Z E T R O N

MODEL 15
OPERATING MANUAL

025-9003L

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WARRANTY

Zetron warrants that all equipment sold pursuant to any resultant agreement shall be free from defects in material or workmanship at the time of delivery. Such warranty shall extend from the time of delivery for One Year. Buyer must provide written notice to Zetron within this prescribed warranty period of any defect; if the defect is not the result of improper usage, service, maintenance, or installation and equipment has not been otherwise damaged or modified after delivery, Zetron shall either replace or repair the defective part or parts of equipment or replace the equipment or refund the purchase price at Zetron's option after return of such equipment by buyer to Zetron. Shipment to Zetron's facility shall be borne on account of buyer.

1. Consequential Damages
   Zetron shall not be liable for any incidental or consequential damages incurred as a result of any defect in any equipment sold hereunder and Zetron's liability is specifically limited to its obligation described herein to repair or replace a defective part or parts covered by this warranty.

2. Exclusive Warranty
   The warranty set forth herein is the only warranty, oral or written made by Zetron and is in lieu of and replaces all other warranties, expressed or implied, including the warranty of merchantibility and the warranty of fitness for particular purpose.

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MODEL 15 TABLE TOP AND RACK MOUNT UNITS

The Model 15 Encoder is available in either a table top or rack mount enclosure. Both units operate identical, except the method for programming the Field Selectable, 'System Parameters', and Selectable 100 Call, 1000 Call, Reach, and Universal Two Tone Formats.

The Model 15 table top unit, referred to as the Model 15T, is supplied with a set of printed circuit board mounted dip switches for selection of the proper format parameters. Refer to Section 7 'Quick Reference'.

The Model 15 rack mount unit, referred to as the Model 15R, allows programming of these parameters via the front panel key pad. Refer to Section 8 'Model 15R Addendum' for information on programming of this unit.

GENERAL
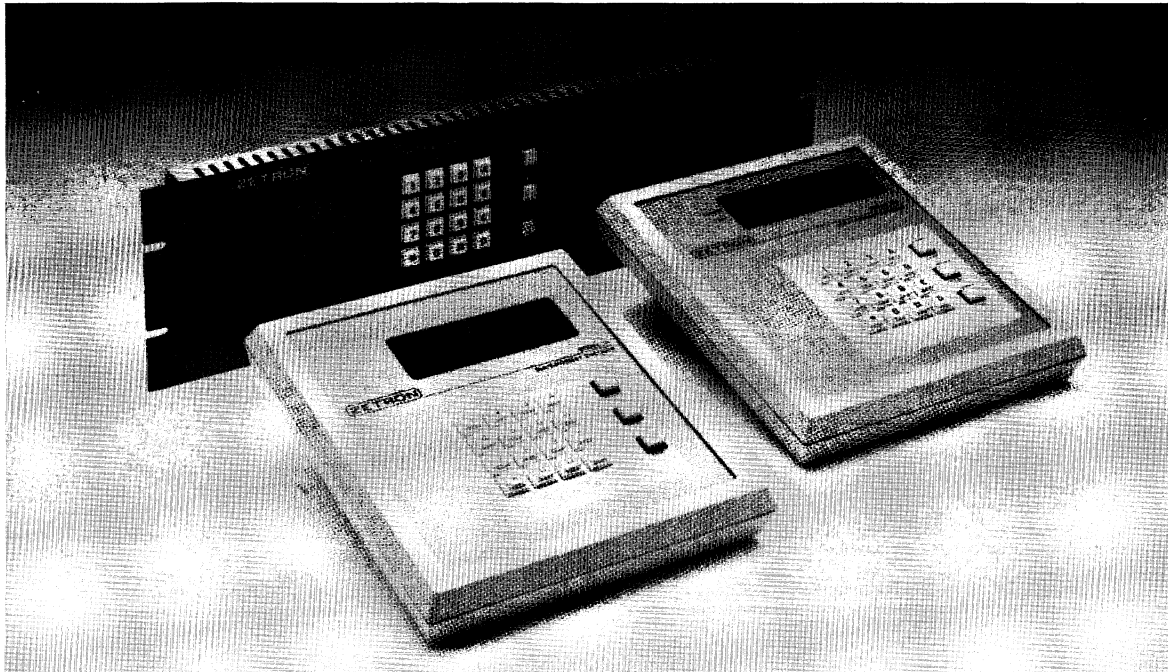
The Zetron Model 15 Communications Encoder is a universal station encoder for the selective calling of radio pagers or mobiles. The keypad has 16 keys, labelled 0-9, *, #, A, B, C, D, and 3 function keys labeled CLEAR, ENTER, and PAGE. The display is a four digit LED readout. Simple connection to a radio communications transmitter or base station via audio and keying relays provides an ideal small dispatching center. The Model 15 desktop encoder can handle mixtures of different paging formats, including 2-Tone, 5/6-Tone, DTMF, 2805 Hz, 1500/600 Hz, Plectron, Multitone, NEC Digital, POCSAG, Motorola Golay, Motorola Optrx, and HSC. Fixed stacks can be ordered so that a group of pagers, all of the same format, can be paged using a single key entry. A set of DIP switches allow user selection of 2-Tone and Reach parameters or these same formats may have been preset.

As your paging needs expand, the addition of new formats or the reconfiguration of existing formats is easily achieved in the field by the replacement of a reprogrammable EPROM memory.

Through advanced microprocessor circuitry, Zetron communications encoders provide a low total parts count resulting in long-term stability and excellent reliability with features found only in encoders costing several times as much. State-of-the-art microprocessor circuitry combined with careful engineering provides compatibility with virtually all signalling formats used in the communications industry.

SIGNALLING FORMATS
Two Tone   Standard Motorola and G.E. Tone Groups and Code Plans

        Call Capacity: 100 call   (1st/2nd tones from one standard tone group each)
                       1000 call (one standard code plan)

        Configurations: (via User-Settable Switches or Pre-Set at order)
        Tone Groups   Motorola 1,2,3,4,5,6,10,11,A,B,Z
        (100-call)   G.E. A,B,C or special

        Code Plan   Motorola B,C,D,E,F,G,H,J,K,L,M,N,P,Q,R,S,T,U,V,W,Y,MT
        (1000-Call)   General, Modified General, General Alternate, G.E. X,Y,Z
                        or special

        Tone Timing   1st /Gap/ 2nd / Group Call
                        1.0 / 0 / 3.0 / 8.0   (GE std, Mot std Tone+Voice)
                        1.0 / 0 / 3.0 / 6.0   (NEC-B)
                        1.0 /.25/ 3.0 / 6.0   (NEC-A)
                        1.0 / 0 / 1.0 / 4.0   (NEC-C)
                        0.5 / 0 / 0.5 / 3.0   (NEC-L)
                        0.4 / 0 / 0.8 / 8.0   (Motorola Tone Only)
                        0.4 / 0 / 0.8 / 4.0   (NEC-M)
                        0.4 / 0 / 0.4 / 3.0   (NEC-D)
                        --- Custom ---

        Diagonal Tone   None (group call) or standard tone group diagonals

        Diag.Placement 1st Tone or 2nd Tone

Two Tone   Universal Tone Group Encoder

    Call Capacity: tones are specified by 2 group and 2
                 tone number entries

    Tone Groups   Motorola 1,2,3,4,5,6,10,11,A,B,Z
                 G.E. A,B,C

    Configurations: via User-Settable Switches
    Tone Timing   1st /Gap/ 2nd / Group Call
                 1.0 / 0 / 3.0 / 8.0   (GE std, Mot std Tone+Voice)
                 1.0 / 0 / 3.0 / 6.0   (NEC-B)
                 1.0 /.25/ 3.0 / 6.0   (NEC-A)
                 1.0 / 0 / 1.0 / 4.0   (NEC-C)
                 0.5 / 0 / 0.5 / 3.0   (NEC-L)
                 0.4 / 0 / 0.8 / 8.0   (Motorola Tone Only)
                 0.4 / 0 / 0.8 / 4.0   (NEC-M)
                 0.4 / 0 / 0.4 / 3.0   (NEC-D)

Reach

    Call Capacity: 100/1000 call and group call

    Configurations: (via User-settable switches or Pre-set at order)
    Tone Timing   1st /Gap/ 2nd / Group Call
                 0.13/ 0 /0.13 / 1.4   (Reach Fast)
                 2.0 / 0 / 0.7 / 4.5   (Reach Slow)
                 ---Custom---

    Group Call   10 group calls or individual calls

Five/Six Tone

    Call Capacity: full format capacity of 100,000 calls

    Configurations:
    Preamble   optional

    Addressing   Single, Dual (using even numbered pages for 1st addr,
                 odd for 2nd addr), or selectable by function digit

    Tones/Timing   EIA, CCIR, or ZVEI

DTMF

    Call Capacity: 3, 4, 5, 6, 7, or 8 digits

    Configurations:
    Tones   all 16 tone pairs available from keyboard

    Timing   custom tone duration and gap duration

2805/1500 Hz

Call Capacity: 3, 4, 5, 6, 7, or 8 digits

Configurations:
Tone Frequency 1500, 2805 Hz, or customer specified

Timing   10 pps

Plectron   Custom specification of pager numbers and tones

Call Capacity: 200 calls

Configurations:
Tones   Up to 2 specified tones per call

Timing   4 different timings are specified by
                1st tone/gap/2nd tone durations

Talk enable   may be set or disabled for each call

Stacks   up to 7

Alert Tones   each call or stack may receive a beep, siren, or
                warble alert

HSC   Hexadecimal Sequential Code

Call Capacity: full format capacity of 100,000 calls in 10
               service blocks. Full group calling capacity.

Configurations:
Functions   9 pager control functions
                10 message/data functions
                all call pager muting
                all call Service Range enable/disable
                all call Battery Saving, 0-60 sec automatic repeat
                cycle

Messages   up to 23 numeric chars of formatted data with
                talk request

POCSAG   Digital Numeric Display Format 512/1200 baud

Call Capacity: full format capacity of 2,097,152 calls

Configurations:
Functions   4 beep/tone alerts

Messages   up to 20 numeric characters

NEC   Digital Tone only and Numeric display formats

    Call Capacity: full format capacity of 100,000 call (Tone only)
              and 1,000,000 calls (Numeric display)

    Configurations:
    Tone Only   when using 5 digits of address

    Display   when using 6 digits of address. Messages of up to
                20 numeric characters.

Motorola GOLAY   Digital Numeric Display Format

    Call Capacity: full format capacity of 1,000,000 calls with
              battery preamble digit

    Configurations:
    Functions   10 beep alert/voice/data combinations

    Messages   up to 12 numeric characters

Motorola METRO   Digital Tone only Format

    Call Capacity: full format capacity of 1,000,000 calls

SPECIAL FEATURES

Display   Large 4-digit .40" high 7-segment readout.
                        Low RFI non-multiplexed drive.
                        Smart alphanumeric operator messages.

Page Indication   " PAGE " message in display.

Voice Prompt   " tALH " message in display when Talk is active.

Built-in Self-Test   Comprehensive automatic test on power-up.
                        Special mode for setting transmitter deviation.
                        Smart messages such as "Err1".

Re-Page   Unit holds prior pager number in display for
                        paging again by simply pressing PAGE.

Stack Entry   Holds several calls in memory to be sent consecutively.
                        "StAC" message in display when each call is entered.

Fixed Stacks   A pre-set stack of calls (all of the same format) may
                        be sent with a single key entry.

Morse Code ID   Automatic Station ID 1200Hz at 20WPM ordered as 15 or
                        30 minute intervals.

ELECTRICAL SPECIFICATIONS

Output Frequency Range   250-3500Hz, +- 1.0dB maximum

Frequency Accuracy   +- 0.1%

Audio Output Drive   Unipolar, single-ended (unbalanced), 600 ohms

Audio Output Amplitude   Adjustable, +5dBm to -20dBm
                         (0-4V pk-pk, adjustable into 600 ohms)

Tone Distortion   2% nominal from pure sinewave

Digital output   Unipolar 0 to 4 volts adjustable

Digital mode   Logic signal (low=digital data)

Control Outputs   2 sets of SPDT contacts, rated 1A at 26VAC;
                         One for Push-to-Talk (P.T.T.),
                         One for switching audio output between
                         internal tone and external voice microphone.

Transmit Inhibit Input   Senses TTL low or closure to ground. Requires that
                         2 seconds of free channel be sensed before paging.

Power Supply   120VAC +-15%, 48-62Hz, wall transformer (9VAC rms)
                         or 12-14VDC at 700mA maximum

Operating Temperature   0 to +65 Celsius

Size   2.7"H x 7.6"W x 7.8"D
                         Desktop high impact plastic case

Weight   19 oz.

POWER-ON

Following installation by qualified radio service personnel, turn on
power to the encoder. The display will come on in the front-panel window
and the unit will perform a built-in self-test while testing the display.
Upon completion of the self-test, the display will show a single minus to
indicate no problem. Any other message such as Err1 signifies an error
condition and the unit should be powered down and a call for repair service
made. Make a note of the error code which is explained in the Repair
section of this manual.

FRONT PANEL DISPLAY

Indication	Meaning (x=any numeric digit)
-	Ready to accept format or fixed stack number from keyboard.
x---	Ready to accept pager code number for format "x" from keyboard, or PAGE key to start fixed stack "x".
____	Ready to accept a message from the keyboard.
xxxx	Shows last four digits of the pager number or message. If a page has already been sent, PAGE will repeat the page again (repage function), or prompt for a new message. When slowly blinking, indicates invalid pager number not in configured code plan. When quickly flashing, indicates that channel is busy and call is being held until channel is free.
StAC	A pager number has just been accepted into the memory stack. Another pager number may now be input. The new pager number may also be moved to the memory stack by pressing ENTER; pressing PAGE will send the pages starting with the most recent entry.
PAGE	Paging information being transmitted.
tALH	Voice interval is active; speak into desk microphone.
Id	Automatic Station ID is being transmitted.
runx	Test number "x" is running.
Errx	Error number "x" detected. Refer to Repair section of this manual.

KEYBOARD

A tactile feel, rugged 16-key conductive rubber keypad is built into the
Zetron Model 15. The buttons are labelled 0-9, *, #, A, B, C, D. Three
extra buttons are provided with panel silk-screening 'CLEAR', 'PAGE', and
'ENTER' next to them. The 16 buttons are used to key in the pager number,
PAGE will send the paging information, ENTER will temporarily store a pager
number in stack memory, and CLEAR will clear a partially-entered number or
message or stop a page in process and return the display to minuses.

CONFIGURATION SWITCHES

The sixteen user settable switches inside the encoder are used to select
Autopage, Autoscroll, Binary Polarity, and Two Tone and Reach parameters.
All of the Model 15 paging formats can have their parameters entirely
specified at order time and these parameters will not change. By ordering
a switched configuration of Two Tone or Reach, the user is given the
versatility to change these parameters at any time; however, the usage of
the switches overlaps, so a given setting will probably apply to only one
format at a time.

The Model 15R Encoder provides the ability to program these features via
the front panel key pad. Refer to Section 8 for information.

PLACING A PAGE

FORMAT SELECTION

The encoder shows a single minus in the display to prompt for a Format
selection. One digit, 0-9 or A-D may be entered to select the Format of the
following pager number. This leading digit is not a part of the address,
nor will it be sent as any part of the page, but it is used to distinguish
between formats in a multiple format encoder. If the encoder uses a single
format configuration or only one fixed stack, no format digit entry is
required.

An incorrect format entry may be erased with the CLEAR key. If a digit is
pressed for which there is no corresponding format or list, the display
will briefly blink and return to showing a single minus.

FIXED STACK

A fixed stack of pagers are called by entering the digit corresponding to
the stack. This is done instead of entering a format selection digit and
pager number. Once the digit is entered, Autopage or depression of the PAGE
key will start the paging sequence.

The display will briefly show each pager number before it is transmitted
and will continue until all calls in the stack have been placed. With
Autoscroll disabled only the last four digits of each pager number are
shown in the display.

PAGER NUMBER

The display will prompt for a pager number by showing the leading digit
(for a multiple format encoder) or a blank (for a single format encoder) at
the left side of the display, followed by one or more minuses. The number
of minuses indicate how many digits of a pager number the unit is prepared
to accept. One or two minuses would prompt for a one or two digit pager
number. Three minuses would indicate that three or more digits might be
accepted for a pager number; the order reference sheet at the back of this
manual should be consulted for the exact number. However, once the encoder
has received the maximum number of digits allowed by the selected format,
it will accept no more.

As the digits are accepted from the keyboard they will fill from the left
to the right until the display is full. Additional entries will shift the
display to the left.

If a format uses extra digits to select special pager functions, these are
generally entered as part of the pager number.

An incorrect pager number can be erased with the CLEAR key. This will cause
the encoder to return to a format selection prompt.

MESSAGE

If a format and/or a selected function allow a message to be sent with the
page, it may be entered when the message prompt, consisting of four
underlines, appears in the display.

Different formats give different interpretations of the non-numeric keys
A-D, *, and #. Silk screened lettering adjacent to these keys is provided
for message formats. These provide a key to the special characters that
these keys will produce.

An incorrect message can be erased by pressing the CLEAR key and starting a
new message. If no message has been entered, the CLEAR key will return the
encoder to the format selection prompt.

AUTOPAGE

The Model 15 is user-settable to start the paging sequence either
automatically after the last digit of the pager code has been entered
(autopage=ON), or only after the PAGE key has been pressed (autopage=OFF).
Autopage is activated after the encoder has received the maximum number of
digits allowable for the chosen format. If the format allows variable
length pager numbers or functions, a depression of the PAGE key may be
necessary to start the paging sequence. Configuration is done using switch
#15 inside the encoder; position A=autopage OFF, B=autopage ON. The encoder
is shipped with the autopage function OFF to allow the operator to review
the pager number in the display before sending the page. (Press the CLEAR
key or power-up the encoder after changing the switch to activate the new
setting). If the chosen format allows a message to be sent, autopage will
show a message prompt. Once the message is entered, it is necessary to
depress the PAGE key; autopage will not activate during message entry. This
allows the operator to verify correct entry.

Autopage is selectable on the Model 15R via the encoders key pad. Refer to Section 8 for information on programming this feature.

AUTOSCROLL

Once a pager number or message has been entered and autopage activated or the PAGE key depressed, Autoscroll will re-display the entry before starting the next sequence. Autoscroll shows the leading digits and the full pager number with straps and function digits. It may be useful for verifying long pager numbers and messages, or to see the strapped digits which are not normally displayed. Autoscroll is configured by setting switch #16 inside the encoder; position A=autoscroll OFF, B=autoscroll ON.

Because Autoscroll can be time consuming it is not normally used. It should also be noted that code substitutions may be made to pager numbers and messages between the time they are entered and the time they are autoscrolled.

Refer to Section 8 for information on setting the Autoscroll feature on the Model 15R.

STRAPPED DIGITS

Some formats require rather long pager numbers and their input can be tedious and repetitive. To alleviate this problem, a portion of the pager number can be pre-set at order time. This limits the call capacity of that format, but it reduces the number of keystrokes necessary to place a page.

When digit strapping is used, it is always the higher order digits which are strapped and they must be consecutive: e.g. a Five Tone pager number could not be strapped as 12x3x where x would be the pager number to input, but 123xx would be acceptable. Formats using service block or battery saving digits require these digits to be entered before the address digits. This allows these digits, which may be the same for an entire group of pagers, to be strapped.

During normal use the strapped digits are not seen and do not affect the display except to reduce the number of enterable digits. If the user wants to see the strapped digits before paging, the AUTOSCROLL option may be used.

STACK ENTRY

A limited number of pager numbers may be entered all at once to the encoder memory and they will be sent consecutively. This allows several pager numbers to be entered and held until they can be sent as a single batch. To put a pager number into the entry stack, enter the format selection and pager number as usual, then depress the ENTER key. The display will briefly flash the message 'StAC' to indicate that the encoder has accepted the entry into its memory. Another format selection and pager number can then be entered. This next entry may be followed by another depression of the ENTER key, or by the PAGE key. As long as pager number inputs are followed by an ENTER key they will be moved to memory until the memory is full. At that point, no further depressions of the ENTER key will be accepted. Press the PAGE key to send the calls consecutively in the opposite order of

entry, i.e. last in, first out.

Digital and tone formats should not be intermixed in a stack. Calls allowing a data message will not be accepted because the stack sequence would be stopped to receive a message from the operator. Calls requiring an additional pager muting transmission are not accepted because different formats may require different muting transmissions.

Depression of the CLEAR key at any time in the stack entry process will cause all of the calls in the memory stack to be lost; therefore entry of these pager numbers should be done with care.

TALK

Many formats allow a voice message to follow the coded page transmission. The duration of this talk interval is selected at order time and is the same for all formats. Several of the formats may be ordered with the Talk option enabled or disabled; other formats enable or disable Talk based on the selected function.

