GORDON KAPES INC.

Technical Practice

ML-4 MULTI-LINK CODE CALL SYSTEM

Contents

1. General Description

1.1 PRACTICE   In the event that this practice is reissued, the reason for the reissue will be given in this paragraph.

1.2 PRODUCT OVERVIEW   The ML-4, in conjunction with a PBX telephone system, implements a sophisticated version of the industry standard code call function. Code call allows one telephone system user to alert another by way of a coded tone output that is broadcast over a public address system. The calling party originates a code call by accessing the ML-4 via a PBX trunk port, and entering the code of the desired party. The ML-4 generates a sequence of "chimes" that represent the code. Upon hearing their code over the public address system, the called party accesses the ML-4 via a PBX extension. The called party now enters their code, and the ML-4 connects the parties together. The ML-4 is capable of supporting up to four active code calls at any given time.

   The ML-4 is ideal for installations where conventional voice paging is inappropriate for security or environmental reasons, i.e. department stores, shopping centers, manufacturing plants, hospitals, nursing homes, schools, etc. The ML-4 Multi-link Code Call System provides a high level of features and performance not found in other code call systems.

1.3 CHIME OUTPUT   Great care was taken in designing the ML-4's chime output stage. An envelope modified triangle

wave creates an effective, yet musically pleasing chime output. The output design allows direct connection to an audio amplifier, or to a group of amplified speakers. An audio transformer is utilized, minimizing the chance of hum and noise pickup between elements in the paging system. Chime level and pitch adjustments allow the installer to optimize ML-4 performance.

1.4 RELAY OUTPUTS   Two form-C relay contacts are provided for background music muting and external device control. Relay 1 follows the cadence of the chime output, while Relay 2 stays energized for the entire duration of a chime cycle. Relay 1 can be used to control an external signaling device, such as a loud horn in a warehouse area. Relay 2 can be used to provide a page enable contact required by some public address systems.

1.5 ORIGINATION PORTS   The originate side of the ML-4 connects to a PBX system via four loop start trunk ports. The ML-4's trunk interfaces appear as standard central office trunks, supplying talk battery and progress tones to the user. Arranging the PBX trunks in a "hunt group" allows the assignment of one common number for users to access the ML-4 and to originate code calls.

1.6 ANSWER PORTS   The answer side of the ML-4 interfaces to a PBX system via four analog extensions (or OPS/OPX

ports). The ML-4's answer ports appear as standard 500/2500-type telephone sets. The answer ports go off-hook in response to standard 20/30Hz bridged ringing. Configuring the PBX in a "hunt group" format simplifies responding to code calls.

1.7 MULTI-LINK OPERATION   The ML-4 implements true multi-channel operation. Up to four simultaneous code call connections are possible. In cases where more than one origination is desired at the same time, the ML-4 interweaves two chime outputs and, if more than two origination requests occur, queues the others. This methodology results in greatly increased call throughput. Two DTMF (touch tone) receivers allow users to originate and answer code calls simultaneously.

1.8 CODE LENGTH   A switch option sets the length of the code to two or three digits. Codes can consist of the digits 1 through 9. Selecting two digits allows 81 different codes; selecting three digits allows 729. Spare your audience! Be sensible about code assignments. Don't assign codes such as "999" unless it's absolutely necessary.

1.9 CHIME OUTPUT SEQUENCE   In response to a code call origination, the ML-4 generates a chime output sequence. A chime output sequence consists of two or three chime cycles. A chime cycle consists of the two- or three-digit code followed by a pause. A switch option selects whether there will be two or three chime cycles per chime output sequence. The ML-4 is pretty smart—once a called party answers a code call, the chime output sequence is terminated. A chime cycle in progress will complete, ensuring that no fragmented codes are generated. Confused about cycles and sequences? We were at first and we were the ones who designed it!

1.10 REPEAT CHIME SEQUENCE   All is not lost! For those of you who feel that one chime output sequence is not of sufficient time to alert the called party, a switch option can be used to set the chime output sequence to repeat. This feature gives the calling party additional time before the ML-4 times out or, if selected, transfers the trunk. The repeated chime output sequence takes a low priority in the output queue. New origination requests will be handled prior to a chime output sequence repeating. Hence, the ML-4 repeats a chime output sequence only when the system output is available.

