

# CML Semiconductor Products

PRODUCT INFORMATION

## CM1481 Non-Predictive Selcall Module

Obsolete Product  
'For Information Only'

### Applications

- Selcall in Two-Way Radio
- Alarm Systems
- Remote Control/Switching
- 'SECURE' Control and Switching
- Industrial Control
- Automatic User Identity

★ *'N'-TONE SELCALL ENCODING & NON-PREDICTIVE DECODING + GROUP CALLING*



## CM1481

Operating  
and  
Programming  
Manual

### Features

- ★ Encoding and Non-Predictive All-Tone Decoding
- ★ All-System GROUP-Call
- ★ Transponding and ANI
- ★ Over-Air *"Stun and Release"* and *"Re-Configuration"*
- ★ Remote Reset Facility
- ★ Simple Radio Interface
- ★ Low-Power Requirement (4.0mA @ 6v to 26v D.C. [typ])
- ★ CCIR, EEA and ZVEI Tonesets
- ★ Simple, Serial Configuration
- ★ Multiple Coded Audio Alerts
- ★ PTT Time-Out Timer
- ★ PTT Lockout

# The CM1481 Non-Predictive Selcall Module

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## Brief Introduction to The CM1481

The CM1481 is a compact 5- or 6-Tone CCIR, EEA and ZVEI selcall module with individual address encoding, non-predictive all-tone decoding, transponding and full, all-system GROUP Call and ANI capabilities.

In addition to normal selcall facilities, the CM1481 offers, as standard, a range of over-air control facilities to allow a base-station additional control when working with remote units.

These added facilities are:

'Stun' and 'Release' - To allow the controller to completely 'freeze' all module and parent radio audio functions rendering it inoperative until 'Released'. This to counter theft, air misuse/abuse or non-payment of fees.

'Re-Configuration' - To change module addresses and modes via an over-air command. This to allow unit participation in other user groups.

'Stun', 'Release' and 'Re-Configuration' operations are carried out using a secure authentication protocol to prevent accidental or illegal transactions.

The unit may be muted by the base.

Under the control of its on-board  $\mu$ Controller, operating from instructions written to it by a simple menu-driven configuration operation from a basic 'PC' type computer, the CM1481 can completely control the workings of the radio's Rx and Tx audio processes.

After Configuration the only operator inputs required are Microphone/Handset, Volume and Selcall Tx/Mute controls.

The CM1481 will detect and decode all incoming tone information, controlling the radio functions whilst providing the operator with various coded audio alerts to indicate status and progress.

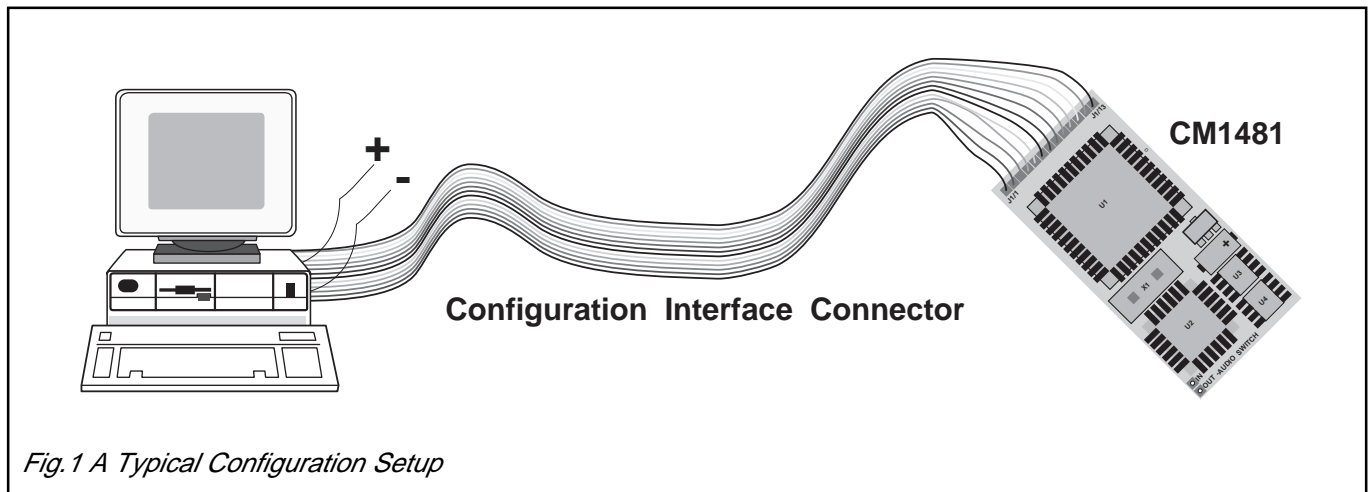


Fig.1 A Typical Configuration Setup

### CM1481 - A Summary of Standard Functions and Features

- |  |   |  |
|--|---|--|
| ■ Configuration by Menu-Driven Software via a Serial 'PC' Link | ■ Individual Addressing                 | ■ Identification (ANI)                   |
| ■ CCIR, EEA and ZVEI Toneset/Length Capabilities               | ■ Extended Group & Data Tone Facilities | ■ Programmable Lead-In Tone and Delay    |
| ■ HSC Signalling Control Features                              | ■ Simple Radio Interface                | ■ Transponding Facility                  |
| ■ Over-Air "Stun" & "Release"                                  | ■ Low-Power Requirement (4.0mA typ)     | ■ Single or Dual Button Operation        |
| ■ Rapid Over-Air "Re-Configuration"                            | ■ "Muted" Call Initiation               | ■ Timed Mute Reset                       |
| ■ Remote Reset   | ■ Programmable I/O Polarities           | ■ Tx (PTT) Time Out + Warning            |
|  | ■ Lead/Trail Automatic Number           | ■ PTT (Busy) Lockout                     |
|  |   | ■ CMOS Compatible Logic                  |
|  |   | ■ Operators' Coded Call-Alert Capability |

# Installation

## Installation Instructions

The CM1481 is designed to be embodied physically within a mobile, portable or handheld transceiver to interface electrically with Rx and Tx audio circuitry via the Radio Interface. The diagram below shows the input and output system functions of the CM1481.

**Before Installation it is recommended that this document is studied carefully.**

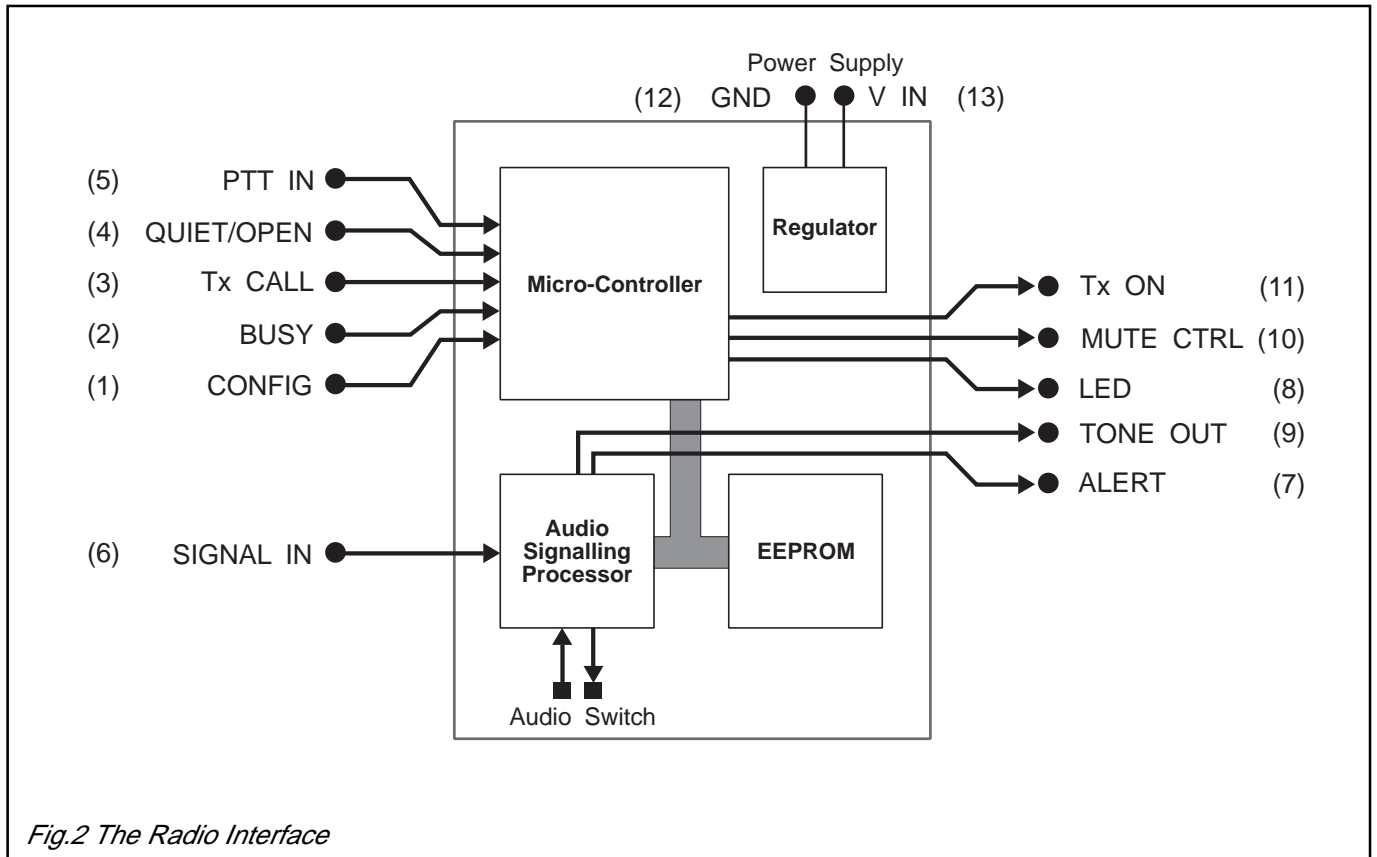


Fig.2 The Radio Interface

## Method of Installation

Ensuring that there is sufficient room to introduce the Radio Interface lead and the Configuration Interface Connector, place the CM1481 into its operating position using the double-sided sticky-pad (supplied) on the discrete component side of the module. Ensure that the module adheres firmly to its mounting surface.