If a Talk interval is activated, the transmitter will be kept ON and the desk microphone will be activated. The display will prompt with the message 'tALH'. The voice message can be given during the talk interval and then the transmitter will be turned off. Longer voice messages can be sent in the normal manner by pressing the push-to-talk (P.T.T.) on the desk microphone. Shorter voice messages can be terminated by pressing the CLEAR key. When talk is OFF, the transmitter is turned off immediately after sending the paging information.

Some formats use an additional transmission to mute the pagers. If a talk message is given for such a page, the desk microphone will be turned off after the talk interval and the additional transmission will be sent before turning off the transmitter. If a short voice message is terminated with the CLEAR key, the pagers will be left unmuted and an additional page may be necessary to mute them.

The Model 15R allows field selection of this feature. Refer to Section 8 for information on Talk Time Programming.

PAGING SEQUENCE

Once the pager number has been entered, the PAGE key may be pressed. If no message is expected, the encoder will immediately start the Paging sequence. If a message format and/or function have been selected, the encoder will respond with a message prompt. After the message has been entered, another depression of the PAGE key will start the Paging sequence. Once the paging sequence starts, the encoder will:

      1) Validate pager numbers and messages. This verifies that all
         entered digits are recognized by the format. An invalid pager
         number is shown by a blinking display. If a pager number in
         a stack is found to be invalid, all following pager numbers will
         be lost.
      2) Check for a channel busy input. If detected, the display will
         continuously blink at a rapid rate until an internal timer

        determines that the channel has been available for 2 seconds.
3) Close the audio relay to disconnect the desk microphone
   and connect the encoder tone output to the transmitter audio
   input.
4) Turn on the transmitter by closing the push-to-talk (P.T.T.)
   relay contact outputs.
5) Send the paging information and display 'PAGE'.

6) If another call is waiting in the memory stack or in a fixed stack,
   the pager number of that call will be displayed, validated, and
   step 5) will be repeated.
7) If Talk is activated: Open the audio relay to connect the desk
   microphone to the transmitter and display 'tALH'. The voice
   message may be spoken at this time.
8) If a pager muting transmission is required: close the audio relay
   to disconnect the desk microphone and display 'PAGE'. The muting
   transmission will then be sent.
9) Turn off the transmitter by opening the P.T.T. relay.
10) Display the pager number again to allow for repaging of the
    pager number displayed by pressing the PAGE key.

REPAGE

Upon completion of a paging sequence, the encoder re-displays the last four
digits of the pager number just sent. To send to that pager again (repage),
just press the PAGE key. The encoder will automatically go through the
entire paging cycle again. A message format will automatically prompt for a
new message and wait for a PAGE key depression to start the paging sequence
again.

Only the pager number shown in the display is repaged. To repage a fixed
stack the stack number will have to be re-entered.

BUSY CHANNEL

The transmit inhibit input senses a busy channel when the input is closed
to ground or at a TTL low level. The transmitter will not be turned on
until this input is open or at a TTL high level for 2 consecutive seconds.

CONTINUOUS TRANSMIT MODE

The encoder will continuously transmit a single page with a one second
pause between repetitions when it is in the Continuous Transmit mode. To
enter this mode press the CLEAR key. While holding down the CLEAR key,
press the C key and hold down, release the CLEAR key, then release the C
key. A single pager number and message may now be entered as usual,
followed by PAGE. The encoder will transmit the page, pause one second,
and repeat this cycle until the CLEAR key is pressed. The Continuous
Transmit mode is in effect only until the CLEAR key is pressed, i.e. it must
be reset just before each continuous transmit page. Note: the Continuous
Transmit mode may not work with PG-50 format display pagers.

MORSE CODE ID   3-7

The automatic station ID Is sent on the first use of the encoder following
powerup. A 15/30 minute ID Interval timer Is used to determine when each
subsequent ID may be sent. The ID will be sent on every first use of the
encoder following timeout of the ID interval timer.

INSTALLATION WARNING

This equipment generates, uses, and can radiate radio frequency energy; and if not installed and used in accordance with the instruction manual and commonly-used radio practices, may cause interference to radio communications. Installation of the Zetron Model 15 encoder should be accomplished by personnel with experience in radio and paging systems.

INTERFACE CONNECTOR

Connections between the encoder and customer's radio equipment are made with the screw terminal strip TB1 inside the case of the encoder. Each connection on the terminal strip is numbered and described below.

TB1-#	Signal	Function
1	9VAC/13VDC	Power source AC/DC of 700mA maximum, paired with pin 2; no polarity requirement.
2	9VAC/13VDC	Power source AC/DC of 700mA maximum, paired with pin 1; no polarity requirement.
3	TONE OUTPUT	Tone output from encoder tone generator, unswitched.
4	SWITCHED AUDIO	Output from audio relay, switches between encoder tone generator and desk microphone.
5	GROUND	System ground for terminating all cable shields and signal grounds.
6	MIC. INPUT	Shielded input audio from desk microphone.
7	CHANNEL BUSY	Inhibits transmitter turn on if logic low or closure to ground sensed. Normal connection is to a carrier-operated-relay (COR) of a base station receiver.
8	DIGITAL MODE	Output used to distinguish between digital and tone data.
9	DIGITAL OUTPUT	0-7V unipolar digital output; provides direct modulation to the transmitter FM input for binary digital paging (use shielded cable).
10	PTT N.C.	Normally closed side of Push-to-talk relay,
11	PTT GND	Push-to-talk reference for transmitter; may be used to provide other than GND when JP2 is in 'B' position.
12	PTT N.O.	Push-to-talk output for transmitter, normally open, at GND during transmit.

Handwritten annotations in left margin: Red (1), Blk (2), Yellow (3), Green (5), Grn (11), Orange (12)

INTERFACE
CONNECTOR

1	} 9VAC/14VDC INPUT
2	
3	TONE OUT
4	SWITCHED AUDIO
5	SYSTEM GROUND
6	MIC. INPUT
7	CHNL. BUSY INPUT
8	DIGITAL MODE *
9	DIGITAL OUTPUT *
10	P.T.T. N.C.
11	P.T.T. GND
12	P.T.T. OUTPUT

TONE RELAY K1 N.O. N.C.

P.T.T. RELAY K2 N.C. N.O.

JP2 A B
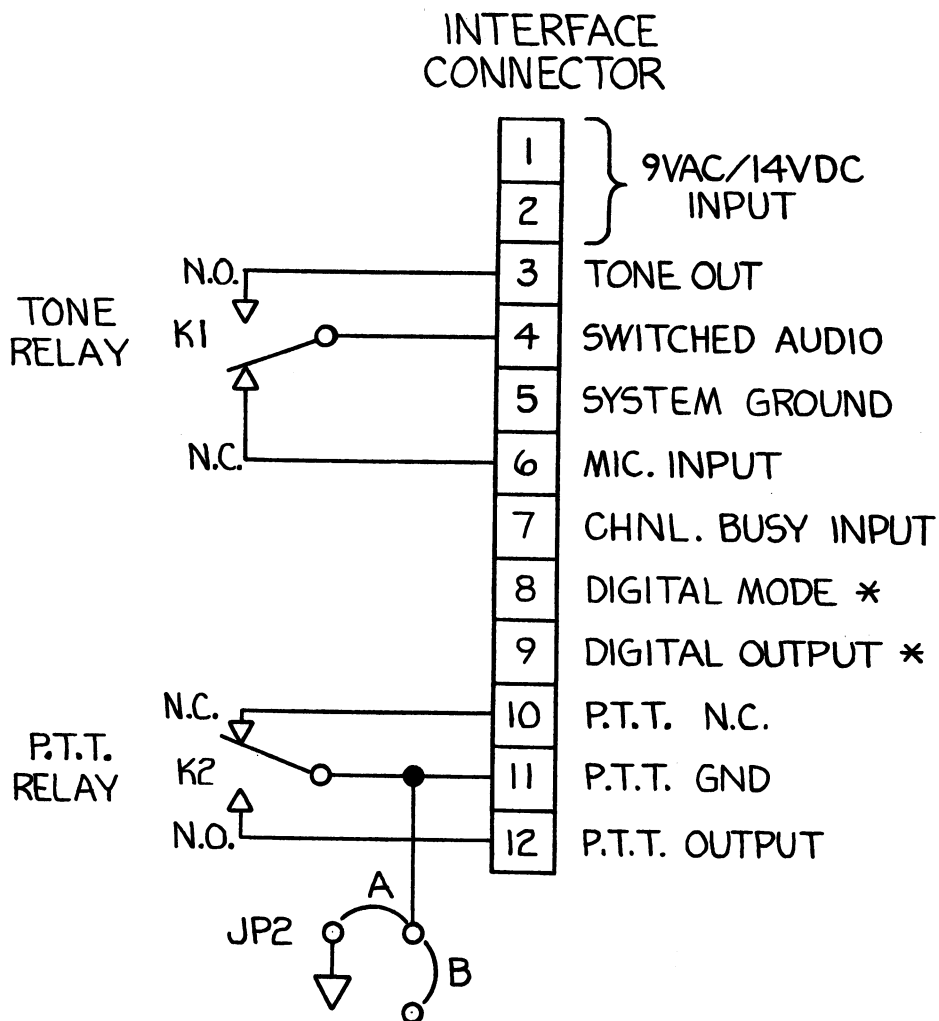
* USE THESE CONNECTIONS ONLY FOR DIGITAL FORMAT ENCODERS

ENCODER / RADIO INTERFACE CONNECTOR

OPENING THE ENCODER

The bottom cover of the encoder is retained by four 7/8" #4 tapping screws at the upper and lower edges of the case. Place the unit face down on a table top, remove the screws, and lift off the bottom cover. The component side of the circuit board will be exposed, including the transmitter interface connector, jumpers, and user-settable configuration switches.

WIRE ROUTING

Route all connecting wires through the hole in the rear of the bottom case and secure them with the tie-wrap restraint on the bottom case.

POWER SUPPLY

If using the external 9VAC wall transformer supplied with the Model 15,
connect its cord to pins 1 and 2 on the terminal strip TB1. If not using
the transformer, connect the proper supply (9-11VAC or 11-14VDC) to pins 1
and 2. The polarity of the supply on these pins does not matter.

AUDIO OUTPUT

The audio output from the encoder may be obtained from either of two
locations. TB1 pin 3 is connected directly to the tone output circuitry,
while TB1 pin 4 is switched by the tone relay between the tone output and
the microphone input. Pin 4 is normally connected to the transmitter
microphone input.

DIGITAL OUTPUT

The binary digital formats require very accurate timing reproduction of the
waveform edges. To guarantee accuracy, the terminal must be located in
close proximity to the digital transmitter; typical distance of 50 feet. It
is also recommended that coaxial cable with a D.C. resistance of less than
100 ohms be used to carry the digital output signal. For connections to
remote transmitters, digital modems are required in order to preserve the
high-bandwidth waveform edges. The pager manufacturer should be consulted
for exact requirements, but in general, NEC requires 300 baud (or faster)
modems, while POCSAG and Motorola GOLAY require 600 baud.

MICROPHONE CONNECTION

The tone relay in the Model 15 is activated during paging transmission and
can be used to mute unwanted microphone audio. To do this, connect the
microphone audio to input TB1 pin 6. If the microphone needs to be 'live'
all of the time, then connect it across the audio output, TB1 pin 4.

If a low-level microphone (millivolt signal levels) is being used, then the
tone output needs to be attenuated to produce levels comparable to the
microphone level. To do this, remove (clip out) 100-ohm resistor R35 from
the encoder circuit board.

PUSH-TO-TALK

Radio transmitter keying is performed with the normal 'push-to-talk'
signal. Connect the encoder's PTT relay output TB1 pin 12 to the radio's
PTT input. If the radio takes a closure to ground for PTT, then make sure
that jumper JP2 is in the 'A' position. If a closure to ground is not
desired, then move JP2 to the 'B' position and connect the return path for
keying to TB1 pin 11. If some other contact configuration is needed, then
simply use the PTT relay as appropriate.

When a desk microphone push-to-talk switch is used in conjunction with the
encoder, it is normally connected in parallel with the encoder's PTT so
that either closure will key the radio.

GROUNDING

It is recommended that shielded cabling be used on all audio connections between the encoder, microphone, and radio. It is advisable that one primary point be chosen as a system ground point and that all signal grounds be returned to this 'unipoint' ground to reduce ground-loop noise. This is especially important when low-level non-preamp microphone circuitry is being used. Connect the encoder ground, TB1 pin 5, to the system ground point.

DIGITAL MODE

The digital mode output at TB1 pin 8 is used to indicate when the encoder is supplying a tone frequency at TB1 pins 3 and 4 or when it is supplying a binary digital waveform at TB1 pin 9. This information may be used by the transmitter to correctly modulate either signal. Digital mode is a TTL signal and is jumper-selectable to determine the polarity. Position A is logic low (0 volts) for digital data and logic high (5 volts) for tone data. Position B is logic high (5 volts) for digital data and logic low (0 volts) for tone data.

EXTENDING THE TALK TIME

Formats using a TALK-ENDER (PG-50) may require a longer talk time; TALK-ENDER is a short message sent at the end of the talk time over the radio channel to mute the pager's audio. The MODEL 15 uses its channel busy input to delay TALK-ENDER and extend the talk time.

Connect pin 7 (channel busy) to pin 12 (PTT) or to COR of the receiver on the channel. NOTE: channel busy requires a logic low or closure to ground to operate properly. This enables the encoder to know when the channel is in use.

To allow a longer voice message than the programmed talk time, the operator presses the PTT on the desk microphone while 'TALK' is in the encoder display. This will extend the talk time as long as PTT is depressed; TALK-ENDER and battery saver (PG-50) will not be sent until PTT is released. During the extended talk time, 'BUSY' will be shown in the encoder display.

If battery saver (PG-50) is enabled, the page cannot be sent until the pager wakes up. The display will blink until the pager wakes up, then the page will be sent.

ZETRON ENCODER

1	9VAC/14VDC
2	INPUT
3 TONE	
4	(SHIELD) AUDIO OUTPUT
GND 5	SYSTEM GROUND
MIC INPUT 6	MIC. AUDIO
7	CHNL. BUSY INPUT
8	DIGITAL MODE
9	DIGITAL OUTPUT
JP2 10	
B P.T.T. GND 11	MIC. P.T.T.
A P.T.T. 12	TRANSMITTER PUSH TO TALK
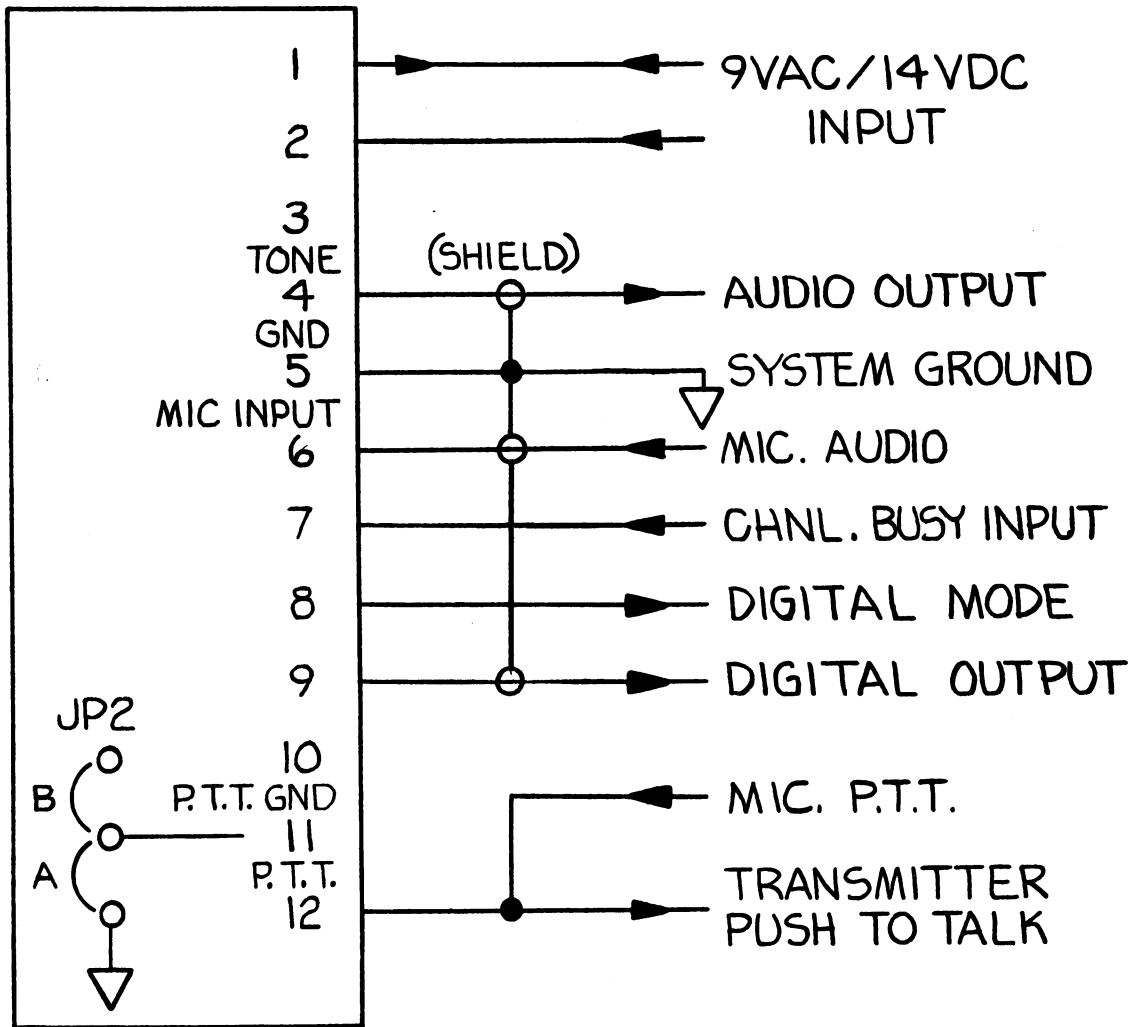
ENCODER INSTALLATION WIRING

LTR	DESCRIPTION	DR	APRD	DATE
A	RELEASE ECN 046	KN	BF	4-11-84
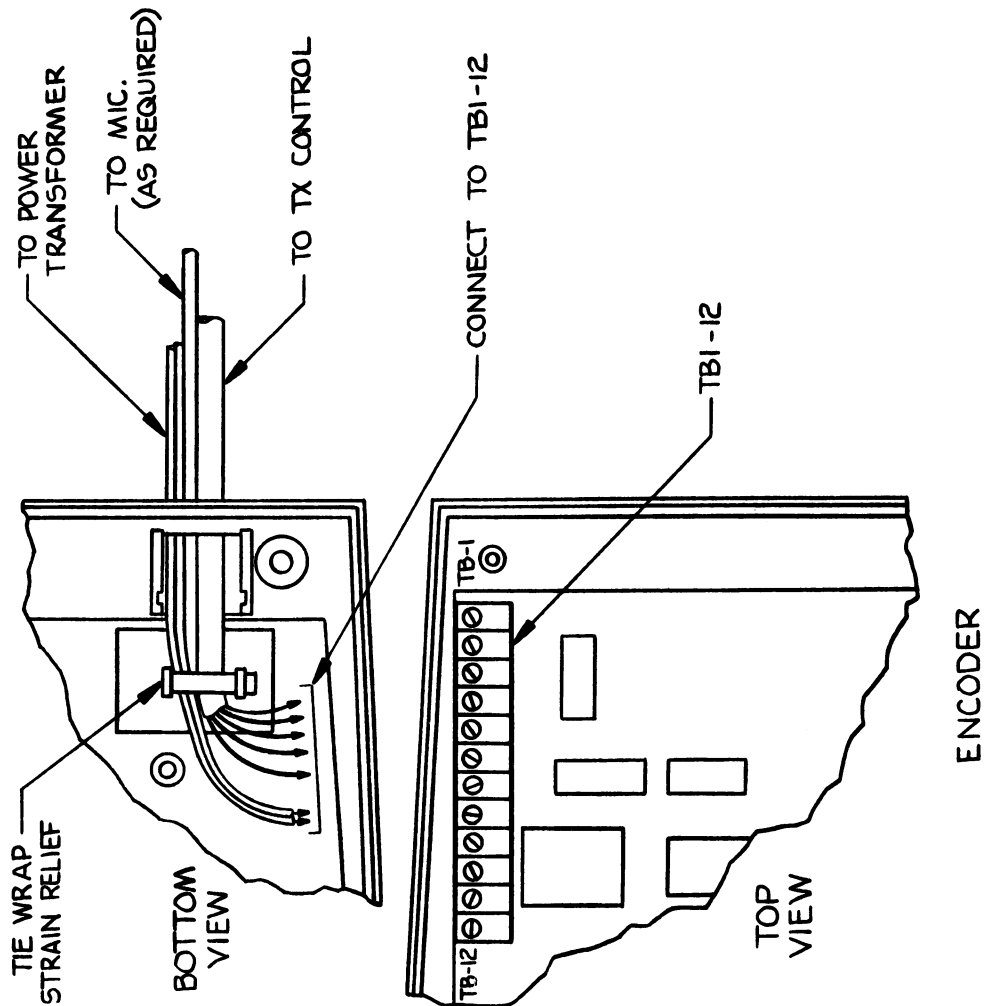
INSTRUCTIONS:

1. REMOVE BOTTOM COVER OF MODEL 10/15 BY REMOVING FOUR (4) SCREWS.

2. INSERT CABLE THRU HOLE IN BOTTOM COVER AND STRAIN RELIEVE TO TIE WRAP PROVIDED.

3. CONNECT CABLE TO 'TB' IN MODEL 10/15 ACCORDING TO GE/ZETRON OPTION CONNECTION DIAGRAM.

4. POWER UP SYSTEM AND ADJUST R37 TONE LEVEL AND/OR R17 DIGITAL LEVEL.

5. INSTALL COVER OF MODEL 10/15 AND FASTEN WITH FOUR (4) SCREWS.

ZETRON INC.