1.11 ORIGINATE TIME-OUT   A time-out period limits the length of time a called party can wait for a code call to be answered. Two switch positions set the time-out period; one minute to 2.5 minutes in 0.5 minute increments. The time-out period starts at the end of the last chime output cycle. If a code call has not been answered upon reaching the time-out period, one of two actions will occur: an error tone will be returned to the calling party; or the calling party will be forwarded via one of the answer ports. A switch option selects which action will occur.

1.12 CALL FORWARDING   A unique ML-4 feature is its ability to forward unanswered code calls. Upon reaching the time-out period, the ML-4 can be set to seize the next available answer port (a PBX extension or OPS/OPX) and connect the calling party (connected to the ML-4 via a trunk) to it. This is where we need your help! To forward using the ML-4's answer ports, the PBX must be programmed to automatically forward outgoing calls to a predetermined destination e.g., an attendant console, or voice mail system. If the forward feature has not been selected, the ML-4 issues error tone to the calling party upon reaching the time-out period.

1.13 PROGRESS TONES   The ML-4 generates five different progress tones to assist the calling and called parties in determining call status. The progress tones consist of dial tone, audible ring tone, error tone, beep tone (an on-hold, waiting-for-called-party indication), and access tone (code call conversation established).

1.14 LED STATUS INDICATORS   Ten LED status indicators located on the ML-4's circuit board are visible with the cover on or off. These LEDs provide assistance in determining the operating status of the ML-4 during installation, operation and maintenance.

1.15 CONNECTIONS   All ML-4 connections, with the exception of power, are made via an industry standard 25-pair plug. The installer must provide a 25-pair cable-mounted (female) connector.

1.16 POWERING   The ML-4 requires a standard 120Vac, 50/60Hz, grounded outlet for proper operation.

1.17 SAFETY COMPLIANCE   The ML-4 is listed by Underwriters Laboratories, Inc. under their UL1459 Telephone Equipment standard.

1.18 PHYSICAL DESCRIPTION   The ML-4 consists of a precision fabricated steel enclosure containing a printed circuit board. The ML-4 measures 14.0 inches (35.6cm) high, 11.1 inches (28.2cm) wide, 2.6 inches (6.6cm) deep, and weighs 11.5 pounds (5.2kg). The ML-4 wall mounts with four #8 screws.

2. Applications

2.1 RANGE OF APPLICATIONS   The ML-4 Multi-Link Code Call System is appropriate for a wide variety of tone paging applications—from department stores to airport terminals, manufacturing plants to office complexes. Please contact Gordon Kapes, Inc. for applications assistance.

2.2 DESIGN GOALS   The ML-4 contains a variety of terrific features not found in other code call systems. They address the goal of serving all likely user requirements, while satisfying the listening audience with an chime signal that is pleasant to the ear. Who knows—maybe shoppers will echo a chime cycle while browsing the aisles!

3. Installation

3.1 WORDS OF CAUTION   As with any product, installing the ML-4 requires a safety first approach.

   Warning: Never install telephone wiring during a lightning storm. Never install telephone jacks in wet locations unless specifically designed for such locations. Never touch non-insulated telephone wires or terminals prior to disconnecting the line at the network interface. Use caution when installing or modifying telephone lines. Do not remove the ML-4's internal power supply cover.

3.2 CHECKING FOR DAMAGE   Upon receipt, immediately inspect the ML-4 for damage. If damaged, file a claim with the shipper. Order a replacement if necessary.

3.3 INSTALLATION KIT   Included in each ML-4 shipping carton is an installation kit. Each kit contains four #8 pan head screws.

3.4 THE COVER   Remove the cover at this time. The cover is secured via two screws located on the front of the unit. To remove the cover loosen the bottom screw and remove the top screw. Lifting up on the cover will free it from the bottom screw.

3.5 MOUNTING   The ML-4 wall mounts using four #8 pan head screws. The type of screws and anchoring method must be appropriate for the specific wall surface. If applicable, use the screws provided in the installation kit.

3.6 CONNECTIONS   All connections, except power, are made via 25-pair plug, P1. The installer must provide a 25-pair cable mounted (female) connector to mate with P1. Figure 2, located at the end of this practice, gives detailed connection information. Refer to this figure when reading the installation procedures.