Consider the requirements for Single or Dual Button operation.

Do not attempt to install the module into areas of the radio where it may be subject to high RF fields. Ensure that the CM1481 is well insulated from other radio components.

It is recommended, at this stage, that some record is formulated to identify the configuration state of the module/radio pair.

## Power Requirements

The supply voltage requirement of the CM1481 is between 6 and 26 volts d.c.

## Handling Precautions

The CM1481, which is supplied in an anti-static package, contains CMOS devices. It is recommended that to prevent damage, Electrostatic Discharge Precautions are employed at all stages of any production process involving this module.

## Alert Audio Levels

If alert levels from the CM1481 are to be fed into an external audio amplifier it is recommended that the LINK is removed. Removal of the LINK will allow connection to high-impedance loads.

LINK IN can drive an external loudspeaker.

LINK OUT can drive an external amplifier.

See layout diagrams, Figure 4, and Table 5 (Audio Alert Descriptions).

## Installation Dimensions

CM1481 board size.


45mm x 22mm x 8mm.

## Installation .....

### CM1481 Radio Interface

The table below shows the functions and interconnections of the CM1481 interface (J1) employed in both NORMAL and CONFIGURATION modes.

Functions prefixed by a star (\*) indicate configurable IN/OUT polarities. Consult the Configuration section of this manual for Configuration Instructions and Configuration Interface Connector termination information.

Pin	Function	Normal Mode - to Radio	Function	Configure Mode - to PC
1	CONFIG	Configuration mode sense. When this pin is "High" the module WILL NOT enter the CONFIGURATION mode, when "Low" the module WILL enter the CONFIGURATION mode on power-up.		
2	* BUSY	Input from the radio squelch circuitry. A level here indicates the presence of an RF carrier.		
3	* Tx CALL	Input from the installation "Operation" momentary-action switch to initiate a Selcall. See "Single/Dual Button" Operation notes.	CLOCK	The CLOCK signal generated by the configuring PC is input here.
4	* QUIET/OPEN	Input from the installation "Operation" momentary-action switch to control the radio mute state. See "Single/Dual Button" Operation notes.	DATA IN	Data from the configuring PC to the module is input here.
5	* PTT IN	Input from the Mic. or peripheral PTT line. The CM1481 controls the radio Tx function via Tx On.		
6	SIGNAL IN	Input for received Selcall tones from the radio demodulator prior to squelch circuitry.		
7	ALERT	Audible alerts output. Introduce into the radio's Rx audio stage with due regard to any audio powersave functions. This output can drive a loudspeaker directly.		
8	* LED	Output drive to an LED indicator. Connect an LED between this pin and GND.	DATA OUT	Data from the module to the configuring PC is output here.
9	TONE OUT	Selcall tone output. Introduce this output into the radio Tx Audio path.		
10	* MUTE CTRL	Connect to radio Rx Squelch circuitry so that when this output is active Rx Audio is muted.		
11	* Tx ON	Tx PTT Drive. When active this output will key the Tx.		
12	GND	Signal Ground (-)		
13	V IN	Positive Supply Voltage (+)		
 AUDIO SWITCH		An on-board (Audio Signalling Processor) all-audio switch-path, accessible via on-board solder-pads. This switch operates in co-ordination with the QUIET/OPEN function for use with all audio signals. When 'Quiet' the switch is OFF, when 'Open' the switch is ON.		

*Table 1 CM1481 Radio Interface Functions*

The position of Pin 1 is identified on Figure 4 (PCB Layout).

# CM1481 Circuit Diagram

# CM1481 Circuit Diagram

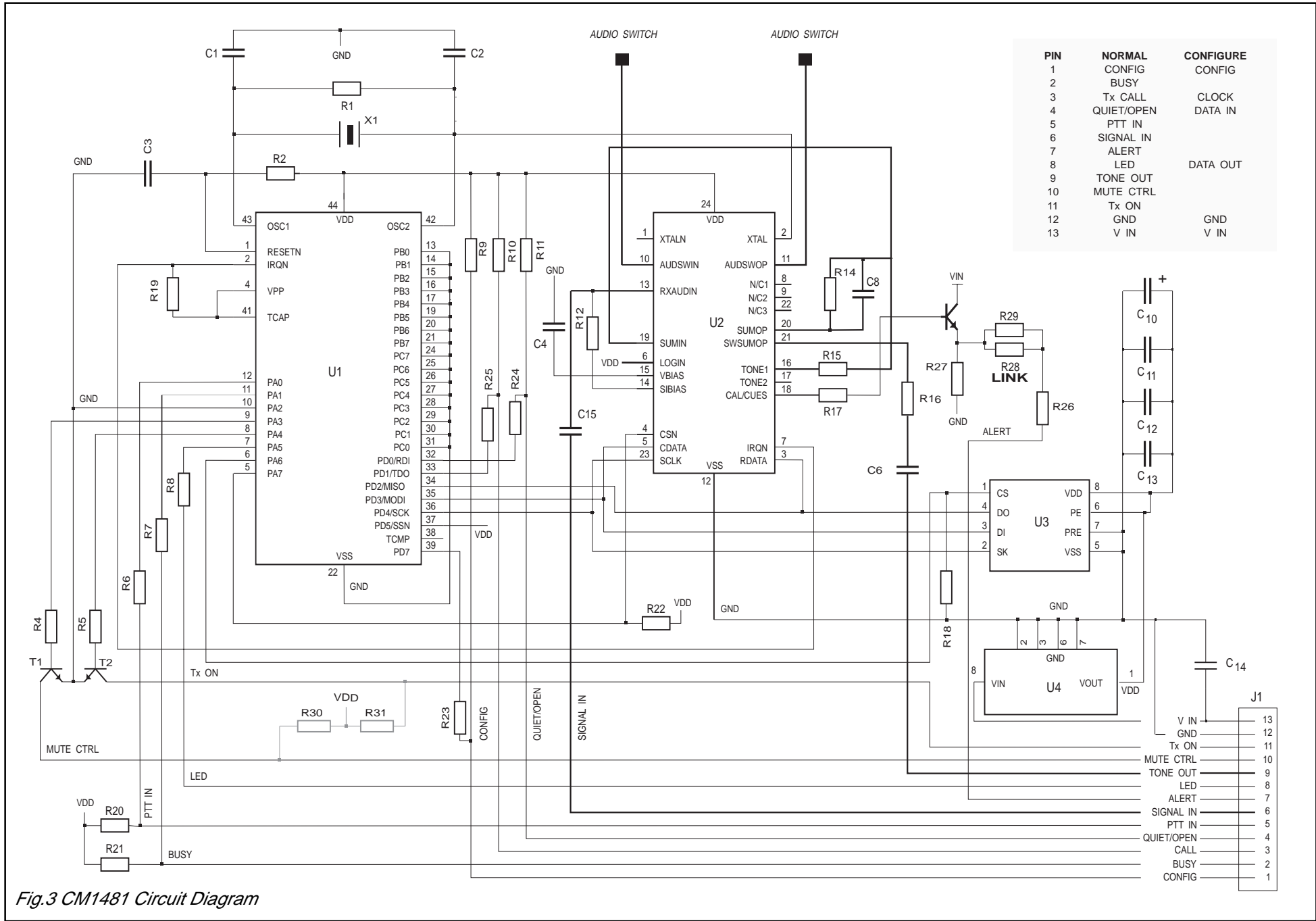
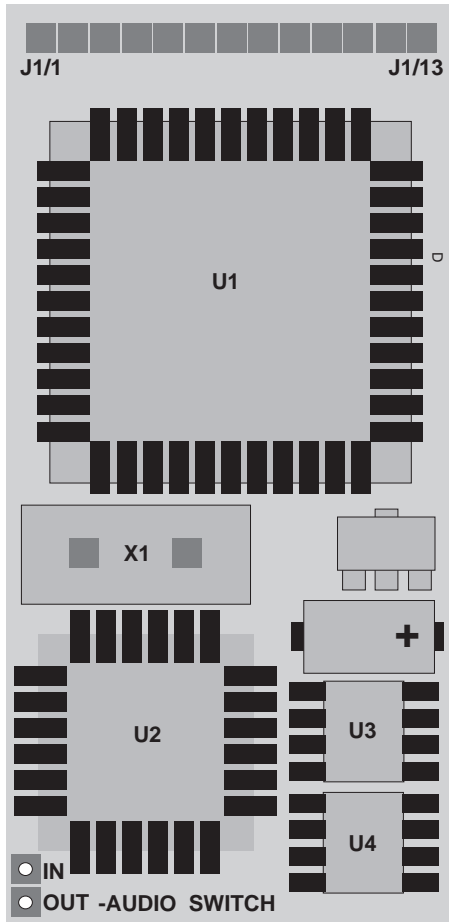


