# KENWOOD

TK-249/349

TK-759/859

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# 1. INTRODUCTION

This document describes the functional specifications of the Integrated Controller Module for the Kenwood TK-709/809 series mobile radio and TK-249/349 series portable radio.

It follows the user requirements specifications as agreed during the meeting at the Kenwood factory in Yokohama, Japan. Integration of specifications for both the TK-709/809 and TK-249/349 is possible because the user interface will be very similar and the programming software will be exactly the same.

The project is covered by the order for development of the ICM issued by Kenwood Japan, and will include the development of the ICM software for both the portable and mobile, PROGSYS and PROGSIM.

## 2. MAIN FEATURES

The TK-709/809 and TK-249/349 ICM (hereafter "ICM") is based on the Rohill 2nd generation ICM concept. The 2nd generation ICM concept offers the following facilities:

* Up to 200 simplex or semi-duplex channels.

* Integrated selcall encode/decode, DTMF encode, CTCSS/DCS transmit and receive, channel scanning with priority scanning and queuing/call-back.

* Same LCD and button configuration as TK-series mobiles and portables, but several application-specific operation methods are provided.

* Five buttons for basic operation; fully programmable, also multiple functions per button (key press, hold-down and release).

* Optional keypad: keypad/microphone for mobile, add-on keypad for portable. Allows operation of advanced ICM capabilities.

* Microphone connector on mobile allows connection of standard microphone, keypad/microphone and PC for programming and remote control. For portable, these functions can be accessed via two jack plugs.

* Basic (PROGSIM) and advanced (PROGSYS) programming software package allows configuration of a wide range of capabilities.

# 3. SUMMARY OF FUNCTIONS

## 3.1 Channel switching and scanning

* Capacity for 200 channels
* Independent frequency for transmit and receive
* Receive-only channels possible
* Programming in 5.00 and 6.25 KHz steps
* Supports multiple frequency bands
* Multiple display formats for channel numbers; 3-digit numerical or 5-digit semi alphanumerical
* Maximum 10 scan groups
* Unlimited number of channels per scan group
* One priority channel per scan group
* User programmable scan list for each scan group, also priority channel can be changed
* Scan for carrier, CTCSS/DCS, selcall 1st tone and both CTCSS/DCS and selcall
* Per system group selectable scan speed, scan wait period, scan resume time and scan configuration
* Per scan group selectable priority channel and priority scan interval
* Configurable behaviour of PTT while scanning

## 3.2 General

* PTT timeout timer
* Warning period before PTT times out
* PTT inhibit after PTT timeout
* Startup channel selection

* Restore last selected channel on power-up
* Default channel or selcall selection by keypad
* RF power per system group selectable or fixed to low or high
* Different display formats to optimize for most frequent used facilities
* Fully user-definable function per button for press, release and hold-down
* Hook control functions
* Up/Down/Shift for basic operation of selcall by buttons
* External alert output for horn relay
* External emergency button input for foot switch
* Near-compatibility mode (buttons ans display) to existing radios

## 3.3 Selective calling, decoding

* Sixteen tonesets, including ZVEI, CCIR, EEA, DZVEI, PZVEI, PCCIR, PZVEI, ZVEI-2, EIA, Natel, AP369 and a Kenwood specific toneset
* Decode format concept allows decoding of up to 15 tones per packet
* Simultaneous decoding of multiple formats, e.g. 5-tone, 6-tone and 2x5-tone
* Decode formats allow multiple decode addresses with fixed and channel dependent digits, keypad-selectable digits and received digits
* Queueing of up to 5-tones on arbitrary positions within decoded packets
* Queue stores up to 4-9 entries, depending on the capacity needed per entry
* Repeat and group tone decoding, different alerts for incoming group calls
* Per group selectable toneset and decode format, thus allowing operation of the same radio within different systems
* Remote stun, revive and remote kill
* Remote close (Philips and Motorola methods)
* Auto-close (Bosch method)

## 3.4 Selective calling, encoding

* Sixteen tonesets; selection of tonesets within encode formats allows switching of tonesets while transmitting
* Tone duration and pause length selectable within encode format from 1 to 7.000 ms, changing tone duration within sequences is possible as well
* Any encode format possible from 1 till 28 tones, containing fixed, channel dependent, keypad-selectable digits and received digits
* Up to 5-tones selectable by keypad or up/down buttons
* Automatic repeat tone generation
* Free-dialling through telephone interconnect to PABX/PSTN, using selcall packets for transferring up to 28 digits
* Single-tone transmission possible for any tone with frequency between 300 and 3.000 Hz and duration between 1 and 7.000 ms.
* Selcall ANI on press and/or release of PTT
* Automatic repeat call until acknowledged
* Carrier, CTCSS, open en close lockouts