3.7 INSTALLING AND TERMINATING THE 25-PAIR CONNECTOR   Install the 25-pair cable mounted connector into plug P1. Ensure that the cable enters the ML-4 cabinets via the access hole in the lower right corner. Secure the connector using the fastener strap that is attached to the plug. Terminate the cable (e.g., on a "66" type block).

3.8 TRUNK CONNECTIONS   The originate side of the ML-4 connects to the PBX via four loop start trunk ports. The ML-4's ports appear just as a standard CO loop start trunk, complete with talk battery and progress tones. Program the PBX software so that all four trunks are accessed via a common, usually two or three digit, number. This configuration will allow for easy code call origination.

3.9 STATION CONNECTIONS   The answer side of the ML-4 connects to the PBX via four analog 500/2500-type station ports. An alternative is to use PBX OPS/OPX ports. Program the PBX software so that all four ports are accessed via a common number. This configuration will allow for easy answering of a code call.

3.10 STATION FORWARDING   If the installation requires the transferring of unanswered code calls, program each station or OPS/OPX port to automatically forward (auto ringdown, auto dial, etc.) calls to the desired destination. Upon the ports going off-hook, the desired destination should be "dialed" and ringback progress tone should be heard.

3.11 CHIME OUTPUT CONNECTION   The chime output can be connected to all types of audio amplifier line level input channels: low or high impedance, balanced or unbalanced. Using amplified speakers has become a popular method of providing a public address/background music system. The ML-4's audio output can be connected directly to up to 20 amplified speakers. If more than 20 amplified speakers are required signal boosters can be obtained from the manufacturers of amplified speakers.

   Do not connect the chime output to an audio amplifier microphone level input. Connecting a line level signal, such as provided by the ML-4, to a microphone input will result in distorted sound being heard over the speakers. If absolutely necessary, an audio attenuator, or "pad" can be used to reduce the ML-4's audio output level to correctly match a microphone input. The pad is installed between the chime output and the microphone input.

3.12 RELAY 1   Relay 1 provides a normally closed (shorted), common, and a normally open (not shorted) contact for installer selected applications. The contacts change state in tempo with the chime output. These contacts can control the activation of horns or mechanical chime units in areas that do not have loud speakers, or in installations that have special requirements. If a caller dials the code "333" Relay 1 will "pulse" in cadence with the chime output.

3.13 RELAY 2   Relay 2 provides a normally closed (shorted), common, and a normally open (not shorted) contact for installer selected applications. The contacts change state for the entire duration of a chime cycle. The COM and NO (common and normally open) contact can be used as an enable contact, required by some public address systems.

3.14 SETTING THE SWITCH OPTIONS   Six sections of an eight position DIP switch are used to configure the ML-4 to the desired operating configuration. The ML-4 software recognizes switch changes as soon as they are made. Changes in feature options are active with the next code call origination. Table 1 contains a summary of the switch settings.

   Code Length: Switch 1 selects if two- or three-digit codes are to be used.

   Cycles Per Sequence: Switch 2 selects if two or three chime cycles are generated in each chime output sequence.

   Repeat Sequence: Switch 3 selects if the chime output sequence will be repeated.

   Forward Unanswered Code Calls: Switch 4 selects if an unanswered code call will be forwarded via an answer port.

   Time-out Interval: Switches 5 and 6 select the time-out interval. The time-output interval starts at the end of the chime cycle. Refer to Table 1 for time selections.

Description	Switch	On	Off
Number of digits in a code	1	2	3
Number of cycles in a sequence	2	2	3
Repeat chime output sequence	3	Y	N
Forward unanswered code calls	4	Y	N
Time-Out Interval		Switch	
		5	6
1.0 minutes		N	N
1.5 minutes		Y	N
2.0 minutes		N	Y
2.5 minutes		Y	Y

Table 1 ML-4 feature options switch settings.

3.15 CONNECTING POWER   Plug the power cord into a standard 120Vac, grounded outlet. There is no power switch on the ML-4; as soon as you plug in the power cord the ML-4 will begin operating. The top LED, labeled POWER, will light.