SCALE: NONE	APPROVED BY:	DRAWN BY: K.NORTH
DATE: 4-11-84	BF	SHT 1 OF 1

TITLE: MODEL 10/15 CABLE INSTALLATION

DRAWING NUMBER: 011-0007   REV: A

TO POWER TRANSFORMER

TO MIC. (AS REQUIRED)

TO TX CONTROL

CONNECT TO TB1-12

TB1-12

TIE WRAP STRAIN RELIEF

BOTTOM VIEW

TB-1

TB-12

TOP VIEW

ENCODER

CONFIGURATION SWITCHES - MODEL 15T

The sixteen user settable switches SW1/SW2 select the encoder's encoding characteristics. These should be set at installation time to match the customer's paging requirements, and can be changed at any time in the field. Each time that the encoder is powered up or the CLEAR key is pressed, the switches are read by software.

Most of the switches are used to configure Two Tone or Reach formats when the parameters of these formats are not preset at order time. Additional switches select the Autopage and Autoscroll options and digital data polarity.

CONFIGURATION SWITCH SETTINGS (ALL FORMATS)

SWITCH SW1								SWITCH SW2							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											BP			AP	AS

BP: BINARY POLARITY
Sw 12   Logic '0' appears at Digital Output as

A   low level
B   high level

AP: AUTO-PAGE
Sw 15   Auto-page

A   Off
B   On

AS: AUTO-SCROLL
Sw 16   Auto-scroll

A   Off
B   On
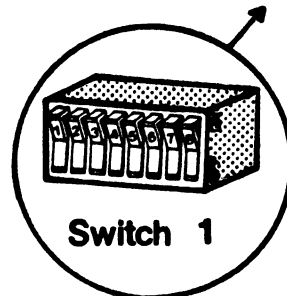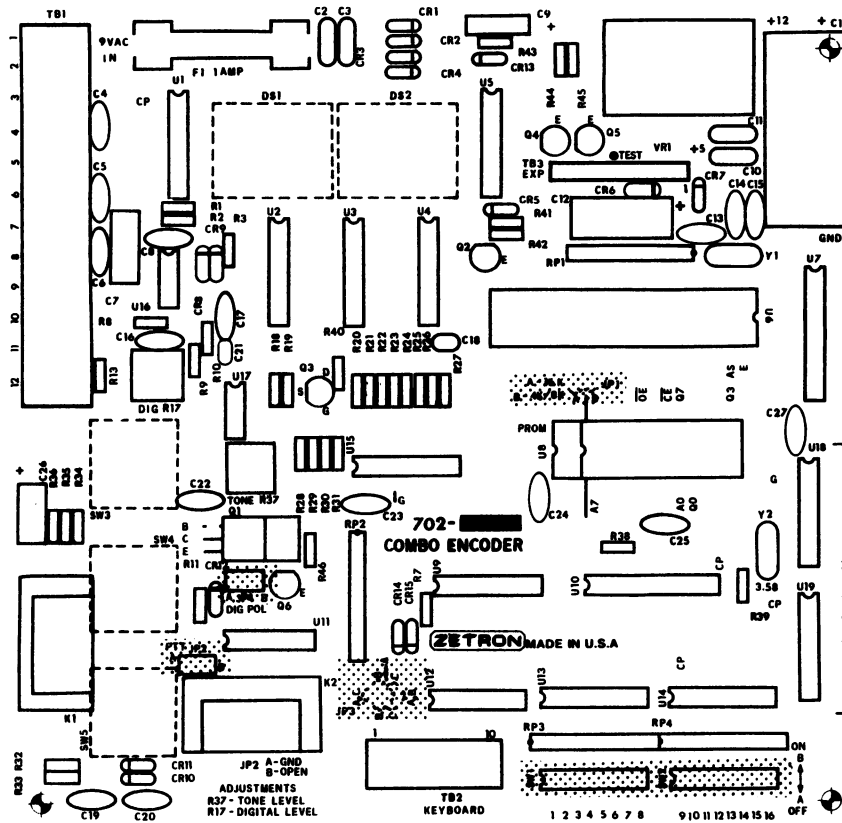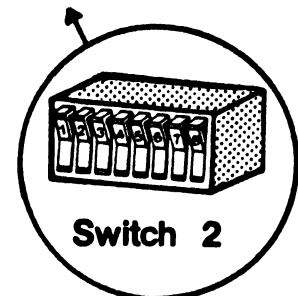
CONFIGURATION SWITCHES AND JUMPER SETTINGS

CONFIGURATION SWITCH SETTINGS - MODEL 15T (100-CALL TWO TONE FORMAT)

		SWITCH SW1								SWITCH SW2					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
F1	F1	F1	F1	F2	F2	F2	F2	TI	TI	TI		DT	DP		

F1: 1ST TONE FREQ.

Switch				Tone
1	2	3	4	Group
A	A	A	A	Mot 1
A	A	A	B	Mot 2
A	A	B	A	Mot 3
A	A	B	B	Mot 4
A	B	A	A	Mot 5
A	B	A	B	Mot 6
A	B	B	A	Mot A
A	B	B	B	Mot B
B	A	A	A	Mot Z
B	A	A	B	GE A'
B	A	B	A	GE B'
B	A	B	B	GE C'
B	B	A	A	Mot 10
B	B	A	B	Mot 11
B	B	B	A	Mot 1
B	B	B	B	No Tone

TI: TIMING   Note: Reach timing conflict

Switch			1st/Gap/2nd/Grp	
9	10	11	(seconds)	
A	A	A	1.0/ 0 /3.0/8.0	(Mot/GE T+V)
A	A	B	0.4/ 0 /0.8/8.0	(Mot Tone)
A	B	A	1.0/ 0 /3.0/6.0	(NEC-B)
A	B	B	1.0/.25/3.0/6.0	(NEC-A)
B	A	A	1.0/ 0 /1.0/4.0	(NEC-C)
B	A	B	0.4/ 0 /0.8/4.0	(NEC-M)
B	B	A	0.5/ 0 /0.5/3.0	(NEC-L)
B	B	B	0.4/ 0 /0.4/3.0	(NEC-D)

DT: DIAGONAL TONE

Sw13	Diagonal Tone
A	No Diagonal (group call)
B	Standard Diagonal tone

DP: DIAGONAL PLACEMENT

Sw14	Tone Placement
A	1st Tone
B	2nd Tone

F2: 2ND TONE FREQ.

Switch				Tone
5	6	7	8	Group
A	A	A	A	Mot 1
A	A	A	B	Mot 2
A	A	B	A	Mot 3
A	A	B	B	Mot 4
A	B	A	A	Mot 5
A	B	A	B	Mot 6
A	B	B	A	Mot A
A	B	B	B	Mot B
B	A	A	A	Mot Z
B	A	A	B	GE A'
B	A	B	A	GE B'
B	A	B	B	GE C'
B	B	A	A	Mot 10
B	B	A	B	Mot 11
B	B	B	A	Mot 1
B	B	B	B	No Tone

CONFIGURATION SWITCH SETTINGS - MODEL 15T (1000-CALL TWO TONE FORMAT)

			SWITCH 1									SWITCH 2			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			CP	CP	CP	CP	CP	TI	TI	TI		DT	DP		

CP: CODE PLAN

Switch					Code
4	5	6	7	8	Plan
A	A	A	A	A	Mot B
A	A	A	A	B	Mot C
A	A	A	B	A	Mot D
A	A	A	B	B	Mot E
A	A	B	A	A	Mot F
A	A	B	A	B	Mot G
A	A	B	B	A	Mot H
A	A	B	B	B	Mot J
A	B	A	A	A	Mot K
A	B	A	A	B	Mot L
A	B	A	B	A	Mot M
A	B	A	B	B	Mot N
A	B	B	A	A	Mot P
A	B	B	A	B	Mot Q
A	B	B	B	A	Mot R
A	B	B	B	B	Mot S
B	A	A	A	A	Mot T
B	A	A	A	B	Mot U
B	A	A	B	A	Mot V
B	A	A	B	B	Mot W
B	A	B	A	A	Mot Y
B	A	B	A	B	Mot MT
B	A	B	B	A	GE X
B	A	B	B	B	GE Y
B	B	A	A	A	GE Z
B	B	A	A	B	Special (If ordered)
B	B	A	B	A	Mod. Gen'l
B	B	A	B	B	Gen'l Alt.
B	B	B	A	A	General
B	B	B	A	B	General
B	B	B	B	A	General
B	B	B	B	B	General

TI: TIMING   Note: Reach timing conflict

Switch			1st/Gap/2nd/Grp	
9	10	11	(seconds)	
A	A	A	1.0/ 0 /3.0/8.0	(Mot/GE T+V)
A	A	B	0.4/ 0 /0.8/8.0	(Mot Tone)
A	B	A	1.0/ 0 /3.0/6.0	(NEC-B)
A	B	B	1.0/.25/3.0/6.0	(NEC-A)
B	A	A	1.0/ 0 /1.0/4.0	(NEC-C)
B	A	B	0.4/ 0 /0.8/4.0	(NEC-M)
B	B	A	0.5/ 0 /0.5/3.0	(NEC-L)
B	B	B	0.4/ 0 /0.4/3.0	(NEC-D)

DT: DIAGONAL TONE

Sw13	Diagonal Tone
A	None (group call)
B	Standard Diagonal tone

DP: DIAGONAL PLACEMENT

Sw 14	Tone Placement
A	1st Tone
B	2nd Tone

CONFIGURATION SWITCH SETTINGS - MODEL 15T (REACH FORMAT)

		SWITCH 1								SWITCH 2					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
										TI		GC			

TI: TIMING   Note: this may conflict with Two Tone timing
Sw11   1st/Gap/2nd/Grp
            (seconds)
A   .13/ 0 /.13/1.4   (REACH Fast)
B   2.0/ 0 /0.7/4.5   (REACH Slow)

GC: GROUP CALL
Sw13   Group Call

A   Group calls
B   Individual calls

JUMPER SETTINGS

There are user-configurable jumpers on the circuit board. Generally these
are set properly at the factory and require no modification by the
installer. At times, the Model 15 requires special radio interfacing.
Check each jumper setting in your encoder and set them as required, using
the information in the following table.

Jumper	Location	Meaning	Factory Setting
JP1	U8	A=U8 is 16Kx8 27128 EPROM B=U8 is 4Kx8 2732 EPROM or 8Kx8 2764 EPROM	B
JP2	K2	A=Relay connects to GND for Push-to-Talk (PTT) B=Relay closure for PTT	A
JP3	TB2	Keypad selection	B
JP4	Q1	A=Digital mode output low B=Digital mode output high	A

ADJUSTMENTS:

Two adjustments are necessary to complete the installation of the encoder;
setting the tone and digital output levels. Both adjustments are made with
the bottom cover off.

PAGING TONE LEVEL

To adjust for tones, plug in or turn on the encoder while holding the PAGE
key depressed. This will activate the tone circuitry to generate a
sequence of calibration tones at 1000Hz, 500Hz, and 2000Hz and key the
transmitter. Adjust tone level potentiometer R37 to obtain a standard FM
peak channel deviation of between 3KHz and 5KHz, as observed on a deviation
meter or oscilloscope.

The same circuit is used for micro-processor generated tones and DTMF tones
and a single adjustment should set the level correctly for both kinds of
output. An encoder having the DTMF option can activate the DTMF test by
plugging in or turning on the decoder with the ENTER key depressed. Once
the self-test completes and the display shows 'PAGE', DTMF tone pairs will
be generated from any key on the 16 key pad. Adjustment of tone level
potentiometer R37 is the same as described above.

DIGITAL OUTPUT LEVEL

To adjust for binary data, plug in or turn on the encoder while holding the
'D' key depressed. Once the self-test completes and the display shows
'PAGE', press one of the following keys:

0	Outputs a steady logic '0'				
1	Outputs a steady logic '1'				
2	Outputs a continuous oscillation at			200	baud
3	"	"	"	300	baud
5	"	"	"	512	baud
6	"	"	"	600	baud
7	"	"	"	1200	baud

Using an oscillation output, monitor the radio channel with a deviation
meter or oscilloscope. Adjust potentiometer R17 to obtain the desired FM
channel peak deviation of 3Khz to 5Khz. The polarity of digital data output
can be set with configuration switch #12. A logic '0' appears at output as
A:low, B:high level.

TONE DE-EMPHASIS

Some radio transmitters have built-in frequency pre-emphasis to boost high
frequencies presented at their microphone inputs. When the Model 15
encoder is wired into the microphone input, its frequency-flat tone output
may appear as increased FM channel deviation as the tones increase in
frequency. The three calibration frequencies described under Adjustments
allow for checking of channel deviation consistency.

To compensate for transmitter pre-emphasis, install a 0.047uF non-polar
(e.g. mylar or ceramic) capacitor into the empty spot labelled C17 on the
Model 15 encoder board. This will provide a -6dB/octave rolloff with -3dB
point at about 1KHz and result in flat FM channel deviation.

EXCEPTIONS

Zetron engineers are available for consultation on exceptional installation
connections not described above.

BASIC FUNCTIONAL DESCRIPTION

The Zetron Model 15 encoder is a microprocessor system whose software intensive architecture makes possible ownership of a single encoder capable of encoding most of the popular formats available today. The microprocessor controls all internal operations in accordance with a control program stored in programmable read-only memory (EPROM). By changing this memory, new formats can quickly and easily be added.

When the encoder is idle, the microprocessor continually scans the keyboard for a key depression. Upon seeing a key, it begins accepting the data and interpreting it as a pager number or message, depending on its current state. This is shown on the large front-panel 7-segment LED display. After the entry is complete, the microprocessor software synchronizes sequencing of the relays and controls the tone generation or digital circuitry for the paging cycle.
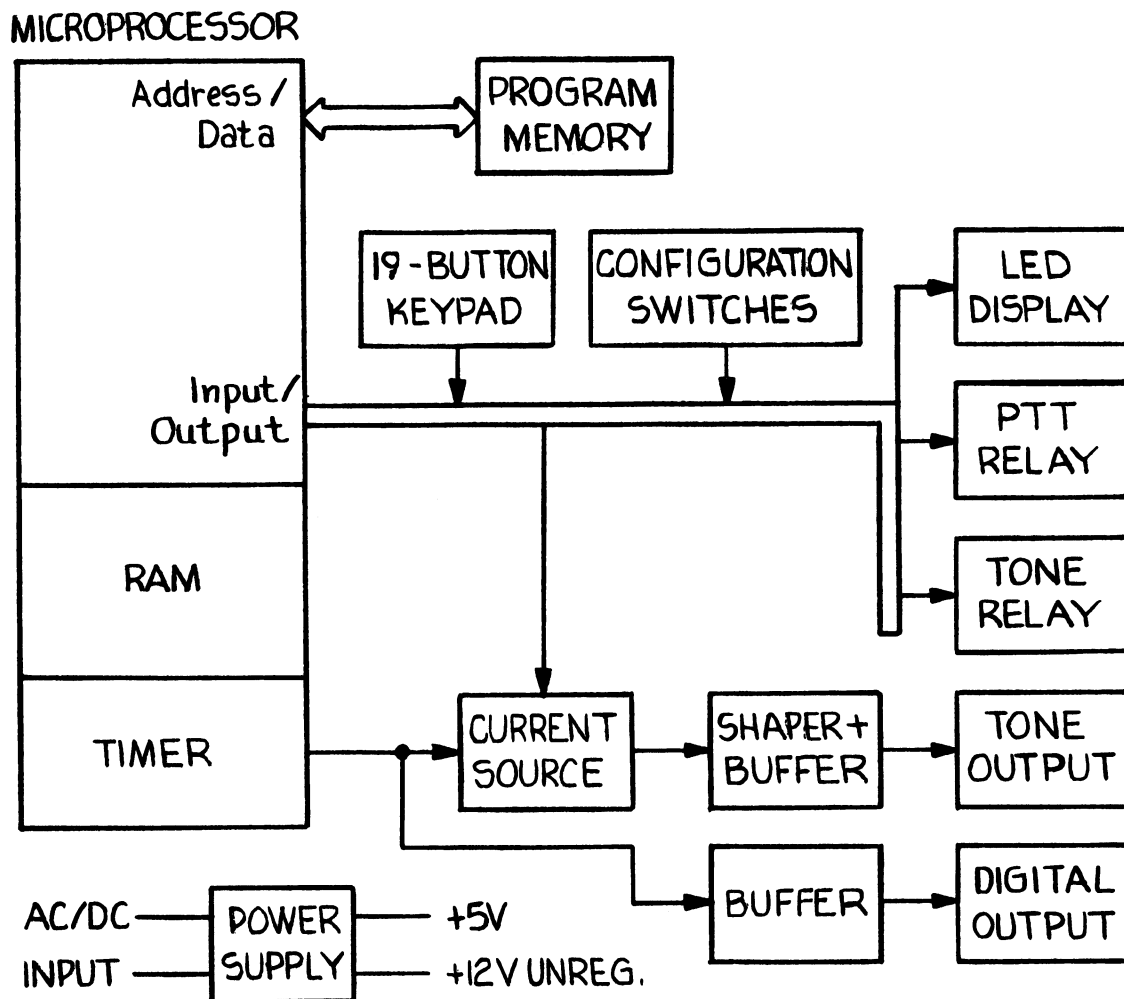
MICROPROCESSOR

MODEL 15 BLOCK DIAGRAM

MICROPROCESSOR CONTROL

Power-on reset is generated by capacitor C12, diodes CR7/CR8, and resistor pack RP1 which hold the processor reset about 0.1 secs to allow the 4.000MHz crystal oscillator to stabilize. Operating software for the microcomputer is stored in erasable read-only memory (EPROM) chip U8 whose address is held stable on each memory cycle by octal latch U7. Address decoder U9 translates software accesses into clocking signals to the various hardware circuit sections.

DISPLAY

The four-digit front-panel display consists of a serial shift register and 7-segment light-emitting-diode (LED) displays. By high-speed clocking of the serial shift register U1-U5, microprocessor software loads bit patterns to individually address each segment of each digit DS1A-DS2B, thereby lighting up letters as well as numbers. Series resistors have been eliminated to save cost by using the inherent output current-limiting characteristic of the CMOS 'B' family digital ICs.

KEYBOARD

A tactile feel, rugged 16-key conductive rubber keypad plugs into the encoder circuit board via connector TB2. Three additional function keys plug directly to the circuit board. Microprocessor software accesses one keypad row at a time by writing a 1-bit into I/O latch U10 followed by open-collector inverting buffer U12 which turn the bit to a 0. If a key is depressed, the microprocessor will see the 0-bit on one of the keypad columns when it reads the keyboard via its I/O port P1x. This keypad scanning action is performed at high-speed by software that also does the key debouncing by waiting for stable key closures and opens. If more than one key at a time is detected, the software considers this an error and will not interpret it as a valid key.

CONFIGURATION SWITCHES - MODEL 15T ONLY

Two user-settable 8-bit switches (16 total switches) SW1/SW2 provide an easy way to select the two-tone and Reach parameters and other encoder characteristics. Each time that the encoder is powered on or the CLEAR key is pressed, the software loads the switch settings into shift registers U13/U14 by pulsing signal -WC000. Then, software reads the output of U13 into I/O port P23 bit by bit as it shifts the sixteen bits by pulsing signal -W4000.

PROGRAMMABLE FEATURES - MODEL 15R ONLY

Programming of the field selectable two tone parameters is accomplished through the front panel key pad. U2 on the circuit board is a 256 bit non-volatile EEPROM capable of storing the selectable data for use by the microprocessor. Refer to Section 8 for information on selectable features.

TONE GENERATION

To accomodate the various tone frequencies and timings, a programmable tone generator (U6, U15, U16, U17) can generate precise tones under control of software. A square-wave output from the internal timer in U6 feeds a programmable current source R20-R27/U15 which is integrated into a ramp-wave by C7/U16A and shaped into a sine-wave by CR10/CR11/U16B. The microprocessor sets both the period of the square-wave and the ramp rate in order to stabilize the amplitude of the resulting shaped sine-wave. A mute (U15 pin 6) is provided to turn off the current source and provide precise zero-crossing tone frequency changes. For long-term charge bleed compensation of coupling capacitor C18, a tone gating FET (Q3) allows software to mute audio output from U16B before each tone sequence while precharging C18.