Fig.3 CM1481 Circuit Diagram

# CM1481 PCB Layout



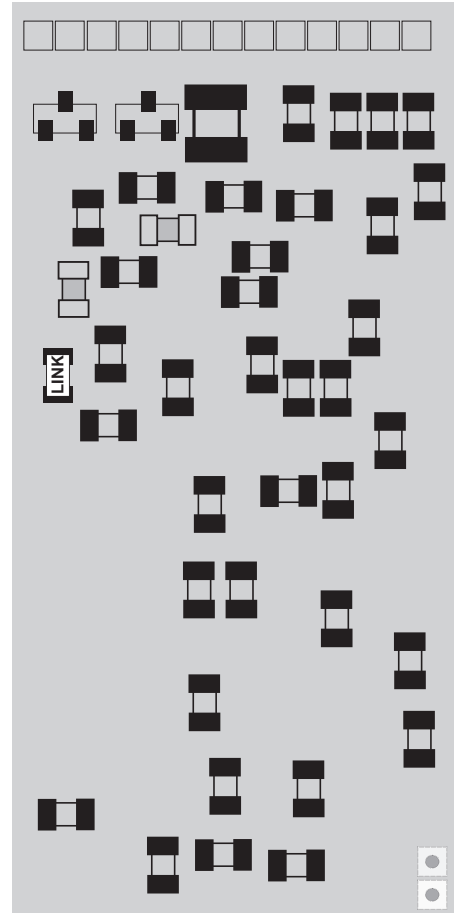
CM1481 Top View

Fig.4 PCB Layout

Note the position of the on-board LINK on the underside of the printed circuit board.

If Alert Levels are to be fed to an external audio amplifier it is recommended that the LINK is removed so that the ALERT output can drive a high impedance stage.

LINK IN will drive an external loudspeaker. LINK OUT will drive an external amplifier



CM1481 Underside View

Component	Value	Component	Value	Component	Value	Component	Value
U <sub>1</sub>	68HC705C8	R <sub>6</sub>	10.0kΩ	R <sub>20</sub>	47.0kΩ	C <sub>3</sub>	0.1μF
U <sub>2</sub>	FX803LS	R <sub>7</sub>	10.0kΩ	R <sub>21</sub>	47.0kΩ	C <sub>4</sub>	0.1μF
U <sub>3</sub>	93CO6	R <sub>8</sub>	330Ω	R <sub>22</sub>	470kΩ	C <sub>5</sub>	not used
U <sub>4</sub>	LM2931-5	R <sub>9</sub>	47.0kΩ	R <sub>23</sub>	10.0kΩ	C <sub>6</sub>	0.1μF
T <sub>1</sub>	BCX19	R <sub>10</sub>	47.0kΩ	R <sub>24</sub>	10.0kΩ	C <sub>7</sub>	not used
T <sub>2</sub>	BCX19	R <sub>11</sub>	47.0kΩ	R <sub>25</sub>	10.0kΩ	C <sub>8</sub>	22.0pF
T <sub>3</sub>	BSR41	R <sub>12</sub>	2.2MΩ	R <sub>26</sub>	22.0Ω	C <sub>9</sub>	not used
R <sub>1</sub>	4.7MΩ	R <sub>13</sub>	not used	R <sub>27</sub>	2.0kΩ	C <sub>10</sub>	22.0μF
R <sub>2</sub>	100kΩ	R <sub>14</sub>	100kΩ	R <sub>28</sub>	LINK	C <sub>11</sub>	0.1μF
R <sub>3</sub>	not used	R <sub>15</sub>	100kΩ	R <sub>29</sub>	100kΩ	C <sub>12</sub>	0.1μF
R <sub>4</sub>	10.0kΩ	R <sub>16</sub>	47.0kΩ	R <sub>30</sub>	Note 1	C <sub>13</sub>	0.1μF
R <sub>5</sub>	10.0kΩ	R <sub>17</sub>	10.0kΩ	R <sub>31</sub>	Note 1	C <sub>14</sub>	0.1μF
		R <sub>18</sub>	470kΩ	C <sub>1</sub>	39.0pF	C <sub>15</sub>	0.1μF
		R <sub>19</sub>	470kΩ	C <sub>2</sub>	22.0pF	X <sub>1</sub>	4.0MHz

Table 2 Components List

## Notes

1. Pads are made available on the CM1481 PCB for resistors R<sub>30</sub> and R<sub>31</sub> (not installed on this version) for future hardware upgrades.
2. The pads to the audio switch are available for use with system audio. This switch operates in conjunction with the Quiet/Open function. Refer to Radio Interface pin functions.

# Configuration

## Module Configuration

The operating parameters and functions of the CM1481 are programmed to the module (in its CONFIG mode) via the Configuration Interface Connector from a PC running CML Configuration software.

The CM1481 is supplied, initially, configured to the *DEFAULT* settings as shown in the example menu below.

Over Air Re-Configuration will enable the changing of the following:

<i>Tx Address</i>	<i>Rx Address</i>	<i>Transpond Address</i>
<i>Transpond Mode</i>	<i>ANI Address</i>	<i>ANI Mode</i>

To make changes to any other parameters a base-conducted configuration operation must be carried out. The following pages and diagrams describe the Configuration operation.

```

CM1481 CONFIGURATION MAIN MENU

Transmit address: 01234          Startup state: Quiet
Receive address: 67890          ANI mode: Off
Transpond address: 21018        Transpond mode: Off
ANI address: 65432             Tones per address: 5
                                Lead in Gap: No
                                Over-air functions: Disabled
                                Extended Group tone: No
                                Open mode: Unmute
                                LED call memory: Off
                                Beep mute state: Unmute

    Toneset: ZVEI1
    Tone length: 70ms
NOTONE timer length: 100ms
Lead in delay length: 200ms
Lead in tone length: Off
Lead in tone digit: 0
    No of call alerts: 15
    Ptt time out: Off
    Pseudo iterations: 32
    Timed mute reset: Off
Extended data tone: No
    Call when Quiet: No
    Radio stunned: No
    Operation: Single Button

                                PTT in: Active low
                                PTT out: Active low
                                Busy: Active low
                                Mute: Active high
                                LED: Active high
                                Quiet/Open: Active low
                                Call: Active low

F1:Load F2:Save F3>Edit F4:Read F5:Write F6:Verify F7:Revision F10:Exit
  
```

## Configuration Interface Connector

Illustrated below is the termination information for the construction of the Configuration Interface Connector.

13-Way SIL CM1481 Connector		25-Way "D" PC Printer Port	Configuration Function
J1 - 13	-		+ve Supply Input
J1 - 12	to	LPT1 - 18*	GND
J1 - 8	to	LPT1 - 13	Data Out
J1 - 4	to	LPT1 - 2	Data In
J1 - 3	to	LPT1 - 1	Clock
J1 - 1	to	LPT1 - 19*	Config
	-	LPT1 - 20*	GND (0V Supply)

*Table 3 Configuration Interface Connector - Terminations*

\* Pins LPT1 -18, -19 and -20 are connected to GND inside the PC.



# Configuration .....

## Configuration Instructions

The CM1481 is configured using a PC running simple CM1481 menu-driven software via the Configuration Interface Connector between the PC Printer Port (LPT1) and the CM1481 Connector (J1).

Using the menu, configuration parameters are defined in the PC and then written to the module.

When configured the module will retain these parameters until re-configured by either: (a) Over-Air Re-Configuration, or (b) complete PC repeat configuration. A power supply of the relevant value is introduced via the Configuration Interface Connector for module power during configuration (see Table 3).

The previous page details the construction and connections of the Configuration Interface Connector and shows an example screen of the DEFAULT software menu.

### Preparation and Configuration

1. With no power applied connect the CM1481 (J1) to the PC Printer Port (LPT1) via the configuration Interface Connector.
2. Start the computer.
  - CM1481 Configuration software will run under MS DOS versions: 3.2, 3.3, 4.01, and 5.0 -
3. With the CM1481 Configuration program disk inserted in the floppy drive, type : *<(Drive): CM1481.EXE>*
4. The CM1481 Configuration Main Menu will be displayed.  
Follow the initial instructions.
5. Provide power to the module via the Configuration Interface Connector.
6. With reference to the function keys at the bottom edge of the screen ---
  - <EXIT> Exits the Configuration program and returns the user to the DOS prompt.
  - <EDIT> Enters 'Configuration-Edit' mode to change parameter/function set-ups.
    - <UP, DOWN> Moves a highlighting cursor to the required parameter.
    - <LEFT, RIGHT> Decreases or increases the chosen parameter value.
    - <CHANGE ADDRESS> When the cursor is placed within an address field, the <CHANGE ADDRESS> function may be activated; this will allow the address to be entered as one entity.
    - <EXIT to PREVIOUS SCREEN> Returns to the previous screen.
  - <LOAD> loads a previously saved set-up file.
  - <SAVE> saves the current set-up file.
  - <READ> reads the set-up information from the module.
  - <WRITE> writes the selected set-up file to the module. This will overwrite any resident information.
  - <VERIFY> A comparison of the screen setup and the written setup.
  - <REVISION> reads the current firmware (CM1481 on-board software status) from module.
7. When the <WRITE> command is completed powerdown the module.  
With power removed from the radio, reconnect the Radio Interface.
8. To configure another CM1481 module, remove the power from the module.  
Remove the current module from the Configuration Interface Connector.  
Connect the new module and continue from Step 5 (above).
9. CONFIGURATION COMPLETE.