4. Final Configuration and Testing

4.1 CONFIRM SWITCH SETTINGS   Confirm that the option switches have been set as desired; refer to Table 1.

4.2 LED STATUS INDICATORS   Ten LED status indicators are located on the ML-4 circuit board and are visible with the cover on or off. The LEDs are labeled POWER, CHIME, ORIGINATE PORTS - TRUNK 1-4, ANSWER PORTS - STATION 1-4. Applying power illuminates the power LED. The chime LED displays the status of the chime output. It lights in cadence with the generation of a chime. The trunk LEDs indicate the hook (loop current) status of the origination ports. The station LEDs light when the ports are in the off-hook state.

4.3 INITIAL OPERATION With the power source connected, make sure that only the power LED is lit. If any other of the LEDs are lit, review the installation procedures.

4.4 CHIME LEVEL AND PITCH ADJUSTMENTS The ML-4 allows adjustment of the chime output level and pitch. The controls are located on the top edge of the ML-4's circuit board. Set both controls for 50 percent rotation. Originate a code call by using the PBX to access one of the ML-4's originate ports. The LED corresponding to the selected port should light. You should hear dial tone being returned by the ML-4. Using touch tones, select a two- or three-digit code that will generate a long chime cycle (e.g., 99 or 999). This will give you time to adjust the chime level and pitch. Adjust the audio amplifier or amplified speakers for the desired output level. If required, the ML-4's level control can be used change the level of the signal going to the amplifier or amplified speakers. Adjust the pitch control to give the desired chime pitch.

4.5 REPLACING THE COVER At this time no other adjustments need to made to the ML-4. The cover should be replaced at this time.

4.6 TESTING THE PBX TRUNK PORTS/ML-4 ORIGINATE PORTS Use a PBX extension to access the first ML-4 originate port. Upon connection the port should return dial tone and have its associated LED light. After about eight seconds, error tone will be heard, then silence until disconnected. Repeat this procedure for the other three originate ports.

4.7 TESTING THE PBX STATION PORTS/ML-4 ANSWER PORTS Use a PBX extension to access the first ML-4 answer port. The port will go off-hook in response to the ringing signal. The port should return dial tone and have its associated LED light. After about six seconds the port will return an error tone, then disconnect. Repeat this procedure for the other three answer ports.

4.8 TESTING FORWARDING Follow this paragraph if the ML-4 has been configured to forward unanswered code calls. The PBX should have previously been set to automatically forward the station (or OPS/OPX) ports upon going off-hook. Save time by testing each station port for correct forwarding. At the MDF (e.g., 66-type block), connect a linepersons handset across each station tip and ring. Go off-hook with the handset and listen for ringback and connection to the desired forwarding point. Repeat this test for each station port.

Now perform a reality check by using the PBX to access one of the ML-4's originate ports. Dial a code and wait for the chime output sequence(s) to be generated and the time-out period to be exceeded. Depending on your configuration, anywhere from two to five minutes later the ML-4 will seize one of the station ports. The PBX will detect this and automatically "dial" the forwarding number. The ML-4 will connect the trunk and station port audio signals. You should hear PBX audible ring progress tone, and get connected to the desired forwarding point. If this performs as described, forwarding is operating correctly.

5. Operation

5.1 ORIGINATING A CODE CALL Using a PBX extension, dial the originate port access number. The ML-4 will return dial

tone, enabling the user to enter a code (two or three digits). There is an eight second limit on entering the desired code. The digits 1-9 are valid.

If more than one user accesses the origination ports at approximately the same time, the requests are processed in the order received. Dial tone is provided to the port currently being processed. Users awaiting ML-4 dial tone are given audible ring tone.

The ML-4 will return error tone if multiple originations of the same code are attempted. Only after a code call is answered, or the request terminated, can that specific code again be entered and processed.

A caller dialing the digits 0, #, or * will receive four seconds of error tone and then silence. At this point, the caller MUST hang-up and redial into the ML-4.

If the caller does not complete the entry of a code within eight seconds, the ML-4 returns error tone for four seconds followed by silence. The caller MUST hang-up and redial.

After the caller enters a valid code, the ML-4 places the call on hold and provides a beep tone hold indication. The beep tone continues until the code call is answered, or the time-out interval is reached.