BINARY DIGITAL GENERATION

Waveforms and timing for binary digital paging are provided from port 2 of
the processor using the same line as that use for tone generation. Software,
assisted by the micro-processor's internal timer, generates a 0-5V TTL
switching waveform. This is buffered and amplitude shifted by U17B and the
final output RF filtered by C6 and pulled to ground by R7. The digital
output is compatible with Quitron digital transmitters and most other
transmitters that will take unipolar input levels (not going below ground).

DTMF GENERATOR

All 16 DTMF tone pairs are selected from U18 by serially shifting into
register U19 and enabling U18 at pin 2. The DTMF chip provides an output
until a series of 1's are shifted into U19 and pin 2 disabled. The output
is amplitude shifted to match the level coming from the tone generation
circuit and fed to the same audio amplifier.

LOW-PASS FILTER

A single-pole low-pass filter R10/C21 provides a -6dB/octave slope with its
-3dB point at about 6KHz to attenuate high-frequency components going into
the output amplifier. If tone de-emphasis is required by the particular
paging tone radio transmitter, the installer may add a 0.047uF non-polar
capacitor C17 to provide a -6dB/octave slope with its -3dB point at about
1KHz.

OUTPUT AMPLIFIER

Amplifier U17A forms an inverting amplifier with adjustable gain from 0-5.
It feeds an emitter follower Q1 to provide current gain into load resistor
R34. The output TB1 pin 3 is coupled with current limiting resistor R35
and D.C. blocking capacitor C26. An extra resistor R36 is provided across
R35 to be used when R35 is removed for very low millivolt-level tones to
match low-level microphones. The output amplifier is capable of operating
into a short-circuit for short periods of time with no damage to its
components.

TONE RELAY

Tone relay K1 is a SPDT relay which switches output TB1 pin 4 between the
tone generator output and the microphone input. It is driven by software
via I/O port P15 and buffered by U11 to sink the 40mA necessary to activate
its 300-ohm coil.

PUSH-TO-TALK RELAY

Push-to-talk relay K2 is a SPDT relay which normally switches output TB1
pin 12 to ground when jumper JP2 is in the 'A' position. With JP2 in the
'B' position, it serves as a normal double-throw relay whose contacts may
be used to key various types of keying arrangements. It is driven by
software via I/O port P16 and buffered by U11 to sink the 40mA necessary to
activate its 300-ohm coil.

POWER SUPPLY

The power supply Is a simple full-wave bridge CR1-CR4, filter capacitor C1,
and monolithic voltage regulator VR1 on a heat sink. Input voltages In the
range of 9VAC-10VAC rms and 11VDC-14VDC can be safely handled to produce
the required typical outputs of 5VDC at 600mA and 12VDC unreg. at 100mA.
The analog circuitry (tone generator and output amplifier) and relays use
the unregulated 12VDC supply to generate large output swings and save on
component costs.

SELF-TEST

By design, the Model 15 is software-intensive and has a minimum of
components to fail. The built-in self-test, which is automatically run
when the encoder is powered up, checks the display by lighting each display
segment in turn, tests internal digital circuitry, and displays the results
in the front-panel pager number window. Each test section is numbered, and
the software displays this number before beginning the test:

Test Section	Display Function	Test
1	run1	U6 microprocessor
2	run2	U8 EPROM
3	run3	U6 microprocessor RAM
4	run4	U6 microprocessor timer

If an error occurs, then the test is halted and an error code is
displayed in the front-panel window.

Error Code Displayed	Probable Failure Cause
Err1	U6
Err2	U7, U8, U9
Err3	U6
Err4	U6
Err5	U6, U8; software jump to an unknown address in memory. This could happen if too many entries are made to the Entry Stack. Err5 can be recovered from by hitting any key. If Err5 is recurrent and the cause unknown then it is likely that U8 is defective.
Err6	EEPROM error

DISPLAY TEST

Every time the encoder powers up, it will cycle the display circuitry
through each segment, lighting one at a time. If no display appears, then
probably the power supply is inoperative. If all of the segments light up
as "8888" then probably the microprocessor/EPROM is non-functional (U6,U8,
or possibly U7, U9), or jumper JP1 is in the wrong position for the given
EPROM capacity.

OUTPUT TESTS

Three output tests are provided to allow setting of the tone output levels
and checking of the frequency accuracy of the main crystal Y1. Any of the
output tests will be ended by depression of the CLEAR key.

Depress the PAGE key while powering up the encoder to activate the tone
output test. The encoder will close the tone relay and generate a sequence
of three test tones at 1000Hz, 500Hz, and 2000Hz (+-0.1Hz) at TB1 pins 3&4.
All micro-processor generated tone frequency accuracies will be referenced
to these test tones.

For an encoder with the DTMF option, depress the ENTER key while powering up the encoder to activate the DTMF output circuit test. After self-test completes and 'PAGE' is displayed, any 16 key keyboard entry will be accepted to generate the corresponding DTMF tone pairs.

Again, while powering up, depress the 'D' key to activate the Digital circuitry tests. After self-testing completes and 'PAGE' is displayed, the encoder will accept a single key for one of the following tests:

0	Logic '0' output
1	Logic '1' output
2	200 baud continuous preamble (alternate 0/1)
3	300 baud preamble
5	512 baud preamble
6	600 baud preamble
7	1200 baud preamble

FAULT IDENTIFICATION

Listed below are some possible problems and their causes to assist in troubleshooting faults:

Problem	Possible Cause(s)
No display on power on.	F1, VR1, C1, CR1-CR4, AC/DC power source
All "8888" in display on powerup.	JP1, U6, U8, U7, U9, CR7, CR8, C12
Error message "Errx".	Refer to chart above
Display lit, but does not respond to any keys.	U10, U9, U12, TB2
Responds to some keys.	U10, U11, U12, TB2, keyboard, JP3
No test tones at TB1 pin 3.	U15, U16, U17, U10, U11, U12
Test tones at TB1-3, but not at pin 4.	K1, U11, +12V unreg. supply
1000/500/2000Hz test tones off frequency.	Y1, U6
1000/500/2000Hz test tones distorted.	U16, U17, Q1, R20-R27
DTMF test tones incorrect	U18, U19, Y2
DTMF test tones distorted	U17, Q1, C25, R38, R39
Binary timing incorrect	U6, Y1
Binary pagers don't work	Sw12 polarity wrong, cable to transmitter too long

Wrong paging tones for keyed in pager number.	Wrong settings on switches SW1/2
Some pagers work, others do not.	Wrong settings on switches SW1/2, Tone de-emphasis (C17) required for transmitter (see Installation section.)
Tone output loads down microphone audio.	Incorrect audio wiring, low-level microphone requires removal of R35.
Insufficient audio output level.	Adjust R37, Q1, output loaded.
Transmitter not keying.	K2, U11, JP2, incorrect wiring for particular transmitter's PTT.
Continuous tone bursts at output while display shows alphanumeric characters.	Pull-up resistor RP1-5 open circuit.

ZETRON MODEL 15 ENCODER PARTS LIST (702-9003G)

ITEM	QTY	ZETRON P/N	DESCRIPTION	COMPONENT REF	MFR. PART #	MANUFACTUR
1.	2	101-0047	47 OHM	R32 33	CARBON FILM	FILMR
2.	1	101-0049	100 OHM	R35		
3.	1	101-0061	330 OHM	R13		
4.	3	101-0066	510 OHM	R11 34 39		
5.	1	101-0073	1K	R7		
6.	1	101-0081	2.2K	R19		
7.	6	101-0085	3.3K	R10 41-43 45 46		
8.	9	101-0097	10K	R18 26 28-31 38 40 44		
9.	1	101-0106	24K	R21		
10.	1	101-0109	33K	R27		
11.	2	101-0113	47K	R3 20		
12.	2	101-0117	68K	R8 25		
13.	1	101-0119	82K	R22		
14.	4	101-0121	100K	R1 9 23 36		
15.	1	101-0125	150K	R24		
16.	1	101-0145	1.0M	R2		
17.	2	107-0502	50K POT	R17 37	760-10-503	VRN
18.						
19.	4	119-0006	10Kx9 RPAK	RP1-4	4610X-101-104	CTS
20.	2	150-0024	24 PF DISC	C14 15	GG-240MK	MULTI-PROD
21.	7	150-0096	1000 PF 1KV	C2-6 19 20	GE-102G	MULTI-PROD
22.	9	150-0110	.01 UF DISC	C8 10 11 13 16 22-24 27	DF-103Z	MULTI-PROD
23.	1	152-0100	.01 UF POLY	C7	SXK-110	MALLORY
24.	1	151-0120	.01 UF TSTAB	C21	CW15C103M	CENTRALAB
25.	2	151-0130	.047 UF TSTAB	C18 25	CW20C473M	CENTRALAB
26.	2	155-0050	10 UF 25V	C9 26	ECE-B1EV100S	PANASONIC
27.	1	155-0080	100 UF 10V	C12	ECE-B1AV471S	PANASONIC
28.	1	155-0120	2200 UF 25V	C1	ECE-B1EV222S	PANASONIC
29.	1	210-0001	NUT #4-40	XVR1		
30.	1	220-0102	SCREW #440 3/8	XVR1		
31.	2	311-0030	DUAL LED 7-SEG	DS1 2	PANASONIC	LN524OK
32.	1	314-4138	1 OF 8 DECODER	U9	74LS138	TI
33.	1	314-4373	OCTAL LATCH	U7	74LS373	AMP
34.	1	314-4374	OCTAL D-FF REG	U10	74LS374	TI
35.	2	315-7406	HEX INV BFR OC	U11 12	7406	TI
36.	1	316-0082	BI-FET OP-AMP	U16	LF353	NATIONAL
37.	1	316-0358	DUAL OP-AMP	U17	LM358	NATIONAL
38.	1	316-7805	5V REGULATOR	VR1	LM340T-5	NATIONAL
39.	1	321-6803	6803 PROCESSOR	U6	MC6803G	MOTOROLA
40.	5	323-4015	DUAL SHIFT REG	U1-5	MC14015B	MOTOROLA
41.	2	323-4021	LOAD SHIFT REG	U13 14	MC14021B	MOTOROLA
42.	1	323-4051	8xANALOG MUX	U15	MC14051B	MOTOROLA
43.	1	340-0029	POWER NPN	Q1	TIP-29C	TI
44.	1	340-3821	N-CHAN FET	Q3	MPF3821	MOT
45.	4	340-3904	NPN-GP SILICON	Q2 4-6	2N3904	MOT
46.	4	342-0001	1N4002 SILICON	CR1-4	1N4002	MOTOROLA
47.	9	342-3009	1N4148 SWITCH	CR5-12	1N4148	MOTOROLA
48.	1	343-3030	1W 6.2V +-5%	CR13	1N4735A	MOTOROLA
49.	3	371-0002	KEYSWITCH	SW3-5		

```
50.  2   371-0010   DIP SWx8          SW1-2          CTS-206-008   CTS
51.  1   376-0004   4.000 MHZ XTAL    Y1             SKO-DS400A    SEIKO
52.  2   380-0030   RELAY SPDT        K1 2           14955DC12V    GUARDIAN
ALT      380-0020   RELAY SPDT                       AZ-530-08-01  AMER-ZETTLER
53.  1   381-0010   HEATSINK TO-220   XVR1           340-1PP       HT SNKS PLUS
54.  1   401-0009   12 POS THRU PCB   TB2            22-14-2094    MOLEX
55   1   401-0120   CONN TERM 12      TB1            3PCV-12-000   RDI
56.  15  401-0052   STAKE PINS        XJP1 2 4 (3EA) 65500-113     BERG
                                      XJP3 (6 EA)
57.
58.  6   402-3040   MINI JMPR         JP1 POS.B      65474-004     BERG
                                      JP2 POS.A
                                      JP3 POS.B (3 EA)
                                      JP4 POS.A
59.  2   407-0008   08 PIN SKT        XU16 17        640463-3      AMP
60.  2   407-0014   14 PIN SKT        XU11 12        640357-3      AMP
61.  11  407-0016   16 PIN SKT        XU1-5 9 13-15  640358-3      AMP
                                        18 19
62.  2   407-0020   20 PIN SKT        XU7 10         640464-3      AMP
63.  1   407-0028   28 PIN SKT        XU8            640362-3      AMP
64.  1   407-0040   40 PIN SKT        XU6            640379-3      AMP
65.  1   410-9004-E PCB, BARE                        410-9004      ZETRON
66.  1   415-9291   SPACER KEYSW      XSW3-5
67.  1   416-1576   FUSE, 1A FB       F1             AGC 1A        LITTLEFUSE
68.  2   416-3040   FUSE CLIP         XF1            926           COMP RES
69.  A/R 561-0001   THERMAL GREASE    XVR1
```

ZETRON MODEL 10/15 ENCODER ENCLOSURE BOTTOM SUB-ASSY PARTS LIST (815-9004B)

ITEM	QTY	ZETRON P/N	DESCRIPTION	REFERENCE
1.	1	265-0002	TY-WRAP	
2.	1	265-0003	MOUNTING PLATE	
3.	1	415-9004	DECAL, BLANK	BOTTOM COVER
4.	4	431-0005	FOOT, BUMPON	BOTTOM COVER
5.	1	810-0002	CASE, TI-5100 B	

ZETRON MODEL 15 ENCODER ENCLOSURE TOP SUB-ASSY PARTS LIST (815-9010B)

ITEM	QTY	ZETRON P/N	DESCRIPTION	REFERENCE
1.	4	220-0110	440 3/16 NYLON SCREW	KEYPAD
2.	1	373-0116	16 KEY PAD	KEYPAD
3.	1	401-0108	8-PIN STRIP	KEYPAD
4.	1	415-9002	LENS, CE-1000	
5.	1	415-9043	PANEL, MODEL 15	
6.	AR	561-0003	CONTACT CEMENT	
7.	1	810-0001	CASE TI-5100 T	

ZETRON MODEL 15 MULTI-FORMAT STATION ENCODER PARTS LIST (901-9018F)

ITEM	QTY	ZETRON P/N	DESCRIPTION	REFERENCE
1.	1	025-9003	MANUAL MODEL 15	
2.	4	220-0108	SCREW #440x1/4"	PCB
3.	4	220-0109	SCREW #440x3/4"	BOTTOM COVER
4.	1	322-____	PROM	U8 NOTE 2
5.	1	415-9094	DECAL SN/PN/FCC	SERIAL NUMBER TAG
6.	1	415-9052	LABEL	NOTE 1
7.	1	449-9000	SHIP BOX	
8.	1	602-____	CUSTOMIZED SOFT	U8
9.	1	702-9003	PCB, ASSEMBLED	
10.	1	815-9034	ENCLOSURE BOTTOM COVER, SUB-ASSEMBLY	
11.	1	815-9037	ENCLOSURE TOP COVER, SUB-ASSEMBLY	

NOTES:

1. PER CUSTOMER ORDER

2. 322-2764 (8Kx8) OR 322-7128 (16Kx8) PER CUSTOMER ORDER.

MODEL 15 SILKSCREEN (702-9003D)
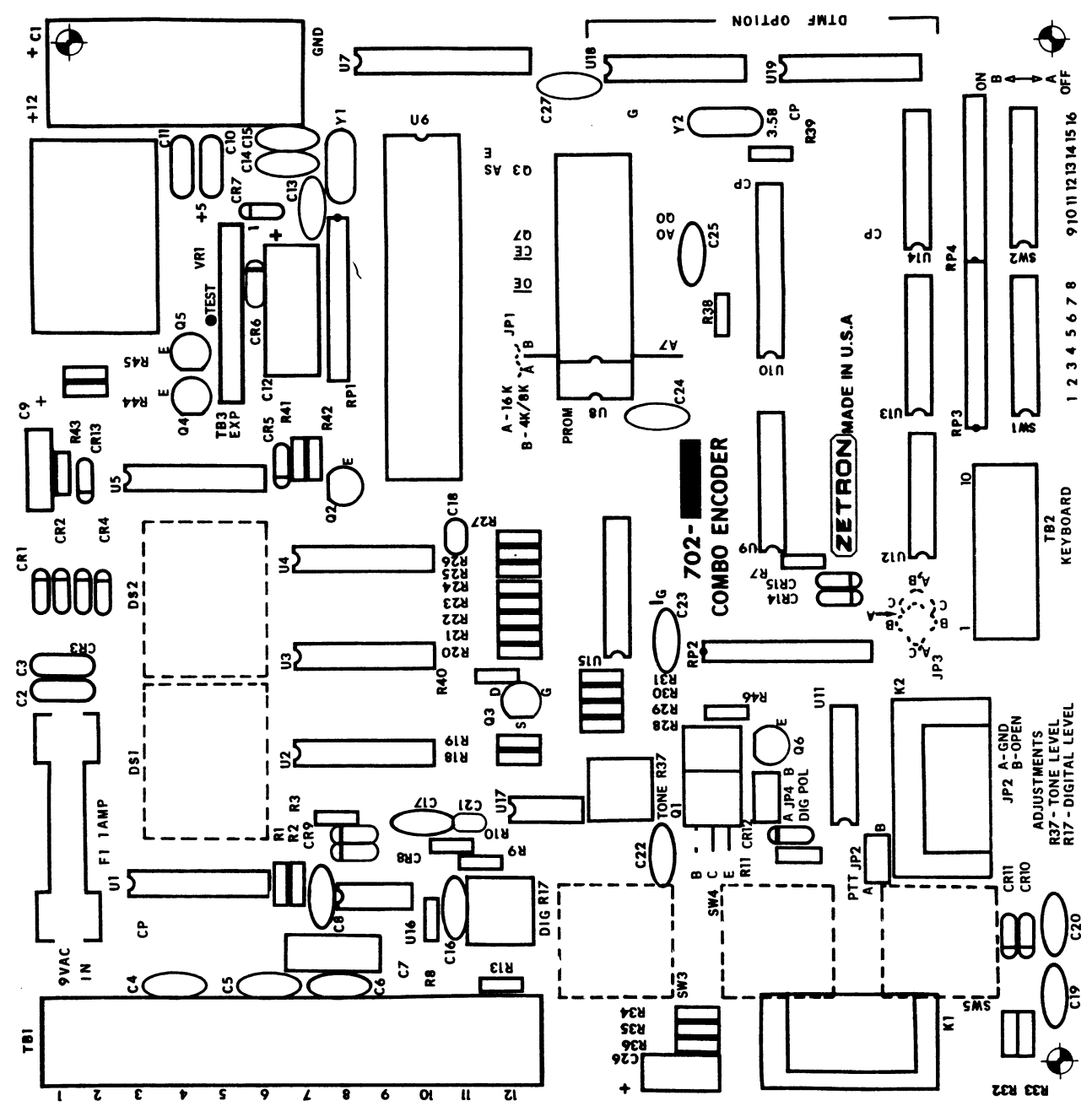
MOTOROLA AND G.E. TONE GROUP FREQUENCIES

Tone Number	Mot 1	Mot 2	Mot 3	Tone Groups Mot 4	Mot 5	Mot 6	Mot A
0	330.5	569.1	1092.4	321.7	553.9	1122.5	358.9
1	349.0	600.9	288.5	339.6	584.8	1153.4	398.1
2	368.5	634.5	296.5	358.6	617.4	1185.2	441.6
3	389.0	669.9	304.7	378.6	651.9	1217.8	489.8
4	410.8	707.3	313.0	399.8	688.3	1251.4	543.3
5	433.7	746.8	953.7	422.1	726.8	1285.8	602.6
6	457.9	788.5	979.9	445.7	767.4	1321.2	668.3
7	483.5	832.5	1006.9	470.5	810.2	1357.6	741.3
8	510.5	879.0	1034.7	496.8	855.5	1395.0	822.2
9	539.0	928.1	1063.2	524.6	903.2	1433.4	912.0
Diagonal Tone:	569.1	979.9	569.1	569.1	979.9	979.9	979.9

Tone Number	Mot B	Mot Z	GE A'	Tone Groups GE B'	GE C'	Mot 10	Mot 11
0	371.5	346.7	682.5	652.5	667.5	1472.9	1930.2
1	412.1	384.6	592.5	607.5	712.5	1513.5	1989.0
2	457.1	426.6	757.5	787.5	772.5	1555.2	2043.8
3	507.0	473.2	802.5	832.5	817.5	1598.0	2094.5
4	562.3	524.8	847.5	877.5	862.5	1642.0	2155.6
5	623.7	582.1	892.5	922.5	907.5	1687.2	2212.2
6	691.8	645.7	937.5	967.5	952.5	1733.7	2271.7
7	767.4	716.1	547.5	517.5	532.5	1781.5	2334.6
8	851.1	794.3	727.5	562.5	577.5	1830.5	2401.0
9	944.1	881.0	637.5	697.5	622.5	1881.0	2468.2
Diagonal Tone:	979.9	979.9	742.5	742.5	742.5	none	none