## CM1481 - Configuration Menu

The table below indicates the functions of the CM1481 and the options that may be achieved via software configuration. Details in **BOLD TYPE** indicate DEFAULT settings.

<b>CM1481 CONFIGURATION PROGRAM</b>		
<b>Function</b>	<b>Default</b>	<b>Options</b>
Transmit Address:	<b>0 1 2 3 4</b>	5 OR (6) VALID ADDRESS TONES
Receive Address:	<b>6 7 8 9 0</b>	
Transpond Address:	<b>2 1 0 1 8</b>	
ANI Address:	<b>6 5 4 3 2</b>	
Toneset:	<b>ZVEI1</b>	CCIR EEA ZVEI1 ZVEI2 ZVEI3 PZVEI
Tone Length:	<b>70ms</b>	30 to 150ms in 10ms steps
NOTONE Timer:	<b>100ms</b>	20 to 300ms in 20ms steps
Lead-In Delay:	<b>200ms</b>	OFF, 0 to 2550ms in 10ms steps
Lead-In Tone Length:	<b>OFF</b>	OFF, 0 to 2550ms in 10ms steps
Lead-In Tone Digit:	<b>0</b>	1 2 3 4 5 6 7 8 9 A B C D E F
Number of Called Alerts:	<b>15</b>	0 to 15 in steps of 1
PTT Time-Out:	<b>OFF</b>	OFF, 10 to 248secs in 1sec steps
Pseudo Iterations:	<b>32</b>	1 to 255 in steps of 1
Timed Mute Reset:	<b>OFF</b>	OFF, 1 to 255secs in 1sec steps
Extended Data Tone (Tx):	<b>No</b>	Yes or No
Call When Quiet:	<b>No</b>	Yes or No
Radio "Stunned":	<b>No</b>	Yes or No
Operation:	<b>Single</b>	Single or Dual -Button
Start-Up State:	<b>Quiet</b>	Quiet or Open
ANI Mode:	<b>OFF</b>	OFF, Lead, Trail or Lead & Trail (both)
Transpond Mode:	<b>OFF</b>	OFF, Address or Beep
Tones per Address:	<b>5</b>	5 or 6
Lead-In Gap:	<b>No</b>	Yes or No
Over-Air Functions:	<b>Disabled</b>	Disabled or Enabled
Extended Group Tone (Tx):	<b>No</b>	Yes or No
Open Mode:	<b>Unmute</b>	Unmute or Transparent
LED Call Memory:	<b>OFF</b>	On or OFF
Beep Mute State:	<b>Unmute</b>	Mute
PTT In:	Active- <b>LOW</b>	HIGH or LOW
PTT Out:	Active- <b>LOW</b>	HIGH or LOW
Busy:	Active- <b>LOW</b>	HIGH or LOW
Mute:	Active- <b>HIGH</b>	LOW or LOW
LED:	Active- <b>HIGH</b>	LOW or LOW
Quiet/Open:	Active- <b>LOW</b>	HIGH or LOW
Call:	Active- <b>LOW</b>	HIGH or LOW

Table 4 Configuration Options

Further information on CM1481 functions is given in the Functional Descriptions section of this manual.

CM1481 Configuration Software, Module firmware and documentation provided are supplied 'as is'. Under this condition CML makes no warranty, express or implied, of the saleability of this media or its fitness for a particular purpose. Under no circumstances whatsoever will CML be liable for ANY damage, loss of profits, or any consequential loss arising from the use of this media, even if CML has been advised of the possibility of such loss. CML does not assume any responsibility for the use of any of the circuitry described. No circuit patent licences are implied and CML reserves the right at any time without notice to change the said circuitry.

# Configuration .....

## Error and Status Messages

Error and/or Status Messages as described below will appear on-screen, in the area above the Function Key menu, during the operation of the Configuration Software.

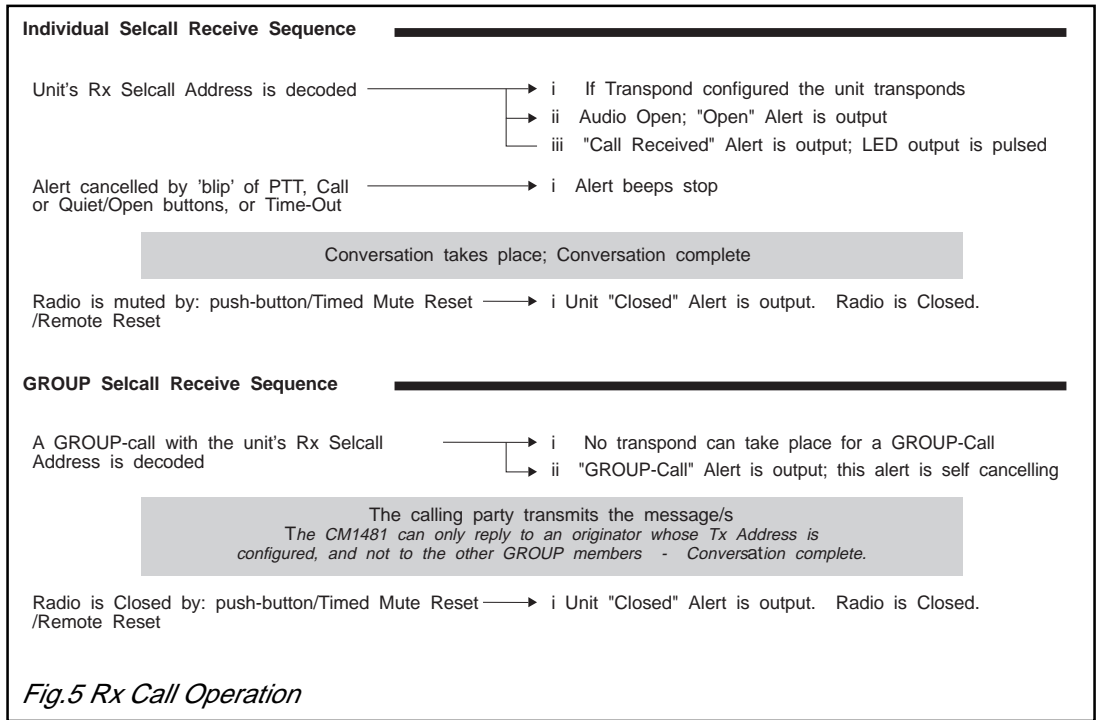
<b>Checking Module Communications:</b>	A READ/WRITE/READ/WRITE action to confirm communications between the PC and the Module.
<b><i>Error in Module Communications:</i></b>	<i>Problems encountered when communication attempted with module. Check for correct connections and power supply.</i>
<b>Writing Module Setup:</b>	WRITING to the Module.
<b><i>Error in Writing to File:</i></b>	<i>Cannot write due to insufficient disk space, Write Protect, Read Only, etc. ....</i>
<b>Verifying Module Setup:</b>	Comparing the WRITTEN setup with the screen version.
<b><i>Setup not Verified:</i></b>	<i>A comparison of the screen setup and the module written setup have produced a disparity. Use a &lt;READ&gt; command to check the setup.</i>
<b>Verify OK:</b>	The current screen setup has been WRITTEN then READ; versions are the same.
<b>Writing Complete And Verified:</b>	Successful WRITE action.
<b>Reading Module Setup:</b>	READING the configured module setup to the screen.
<b><i>Error in Opening File:</i></b>	<i>File name not recognized or located.</i>
<b><i>Error in Reading from File:</i></b>	<i>File open but cannot be READ from.</i>
<b>Reading Complete:</b>	READ action successful.
<b>Reading Firmware Information:</b>	READING 'version' information to the screen.
<b>Firmware Information Recovered:</b>	Firmware information displayed is correct.
<b><i>Incorrect Address Length:</i></b>	<i>Too few elements in the setup. Re-enter the correct address.</i>
<b><i>Invalid Address Characters:</i></b>	<i>Invalid characters used in setup. Re-enter the correct address.</i>
<b><i>Invalid Module Setup:</i></b>	<b><i>[WRITE current setup to module first]:</i></b> <i>The parameters entered will not produce a valid Selcall setup. The screen will revert to the previous setup; this must be written to the module before continuing.</i>

**Error Messages** will **FLASH** on the screen and are cancelled by using the relevant Function Key.

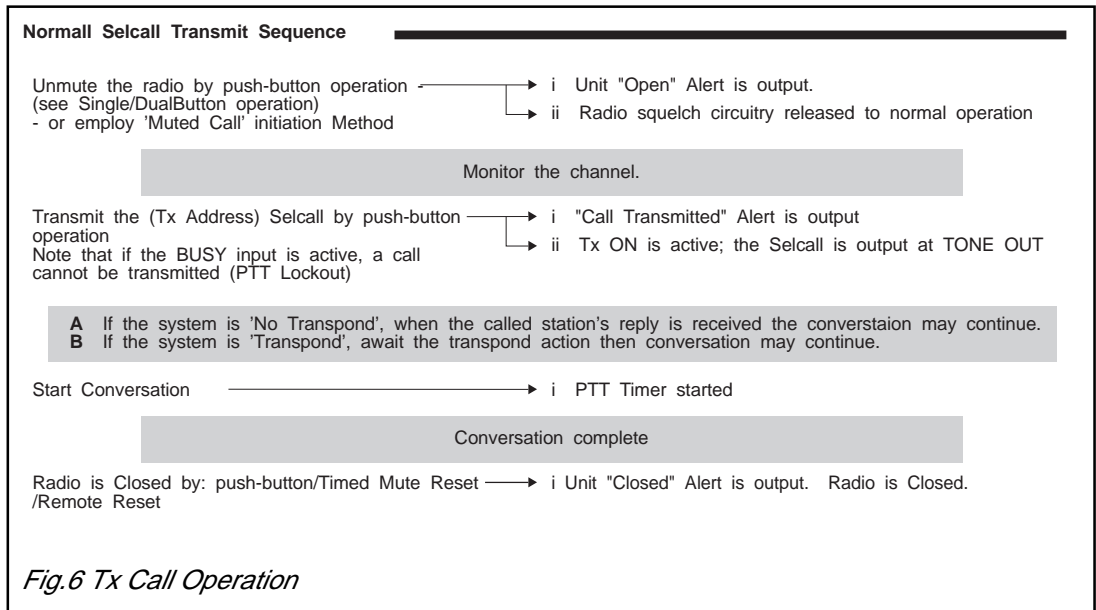
**Status Messages** indicate operational progress and remain steady on the screen during the action that they refer to.