5.2 RESPONDING TO A CODE CALL The answering of a code call is much like originating one. Using a PBX extension, dial the answer port access number. When the ML-4 is ready, it will answer the port. If more than one person is responding to different code calls, the ML-4 will answer the ports in the order received. A station port waiting to be answered continues receiving PBX audible ring tone.

After an answer port is answered, dial tone is provided to indicate that the ML-4 is ready to accept the entry of a code. Similar to the originate ports, a timer monitors the code entry. A maximum of six seconds are allowed to enter the two- or three-digit code. If the entered code is invalid (0, #, or *), or is not a code awaiting answer, error tone is returned is for two seconds, then the answer port returns to the on-hook state. If the entered code matches an active code call, the station and trunk audio are connected, along with a burst of access tone. After a code call is answered, the ML-4 does not output any further chime cycles.

5.3 CODE CALL REMAINS UNANSWERED A timer monitors the period starting after the end of the last chime output sequence. Should a code call go unanswered beyond the timer interval one of two events will occur. If set to forward unanswered code calls, the ML-4 will seek the next available answer port and initiate a transfer of the calling party to a designated PBX port (attendant console, message center, etc.).

A different course is taken if the ML-4 is not set to forward unanswered calls. After reaching the end of the time interval, four seconds of error tone is returned to the calling party and then the port goes silent. The port is reset after the calling party hangs up, and the PBX releases the trunk connection.

5.4 DISCONNECTING FROM THE ML-4 The ML-4 does not limit the time of a code call conference. The ML-4 monitors the hook status of the originate port. Upon the originate port going on-hook, the associated answer port is released (goes on-hook). Should the originate port remain off-hook, the associated answer port will also remain off-hook.

6. Circuit Description

6.1 GENERAL DESCRIPTION   The circuit description will familiarize you with the ML-4 for engineering, applications, and curiosity purposes. Use Figure 1, ML-4 Block Diagram, as an aid to this circuit description.

6.2 POWER SUPPLY   The power supply section produces the four voltage sources required by the analog and digital circuitry. Nominal 120Vac enters the ML-4 via a 3-conductor line cord. This voltage connects via a fuse to the primary of a step-down transformer. Rectifying and filtering the secondary of the transformer provides unregulated +13Vdc and +26Vdc. The unregulated +13Vdc is fed to a linear regulator to produce +5Vdc. This +5Vdc powers analog and digital circuitry. The unregulated +26Vdc powers several analog gates, the station off-hook relays, and connects to two sections of voltage regulator circuitry. Two linear voltage regulator integrated circuits produce +18Vdc for the trunk loop current, and +10Vdc for the analog circuitry.

6.3 MICROCOMPUTER   At the heart of the ML-4 is a Motorola 6805-series microcomputer (MCU). The MCU contains memory permanently loaded with the ML-4 program software. In addition to program storage memory, the MCU contains clock, RAM memory, bidirectional ports, and timer circuitry. A 3.579545 MHz crystal provides the time base for the MCU.

6.4 MCU WATCHDOG TIMER   Just like your dog at home, a watchdog makes a very good companion for the MCU. The ML-4 software fends off potential problems by steadily generating pulses at one of the MCU output ports. The ML-4 utilizes a watchdog integrated circuit to accept these regular "pats on the head" from the MCU. Should the MCU "lockup" due to a power glitch, static discharge, or other conditions the MCU's pulses will stop, causing the watchdog circuit to reset and restart the MCU.

6.5 TRUNK INTERFACES   A conventional battery feed circuit with a split primary, 600 ohm to 600 ohm transformer interfaces the originate ports with the PBX trunk ports. Two power resistors couple +18Vdc and analog ground to the transformer's center taps. The transformer center taps also drive an off-hook detect circuit. The secondary of the transformer connects the audio path to a solid-state cross-point switch.

6.6 STATION INTERFACES   A transformer-based interface connects the answer ports with the PBX extension ports. Ring detection is accomplished using an optocoupler. The MCU controls the off-hook status by driving a relay via a relay driver integrated circuit. The secondary of the transformer connects to the cross-point switch. Loop current detection is not required due to the special nature of this product.

6.7 CROSS-POINT SWITCH   A solid-state cross-point switch provides the majority of the analog signal routing. It connects the originate and answer ports to each other, as well as to the progress tones sources and DTMF decoders. The MCU digitally controls the operation of the cross-point switch.