MOTOROLA AND G.E. CODE PLANS

Code Plans

Pager Cap-Code	Mot B Groups	Mot C Groups	Mot D Groups	Mot E Groups	Mot F Groups	Mot G Groups	Mot H Groups	Mot J Groups	Mot K Groups
0xx	2+4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1xx	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1
2xx	2+2	2+2	2+2	2+2	1+3	1+3	1+3	1+4	1+4
3xx	3+3	1+2	1+2	1+2	3+3	3+3	3+3	4+1	4+1
4xx	1+2	4+4	1+5	2+1	4+4	3+1	3+1	4+4	4+4
5xx	1+3	1+4	5+5	1+6	3+1	5+5	1+6	5+5	1+6
6xx	2+1	2+1	2+1	6+6	1+4	1+5	6+6	1+5	6+6
7xx	3+1	4+1	5+1	6+1	4+1	5+1	6+1	4+5	6+1
8xx	2+3	2+4	2+5	2+6	3+4	3+5	3+6	5+4	4+6
9xx	3+2	4+2	5+2	6+2	4+3	5+3	6+3	5+1	6+4
Groups:	1,2,3,4	1,2,4	1,2,5	1,2,6	1,3,4	1,3,5	1,3,6	1,4,5	1,4,6

Code Plans

Pager Cap-Code	Mot L Groups	Mot M Groups	Mot N Groups	Mot P Groups	Mot Q Groups	Mot R Groups	Mot S Groups	Mot T Groups	Mot U Groups
0xx	N/A	4+2	4+2	4+2	4+2	4+2	4+2	4+2	4+2
1xx	1+1	2+3	2+3	2+3	2+4	2+4	2+5	3+4	3+4
2xx	1+5	2+2	2+2	2+2	2+2	2+2	2+2	4+3	4+3
3xx	5+1	3+3	3+3	3+3	4+2	4+2	5+2	3+3	3+3
4xx	1+6	4+4	3+2	3+2	4+4	4+4	2+6	4+4	4+4
5xx	5+5	3+2	5+5	2+6	5+5	2+6	5+5	5+5	3+6
6xx	6+6	2+4	2+5	6+6	2+5	6+6	6+6	3+5	6+6
7xx	6+1	4+2	5+2	6+2	4+5	6+2	6+2	4+5	6+3
8xx	5+6	3+4	3+5	3+6	5+4	4+6	5+6	5+4	4+6
9xx	6+5	4+3	5+3	6+3	5+2	6+4	6+5	5+3	6+4
Groups:	1,5,6	2,3,4	2,3,4,5	2,3,4,6	2,4,5	2,4,6	2,5,6	2,3,4,5	2,3,4,6

Code Plans

Pager Cap-Code	Mot V Groups	Mot W Groups	Mot Y Groups	Mot MT Groups	GE X Groups	GE Y Groups	GE Z** Groups
0xx	4+2	4+2	N/A	4+2	A'+A'	B'+B'	A'+A'
1xx	3+5	4+6	A+A	1+1	B'+A'	C'+B'	C'+A'
2xx	5+3	6+4	B+B	2+2	B'+B'	C'+C'	C'+C'
3xx	3+3	5+6	Z+Z	1+2	A'+B'	B'+C'	A'+C'
4xx	3+6	4+4	A+B	4+4	C'+C'	N/A	N/A
5xx	5+5	5+5	A+Z	5+5	C'+A'	N/A	N/A
6xx	6+6	6+6	B+A	2+1	C'+B'	N/A	N/A
7xx	6+3	4+5	Z+A	4+5	A'+C'	N/A	N/A
8xx	5+6	5+4	B+Z	5+4	B'+C'	N/A	N/A
9xx	6+5	6+5	Z+B	2+4	N/A	N/A	N/A
Groups:	2,3,4,5,6	2,4,5,6	A,B,Z	1,2,4,5	A',B',C'	B',C'	A',C'

Notes: **G.E. 100-call plan Z is tone groups C'+C'; use (100-Call format).
For cap-codes ending in double-digits using tone group twice,
(example: 122 in code plan C), use diagonal as one of the tones.

GENERAL ENCODING PLANS

	General Plan		Modified General Plan		General Alternate Plan	
Pager	Tone	Diagonal	Tone	Diagonal	Pager	
Cap-Code	Groups	Tone	Groups	Tone	Cap-Code	Tone Groups
0xx	4+2	N/A	N/A	N/A	0xx	N/A
1xx	1+1	569.1	1+1	569.1	1xx	953.7 + Mot 1
2xx	2+2	979.9	2+2	979.9	2xx	953.7 + Mot 2
3xx	1+2	N/A	3+3	569.1	3xx	979.9 + Mot 2
4xx	4+4	569.1	4+4	569.1	4xx	953.7 + Mot 4
5xx	5+5	979.9	5+5	979.9	5xx	953.7 + Mot 5
6xx	2+1	N/A	6+6	979.9	6xx	979.9 + Mot 1
7xx	4+5	N/A	N/A	N/A	7xx	979.9 + Mot 5
8xx	5+4	N/A	N/A	N/A	8xx	979.9 + Mot 4
9xx	2+4	N/A	N/A	N/A		
**Axx	3+3	569.1	N/A	N/A		

Tone Groups: 1,2,3,4,5   1,2,3,4,5,6

Notes: 1) On General and Modified General plans, there are different diagonal
          tones for different pager blocks.
       2) **General has an eleventh pager block with cap-codes 'Axx',
          which is not coded on the Model 15.
       3) For General Alternate Code Plan, last two digits of cap-code
          are the same as each other.

REACH ENCODING PLAN

Tone Number	Freq.	Tone Number	Freq.	Tone Number	Freq.	Tone Number	Freq.
0	3960.0	15	2354.0	30	1400.0	45	832.0
1	3824.0	16	2274.0	31	1352.0	46	804.0
2	3694.0	17	2196.0	32	1306.0	47	776.0
3	3568.0	18	2121.0	33	1261.0	48	750.0
4	3446.0	19	2049.0	34	1219.0	49	725.0
5	3329.0	20	1980.0	35	1177.0	50	700.0
6	3215.0	21	1912.0	36	1137.0	51	676.0
7	3106.0	22	1847.0	37	1098.0	52	653.0
8	3000.0	23	1784.0	38	1061.0	53	631.0
9	2898.0	24	1723.0	39	1025.0	54	609.0
10	2799.0	25	1664.0	40	990.0	55	588.0
11	2704.0	26	1608.0	41	956.0	56	568.0
12	2612.0	27	1553.0	42	923.0	57	549.0
13	2523.0	28	1500.0	43	892.0	58	530.0
14	2437.0	29	1449.0	44	862.0	59	512.0
						60	495.0

ZETRON TONE GROUPS FOR REACH ENCODING

Tone Number	Z1	Z2	Z3	Z4	Z5
0	1980.0	1177.0	1400.0	832.0	588.0
1	2704.0	1608.0	1912.0	1137.0	804.0
2	2612.0	1553.0	1847.0	1098.0	776.0
3	2523.0	1500.0	1784.0	1061.0	750.0
4	2437.0	1449.0	1723.0	1025.0	725.0
5	2354.0	1400.0	1664.0	990.0	700.0
6	2274.0	1352.0	1608.0	956.0	676.0
7	2196.0	1306.0	1553.0	923.0	653.0
8	2121.0	1261.0	1500.0	892.0	631.0
9	2049.0	1219.0	1449.0	862.0	609.0

REACH CODE PLAN

Pager Cap-Code	Indiv. Call Tone Groups x + y
0yx	Z5+Z3
1xy	Z1+Z2
2yx	Z2+Z1
3xy	Z3+Z4
4yx	Z4+Z3
5xy	Z1+Z4
6yx	Z4+Z1
7xy	Z1+Z5
8yx	Z5+Z1
9xy	Z3+Z5

Note that the ones/tens digit encoding, shown by 'x' and 'y' reverses position for each 100 pager block. In GE/Motorola plans, 1st tone is always tens digit, and 2nd tone is ones digit.

For REACH group call, 0xx group is not present. Instead, ten group calls are accessible using pager numbers 000,011,022, ... 099, that generate the ten group call tones from tone group Z1. The group calls activate 1st tone Z1 pagers (cap codes 1xx, 5xx, and 7xx).

5/6 TONE FREQUENCIES AND TIMINGS

	Tone Number	EIA	CCIR	ZVEI
freqs	0	600	1981	2400
in	1	741	1124	1060
Hz	2	882	1197	1160
	3	1023	1275	1270
	4	1164	1358	1400
	5	1305	1446	1530
	6	1446	1540	1670
	7	1587	1640	1830
	8	1728	1747	2000
	9	1869	1860	2200
2nd Addr	X	2010	2247	2796
Repeat	R	459	2110	2600
timing	Preamble	690	690	690
in	Gap	65	65	65
msec	Tone	33	100	100
	X Tone	65	100	100

HSC TONE FREQUENCIES AND TIMINGS

	HSC	EIA/ USA	CCIR	ZVEI	EEA
freqs	0	600	1981	2400	1981
in	1	741	1124	1060	1124
Hz	2	882	1197	1160	1197
	3	1023	1275	1270	1275
	4	1164	1358	1400	1358
	5	1305	1446	1530	1446
	6	1446	1540	1670	1540
	7	1587	1640	1830	1640
	8	1728	1747	2000	1747
	9	1869	1860	2200	1860
	A	2151	2400	2800	1055
	B	2435	930	810	930
	C	2010	2247	970	2247
	D	2295	991	886	991
	E	459	2110	2600	2110
No Tone	F				
timing	Gap	64	290	140	100
in	Tone	33	100	70	40
msec					

DTMF TONE PAIR FREQUENCIES

Key from 16 button keypad/frequencies in Hz

	Columns		
1	2	3	4

Rows

Rows	1	2	3	4
1	--1-- 701.3 1215.9	--2-- 701.3 1331.7	--3-- 701.3 1471.9	--A-- 701.3 1645.0
2	--4-- 771.4 1215.9	--5-- 771.4 1331.7	--6-- 771.4 1471.9	--B-- 771.4 1645.0
3	--7-- 857.2 1215.9	--8-- 857.2 1331.7	--9-- 857.2 1471.9	--C-- 857.2 1645.0
4	--*-- 935.1 1215.9	--0-- 935.1 1331.7	--#-- 935.1 1471.9	--D-- 935.1 1645.0

CONFIGURATION SWITCHES - ALL FORMATS

				SWITCH SW1								SWITCH SW2					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
											BP			AP	AS

BP: BINARY POLARITY
Sw12   Logic '0' sent as

A   low level
B   high level

AP: AUTO-PAGE
Sw15   Auto-page

A   Off
B   On

AS: AUTO-SCROLL
Sw16   Auto-scroll

A   Off
B   On

CONFIGURATION SWITCH SETTINGS (REACH FORMAT)

				SWITCH 1								SWITCH 2				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
								TI	TI	TI		GC			

TI: TIMING   Note: may conflict with Two Tone timing
Sw11   1st/Gap/2nd/Grp
            (seconds)
A   .13/ 0 /.13/1.4   (REACH Fast)
B   2.0/ 0 /0.7/4.5   (REACH Slow)

GC: GROUP CALL
Sw13   Group Call

A   Group calls
B   Individual calls

MODEL 10/15 CONFIGURATION SWITCH DIFFERENCES

Model 10 Sw12 & 13   Selects one of 3 Two Tone diagonals, or Group Call.
                           Model 15 uses only Sw13 to select Diagonal or Group.
Model 10 Sw16   Selects 0 or 5 seconds of Talk time. Model 15 Talk
                           time is ordered for any value 0-99 seconds.

CONFIGURATION SWITCH SETTINGS (100-CALL TWO TONE FORMAT)

	SWITCH SW1								SWITCH SW2						
1	2	3	4	5.	6	7	8	9	10	11	12	13	14	15	16
F1	F1	F1	F1	F2	F2	F2	F2	TI	TI	TI		DT	DP	AP	AS

F1: 1ST TONE FREQ.

Switch				Tone
1	2	3	4	Group
A	A	A	A	Mot 1
A	A	A	B	Mot 2
A	A	B	A	Mot 3
A	A	B	B	Mot 4
A	B	A	A	Mot 5
A	B	A	B	Mot 6
A	B	B	A	Mot A
A	B	B	B	Mot B
B	A	A	A	Mot Z
B	A	A	B	GE A'
B	A	B	A	GE B'
B	A	B	B	GE C'
B	B	A	A	Mot 10
B	B	A	B	Mot 11
B	B	B	A	Mot 1
B	B	B	B	No Tone

F2: 2ND TONE FREQ.

Switch				Tone
5	6	7	8	Group
A	A	A	A	Mot 1
A	A	A	B	Mot 2
A	A	B	A	Mot 3
A	A	B	B	Mot 4
A	B	A	A	Mot 5
A	B	A	B	Mot 6
A	B	B	A	Mot A
A	B	B	B	Mot B
B	A	A	A	Mot Z
B	A	A	B	GE A'
B	A	B	A	GE B'
B	A	B	B	GE C'
B	B	A	A	Mot 10
B	B	A	B	Mot 11
B	B	B	A	Mot 1
B	B	B	B	No Tone

TI: TIMING   Note: conflict with Reach timing

Switch			1st/Gap/2nd/Grp
9	10	11	(seconds)
A	A	A	1.0/ 0 /3.0/8.0 (Mot/GE T+V)
A	A	B	0.4/ 0 /0.8/8.0 (Mot Tone)
A	B	A	1.0/ 0 /3.0/6.0 (NEC-B)
A	B	B	1.0/.25/3.0/6.0 (NEC-A)
B	A	A	1.0/ 0 /1.0/4.0 (NEC-C)
B	A	B	0.4/ 0 /0.8/4.0 (NEC-M)
B	B	A	0.5/ 0 /0.5/3.0 (NEC-L)
B	B	B	0.4/ 0 /0.4/3.0 (NEC-D)

DT: DIAGONAL TONE

Sw13	Diagonal Tone
A	No Diagonal (group call)
B	Standard Diagonal tone

DP: DIAGONAL PLACEMENT

Sw14	Tone Placement
A	1st Tone
B	2nd Tone

AP: AUTO-PAGE

Sw15	Auto-page
A	Off
B	On

AS: AUTO-SCROLL

Sw16	Auto-scroll
A	Off
B	On

CONFIGURATION SWITCH SETTINGS (1000-CALL TWO TONE FORMAT)

			SWITCH 1									SWITCH 2			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			CP	CP	CP	CP	CP	TI	TI	TI		DT	DP	AP	AS

CP: CODE PLAN

Switch					Code
4	5	6	7	8	Plan
A	A	A	A	A	Mot B
A	A	A	A	B	Mot C
A	A	A	B	A	Mot D
A	A	A	B	B	Mot E
A	A	B	A	A	Mot F
A	A	B	A	B	Mot G
A	A	B	B	A	Mot H
A	A	B	B	B	Mot J
A	B	A	A	A	Mot K
A	B	A	A	B	Mot L
A	B	A	B	A	Mot M
A	B	A	B	B	Mot N
A	B	B	A	A	Mot P
A	B	B	A	B	Mot Q
A	B	B	B	A	Mot R
A	B	B	B	B	Mot S
B	A	A	A	A	Mot T
B	A	A	A	B	Mot U
B	A	A	B	A	Mot V
B	A	A	B	B	Mot W
B	A	B	A	A	Mot Y
B	A	B	A	B	Mot MT
B	A	B	B	A	GE X
B	A	B	B	B	GE Y
B	B	A	A	A	GE Z
B	B	A	A	B	Special
B	B	A	B	A	Mod. Gen'l
B	B	A	B	B	Gen'l Alt.
B	B	B	A	A	General
B	B	B	A	B	General
B	B	B	B	A	General
B	B	B	B	B	General

TI: TIMING   Note: conflict with Reach

Switch			1st/Gap/2nd/Grp	
9	10	11	(seconds)	
A	A	A	1.0/ 0 /3.0/8.0	(Mot/GE T+V)
A	A	B	0.4/ 0 /0.8/8.0	(Mot Tone)
A	B	A	1.0/ 0 /3.0/6.0	(NEC-B)
A	B	B	1.0/.25/3.0/6.0	(NEC-A)
B	A	A	1.0/ 0 /1.0/4.0	(NEC-C)
B	A	B	0.4/ 0 /0.8/4.0	(NEC-M)
B	B	A	0.5/ 0 /0.5/3.0	(NEC-L)
B	B	B	0.4/ 0 /0.4/3.0	(NEC-D)

DT: DIAGONAL TONE

Sw13	Diagonal Tone
A	None (group call)
B	Standard Diagonal tone

DP: DIAGONAL PLACEMENT

Sw 14	Tone Placement
A	1st Tone
B	2nd Tone

AP: AUTO-PAGE

Sw15	Auto-page
A	Off
B	On

AS: AUTO-SCROLL

Sw16	Auto-scroll
A	Off
B	On

CONFIGURATION SWITCH SETTINGS (UNIVERSAL TWO TONE FORMAT)

				SWITCH 1							SWITCH 2				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
								TI	TI	TI				AP	AS

TI: TIMING   Note: conflict with Reach

Switch			1st/Gap/2nd/Grp	
9	10	11	(seconds)	
A	A	A	1.0/ 0 /3.0/8.0	(Mot/GE T+V)
A	A	B	0.4/ 0 /0.8/8.0	(Mot Tone)
A	B	A	1.0/ 0 /3.0/6.0	(NEC-B)
A	B	B	1.0/.25/3.0/6.0	(NEC-A)
B	A	A	1.0/ 0 /1.0/4.0	(NEC-C)
B	A	B	0.4/ 0 /0.8/4.0	(NEC-M)
B	B	A	0.5/ 0 /0.5/3.0	(NEC-L)
B	B	B	0.4/ 0 /0.4/3.0	(NEC-D)

AP: AUTO-PAGE
Sw15   Auto-page

A   Off
B   On

AS: AUTO-SCROLL
Sw16   Auto-scroll

A   Off
B   On

CAPCODE ENTRY: ggtt

g   = tone group (0-D,#)

t   = tone number (0-9, A=Diagonal tone)

Key g	Tone Groups
0	No Tone
1	Mot 1
2	Mot 2
3	Mot 3
4	Mot 4
5	Mot 5
6	Mot 6
7	Mot A
8	Mot B
9	Mot Z
A	GE A'
B	GE B'
C	GE C'
D	Mot 10
#	Mot 11

HSC FUNCTIONS:

NON-DATA

f   Pager Response

0   Mute Audio and Reset Auxiliary 1 & 2
1   Mute Audio
2   Tone-only Call Alert
3   Voice Message Call Alert, Unmute Audio.
4   Set Aux. 1
5   Set Aux. 2
6   Set Auxs 1 & 2
8   Reset Aux. 1
9   Reset Aux. 2

Usually only non-data functions 1,2 and 3 are useful with HSC pagers.

DATA   p=priority: 0=none, 1=priority page

Pager display symbol shown and # of characters in field (field number)

pf	Large Telephone (for telephone #)	C (for code)	S (for source)	Small Telephone (for extension)	D (for data)
p0	12(d1)				
p1		12(d1)			
p2		12(d1)	7(d2)		
p3		12(d1)			7(d2)
p4	12(d1)		7(d2)		
p5	12(d1)				7(d2)
p6	12(d1)			4(d2)	
p7	12(d1)			4(d2)	7(d3)
p8	12(d1)		7(d3)	4(d2)	

No priority, data only (no message formatting by pager)
  7   12 characters # PAGE

IMMEDIATE ZETRON FUNCTIONS

No address or message required. Press the leading digit, If required, then
the key for the selected function. All Immediate Functions use an All Call
address of HSC code 'A's except where digits are strapped or a service
block must be specified.

f   Pager Response

0-9 All Pagers In service block   f   mute audio speakers
C   Service Range Enable all pagers (all service blocks)
D   Service Range Disable all pagers (all service blocks)
B   Enables or Disables automatic Battery Saving.
     If previously Enabled, the display will blink 'oFF' and the function
will be disabled. If previously Disabled, the display will blink 'on' and the
function will be enabled. When enabled the Battery Saver transmission Is
periodically sent when the previous sleep time has expired, there is no
transmit inhibit, no other page Is currently taking place, and a capcode
entry is not taking place. However, if the capcode entry takes longer than
13 seconds between key hits, the Battery Saver will interrupt and display
'SAvE' while transmitting. The display will be CLEARED.