# Functional Descriptions

## Receive Call Operation



## Transmit Call Operation



## LED Drive

A polarity programmable LED drive output is available if a visual indication of a received Selcall is required. It is recommended that, under LED conditions, this output is configured as an "active high" and an external LED is connected directly to GND (0V). With due regard to the specified current limits, this output may be used to activate mobile horn-honk/indicator driver circuits.

## LED Call Memory

If the 'Selcall Received Alert' has been activated but not cancelled, the module can be configured so as to leave the LED illuminated as a Call Memory. The use of any push-button function will cancel this LED action.

*Configured as LED Call Memory:*

# Functional Descriptions .....

## Audio Alerts

The CM1481 will provide 'alert' output signals to be used in an audio system to indicate and highlight certain operations; these are described below.  
 The alert output signal takes the form of a square-wave at the frequencies and durations described.  
 It is recommended that the Alert output is introduced to the receiver audio amplifier stages after the squelch gate and with due regard to any audio powersave functions.  
 To facilitate either loudspeaker or amplifier operation, a removable LINK is provided on the CM1481 PCB. To drive a loudspeaker, leave the LINK in place. To interface with an external amplifier, remove the LINK (see PCB Layout, Figure 4).

Cause of Alert	Alert Description	Frequencies
Entering 'Quiet' condition	Short duration low-pitch beep	1 x 200ms at 250Hz
Entering 'Open' condition	Short duration high-pitch beep	1 x 200ms at 1kHz
Selcall Received	A train of rapid mid-pitch beeps ('n' configured as "Called Alerts") cancelled by a PTT, CALL or QUIET/OPEN action [+ activation of LED output.] See LED Call Memory	'n' x 200ms at 1.25kHz
GROUP Call received	3 short duration mid-pitch beeps	3 x 200ms at 750Hz
Selcal transmitted	Short duration mid-pitch beep	1 x 100ms at 500Hz
Tx Time-out warning	Short duration high-pitch beep	1 x 100ms at 1.5kHz
PTT action disabled	Continuous low-pitch tone	347Hz
CALL action disabled	Continuous low-pitch tone	347Hz

*Table 5 Audio Alert Descriptions*

## PTT Lockout

An internal operation carried out by the CM1481 that will prevent the Tx On line being placed in an active condition irrespective of the state of the PTT In input.

Conditions that cause a PTT Lockout are:

- An active 'BUSY' input.
- The CM1481 in the 'Quiet' (muted) condition.
- PTT Timeout expired and not reset.

## Automatic REPEAT-Tone

If in any tone sequence (address or data) one tone character is identical to the preceding one, to prevent confusion at the decoder a REPEAT-tone ('E') must be transmitted in its place.

At configuration the CM1481 addresses are entered using the code characters '0' thro 'A' and identical characters entered as required.

The PC software then processes the address inserting REPEAT-tones as necessary before writing the information to the module. The REPEAT-tone must not be used as the first character of a sequence; Address/Data tones received by the CM1481 must conform to the REPEAT-tone rule for complete decode accuracy.

Example:	
<b>Required Sequence</b>	<b>Transmitted Sequence</b>
1 2 3 <b>3</b> 5	1 2 3 <b>E</b> 5

## Timed Mute Reset

When configured this function will automatically close (re-mute) the CM1481, if in the Open mode, after the configured time-period of inactivity.

*Configured as Timed Mute Reset:*

# Functional Descriptions .....

## Single or Dual Button Operation

The CM1481 can be configured to one of two modes of user control.

**Dual Button** mode. The 'Quiet/Open' switch toggles the 'Quiet/Open' (mute) function; the 'Tx Call' switch initiates a Selcall 'Tx Call'.

If it is required to operate in a unit with no local means of 'Quiet/Open' operation, this dual-button mode should be configured but the 'Quiet/Open' input not connected internally.

**Single Button** mode. A single switch (push-button) connected to either 'Quiet/Open' or 'Tx Call' inputs controls both Mute and Selcall operations.

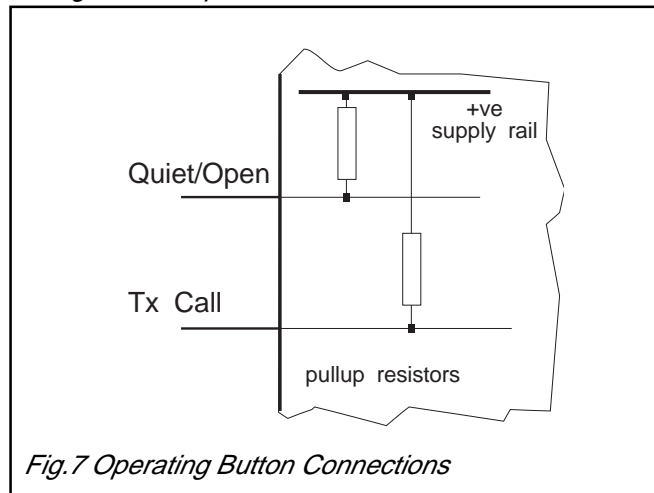
A "press" of less than 1-second will toggle the 'Quiet/Open' condition; a "press" of more than 1-second will initiate a Selcall.

Both inputs can be configured to active "High" or "Low" polarities; with reference to the CM1481, both inputs are connected, on-board, to the positive supply rail ( $V_{DD}$ ) via 47k $\Omega$  pullup resistors.

For an active "Low" input, the switches should be connected directly to 0V (GND).

For an active "High" requirement, the on-board pullup resistors must be considered.

*Configured as Operation:*



*Fig.7 Operating Button Connections*

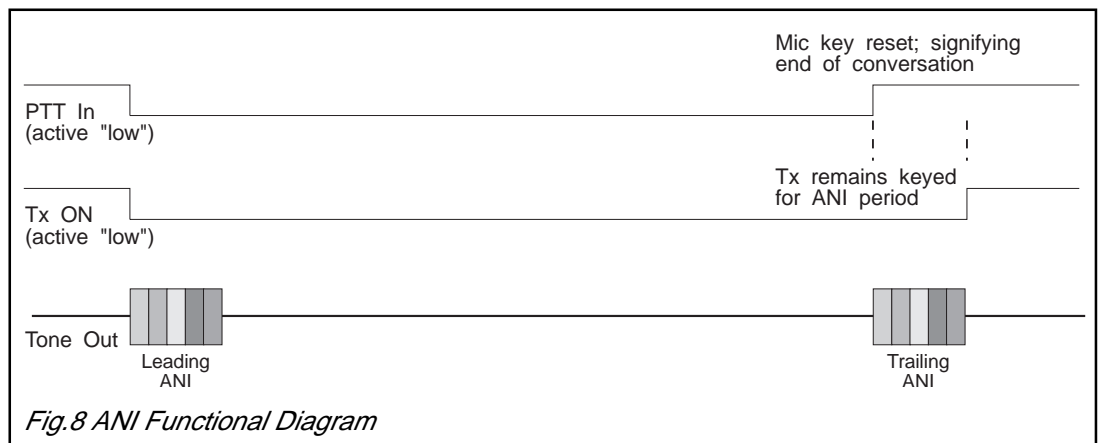
## Automatic Number Identification (ANI)

Each unit is assigned a unique ANI code which enables identification of a transmission. In the CM1481 this code is programmable, both by initial configuration and by over-air re-configuration, as the ANI address.

When enabled the ANI code is transmitted at the beginning (leading) and/or the end (trailing) of a transmission. In the CM1481 the ANI operation is selectable by configuration to either OFF, Lead, Trail, or Lead and Trail.

If the PTT Time-Out function is activated, a trailing ANI (if configured) is transmitted before shut-down.

*Configured as ANI Mode: and ANI Address:*



*Fig.8 ANI Functional Diagram*

# Functional Descriptions .....

## Input/Output Polarities

The following input and output activation polarities may be set at configuration.

Function	Notes	On-Board State	Connected To
PTT In	Input	Pullup to V <sub>DD</sub>	- the microphone end of the radio PTT line
Tx On	Output		- the PTT line to the Tx circuitry
Busy	Input	Pullup to V <sub>DD</sub>	- Rx carrier detect circuitry
Mute Ctrl	Output		- to operate the radio squelch gate
LED	Output		- to drive an LED to provide a visual alert
Quiet/Open	Input	Pullup to V <sub>DD</sub>	- to control the radio mute state
Tx Call	Input	Pullup to V <sub>DD</sub>	- Selcall initiation

*Table 6 Input/Output Programmable Polarities*

## Tx Timeout and Warning

To prevent nuisance and to regulate transmissions to a reasonable period, the PTT Timeout function will disable all PTT Tx functions after a pre-determined (configured) time period.

