively. Other mark and space frequencies may be generated simply reprogramming R3 and R4. Also, it is possible to generate the signaling formats of other makes of binary type base stations by reprogramming the registers of the Tone Control function.