FIVE/SIX TONE FORMAT

CAPCODE ENTRY:
      Five Tone   xxxxx e   (one or more x may be strapped)
      Six Tone   p xxxxx e   (p and one or more x may be strapped)

      p   = preamble digit 0-9
              = * preamble tone omitted

      xxxxx   = address, digits 0-9

      e   = extra address digit 1 or 2 (if used)

Three addressing modes are available for the Model 15 5/6 Tone formats. Single addressing always instructs pagers to give a 1st address beep alert. Dual addressing sends single address tones for even numbered pager entries and sends the extra dual address tone for odd numbered pager entries. The actual address sent is always even, however. With this option all of the user's pagers are required to be even numbered, reducing the call capacity by half.
Extra digits addressing requires an extra function digit to be entered after the pager number, 1=first address, 2=second address. This scheme requires an extra keystroke but allows all 100,000 addresses to be sent.

POCSAG DIGITAL FORMAT

If any message function is Re-Paged, a new message must be entered before paging. The old message is lost.

No POCSAG pager numbers may be entered into the memory stack.

CAPCODE ENTRY: xxxxxxx f   (one or more x may be strapped)

   xxxxxxx   = address, digits 0-9, range 0000000-2097151

   f   = beep alert function 1-4

MESSAGE ENTRY: free form, up to 20 characters

MESSAGE CHARACTERS:

Model 15 key   Received Character In Pager

   0-9   0-9
   A   [left bracket
   B   ] right bracket
   C   U
   D   none, activates alphanumeric test message (see below)
   #   space
   *   - (hyphen)

TEST MODES ENTRY: 2018536 † PAGE

   †   = test mode number 1 or 2
               Test #1 transmits test sequence #1 for NEC type D4 pagers
               Test #2 transmits test sequence #2 for NEC type D4 pagers

ALPHANUMERIC TEST ENTRY: xxxxxxx f PAGE D † PAGE

   †   = alphanumeric test message 1 or 2
               Test message 1 = "ABCDEFGHJKLM
                                 NPQRSTUVWXYZ"
               (24 characters, control character <EOT> terminates
                the message)
               Test message 2 = "0123456789:;
                                 <=>?@ABCDEFG
                                 HIJKLMNOPQRS
                                 TUVWXYZ[ ] _"
               (48 characters, ASCII $30 to $5F, control character
                <EOT> terminates the message)

NEC DIGITAL FORMAT

If any message function is Re-Paged, a new message must be entered before paging. The old message is lost.

No NEC pager numbers may be entered into the memory stack.

CAPCODE ENTRY:

Tone Only Page xxxxx		(one or more x may be strapped)
Data Page	xxxxxx	(one or more x may be strapped)

xxxxx	= address, digits 0-9, range 00000-65535		
xxxxxx	= address, digits 0-9		
	Group 1	xx0000-xx2499	
	Group 2	xx2500-xx4999	
	Group 3	xx5000-xx7499	
	Group 4	xx7500-xx9999	

MESSAGE ENTRY: free form, up to 20 characters

MESSAGE CHARACTERS:

Model 15 key	Received Character in Pager
0-9	0-9
A	a
B	b
C	C
D	d
#	space
*	- (hyphen)

TEST MODES ENTRY: t PAGE

t	= test mode number 1 or 2
	Test #1 transmits test sequence #1 for NEC type D3 pagers
	Test #2 transmits test sequence #2 for NEC type D3 pagers and repeats after 1 second

MOTOROLA GOLAY DIGITAL FORMAT

For any function that requests Talk, the interval will be given
following transmission of the GSC address and message data. Speak
when "tALK" is displayed. A pager Mute will automatically follow the
Talk interval; "PAGE" will again be displayed.

If any message function is Re-Paged, a new message must be entered before
paging. The old message is lost.

No GOLAY GSC pager numbers may be entered into the memory stack.

CAPCODE ENTRY: xxxxxx f   (one or more x may be strapped)

      xxxxxx   = address, digits 0-9

      f   = pager function
                 =1-4 Voice page
                 =5-8 Data page
                 =9,0 Tone only page

MESSAGE ENTRY: free form, up to 12 numeric characters

MESSAGE CHARACTERS:

Model 15 key   Received Character in Pager

      0-9   0-9
      A   # (3 horizontal bars)
      B   E
      C   U
      D   none, activates alphanumeric test message (see below)
      #   space
      *   - (hyphen)

ALPHANUMERIC TEST ENTRY: xxxxxx f   PAGE D t PAGE

      t   = alphanumeric test message 1 of 2
                 Test message 1 = "ABCDEFGHJKLM
                                   NPQRSTUVWXYZ"
                 (24 characters)
                 Test message 2 = "0123456789:;
                                   <=>?*ABCDEFG
                                   HIJKLMNOPQRS
                                   TUVWXYZ[/]$%"
                 (48 characters)

MOTOROLA METRO DIGITAL FORMAT

No METRO pager numbers may be entered into the memory stack.

CAPCODE ENTRY: xxxxxx (one or more x may be strapped)
                 xxxxxx = address, digits 0-9

GENERAL

8-1
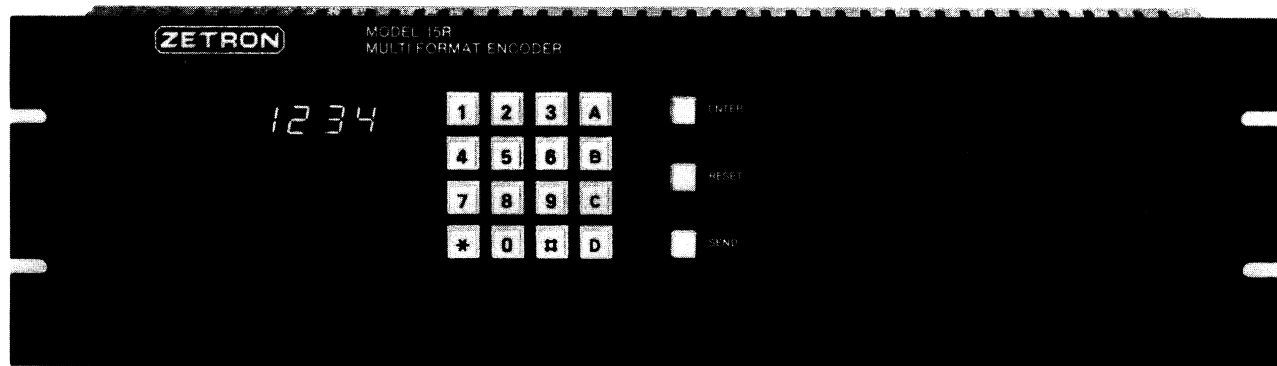
The operation of the Model 15R multi-format encoder is identical to that of
the Model 15 desk top encoder. It resides in a 5.25" X 19.0" rack mount
enclosure allowing easy installation in any standard radio control console.
The interface connector, fuse, tone level and digital level adjustments may
be accessed on the encoder's rear panel. Flexible power requirements allow
input voltages of 9VAC or 12 to 14VDC at 800ma.

ELECTRICAL SPECIFICATIONS

Output Frequency Range   250-3500Hz, +- 1.0dB maximum

Frequency Accuracy   +- 0.1%

Audio Output Drive   Unipolar, single-ended (unbalanced), 600 ohms

Audio Output Amplitude   Adjustable, +13dBm to -20dBm
                         (0-5.2V pk-pk, adjustable into 600 ohms)

Tone Distortion   2% nominal from pure sinewave

Digital output   Unipolar 0 to 4.2 volts adjustable

Digital mode   Logic signal (low=digital data)

Control Outputs   2 sets of SPDT contacts, rated 1A at 26VAC;
                         One for Push-to-Talk (P.T.T.),
                         One for switching audio output between
                         internal tone and external voice microphone.

Transmit Inhibit Input   Senses TTL low or closure to ground. Requires that
                         2 seconds of free channel be sensed before paging.

Power Supply   120VAC +-15%, 48-62Hz, wall transformer (9VAC rms)
                         or 12-14VDC at 800mA maximum

Operating Temperature   0 to +65 Celsius

Size   5.2"H x 19"W x 1.2"D

Weight   44 oz.

TONE LEVEL ADJUSTMENT

Access to the Tone Level control is provided on the rear panel of the encoder. Clockwise rotation will increase the audio output level between 0V and 5.2V peak to peak. This level must be set to provide proper deviation.

DIGITAL LEVEL ADJUSTMENT

Access to the Digital Level control is provided on the rear panel of the encoder. This adjustment must be set to provide proper deviation. Rotation in a clockwise direction will increase the output voltage between 0VDC and 4.2VDC. For information on Digital Test Modes refer to pages 6-1 and 6-2.

INTERFACE CONNECTOR

Access to the 12 pin Interface Connector is provided on the encoder's rear panel. Refer to pages 4-1 and 4-2 information regarding pin and signal definitions for this connector.
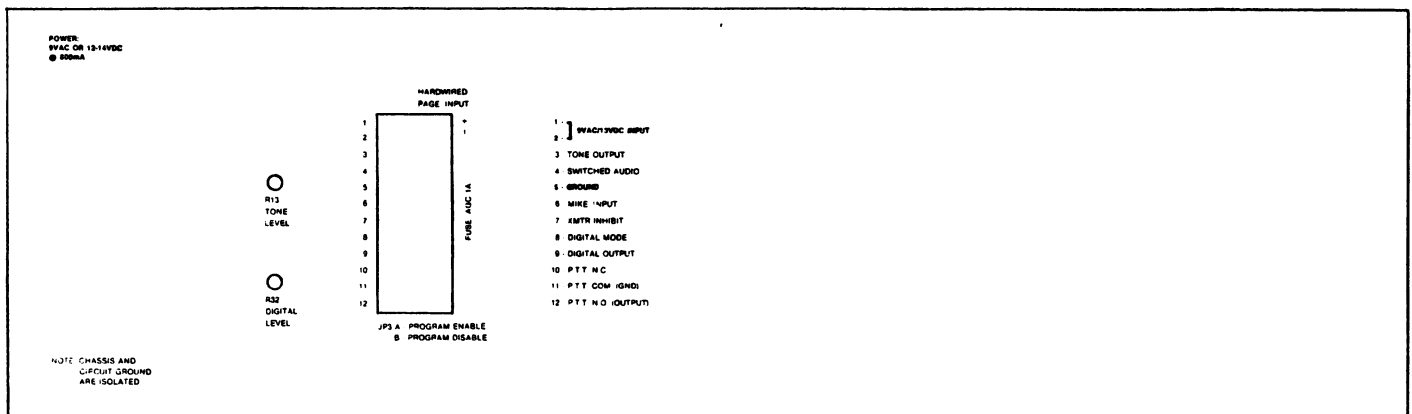
KEYBOARD LABELS

Labels are provided on the last pages of this manual for use in displaying your keyboard page assignments. These labels may be removed and seperated for installation into the label holder supplied with your unit.

SYSTEM PARAMETER PROGRAMMING

The Model 15R is equipped with a 256 bit, serial, non-volitile EEPROM memory for long term storage of the systems parameters. Programming the encoders 'software switches' is accomplished through the encoders key pad, allowing the installer to easily configure the system.

JUMPER SETTINGS

The Model 15R is equipped with user configurable jumpers mounted on the
circuit board (page 8-9). The factory settings for these jumpers are
correct for most applications, requiring no modification by the installer.
In cases where alteration of factory settings is required, consult the
following table for information on jumper positioning.

JUMPER	LOCATION	MEANING	FACTORY SETTING
JP1	U14	A = DE-EMPHASIS B = FLAT C = PRE-EMPHASIS	A
JP2	K2	A = P.T.T. COMMON (GROUNDED) B = P.T.T. COMMON (OPEN)	A
JP4	U8	KEYBOARD CONFIGURATION	B (3 POSITIONS)
JP5	U15	A = DIGITAL MODE (NON-INVERTED) B = DIGITAL MODE (INVERTED)	A
JP7	U20	A = U20 IS 8K X 8 (2764) A = U20 IS 16K X 8 (27128) B = U20 IS 4K X 8 (2732)	A
TB4	TB1	NOT USED	OPEN

ENTERING THE PROGRAM MODE

STEP 1   Hold down the '0' key

STEP 2   Power up the Model 15R while the '0' key is STILL DEPRESSED

STEP 3   Release the '0' key

PROMPT 'P - - ' Will be displayed

The Model 15R is now in the Program mode idle state, and is waiting for a two digit 'Select Code' entry.

FUNCTION CODE ENTRY

Once in the Program mode idle state, the prompt 'P - -" will be displayed and the encoder will wait for a two digit, 'Select Code' entry. The valid entries are listed in each section under System Parameters, 100 Call Two Tone, 1000 Call Two Tone, Reach, and Universal Two Tone.

If an illegal two digit entry is made, the encoder will blink three times and return to the Program mode idle state.

Following the two digit Select Code entry, one or two additonal digits may be required to complete the sequence. The encoder will prompt for these digits by displaying:

PROMPT   P   -   One additional digit required

PROMPT   P - -   Two additional digits required

In each format section, the valid Select Code entries are listed. Those entries requiring additional digits will be followed by 'N' or 'NN' for one or two digits respectively.

ENCODER RESET KEY

During normal operation the Reset key is pressed to reset the unit or to cancel a page in progress.

While in the Program mode, the reset key will perform two functions:

1) If one or more incorrect digits are entered, depression of the reset key will cancel the entries, and return the encoder to the Program mode idle state.

2) If the encoder is in the Program mode idle state, depression of the reset key will cause the encoder to leave the Program mode, execute the normal power up self test, and exit to the normal operating mode.

SYSTEM PARAMETERS

These parameters are always resident regardless of which formats have been preprogrammed into the encoder. These settings effect System operation, and should be reconfigured if other than fault values are desired.

SYSTEM PARAMETERS - MODEL 15R

Select Code	Description	
00	Initialize EEPROM	This command resets the system to the default values shown.
01 N	Set AUTOPAGE	N = 0 off - default N = 1 on
02 N	Set AUTOSCROLL	N = 0 off - default N = 1 on
03 N	Binary Polarity	N = 0 low - default N = 1 high
08 NN	Set KEY UP - DELAY (time between closing PTT & generation of tones)	NN = 00-99 (0.0-9.9sec) key up delay x 100 millisec 10 = 1.0 sec - default
09 NN	Set TALK TIME (time after a page allocated to a voice message)	NN = 00-99 (00-99sec) talk time x 1 sec 00 = no talk time - default
95	Display software version	Displayed 4 digit version #

FORMAT PARAMETERS

Each of the four field pragrammable formats; 100 Call, 1000 Call, Reach and Univeral Two Tone is provided with programmable 'software switches' which may be changed to configure the system as required. Only one of these field programmable formats may reside in the encoder at a time. Any number of additional non-field programmable factory programmed formats may be added up to the limit of the encoder.

100 CALL TWO TONE - MODEL 15R

Select Code	Description	
10 NN	Set 1st Tone Group	NN = 00-15 see Tone Group Table
11 NN	Set 2nd Tone Group	NN = 00-15 see Tone Group Table
12 N	Set Timing	N = 0-7 see Timing Table
13 N	Diagonal Tone	N = 0 Group Call N = 1 Diagonal Tone
14 N	Diagonal Tone Placement	N = 0 1st Tone N = 1 2nd Tone

TONE GROUP TABLE - MODEL 15R

Entry	Tone Group	Entry	Tone Group
00	MOT 1	08	MOT Z
01	MOT 2	09	GE A'
02	MOT 3	10	GE B'
03	MOT 4	11	GE C'
04	MOT 5	12	MOT 10
05	MOT 6	13	MOT 11
06	MOT A	14	MOT 1
07	MOT B	15	NO TONE

TIMING TABLE - MODEL 15R

Entry	Timing	
0	1.0/0/3.0/8.0	(MOT/GE T+V)
1	0.4/0/0.8/8.0	(MOT TONE)
2	1.0/0/3.0/6.0	(NEC - B)
3	1.0/.25/3.0/6.0	(NEC - A)
4	1.0/0/1.0/4.0	(NEC - C)
5	0.4/0/0.8/4.0	(NEC - M)
6	0.5/0/0.5/3.0	(NEC - L)
7	0.4/0/0.4/3.0	(NEC - D)

1000 CALL TWO TONE - MODEL 15R

Select Code	Description	
21 NN	Set Code Plan	NN = 00-29 See Code Plan Table
22 N	Set Timing	N = 0-7 See Timing Table
23 N	Diagonal Tone	N = 0 Group Call N = 1 Diagonal Tone
24 N	Diagonal Tone Placement	N = 0 1st Tone N = 1 2nd Tone

CODE PLAN TABLE - MODEL 15R

Entry	Code Plan	Entry	Code Plan
00	MOT B	15	MOT S
01	MOT C	16	MOT T
02	MOT D	17	MOT U
03	MOT E	18	MOT V
04	MOT F	19	MOT W
05	MOT G	20	MOT Y
06	MOT H	21	MOT MT
07	MOT J	22	GE X
08	MOT K	23	GE Y
09	MOT L	24	GE Z
10	MOT M	25	SPECIAL
11	MOT N	26	MOD. GEN'L
12	MOT P	27	GEN'L ALT.
13	MOT Q	28	GENERAL
14	MOT R	29	GENERAL

TIMING TABLE -MODEL 15R

Entry	Timing	
0	1.0/0/3.0/8.0	(MOT/GE T+V)
1	0.4/0/0.8/8.0	(MOT TONE)
2	1.0/0/3.0/6.0	(NEC - B)
3	1.0/.25/3.0/6.0	(NEC - A)
4	1.0/0/1.0/4.0	(NEC - C)
5	0.4/0/0.8/4.0	(NEC - M)
6	0.5/0/0.5/3.0	(NEC - L)
7	0.4/0/0.4/3.0	(NEC - D)

REACH TWO TONE - MODEL 15R

Select Code	Description
32 NN	Set Timing
33 N	Set Group Calls

N = 0   Fast (.13sec/0/.13sec)
N = 1   Slow (2.0sec/0/0.7sec)

N = 0   Group Calls
N = 1   Individual

UNIVERSAL TWO TONE - MODEL 15R

Select Code	Description
42 N	Set Timing

N = 0-7   See Timing Table

TIMING TABLE -MODEL 15R

Entry	Timing	
0	1.0/0/3.0/8.0	(MOT/GE T+V)
1	0.4/0/0.8/8.0	(MOT TONE)
2	1.0/0/3.0/6.0	(NEC - B)
3	1.0/.25/3.0/6.0	(NEC - A)
4	1.0/0/1.0/4.0	(NEC - C)
5	0.4/0/0.8/4.0	(NEC - M)
6	0.5/0/0.5/3.0	(NEC - L)
7	0.4/0/0.4/3.0	(NEC - D)

ZETRON MODEL 15D & 15R SPARE PARTS KIT (951-9018E)

ITEM	QTY	ZETRON P/N	DESCRIPTION	COMPONENT REF. M15T	COMPONENT REF M15R
1.	1	105-0002	VARISTOR	N/A	RV1
2.	1	107-0502	50K POT	R17 37	R13 32
3.	1	152-0100	.01 UF POLY	C7	C15
4.	1	155-0050	10 UF 25V	C9 26	C3 13
5.	1	155-0080	100 UF 10V	C12	C7
6.	1	155-0120	2200 UF 25V	C1	C2
7.	5	220-0108	SCREW #440x1/4	PCB	PCB
8.	2	220-0109	SCREW #440x7/8	BOTTOM COVER	N/A
9.	4	220-0110	SCREW #440x3/16	KEYPAD	N/A
10.	2	250-0104	STDOFF #440x1/2	N/A	PCB
11.	1	311-0008	OPTO ISOLATOR	N/A	U1
12.	1	311-0030	DUAL LED 7-SEG	DS1 2	DS1 2
13.	1	314-4138	1 OF 8 DECODER	U9	N/A
14.	1	314-4373	OCTAL LATCH	U7	U18
15.	1	314-4374	OCTAL D-FF REG	U10	U17
16.	1	315-7406	HEX INV BFR OC	U11 12	U15 16
17.	1	316-0082	BI-FET OP-AMP	U16	U7
18.	1	316-0358	DUAL OP-AMP	U17	U14
19.	1	316-7805	5V REGULATOR	VR1	VR1
20.	1	321-6803	6803 PROCESSOR	U6	N/A
21.	1	321-6804	6803U4 PROCES W/RAM	N/A	U6
22.	1	323-4015	DUAL SHIFT REG	U1-5	U4 5 10-12
23.	1	323-4021	LOAD SHIFT REG	U13 14	N/A
24.	1	323-4051	8xANALOG MUX	U15	U13
25.	1	324-4138	1 OF 8 DECODER	N/A	U9
26.	1	340-0029	POWER NPN	Q1	Q1
27.	1	340-3821	N-CHAN FET	Q3	Q2
28.	1	340-3904	NPN-GP SILICON	Q2 4-6	Q3-6
29.	2	342-0001	1N4002 SILICON	CR1-4	CR7-10
30.	1	342-3009	1N4148 SWITCH	CR5-12	CR1-6 12 13 16
31.	1	343-3030	1W 6.2V	CR13	CR11
32.	1	371-0002	KEYSWITCH	SW3-5	SW1-3
33.	1	373-0116	16 KEY PAD	KEYPAD	KEYPAD
34.	1	376-0004	4.000 MHZ XTAL	Y1	Y2
35.	1	380-0030	RELAY SPDT	K1 2	K1 2
36.	8	401-0108	STAKE PIN .6"	KEYPAD	KEYPAD
37.	2	402-3040	MINI JMPR	JP1 3 POS.B JP2 4 POS.A	JP1 2 5 7 POS.A JP4 POS.B
38.	2	416-1576	FUSE, 1A FB	F1	F1
39.	4	431-0005	FOOT, BUMPON	BOTTOM COVER	N/A