When the PTT is activated the PTT Timer will run for the configured interval giving an **Audible Warning** 6-seconds before the timeout. If the PTT is still active 6-seconds after the warning the transmission will be aborted at that time and all PTT functions completely disabled for a short period (6-seconds) to enable other users the opportunity to enter the channel.

Although not recommended, if the the PTT is released and re-keyed frequently before the PTT Timeout Warning, the PTT Timer will be reset and the Tx Timeout will not be activated

Under Tx Timeout conditions, the PTT must be released and will not be re-enabled for a predetermined period. The PTT Timeout period can be configured to OFF.

*Configured as PTT Time-Out:*

## NOTONE Timer

A configurable function incorporated to indicate the end of a tone or tone sequence to the on-board  $\mu$ Controller. For optimum CM1481 performance it is recommended that this function be set to approximately 1.5 times the selected Tone Length.

*Configured as NOTONE Timer:*

Recommended NOTONES

Toneset	Tone Length	NOTONE Period
EEA	40ms	60ms
CCIR	100ms	160ms
ZVEI	70ms	100ms

## Transponding

In reply to a Selcall the CM1481 can be configured to respond by transmitting either its Transpond Address (Tp) or a BEEP (tone F). This function can be re-configured over-air.

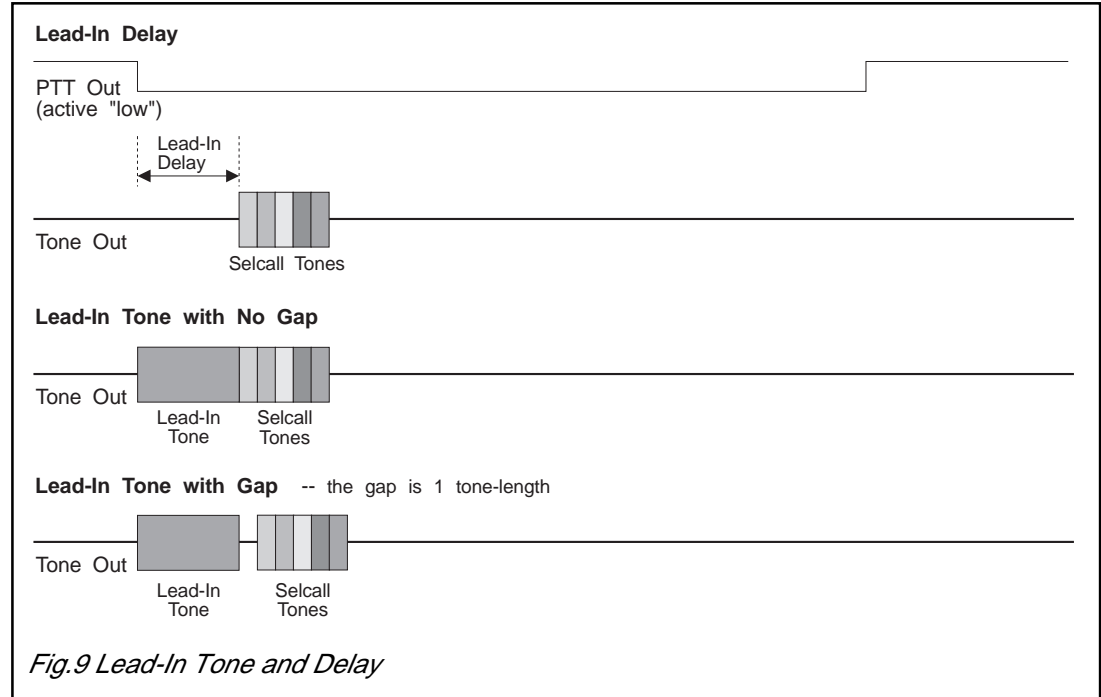
*Configured as Transpond Mode: and Transpond Address:*

# Functional Descriptions

## Lead-In Delay

A configurable delay period between the operation of the PTT and the Selcall Tone output from the module. This function is available to allow sufficient time for the transmitter to stabilize before modulation.

*Configured as Lead-In Delay:*



*Fig.9 Lead-In Tone and Delay*

## Lead-In Tone

To operate on and gain access to, repeater systems the Selcall address output of the module can be preceded by an extended tone. At configuration the tone operation, frequency and length can be set; if required a single Selcall tone-period gap between the lead-In tone and the Selcall address may be set.

*Configured as Lead-In Tone Length;, Lead-In Tone Digit: and Lead-In Gap:*

## Quiet/Open Modes

The CM1481 has two audio operational modes - **‘Quiet and Open’**.

### Quiet/Open operations are initiated by:

- (i) Pressing the Quiet/Open button (Dual Button operation) or a short press of the Operate button (Single Button operation).

### Quiet operations are initiated by:

- (i) A Timed Mute Reset operation.
- (ii) A Remote Reset command received.

### Quiet

The radio Rx audio is muted.  
PTT (Tx) action is disabled.

Selcalling can either be disabled or enabled via initial configuration. There are no operational alerts except for PTT and Call Action Disabled or Selcall Transmitted (if configured).

### Open

Open modes can be configured to either **Unmuted** or **Transparent** states.  
If called in an “Open” mode received Selcall tones will be output at the loudspeaker.

*Configured as Open Mode:*

#### Unmuted:

The radio is unmuted (MUTE CTRL inactive) and the loudspeaker (hash) is enabled. All functions are enabled and operate as configured.

#### Transparent:

The radio audio circuits act as if squelched; Audio output is dependant upon the presence of an RF carrier (BUSY input). MUTE CTRL is only inactive if the BUSY input is active.



# Functional Descriptions

## 'Muted' Call Initiation

It is possible for the CM1481 to be embodied within a radio that has no local means of Quiet/Open control; the CM1481 will be configured to Dual button operation but the Quiet/Open input not used. Such a system will require the base station to operate its mute system and open the squelch or re-mute with a Remote Reset command.

In a radio that has no local means of opening its mute function, the operator must initiate a Selcall to the base; PTT Lockout will prevent any illegal voice transmission.

The base must be so configured as to contact the CM1481 fitted radio and lift the mute function (and therefore allow normal operation) by replying with the unit's Receive Address. Reception of its receive address Selcall will cause an alert beep sequence at the CM1481; operation of the PTT will halt the alert and unmute the radio; normal operation may take place.

Upon completion of the conversation the unit's operation will be reset (muted) by the base with a Remote Reset command.

*Configured as Call When Quiet:*

## Power-Up 'Quiet'/'Open'

The CM1481 can be configured to assume one of two mutes conditions upon power-up.

Quiet -- The audio output is muted; a Quiet/Open operation is required to monitor channel activity.

Open -- The audio output is active; the channel can be monitored to ascertain activity and correct operation.

*Configured as Start-Up State:*

## Over-Air Functions

### (a) Remote Reset      (b) 'Re-Configuration'      (c) 'Stun'      (d) 'Release'

The above operations may be carried out from a suitably configured remote station (the controlling base) to:

#### (a) Mute a Radio:

Using a "C" or "D" tone appended to the units Rx Selcall address. See Figure 13.

#### (b) 'Re-Configure' the following parameters:

<i>Tx Address</i>	<i>Rx Address</i>
<i>ANI Address</i>	<i>ANI Mode</i>
<i>Transpond Address</i>	<i>Transpond Mode</i>

#### (c) 'Stun' a Radio:

To completely disable a CM1481 fitted radio unit.  
Rx audio is permanently muted; PTT line is disabled; Selcall transmission is inhibited.

#### (d) 'Release' a Radio:

To release the CM1481 fitted radio from the 'Stun' mode and allow normal operation.

Over-Air function operation is enabled and disabled at Configuration as *Over-Air Function:*

# Functional Descriptions .....

## Security Checks

To prevent unauthorised or 'accidental' over-air operations, items (b), (c) and (d), described on the previous page are carried out using a secure authentication protocol based upon the synchronization of two pseudo-random number generators, one in the base, one in the CM1481 unit. Figure 10 shows an operational security transaction.

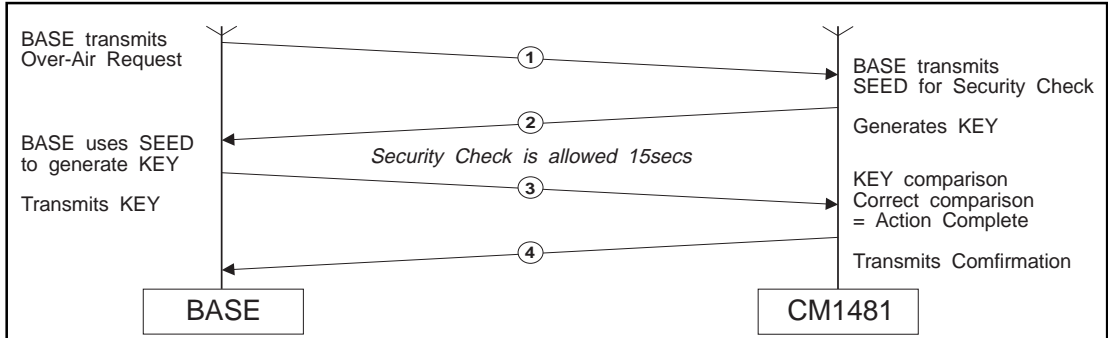


Fig. 10 An Over-Air Security Transaction

## Over-Air Functions

On reception of an over-air request [1] the CM1481 will produce, and transmit, a random SEED (random number) [2] which will set the start-count position for both pseudo-random generators; under the control of the configured "Iterations" parameter both generators will produce the KEY.