6.8 PROGRESS TONES   Operational amplifiers configured as oscillators produce 350, 440, and 480Hz signals. These signals provide the five separate progress tones that connect to the cross-point switch. Dial tone consists of 350Hz mixed with 440Hz. Audible ringing tone is a mixture of 440Hz and 480Hz. Beep tone is straight 440Hz; access tone is 480Hz; error tone is 350Hz.

The MCU controls the timing and/or interruption rate of each signal through making and breaking the appropriate cross point connections.

6.9 DTMF RECEIVERS   One DTMF receiver integrated circuit is electronically shared among the four originate ports. A second receiver serves the four answer ports.

6.10 CHIME GENERATOR   The chime generator consists of two major parts: waveform source and envelope control. A voltage controlled oscillator produces a triangular wave form. A voltage controlled amplifier creates the chime envelope. User accessible controls allow for adjustment of chime pitch and level. A 600 ohm to 600 ohm matching transformer isolates the chime output from external equipment.

6.11 RELAYS   The ML-4 utilizes sealed, bifurcated contact relays to provide station off-hook control, as well as the Relay 1 and Relay 2 contacts. The MCU controls the relays via a relay driver integrated circuit.

6.12 LED INDICATORS   Ten LED indicators provide assistance during installation, operation, and maintenance. The LEDs indicate power, chime active, trunk ports off-hook, and station ports off-hook.

7. Specifications

SAFETY COMPLIANCE
Underwriters Laboratories, Inc., Listed Telephone Equipment

FCC REGISTRATION
The ML-4 does not require FCC registration as it is not intended for connection to the public switched telephone network

RELIABILITY
MTBF 14.6 years, per Method I of Bellcore TS-TSY-000332, Issue 2, July 1988

POWER REQUIREMENT
120Vac, 0.25 Amps, 50/60Hz

FUSE
1/4A, 3AG type 312, not field replaceable

LED INDICATORS
10 LEDs display ML-4 status: power, chime, originate ports (trunk) 1-4, and answer ports (station) 1-4

CONFIGURATION SWITCHES
One 8-position DIP switch, selecting five features

INTERCONNECTIONS
One 25-pair plug. Installer must provide cable with 25-pair connector.

ENVIRONMENT
0 to 50 degrees C, humidity to 95% (no condensation)

DIMENSIONS
14.0 inches high (35.6cm)
11.1 inches wide (28.2cm)
2.6 inches deep (6.6cm)

WEIGHT
11.5 pounds (5.2kG); shipping weight 12.5 pounds (5.7kG)

MOUNTING
Four #8 pan head screws of the type appropriate for the wall material

ORIGINATE PORTS—TRUNK PARAMETERS
Intended for connection to PBX loop start trunk ports
Impedance: 600 ohms
Loop Supply Voltage: 18Vdc
Loop Supply Current: 34mA with 200 ohm loop, 16mA with 800 ohm loop, 52mA with shorted Tip and Ring
Disconnect Signal: 250mSec break of loop current (minimum)

ANSWER PORTS—STATION PARAMETERS
Intended for connection to PBX loop start extension ports or OPS/OPX ports with standard bridged ringing
Impedance: 600 ohms, DC off-hook resistance 90 ohms
Ringing Detection: 40 to 150Vac RMS, 18 to 66Hz, ringer equivalence 0.9

PROGRESS TONES
Dial Tone: 350 + 440Hz, non-interrupted
Audible Ring Tone: 440 + 480Hz, 1 second on, 3 second off
Error Tone: 350Hz, 120 ipm (250mSec on, 250 mSec off)
Beep Tone: 440Hz burst, 0.5 seconds repeated every 5 seconds
Access Tone: 480Hz burst, 0.6 seconds in duration
All progress tones transmitted at maximum level of −16dBm

CHIME OUTPUT
Impedance: 600 ohms, transformer coupled
Pitch: adjustable from 325Hz to 2kHz
Level: adjustable, +8dBu maximum

CHIME TIMING
Time Between Tones: 250mSec
Time Between Digits: 1.5 second
Time Between Chime Cycles:
    One active code output: 8 seconds
    Two or more codes active: 4 seconds