## 3.5 CTCSS

* 38 standard EIA tones
* Encode/decode tone selectable per channel
* Trailing CTCSS mute to suppress noise on receiving radio
* Two CTCSS PTT lockout conditions

## 3.6 DCS

* Motorola DPL compatible
* Encode/decode DCS tone selectable per channel
* Includes four decoding performance modes
* Two DCS PTT lockout conditions
* Tone burst at PTT release to suppress trailing noise

## 3.7 DTMF

* PTT overdialling (press buttons on keypad while pressing PTT)
* PTT 'on hook' dialling: enter dialling string, then transmit call
* Key buffer, selectable tone and pause duration

# 4. USER INTERFACE

In this chapter the user interface is described in detail. In chapter Operations a more detailed description is included for reference.

## 4.1 Buttons

In its basic configuration, both the mobile and portable provide a number of buttons for operation. These buttons can be used for similar purposes as for the F-series of mobiles and portables, however it is possible to configure them for other purposes.

The F-series mobiles provides the following key functions: MON (speaker symbol, monitor), SQUELCH (squelch symbol), CALL (tone symbol), x10 (left digit up) and x1 (right digit up). On the microphone a PTT (Push-to-Talk) button is provided.

The F-series portables provide the following key functions: MONI (Monitor), PTT (Push-to-Talk), CALL, x10 (left digit up), x1 (right digit up), SQUELCH (squelch symbol) and LAMP.

### 4.1.1 Button actions

The ICM allows assignment of button functions for the following key actions: key press, key hold-down and key-release. In addition a shift-key function is provided.

The key press function is immediately executed when pressing the key. After the debounce period of time (about 30 ms), the attached function will be executed. A key function attached to key hold-down will be executed after holding down the key during 500 ms. This will be confirmed by a double-beep.

If a hold-down function is assigned to a button, normally no key press function is assigned to prevent a double action. In this case, a key release is assigned, so this key function is executed when releasing the key before the hold-down period of time is expired.

The shift-key function can be used for a secondary function, which is operated by pressing the shift-key first and then the appropiate key.

See section 4.7 for full overview of available key functions.

### 4.1.2 Available buttons

To allow programming of the portable and mobile with the same programming software package, one set of keys has been defined. These are:

| | |
|---|---|
| MONI | MONI on portable, [speaker] on mobile |
| CALL | CALL on portable, [tone] on mobile |
| SQ | [squelch] on both portable and mobile |
| x10 | x10 on both portable and mobile |
| x1 | x1 on both portable and mobile |
| LAMP | LAMP on portable, not available on mobile |

The behaviour of the PTT button is seperately programmable. The PTT linked functions are identical for the mobile and portable.

### 4.1.3 Suggested operation of buttons

The default operation of buttons is specified in the table below:

| Button | key release action | key hold-down action |
|---|---|---|
| MONI | selcall open/close | who-has-called |
| CALL | transmit normal call | transmit status call |
| SQ | noise squelch defeat | external alert on/off |
| x10 | selcall x10 or shift | priority scan on/off |
| x1 | selcall x1 or up | scan on/off |
| LAMP | LAMP on/off | |

The PTT operates as Push-to-Talk. Several options are available to prevent speech transmission; if one of these conditions occurs, an error beep will be sounded.

## 4.2 Keypad

The full range of capabilities of the ICM can be utilized only when a keypad is provided. For the mobile a keypad/microphone is available, for the portable an add-on keypad can be mounted.

Also each button on the keypad is fully user-configurable using the programming software. For each button a key-press, key hold-down, key release and shift key function is provided.

In addition to the numerical keys 0 to 9, the function keys *, #, A, B, C and D are available for direct selection of facilities. It is suggested that one of the keys is used as shift-leadin key to activate and de-activate the shift function. Although it is possible to use the hold-down key function, it is suggested to use the shift function instead.

In the following overview the default operation of the keypad is described:

| key | key press | key shift |
|---|---|---|
| 0 | 0 | group digit |
| 1 | 1 | freedial selcall |
| 2 | 2 | freedial DTMF |
| 3 | 3 | long-tone |
| 4 | 4 | status call |
| 5 | 5 | scan on/off |
| 6 | 6 | pri scan on/off |
| 7 | 7 | channel entry mode |
| 8 | 8 | selcall entry mode |
| 9 | 9 | queue entry mode |
| * | call | N/A |
| # | monitor | N/A |
| A | shift | unshift |
| B | N/A | code lock |
| C | clear digit | clear all |
| D | power lo/hi | scan programming |

While the PTT is pressed, the operation of the keypad is changed to DTMF overdial. This is described in the relevant section of this document.