Correct KEY comparison will allow the over-air operation to be completed and confirmed [3].

Each over-air operation requires its Security Check to be completed within a preset time period of 15 seconds.

Failure to complete the transaction in the pre-determined time or an incorrect KEY comparison will result in the cancellation and failure of the relevant operation.

Due to the covert manner of this operation the CM1481 will not produce an "OPEN" or "Selcall Received" alert during these transactions.

Neither ANI or Transpond functions are available during Over-Air operations.

# Functional Descriptions .....

## Example Over-Air Transactions

Figure 11 (below) shows, in diagrammatic form, the sequence of tones for an Over-Air Re-Configuration of the Tx Address between the controlling base station and the CM1481. Figure 13 shows the complete range of tone sequences to be used with the CM1481. For Over-Air transactions follow the steps illustrated in Figure 11 substituting the required action in STEP 1 with the required request and confirmation from Figure 13. Note the use of the Data Prefix tone "B" in the data field; all operations must conform to the HSC Operational Rules which are described on the following pages.

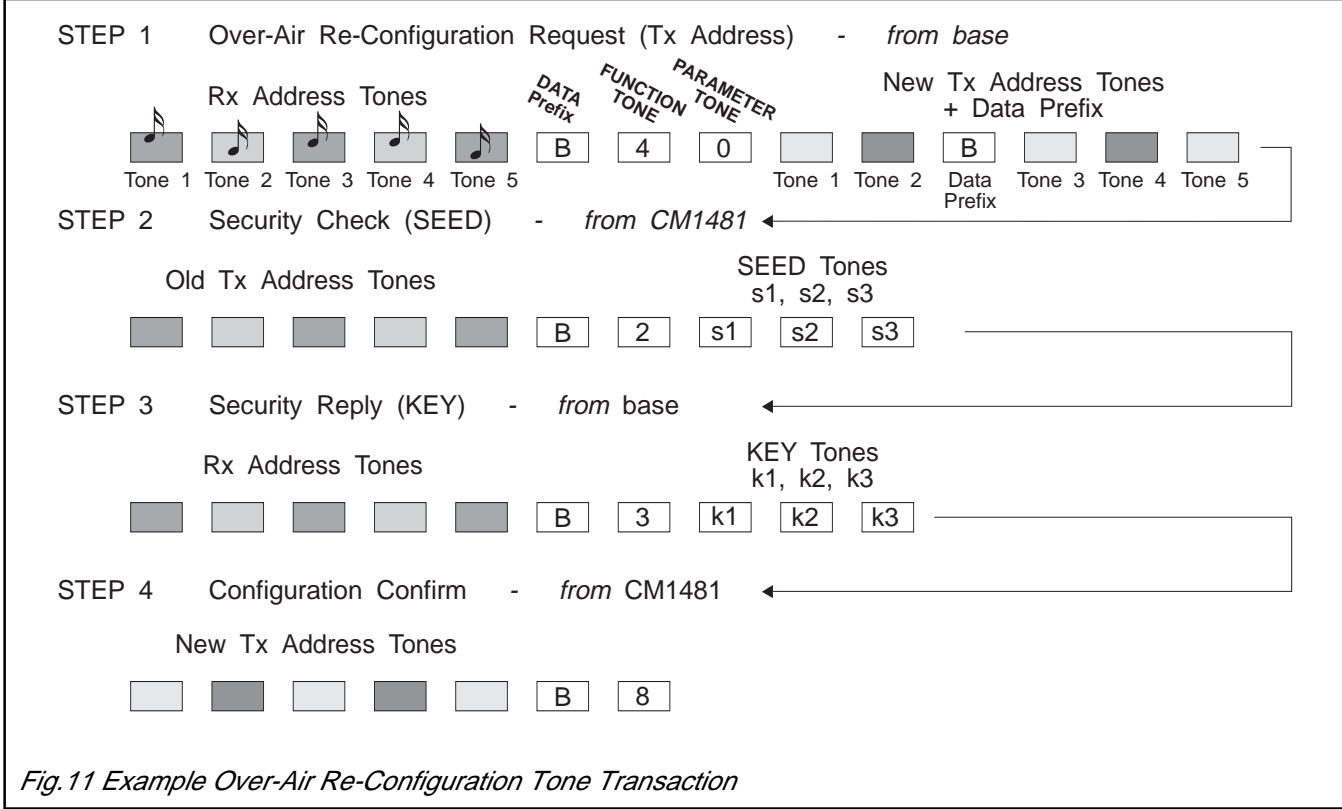


Fig.11 Example Over-Air Re-Configuration Tone Transaction

## Pseudo-Random Number Information

The figure below shows the pseudo-random number generation in diagrammatic form. The base unit controller's software and circuitry will require to emulate this function. The SEED is a random 8-bit number produced by the CM1481. The SEED is loaded into the register and shifted right by the amount of steps configured as: *Pseudo Iterations*. Note the Exclusive-OR functions. The result is the KEY.