RELAY CONTACTS
Type: Form C (Break Before Make), provides common, normally open, and normally closed connections
Rating: 1A maximum at 30Vdc or 100Vac (resistive)
Relay 1: follows cadence of chime output. Relay energized 250mSec for each chime. Relay de-energizes for 250mSec between each chime.
Relay 2: energized 500mSec prior to start of chime output sequence, de-energized 250mSec after the last chime in chime output sequence

8. Incorrect Operation
8.1 REVIEW PRACTICE   Should problems arise in ML-4 operation, please review Section 3—Installation of this practice. If another ML-4 is available, substitute and retest.
8.2 LED INDICATORS   The 10 LED indicators located on the ML-4 circuit board can provide assistance in locating the source of trouble. With power connected, the power LED should always be lit. The originate port LEDs will help in determining if the ML-4 can recognize a trunk seizure. The answer port LEDs will light only after the ML-4 responds to

ringing voltage. The chime LED displays when the chime output is active.
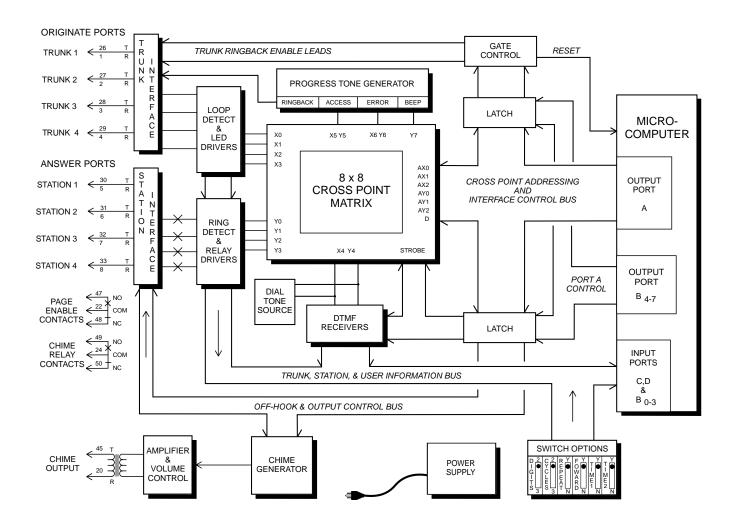**8.3** SWITCH SETTINGS   Ensure that the switches settings agree with the desired configuration.
8.4 ADJUSTMENTS   Chime level and pitch controls can be set to the desired positions. Correctly adjusting each control ensures that the chime output can be heard or recognized.
8.5 TESTING THE ORIGINATE PORTS   A simple means of checking the originate ports is to connect a lineperson's handset across the tip and ring connections. The lineperson's handset will simulate the PBX trunk. You can draw ML-4 dial tone going off-hook with the linepersons handset. DTMF dial a code and listen for the chime output.

9. Repair and Replacement
9.1 NOT SO FAST   Statistically, most equipment returned to Gordon Kapes, Inc. for repair actually has nothing wrong with it. A telephone call to Gordon Kapes, Inc. technical support can often help to get the equipment operating correctly. We don't mind spending time with our customers getting a site up and running.
9.2 SEND IT BACK   If you determine that the ML-4 is defective, return for repair or replacement according to the Gordon Kapes, Inc. Warranty/Repair and Return policy.
9.3 ONLY WE FIX IT   In the event repairs are ever needed on your ML-4, they should be performed by Gordon Kapes, Inc. or an authorized representative. For further information, contact Gordon Kapes, Inc.