## 4.3 Channel knob

A turn-knob is provided on both portable and mobile to select the radio channel. By rotating the knob leftwise, the preceeding channel number will be selected, and by turning the knob rightwise, the following channel will be selected. Note that the channels are selected in the order as programmed, which can be different from the order of channel number as shown on the display.

Channels with a numerical readout can also be selected by the keypad; channel readouts with alphanumerical characters can only be selected using the channel knob.

## 4.4 Display

The display for the portable and mobile have a similar layout. The Liquid Crystal Display supports the following features:

* Five large digits
* Two smaller digits at left side of display
* One smaller digit at right side of display
* Indicator for transmit (mobile only) TX
* Indicator for channel busy BUSY
* Indicator for monitor MON
* Indicator for squelch defeat SQ
* Indicator for channel CH
* Indicator for called (mobile only) CALL
* Indicator for low power (portable only) LO
* Red LED for transmit (portable only) TX-LED

The numerical fields can be used in different formats, so the operation can be matched best to the application. The indicators have a fixed meaning, as described below:

| indicator | off | on | flashing |
|---|---|---|---|
| TX (mobile) | receive | transmit | lockout |
| BUSY | channel clear | channel busy | |
| MON | close | open | called |
| SQ | mute | unmute | scan prog |
| CHANNEL | selcall entry | channel entry | queue mode |
| CALL (mobile) | no alarm/transf | ext.alarm | transfer call |
| LO (portable) | high power | low power | battery low |
| TX-LED (port.) | receive | transmit | lockout |

## 4.5 Audible alerts

The following audible alerts are defined:

- Power-on cadence
- Short beep for key press
- Double high/high beep for key hold-down
- Double high/low beep for error
- Three high beeps for battery-low warning (repeated)
- 24 different beeps to alert for incoming calls

In total 32 beep sequences are specified. A full overview of frequencies, durations and pauses of these 32 beep sequences is included in appendix G.

## 4.6 Error messages

The following error messages are provided:

- Error 1 Hardware fault
- Error 2 EEPROM data corrupt (CRC error)
- Error 3 PLL out-of-lock

The error message is shown during the period of time the fault occurs. In the following overview the operating restrictions and recommended actions are explained:

- Error 1: a hardware fault will be detected on power-up. The error message will remain in the display until the radio is turned off, and operation of the radio is not possible. Return the radio to a service shop for repair.

- Error 2: the EEPROM CRC-check is executed on power-up. The error message will remain in the display until the radio is turned off, and operation of the radio is not possible. The problem can be corrected by re-programming the radio.

- Error 3: this error message is shown when the PLL (Phase Lock Loop) goes out-of-lock. This condition is tested continuesly during transmit as well as receive, and can happen also for transmit or receive only. Channel switching is still possible. To correct this problem it is recommended to check the programmed frequencies, and if these are correct, to return the radio to a service shop for repair.

When an error message is shown, all other symbols and digits are cleared. The error message is shown on the display as 'Err n' where n is the error number.

## 4.7 Key definitions

To each key action a key function can be attached. These key actions are described in section 4.1.1. The programming software includes a key definition matrix where for each key and each action a key function can be selected. In total 6 buttons and 16 keys are supported.

The following key functions are available:

| | |
|---|---|
| [OFF] | not assigned |
| 0 | enter digit 0 |
| 1 | enter digit 1 |
| 2 | enter digit 2 |
| 3 | enter digit 3 |
| 4 | enter digit 4 |
| 5 | enter digit 5 |
| 6 | enter digit 6 |
| 7 | enter digit 7 |
| 8 | enter digit 8 |
| 9 | enter digit 9 |
| group digit | enter digit A |
| clear digit | erase one digit |
| mon.selcall | monitor selcall (open/close) |
| mon.SAT | monitor sub-audible tone |
| mon.both | monitor selcall/SAT |
| selcall res. | mute selcall (close) |
| shift | activate shift mode |
| unshift | deactivate shift mode |
| digit 1x | rightmost digit up |
| digit 10x | 2nd digit from right up |
| digit up | selected digit up |
| digit shift | select next digit |
| mode select | toggle between selcall and channel entry |
| mode reset | reset to default mode |
| scan on/off | toggle scan on/off |
| pri on/off | priority scan on/off |
| scan+pri | toggle priority+scan on/off |
| scan on | start scanning |
| pri on | start priority scanning |
| scan+pri on | start both scan and priority scan |
| lamp on/off | switch backlight on/off |
| lamp on | switch backlingt on |
| key lock | lock keypad |
| code lock | lock operation of radio (4 digit PIN) |
| power select | select power low/high |
| channel ent. | select channel entry mode |
| selcall ent. | select selcall entry mode |
| status ent. | select status entry mode |