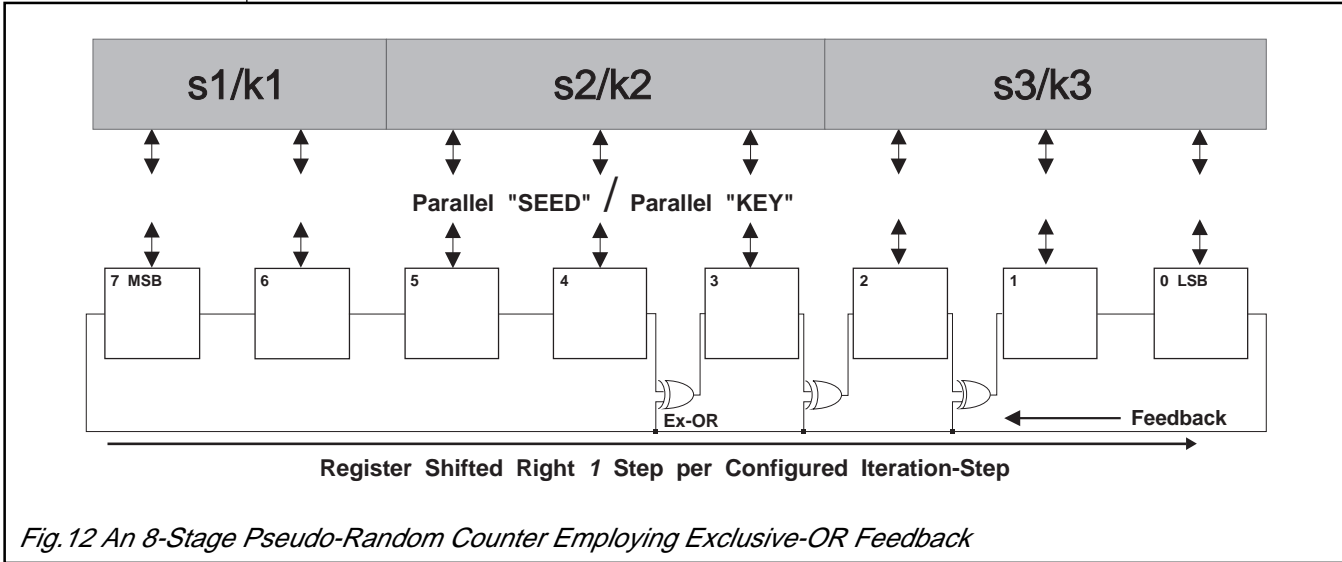


Fig.12 An 8-Stage Pseudo-Random Counter Employing Exclusive-OR Feedback

# Functional Descriptions .....

## Over-Air Tone Information

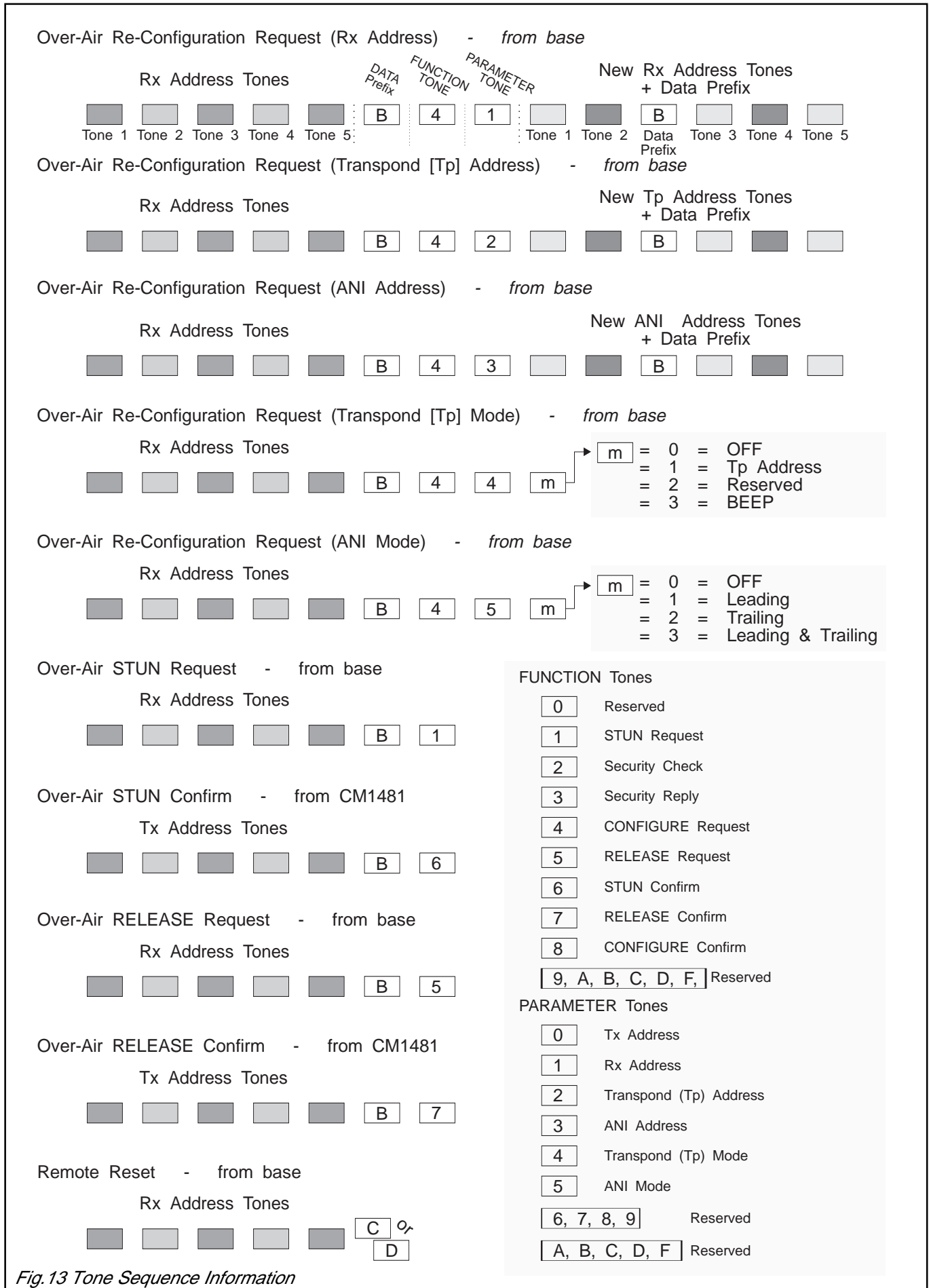


Fig.13 Tone Sequence Information

# Functional Descriptions .....

## HSC Hexadecimal Sequential Code

An in-band audio signalling system used for the communication of Address and Data information using sequential tone signalling. Sequential tone signalling has been adopted to national and international standard tonesets. The CM1481 will operate to any one of the following tonesets in both frequency and tone-length. The required toneset is selected at initial configuration from the selection shown below.

Tone No (Hex)	EEA	CCIR	ZVEI 1	PZVEI	ZVEI 2	ZVEI 3 DZVEI
0	1981	1981	2400	2400	2400	2200
1	1124	1124	1060	1060	1060	970
2	1197	1197	1160	1160	1160	1060
3	1275	1275	1270	1270	1270	1160
4	1358	1358	1400	1400	1400	1270
5	1446	1446	1530	1530	1530	1400
6	1540	1540	1670	1670	1670	1530
7	1640	1640	1830	1830	1830	1670
8	1747	1747	2000	2000	2000	1830
9	1860	1860	2200	2200	2200	2000
A	1055	2400	2800	970	885	825
B	930	930	810	810	810	740
C	2247	2247	970	2800	740	2600
D	991	991	885	885	680	885
E	2110	2110	2600	2600	970	2400
F	2400	1055	680	680	2600	680

*Table 7 Tone Frequencies (in Hz)*

## Operational Rules

To ensure all-system compatibility, the CM1481 has been designed to operate to the following rules.

Base and other units working with the CM1481 must conform to these rules.

- 1** All calls, commands and interrogations to, and calls from, the CM1481 are prefixed with a 5 (or 6)-tone HSC format Selcall Address.
- 2** Full international group-calling is possible to more than one user group via GROUP and REPEAT tones.
- 3** A DATA FUNCTION tone "B" is appended after the Selcall address. No more than 4 adjacent DATA tones are allowed; if more than 4 are required, a DATA FUNCTION tone should be inserted after every fourth DATA tone.
- 4** The DATA FUNCTION tone may be lengthened to twice the chosen toneset length under the control of the Extended Data Tone command at initial configuration.
- 5** If in any tone sequence (address or data) one tone character is identical to the preceding one, to prevent confusion at the decoder a REPEAT-tone ['E'] must be transmitted in its place.

# Functional Descriptions .....

## Tone Allocations

Character	Function
<b>0 thro' 9</b>	Decimal digits in the address or data fields.
<b>A</b>	GROUP character in the address field or "A <sub>HEX</sub> " in the data field.
<b>B</b>	Data prefix tone or "B <sub>HEX</sub> " in the data field.
<b>C</b>	REMOTE RESET character address code suffix or "C <sub>HEX</sub> " in the data field
<b>D</b>	REMOTE RESET character address code suffix or "D <sub>HEX</sub> " in the data field
<b>E</b>	REPEAT character
<b>F</b>	"F <sub>HEX</sub> " in the data field

*Table 8 Tone Allocations*

## International GROUP CALL

The international standard for calling a specific group of units by inserting the GROUP-Tone ('A') into a Selcall.

The GROUP-Tone ('A') represents all tone digits from 0 to 9. Any character in the Selcall address can be replaced by a GROUP-Tone ('A'); a second consecutive GROUP-Tone should be replaced by a REPEAT-Tone. The flexibility of placing GROUP-Tones within a Selcall Address allows more user-groups to be set-up.

Example:

Address Sequence	Addressed Units
1 2 3 4 A	1 2 3 4 0 to 1 2 3 4 9
1 2 A 4 5	1 2 0 4 5 to 1 2 9 4 5
1 A 3 4 A	1 0 3 4 0 to 1 9 3 4 9
1 2 A E A	1 2 0 0 0 to 1 2 9 9 9

## Non-International GROUP CALL

To provide compatibility with Selcall systems where the only characters permitted to follow a GROUP-Tone ('A') in a sequence are other GROUP- or REPEAT-Tones. Under this protocol, the first GROUP-Tone is extended to 3 times the normal system length.

To transmit to such a system as opposed to an International system, the Extended GROUP-Tone (Tx) option must be selected at initial configuration. This method restricts the number of Groups available.

Example:

Address Sequence	Addressed Units
1 2 3 4 A	1 2 3 4 0 to 1 2 3 4 9
1 2 3 A E	1 2 3 0 0 to 1 2 3 9 9
1 2 A E A	1 2 0 0 0 to 1 2 9 9 9
1 A E A E	1 0 0 0 0 to 1 9 9 9 9
A E A E A	0 0 0 0 0 to 9 9 9 9 9

The CM1481 is able to transmit and respond to both International and Non-International GROUP-Calls.

The Transpond facility (Tp) is not available for GROUP-Calls.

The GROUP-Call character can be configured into any address set-up.

## Specification

### Absolute Maximum Ratings

Exceeding the maximum rating can result in module damage. Operation of the module outside the operating limits is not implied.

Supply voltage 6.0V to 26.0V

Operating temperature range: **CM1481** 0°C to +70°C

Storage temperature range: **CM1481** -20°C to +85°C

### Operating Limits

All module characteristics are measured under the following conditions unless otherwise specified:

$V_{IN} = 6.0V$  to  $12.0V$ ,  $T_{OP} = 0^{\circ}C$  to  $+70^{\circ}C$ .

Characteristics	See Note	Min.	Typ.	Max.	Unit
Supply Voltage ( $V_{IN}$ )		6.0		26.0	V
Operating Current (Tx/Rx)		-	9.5	-	mA
Standby Current	7	-	2.5	-	mA
LED Drive Current		-	-	15.0	mA
Current Limits (PTT and Mute O/Ps)		-	-	50.0	mA
Input Sensitivity	1	31.0	-	-	mVrms
Tone Out Level		-	308	-	mVrms
Tone Out Accuracy		-	-	±0.1	%
Alert-Tone Output Level	2	-	250	-	mV p - p
Tone Decode Bandwidths					
CCIR		-	±2.30	-	% fc (Hz)
EEA		-	±2.30	-	% fc (Hz)
ZVEI		-	±3.80	-	% fc (Hz)
Signal -to-Noise Performance	3	-	100	-	%
Logic "1" In	6	3.5		13.8	V
Logic "0" In	6	0		1.0	V
LED Logic "1" Out		4.2	-	-	V
LED Logic "0" Out		-	-	0.4	V
Audio Switch Signal		-	-	5.0	V p - p
Alert Output Impedance	4	-	140	-	$\Omega$
	5	-	100	-	k $\Omega$
Signal Input Impedance		-	20.0	-	M $\Omega$
Signal Output Impedance		-	10.0	-	k $\Omega$
Configuration Clock Rate		-	-	1.0	kHz
On-Board Xtal Frequency		-	4.0	-	MHz

#### Notes

- Under pure-tone conditions.
- The 'Alert' square-wave driving an 8 $\Omega$  load with on-board LINK in position (see Figure 4).
- At -4.0dBs S/N (using a 100ms CCIR signal at 248 mVrms).
- With on-board LINK in position.
- With on-board LINK removed.
- PTT, CALL, QUIET/OPEN, BUSY, CONFIG. Inputs.
- The standby condition is when the CM1481 is in the Quiet mode.

## Ordering Information

**CM1481      Non-Predictive Selcall Module**

[Module + Radio Interface]

**CK1481      Configuration Kit**

[Configuration Interface Connector  
+ Software {5<sup>1</sup>/<sub>4</sub> & 3<sup>1</sup>/<sub>2</sub>" disks} ]

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