ZETRON MODEL 15R ENCODER PARTS LIST (702-9063C)

ITEM	QTY	ZETRON P/N	DESCRIPTION	COMPONENT REF.	MFR. PART #	MANUFACTURER
1.	2	101-0047	47 OHM	R33 34		
2.	1	101-0049	100 OHM	R7		
3.	1	101-0061	330 OHM	R14		
4.	3	101-0066	510 OHM	R3 6 35		
5.	2	101-0073	1K	R1 36		
6.	1	101-0081	2.2K	R5		
7.	6	101-0085	3.3K	R10 15 16 18 19 21		
8.	4	101-0097	10K	R2 17 29 31		
9.	1	101-0106	24K	R25		
10.	1	101-0109	33K	R30		
11.	2	101-0113	47K	R11 23		
12.	2	101-0117	68K	R22 28		
13.	1	101-0119	82K	R24		
14.	4	101-0121	100K	R4 8 12 26		
15.	1	101-0125	150K	R27		
16.	1	101-0145	1.0M	R9		
17.	1	105-0002	VARISTOR	RV1	V22ZA31	
18.	2	107-0502	50K POT	R13 32	780-12P-503	VRN
20.	1	119-0006	10Kx9 R PAK	RP1	4610X-101-104	CTS
21.	3	119-0008	10Kx7 R PAK	RP2-4		
22.	2	150-0024	24 PF DISC	C9 10	GG-240MK	MULTI-PROD
23.	7	150-0096	1000 PF 1KV	C16-18 22-24 26	GE-102G	MULTI-PROD
24.	10	150-0110	.01 UF DISC	C1 4 5 8 11 19-21 27 28	DF-103Z	MULTI-PROD
25.	1	151-0120	.01 UF TS	C12		
26.	3	151-0130	.047 UF TS	C6 14 25	CW20C473M	CENTRALAB
27.	1	152-0100	.01 UF POLY	C15	SXK-110	MALLORY
28.	2	155-0050	10 UF 25V	C3 13	ECE-B1EV100S	PANASONIC
29.	1	155-0080	100 UF 100V	C7		
30.	1	155-0120	2200 UF 25V	C2	ECE-B1EV222S	PANASONIC
31.	1	210-0001	NUT #440	XVR1		
32.	1	220-0102	SCREW #440 3/8	XVR1		
33.	1	265-0001	TY-WRAP, STD	XC2		
34.	1	311-0008	OPTO ISOLATOR	U1	4N26	
35.	2	311-0030	DUAL LED 7-SEG	DS1 2	PANASONIC	LN5240K
36.	1	314-4373	OCTAL LATCH	U18	74LS373	AMP
37.	1	314-4374	OCTAL D-FF REG	U17	74LS374	TI
38.	2	315-7406	HEX INV BFR OC	U15 16	7406	TI
39.	1	316-0082	BI-FET OP-AMP	U7	LF353	NATIONAL
40.	1	316-0358	DUAL OP-AMP	U14	LM358	NATIONAL
41.	1	316-7805	5V REGULATOR	VR1	LM340T-5	NATIONAL
42.	1	321-6804	PROCESSOR W/RAM	U6	6803U4CP	MOTOROLA
42.1	1	322-0494	256 BIT EEPROM	U2	COP494	NATIONAL
43.	5	323-4015	DUAL SHIFT REG	U4 5 10-12	MC14015B	MOTOROLA
44.	1	323-4051	8xANALOG MUX	U13	MC14051B	MOTOROLA
45.	1	324-4138	1 OF 8 DECODER	U9	74HC138	TI
46.	1	340-0029	POWER NPN	Q1	TIP-29B	TI
47.	1	340-3821	N-CHAN FET	Q2	MPF3821	MOT
48.	4	340-3904	NPN GP SILICON	Q3-6	2N3904	
49.	4	342-0001	1N4002 SILICON	CR7-10	1N4002	MOTOROLA
50	9	342-3009	1N4148	CR1-6 12 13 16	1N4148	MOTOROLA

ZETRON MODEL 15R ENCODER PARTS LIST (702-9063C) cont.

|							
51.	1	343-3030	1W 6.2V +-5%	CR11		1N4735A	
52.	3	371-0002	KEYSWITCH	SW1-3		CTS-206-008	CTS
53.	1	376-0004	4.000 MHZ	Y2		SKO-DS400A	SEIKO
54.	2	380-0030	RELAY DPDT	K1 2		14955D12V	GAURDIAN
55.	1	381-0010	HEATSINK TO-220	XVR1		340-1PP	HEAT SINKS PL
56.	1	401-0009	12-POS PCB	TB2		22-14-2094	MOLEX
57.	1	401-0015	12-POS RECEPT	TB1		3PCV-12-000	RDI
58.	20	401-0052	STAKE PIN	TP1 (1EA)		65500-113	BERG
				XJP1 (4EA)			
				XJP2 5 7 (3EA)			
				XJP4 (6EA)			
59.	13	401-1364	STAKE PIN	TB4 (2EA)			
				TB3 (11EA)			
60.	7	402-3040	MINI JMPR	JP1 2 5 7 POS.A		65474-004	BERG
				JP4 POS.B			
61.	3	407-0008	08 PIN SKT	XU2 7 14		640463-3	AMP
62.	2	407-0014	14 PIN SKT	XU15 16		640357-3	AMP
63.	9	407-0016	16 PIN SKT	XU3-5 8-13		640358-3	AMP
64.	2	407-0020	20 PIN SKT	XU17 18		640464-3	AMP
65.	1	407-0028	28 PIN SKT	XU20		640362-3	AMP
66.	1	407-0040	40 PIN SKT	XU6		640379-3	AMP
67.	2"	408-0005	26GA BARE WIRE	XY2			
68.	1	410-9062A	PCB, BARE			410-9004	ZETRON
69.	1	416-1576	FUSE, 1A FB	F1		AGC 1A	LITTLEFUSE
70.	2	416-3040	FUSE CLIP	XF1		926	COMP RESOURCE
71.	A/R	561-0001	THERMAL GREASE	XVR1			

DO NOT INSTALL:
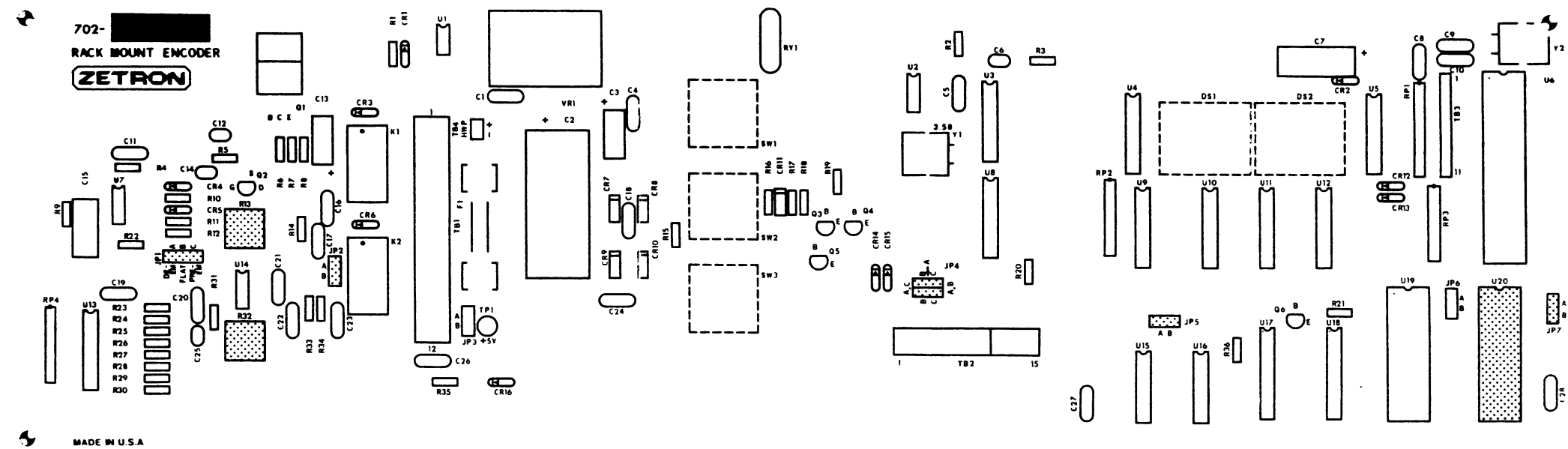
CR14 15

JP3 6

R20

U3 8 19

Y1

ZETRON MODEL 15R ENCODER SCHEMATIC (008-9063C)
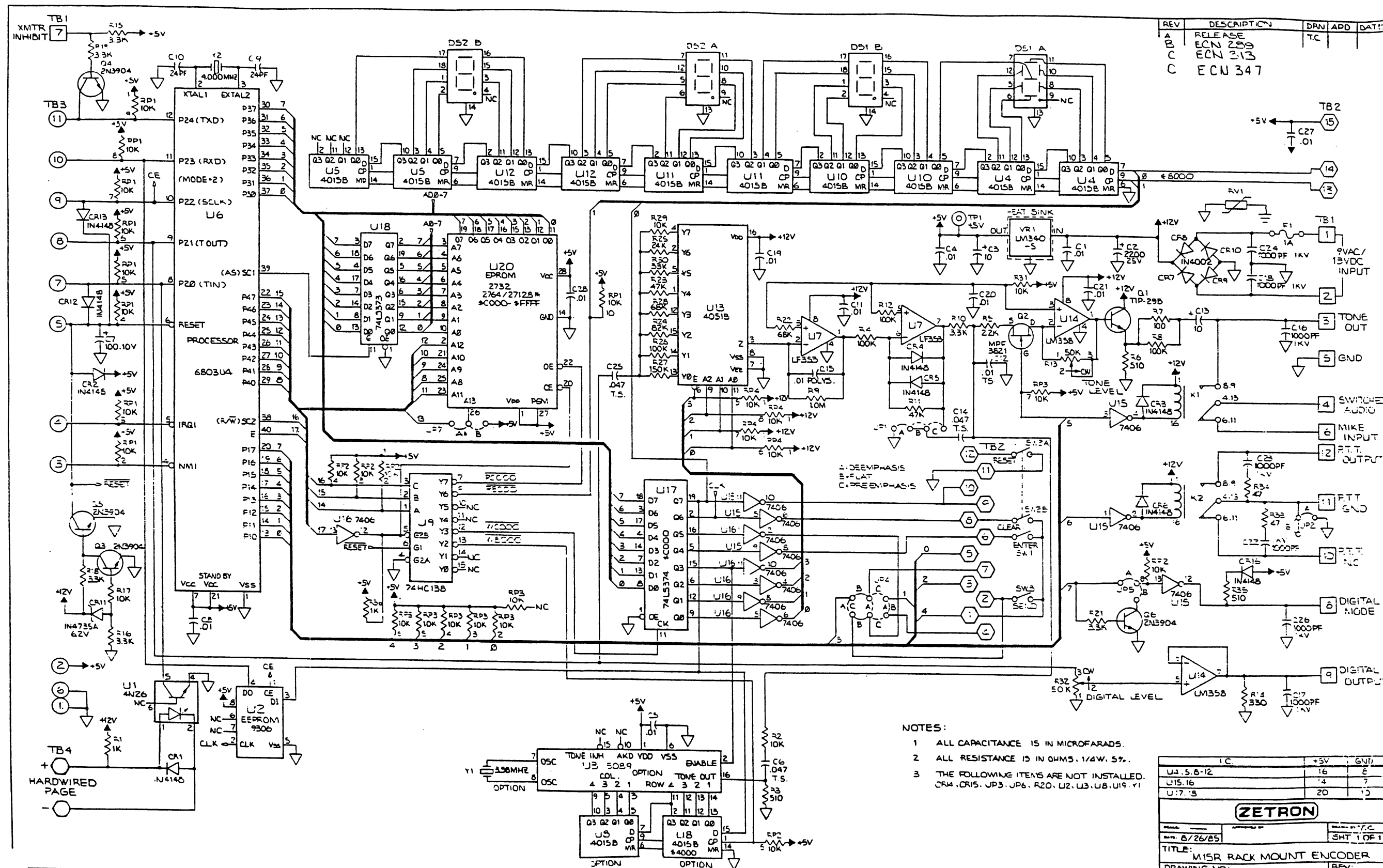
ZETRON MODEL 15R ENCODER SILKSCREEN (702-9063A-C)

Use this sheet of labels for your Model 15R Encoder. The labels may be
printed using a typewriter. Remove the labels from the sheet by cutting
outside the border.

GENERAL

The Model 15B provides the capability for an operator to send alphanumeric messages to display pagers. Capcode and message entry is performed on a dumb terminal or CRT connected to a serial port on the Model 15B. Features include:

- keypad operation is identical to previous Model 15 versions

- CRT operation provides all prompts normally seen on the LED display so that an operator can page from a remote terminal beyond sight of the Model 15B.

- 6 character LED display

- up to 128 characters per display message

- tone-only, tone+voice, numeric, and alphanumeric encoding

- a new programming mode allows the user the quickly set or review the DIP switch settings, digital mode polarity, continuous-test mode and talk-time. All are programmed from the keypad and may be accessed at any time.

INSTALLATION

Do not follow the installation procedure outlined in "Section 4 - Installation." There are a number of hardware differences that change the installation procedure for the Model 15B. Make the connections outlined below instead.

INTERFACE CONNECTORS

TB1-#	Signal	Function
1	AC/DC In	12 VAC wall transformer or +12 VDC
2	AC In	12 VAC wall transformer
3	Audio Out	(not used)
4	Switched Audio Out	Audio for paging
5	Ground	Common ground
6	Switched Mic Input	Microphone input for voice paging
7	Channel Busy	Inhibit page-out when channel is in-use. Normally connected to carrier-operated relay (COR).
8	Digital Mode	Digital/Audio output indicator
9	Digital Data	Data for digital paging
10	PTT Normally Open	PTT relay for transmitter control
11	PTT Common	PTT relay for transmitter control
12	PTT Normally Closed	PTT relay for transmitter control

TB2-#	Signal	Function
13	(not used)	
14	Ground	
15	RS-232 receive	Serial data from CRT
16	RS-232 ground	Serial ground
17	RS-232 transmit	Serial data to CRT
18	(not used)	
19	(not used)	
20	PTT common	PTT relay common
21	PTT N.O./N.C.	PTT selectable N.O. or N.C.
22	(not used)	
23	(not used)	
24	(not used)	

JUMPERS

JP#	Name	Function
1	Channel Busy Input	Select input from receiver (pos-B or out) or pulled high (pos-A).
2	PTT-2 operation	Select PTT-2 N.C. (pos-B) or N.O. (pos-A).
3	Aux aud rly select	Select auxiliary relay audio (pos A and C).
4	PTT-common ground-1	Ground PTT common (IN)
5	PTT-common ground-2	Ground PTT common (IN)
6	Aux-common ground	Ground Aux-relay common (IN)
10	Paging mic/line in	B=mic input (de-emph) A=line input (flat)
13	Aux relay control	Separate (pos-A), follow PTT (pos-B)
14	Baud select	One of 300, 600, 1200, 2400, 4800 or 9600.
17	Chnl busy polarity	Normal (pos-A), inverted (pos-B)

PROCEDURE

1. Connect the transmitter's PTT inputs to TB1 pin 11 (common) and to TB1 pin 10 (normally open) or pin 12 (normally closed).

2. For tone and/or voice paging, connect the transmitter's audio input (using shielded cable) to TB1 pins 4, connect the shield to pin 5.

3. For voice paging, connect mic audio to TB1 pin 6, connect the shield to pin 5. If voice audio is to be transmitted at times other than when paging, a separate PTT indication from the mic must also control the transmitter.

4. For digital paging, connect the transmitter's digital mode line (digital page or tone page) to TB1 pin 8, and the transmitter's digital data input to TB1 pin 9. Use shielded cable for the digital data connection. The mode line polarity and digital data polarity are programmable (see below).

5. If a channel busy indication is desired, connect receiver COR to TB1 pin 7, select the polarity with JP-17 and remove JP-1. The channel busy input can also be connected to a desk mic PTT to extend the talk time on voice pagers. NOTE: It must be used to extend voice time on pagers requiring a "voice off" command from the encoder (HSC, Optrix, and PMR-2000). Otherwise, install JP-1 in position A and JP-17 in position A.

6. For alpha paging, connect the CRT's serial receive line to TB2 pin 17, the CRT's serial transmit line to TB2 pin 15 and the CRT's serial ground line to TB2 pin 16. Install JP-14 to select the serial baud rate from 300 to 9600.

7. WITHOUT ACTUALLY APPLYING POWER, connect 12 VAC from a wall tranformer to TB1 pins 1 and 2, or +12 VDC to TB1 pins 1 and ground on pin 5.

SERIAL CRT INTERFACE

The requirements for serial interface to the Model 15B are listed below. Configure the CRT to match.

MODEL 15B SERIAL DATA

Baud rate	300, 600, 1200, 2400, 4800 or 9600
Data bits	8
Stop bits	1
Parity bits	none
Handshake	none
Duplex	full

POWER-UP TEST

Unlike the Model 15, the Model 15B has no DIP switches. Instead, the options are selected in Programming Mode (see, below). This means that nothing has to be set before applying power.

To test the CRT installation, power first the CRT and then the Model 15B. When the Model 15B powers up, it prints the following message on the CRT screen:

Model 15B -- Performing power up test.

If this message is not received, check to see that the serial cable is wired correctly (TX and RX may be reversed). If garbled characters are received, the CRT and Model 15B baud rates are different or the communication parameters above (8 data bits, 1 stop bit and no parity) are not set correctly on the CRT.

OPERATION

When the power up tests are complete, the following message is printed on the CRT screen:

PASSED ALL SELF-TESTS

Model 15B Ver: X.x
Copyright, 1984-1988, ZETRON INC.

KEYPAD ACTIVE: Any key activates CRT.

Enter capcode:

When the Model 15B is first powered-up, it expects to receive commands from the keypad. All keys (0-9,A-D,*,#) typed at the keypad are displayed on the CRT. To begin input from the CRT, press any character on the CRT, the following message is displayed:

CRT ACTIVE...

Enter capcode:

The Model 15B displays "CRT ON" when it expects input from the CRT. Characters typed on the CRT are NOT displayed on the Model 15B display.

SPECIAL KEYS

KEYPAD	CRT	FUNCTION
ENTER	CTRL-K	The keypad ENTER key or CRT CTRL-K key is used to enter a page on the stack for later recall and paging. The keypad ENTER key is also used to accept entered programming data in the program mode.
CLEAR	CTRL-C	The keypad CLEAR key or CRT CTRL-C key is used to cancel a page or message entry or to abort a page in progress.
PAGE	ENTER	The keypad PAGE key or CRT ENTER (or RETURN) key is used to start a page. The keypad PAGE key is also used to accept entered programming data in the program mode.
	BACKSPACE	The CRT BACKSPACE key (not available on keypad) is used to erase the last character entered.

CRT PAGING EXAMPLES

Five-tone page with talk time (assuming 5-tone is leading digit 0):

YOU TYPE	PROMPT	EVENT
	"Enter capcode:"	Ready for pager code
0654327	"Enter capcode: 0654327"	Bad code entered
BACKSPACE	"Enter capcode: 065432"	Prepare for correction
1	"Enter capcode: 0654321"	Enter new character
ENTER/RETURN	"Paging..."	Start page
	"Talk now:"	Talk time
	"Enter capcode:"	Ready for next page code
ENTER/RETURN	"Enter capcode: 0654321"	Remember last page
ENTER/RETURN	"Paging..."	Re-page
CTRL-C	"Enter capcode:"	Page-in-progress aborted
0246801	"Enter capcode: 0246801"	New page code entered
CTRL-K	"Stacked page."	Stacked page code
	"Enter capcode:"	
0135791	"Enter capcode: 0135791"	Next page code entered
ENTER/RETURN	"Paging..."	Both pages sent
	"Talk now:"	Talk time
	"Enter capcode:"	Ready for next page code

Alpha POCSAG (assuming POCSAG is leading digit 1):

YOU TYPE	PROMPT	EVENT
	"Enter capcode:"	Ready for pager code
0	"Enter capcode: 0"	Wrong leading digit
CTRL-C	"Enter capcode:"	Start over
11122334	"Enter capcode: 11122334"	POCSAG capcode
ENTER/RETURN	"Enter message:"	Ready for message
MSG 4 BILL	"Enter message: MSG 4 BILL"	Message
ENTER/RETURN	"Paging..."	Start page
	"Enter capcode:"	Ready for next page code
ENTER/RETURN	"Enter capcode: 11122334"	Remeber last page
ENTER/RETURN	"Enter message:"	Get new message
MSG 2 JOHN	"Enter message: MSG 2 JOHN"	New message
ENTER/RETURN	"Paging..."	Start page
	"Enter capcode:"	Ready for next page code

PROGRAMMING

The programming mode allows you to change the Configuration Switches (as described on pages 4-7 to 4-11), the digital mode polarly, the continuous-test option and the talk time.