Figure 1   ML-4 Multi-Link Code Call System Block Diagram

ORIGINATE PORTS

TRUNK 1 26 / 1 T / R

TRUNK 2 27 / 2 T / R

TRUNK 3 28 / 3 T / R

TRUNK 4 29 / 4 T / R

TRUNK INTERFACE

ANSWER PORTS

STATION 1 30 / 5 T / R

STATION 2 31 / 6 T / R

STATION 3 32 / 7 T / R

STATION 4 33 / 8 T / R

STATION INTERFACE

PAGE ENABLE CONTACTS 47 NO / 22 COM / 48 NC

CHIME RELAY CONTACTS 49 NO / 24 COM / 50 NC

LOOP DETECT & LED DRIVERS

RING DETECT & RELAY DRIVERS

TRUNK RINGBACK ENABLE LEADS

PROGRESS TONE GENERATOR

RINGBACK | ACCESS | ERROR | BEEP

8 x 8 CROSS POINT MATRIX

X0 X1 X2 X3

X5 Y5   X6 Y6   Y7

Y0 Y1 Y2 Y3

X4 Y4   STROBE

AX0 AX1 AX2 AY0 AY1 AY2 D

DIAL TONE SOURCE

DTMF RECEIVERS

GATE CONTROL   RESET

LATCH

LATCH

CROSS POINT ADDRESSING AND INTERFACE CONTROL BUS

PORT A CONTROL

MICRO-COMPUTER

OUTPUT PORT A

OUTPUT PORT B 4-7

INPUT PORTS C,D & B 0-3

TRUNK, STATION, & USER INFORMATION BUS

OFF-HOOK & OUTPUT CONTROL BUS

CHIME OUTPUT 45 T / 20 R

AMPLIFIER & VOLUME CONTROL

CHIME GENERATOR

POWER SUPPLY

SWITCH OPTIONS

DIGITS 2 3 | CYCLES 2 3 | REPEAT Y N | FORWARD Y N | TIME1 Y N | TIME2 Y N

Figure 2   ML-4 Multi-Link Code Call Cable Connection Chart

P1 Pin Number	Cable Color	Connection	
26	WHT-BLU	T	Originate Port 1 (see Note 1)
1	BLU-WHT	R	
27	WHT-ORN	T	Originate Port 2 (see Note 1)
2	ORN-WHT	R	
28	WHT-GRN	T	Originate Port 3 (see Note 1)
3	GRN-WHT	R	
29	WHT-BRN	T	Originate Port 4 (see Note 1)
4	BRN-WHT	R	
30	WHT-SLT	T	Answer Port 1 (see Note 2)
5	SLT-WHT	R	
31	RED-BLU	T	Answer Port 2 (see Note 2)
6	BLU-RED	R	
32	RED-ORN	T	Answer Port 3 (see Note 2)
7	ORN-RED	R	
33	RED-GRN	T	Answer Port 4 (see Note 2)
8	GRN-RED	R	
34	RED-BRN		
9	BRN-RED		
35	RED-SLT		
10	SLT-RED		
36	BLK-BLU		
11	BLU-BLK		
37	BLK-ORN		
12	ORN-BLK		
38	BLK-GRN		
13	GRN-BLK		
39	BLK-BRN		
14	BRN-BLK		
40	BLK-SLT		
15	SLT-BLK		
41	YEL-BLU		
16	BLU-YEL		
42	YEL-ORN		
17	ORN-YEL		
43	YEL-GRN		
18	GRN-YEL		
44	YEL-BRN		
19	BRN-YEL		
45	YEL-SLT	+	Audio Output
20	SLT-YEL	–	
46	VIO-BLU		
21	BLU-VIO		
47	VIO-ORN	NO	RELAY 1 (see Note 3)
22	ORN-VIO	COM	
48	VIO-GRN	NC	
23	GRN-VIO		
49	VIO-BRN	NO	RELAY 2 (see Note 3)
24	BRN-VIO	COM	
50	VIO-SLT	NC	
25	SLT-VIO		

Note 1

The originate ports connect to a PBX system via loop start trunk ports. The ML-4's ports appear as standard central office trunks, supplying talk battery and progress tones to the user. Arranging the PBX trunks in a "hunt group" allows the assignment of one common number for users to access the ML-4 and to originate code calls.

Note 2

The answer side of the ML-4 interfaces to a PBX system via four extensions (or OPS/OPX ports). The ML-4's answer ports appear as standard 500/2500-type telephone sets. The answer ports go off-hook in response to standard 20/30Hz bridged ringing. Configuring the PBX in a "hunt group" format simplifies responding to code calls.

Note 3

NO: normally open (not shorted) relay contact
COM: common connection for NO and NC contacts
NC: normally closed (shorted) relay contact

Relay 1 follows the cadence of the chime output. Use these contacts to control an external horn or chime in locations where loudspeakers are not present.

Relay 2 is energized during the entire duration of a chime output sequence. Use the COM and NO connections to serve as a page enable contact for an associated audio amplifier that requires a contact closure for activation of an audio input.

Specifications and information contained in this technical practice subject to change without notice.