Programming may only be done from the Model 15B keypad.

To Enter Programming Mode:

    1) wait until the power-up self-tests are complete
    2) press and hold down the "C" key on the keypad
    3) press and release the CLEAR key
    4) release the "C" key

The prompt "ConFIG" appears briefly to verify that you are in Programming Mode.

Viewing/Setting Values:

    Each programmable value is shown by name, followed by an equals sign and the numeric value. You may quickly review what all the settings are by pressing the ENTER or PAGE key after each is shown. To change a setting, key in the new value, which will be shown briefly before going to the next one. To skip remaining values, press the CLEAR key.
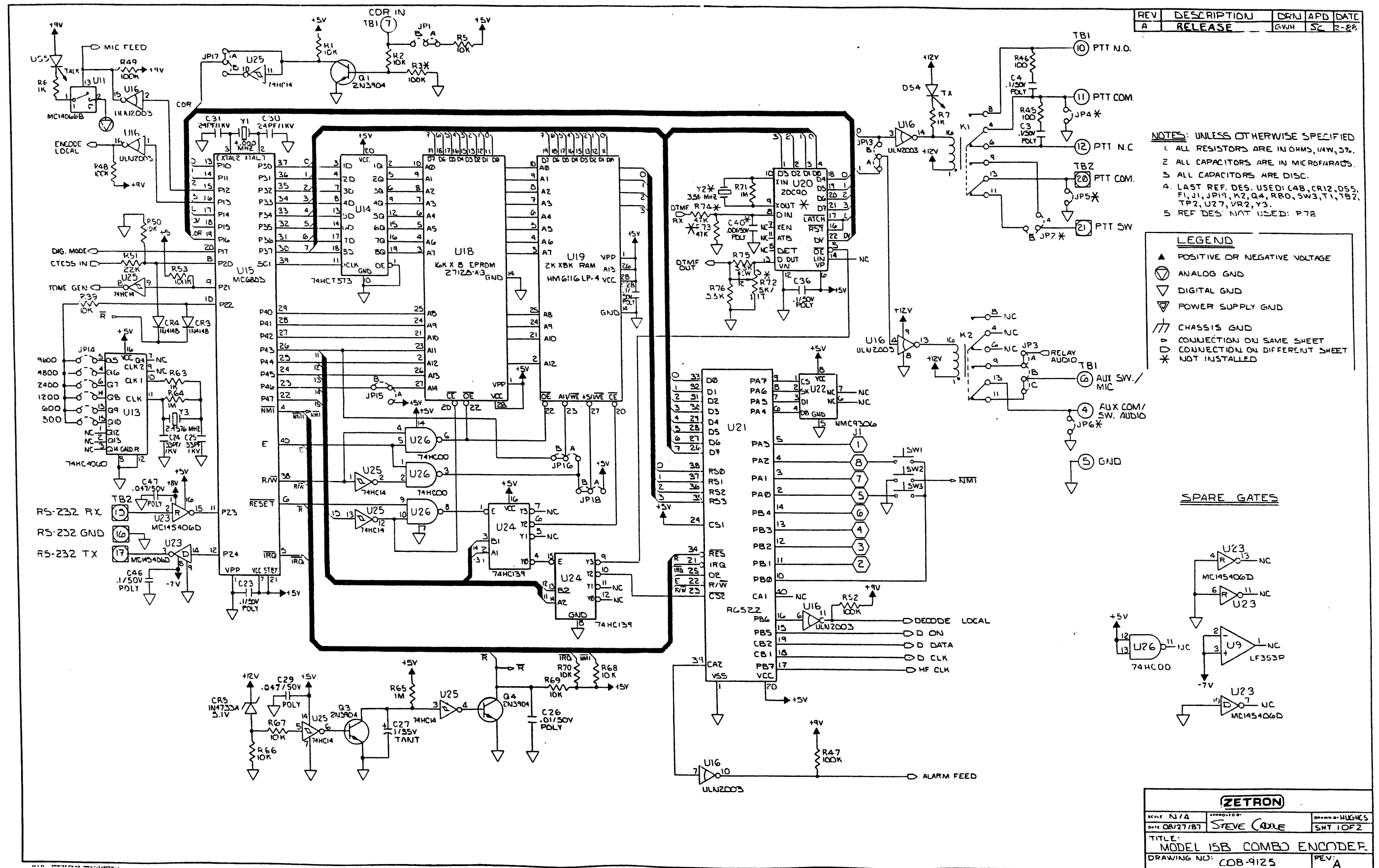
Leaving Programming Mode:

    You can leave Programming Mode at any time by pressing the CLEAR key. The prompt "donE ?" is displayed to verify that you are done programming. If so, press the ENTER or PAGE key. You also leave programming mode automatically after all programmable values have been displayed. If you are not done and wish to go back to change something, press any key other than ENTER or PAGE. The prompt "ConFIG" is displayed again to show that you are still in Program mode. When programming is complete, the prompt "rESEt" is displayed to show that the values programmed are now active.

PROGRAMMABLE VALUES

Prompt	Values	Description
dP1 =0	0-1	0 = A position 1 = B position (see pages 4-7 to 4-11 for a complete description of what the configuration switches 1-16 do)
dP12=0	0-1	Binary Polarity
dP15=0	0-1	Auto-page 0 = Off 1 = On
dP16=0	0-1	Autoscroll 0 = Off 1 = On

mode=0   0-1   Digital mode polarity
                        0 = Active low
                        1 = Active high

cont=0   0-1   Continuous-test mode
                        0 = Off
                        1 = On

tlk= 2   0-30   Talk time in seconds

MODEL 15B COMBO ENCODER SCHEMATICS (008-9125A) SHT. 1 OF 2

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. ALL CAPACITORS ARE DISC.
4. LAST REF. DES. USED: C48, CR12, DS5, F1, J1, JP19, K2, Q4, R80, SW3, T1, TB2, TP2, U27, VR2, Y3.
5. REF DES. NOT USED: P78

LEGEND
▲ POSITIVE OR NEGATIVE VOLTAGE
▽ ANALOG GND
▽ DIGITAL GND
▽ POWER SUPPLY GND
/// CHASSIS GND
□ CONNECTION ON SAME SHEET
▷ CONNECTION ON DIFFERENT SHEET
✱ NOT INSTALLED

SPARE GATES

ZETRON

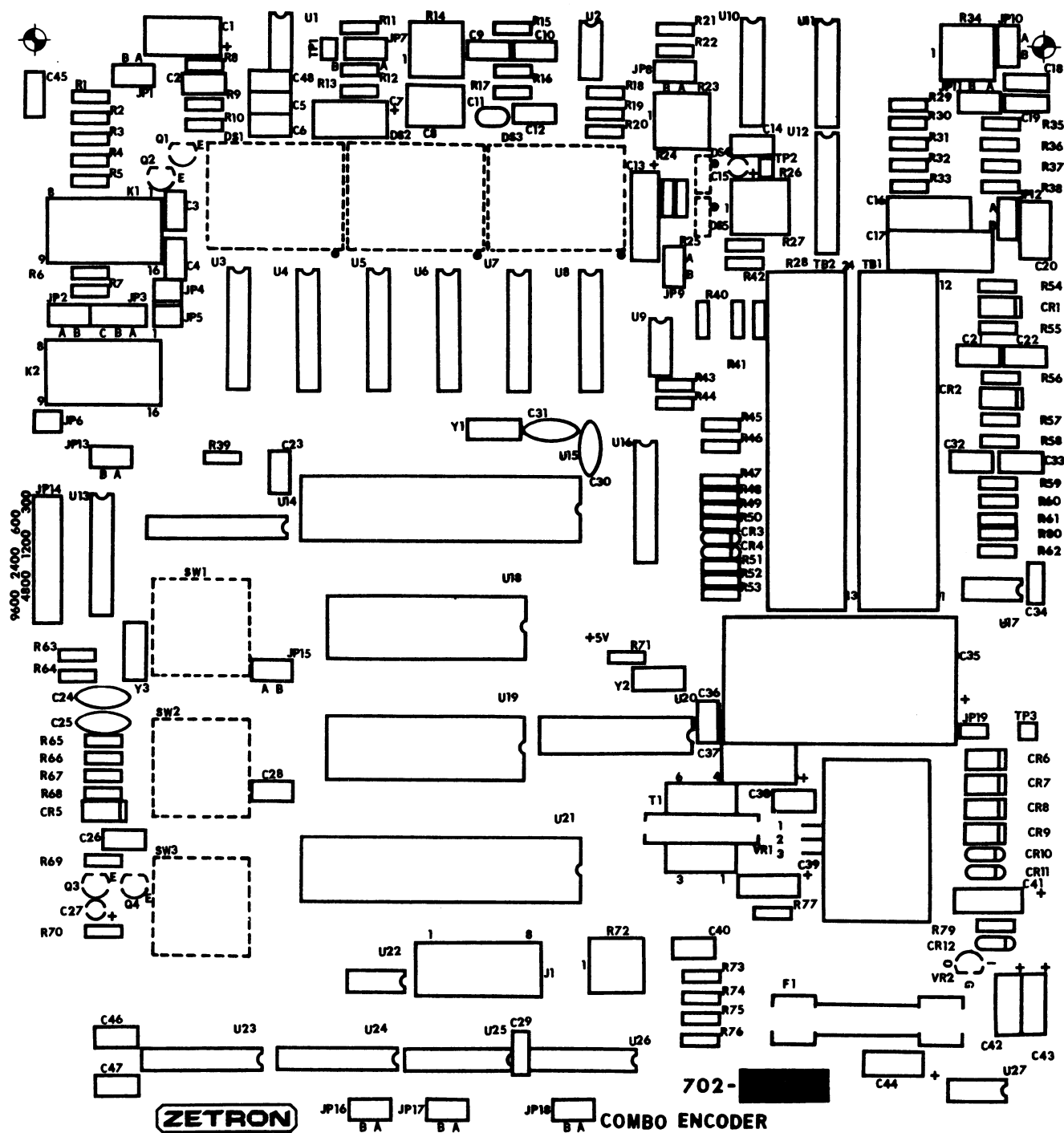| SCALE N/A	APPROVED: STEVE CAYLE	DRAWN BY: HUGHES
DATE 08/27/87		SHT 1 OF 2

TITLE: MODEL 15B COMBO ENCODER
DRAWING NO: COB-9125   REV: A

9-9

MODEL 15B COMBO ENCODER SCHEMATICS (008-9125) SHT. 2 OF 2
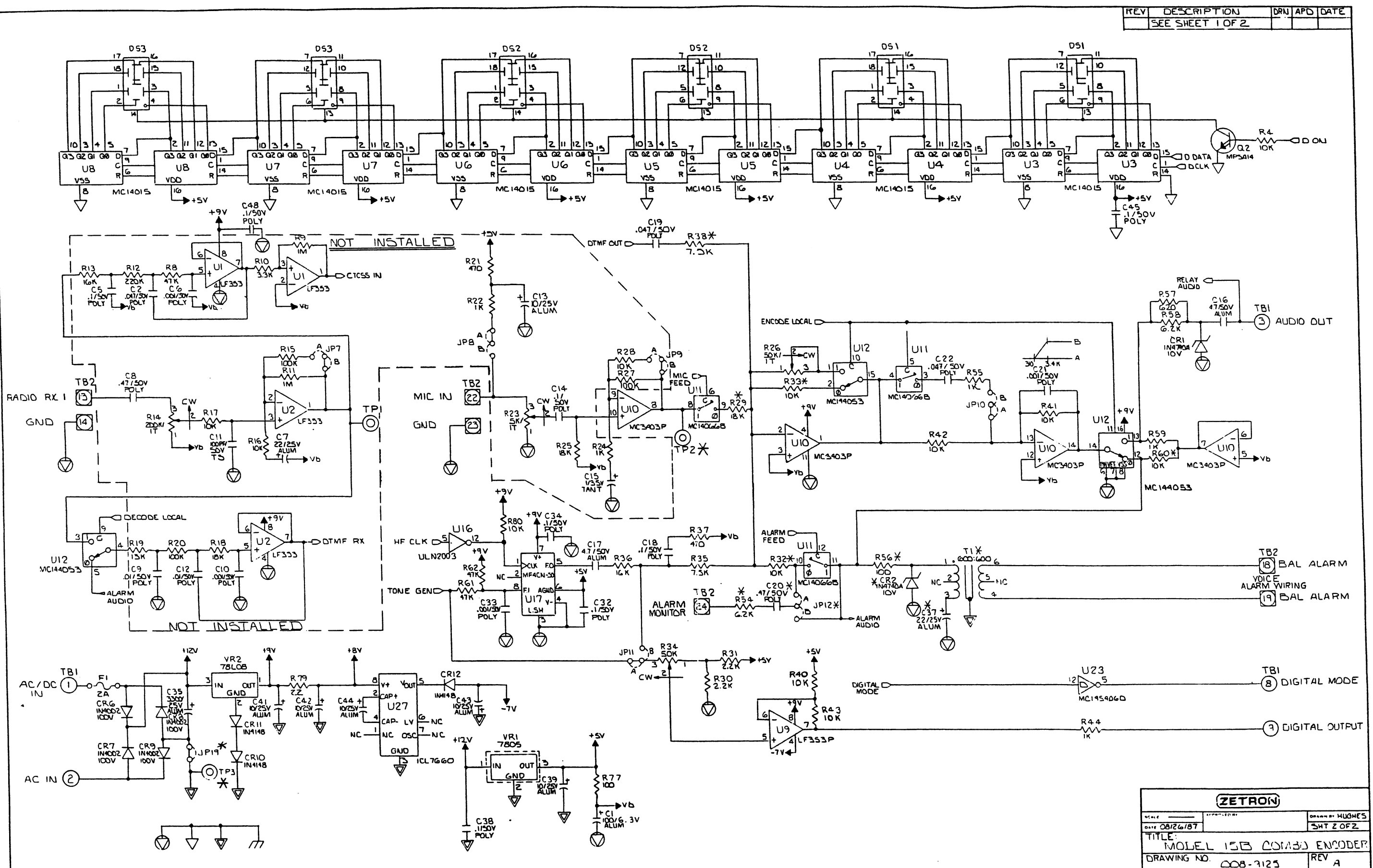
MODEL 15B COMBO ENCODER SILKSCREEN (702-9125A)

MODEL 15B COMBO ENCODER PARTS LIST (702-9125A)

ITEM	QTY	ZETRON P/N	DESCRIPTION	COMPONENT REF	MFR. PART #
1.	1	101-0033	22 OHM	R79	
2.	4	101-0049	100 OHM	R37 45 46 77	
3.	1	101-0068	620 OHM	R57	
4.	7	101-0073	1K	R6 7 35 44 55 59 63	
5.	2	101-0081	2.2K	R30 31	
6.	2	101-0085	3.3K	R75 76	
7.	1	101-0092	6.2K	R58	
8.	2	101-0094	7.5K	R36 38	
9.	16	101-0097	10K	R1 2 4 5 39-43 50 66-70 80	
10.	1	101-0105	22K	R51	
11.	2	101-0113	47K	R61 62	
12.	5	101-0121	100K	R47-49 52 53	
13.	3	101-0145	1M	R64 65 71	
14.	1	107-0502	50K POT 1 TURN	R34	
15.	1	107-3085	10K POT 1 TURN	R26	
16.	2	150-0024	24 PF 1KV DISC	C30 31	
17.	2	150-0033	33 PF 1KV DISC	C24 25	
18.	1	151-0199	.47UF 50V TS	C18	
19.	12	152-0012	.1 UF 50V POLY	C3 4 23 28 32 34 36 38 45-47 48	
20.	2	152-0040	4.7 UF 50V NON-POLAR	C16 17	
21.	1	152-0085	.01 UF 50V POLY	C26	
22.	2	152-0089	.001 UF 50V POLY	C21 33	
23.	3	152-0250	.047 UF 50V POLY	C19 22 29	
24.	1	154-0025	1 UF 35V TANT	C27	
25.	5	155-0050	10 UF 25V ALUM AX	C39 41-44	
26.	1	155-0078	100 UF 6.3V ALUM	C1	
27.	1	155-0140	3300 UF 25V ALUM AX	C35	
28.	1	210-0001	440 KEPT NUT PLATED	XVR1	
29.	1	220-0102	440x3/8 PH SCREW	XVR1	
30.	3	311-0030	DUAL LED 7-SEG AMBER	DS1-3	
31.	2	311-3213	REC. RED LED	DS4 5	
32.	1	316-0004	TONE FILTER	U17	MF4CN-50
33.	1	316-0353	OP-AMP, DUAL BIFFET	U9	LF353
34.	1	316-3403	QUAD OP-AMP	U10	MC3403P
35.	1	316-7660	VOLTAGE CONVERTER	U27	ICL7660CPA
36.	1	316-7805	REGULATOR +5V 1.5A	VR1	LM340T-5
37.	1	316-7808	REGULATOR +8V	VR2	LM78L08CZ
38.	1	317-5406	DUAL RS-232 DRIVER	U23	MC145406D
39.	1	321-6116	2Kx8 RAM	U19	HM6116 LP-4
40.	1	321-6522	VIA/TIMER	U21	R6522
41.	1	321-6803	MICROPROCESSOR	U15	6803P
42.	1	322-9306	256 BIT SERIAL EPROM	U22	NCM9306
43.	6	323-4015	DUAL 4-BIT SHIFT REG.	U3-8	MC14015B
44.	1	323-4053	3PDT SWITCH	U12	MC144053
45.	1	323-4066	QUAD ANALOG SWITCH	U11	MC14066B
46.	1	324-4060	14 BIT COUNTER	U13	74HC4060
47.	1	324-4139	DUAL 2-4 LN DECODER	U24	74HC139
48.	1	324-7400	QUAD NAND	U26	MC74HC00

49.	1	324-7414	HEX SCHMIDT	U25	74HC14
50.	1	325-4373	OCTAL LATCH	U14	74HCT373
51.	1	340-2003	RELAY DRIVER 50V/.5A	U16	ULN2003
52.	1	340-0014	NPN DARLINGTON	Q2	MPSA14
53.	3	340-3904	NPN 40V/200MA	Q1 3 4	2N3904
54.	4	342-0001	SILICON 1A/100V	CR6-9	1N4002
55.	5	342-3009	SILICON	CR3 4 10-12	1N4148
56.	1	343-3029	1W 5.1V +-5%	CR5	1N4733A
57.	1	343-3102	1W 10V	CR1	1N4740A
58.	3	371-0002	SINGLE KEY	SW1-3	
59.	1	376-0004	4.000 MHZ HC18	Y1	
60.	1	376-0245	2.4576 MHZ HC33/HC18	Y3	
61.	2	380-0030	DPDT 12V COIL MINI	K1 2	
62.	1	381-0010	HEATSINK	XVR1	
63.	1	401-0009	12 POS THRU PCB	J1	
64.	21	401-0052	STAKE PINS	XJP1 10 17 (3 EA) XJP14 (12 EA)	
65.	2	401-0112	12-POS 45DG SCR TERM	TB1 2	
66.	4	402-3040	MINI JUMPER	JP1 10 17 POS A JP14 POS 9600	
67.	4	407-0008	SKT, 08 PIN DIP	XU9 17 22 27	
68.	4	407-0014	SKT, 14 PIN DIP	XU10 11 25 26	
69.	11	407-0016	SKT, 16 PIN DIP	XU3-8 12 13 16 23 24	
70.	1	407-0020	SKT, 20 PIN DIP	XU14	
71.	1	407-0022	SKT, 22 PIN DIP	XU22	
72.	2	407-0028	SKT, 28 PIN DIP	XU18 19	
73.	2	407-0040	SKT, 40 PIN DIP	XU15 21	
74.	4	408-0001	WIRE JUMPER	JP11 13 15 16 18 POS A JP3 POS A & C	
75.	1	410-9125A	PCB, BARE		
76.	1	416-1202	FUSE, AGC 2A	F1	
77.	2	416-3040	FUSE CLIP	XF1	
78.	A/R	561-0001	THERMAL COMPOUND	XVR1 (NOTE 1)	

NOTES:
1. APPLY BETWEEN VR1, ITEM 36 AND HEATSINK, ITEM 59
2. FOR DTMF OPTION INSTALL U20 (321-2090) & Y2 (376-0358)
DO NOT INSTALL:
C2 5-15 20 37 40
CR2
JP2 4-9 12 19
R3 8-25 27-29 32 33 54 56 60 72-74
T1
TP1-3
U1 2 18 20
Y2