| | |
|---|---|
| queue mode | select queue mode |
| queue next | select next queue entry |
| queue select | select next queue entry, return to normal operation |
| encode #1 | execute encode format #1 |
| encode #2 | execute encode format #2 |
| encode #3 | execute encode format #3 |
| encode #4 | execute encode format #4 |
| encode #5 | execute encode format #5 |
| encode #6 | execute encode format #6 |
| mon.unmute | squelch unmute |
| mon.mute | squelch mute |
| mon.toggle | squelch mute/unmute |
| clear all | clear digit buffer, queue |
| scan prog | access to scan programming mode |
| ext/transfer | switch on/off external alarm and transfer |
| hold delay | execute key hold delay |
| beep volume | select key beep volume |
| alert volume | select alert volume |

## 4.8 Display formats

The usage of the numerical digits vary for the different modes which can be activated, and the configuration of the radio choosen while programming the radio. In the following sections these display formats are explained.

### 4.8.1 Default display format

The ICM provides four default display formats, each optimized for certain applications. These display formats are:

1. Channel readout
   The channel number is shown as a number or as a string of 5 characters on the large digit section of the display. This display format is preferred if selcall is not used, or if the selectable selcall address digits are changed rarely. Some examples of this display format:

   | | |
   |---|---|
   | Ch 3 | channel 3 selected, numerical readout |
   | Ch 04 | channel 04 selected, numerical readout |
   | Ch199 | channel 199 selected, numerical readout |
   | Ch-12 | channel 12 selected, numerical readout |
   | POL-3 | example of character string readout (Police-3) |

   The available characters for the three digit numerical channel number readout are: 0 to 9, A, B, C, - and <space>. The 5-digit alphanumerical format allows programming of any character or symbol which can fit in a 7-segment form.

2. **Selcall address readout**
This display format is preferred for applications where channel switching is not or rarely used. On the large digit section of the display, the selectable part of the selcall address is shown.

If less than 5 digits are selectable, the selectable digits are shown at the right side of the large digit field. The non-selectable digits are replaced by a standard text, which can be configured while programming. Some examples of this display format:

| | |
|---|---|
| 59402 | selcall address 59402 selected |
| 22 | selcall address 22 selected (2 digits selectable) |
| 4AA | selcall address 4AA selected (includes group digits) |
| SEL02 | selcall address 02 selected, overlay text 'SEL ' |

Only numerical digits and group digit A can be shown and selected at the selectable digit positions.

3. **Combined selcall and channel readout, small/large digits**
This display format shows the channel number and current selected selcall address simultaneously. The channel number is shown on the small 2-digit field at the left side of the display, the selcall address is shown at the large 5-digit field. Because the channel field is 2 digits wide, only the rightmost two digits of the channel readout number or string are shown in this field. At the selcall address field on the display only the selectable digits are shown. Below a number of examples are shown:

| | |
|---|---|
| 01 59402 | channel 01, selcall address 59402 |
| 14 402 | channel 14, selcall address 402 |
| 3 98 | channel 3, selcall address 98 |
| L7 12345 | channel L7, selcall address 12345 |
| A2 SEL45 | channel A2, selcall address 45, overlay text 'SEL ' |

Although it is possible to use alphanumerical characters in the channel number field, the three leftmost characters are discarded. For the channel and selcall digits, the same rules apply as for the seperate channel and selcall formats.

4. **Combined selcall and channel readout, large digits only**
This display format is similar to the existing TK-series mobile display format for combined selcall and channel selection. This format shows both the channel number and selcall address as two digits on the large display field. Some examples:

| | |
|---|---|
| 02 01 | channel 01, selcall address 02 |
| 4 12 | channel 12, selcall address 4 |
| 99 7 | channel 7, selcall address 99 |
| 31 B9 | channel B9, selcall address 31 |

Also here, the same rules apply for the selcall and channel digits as previously explained.

### 4.8.2 Status entry mode

The status entry mode operates similar as the selcall entry mode. Up to 5 digits can be selectable for status number entry. If less than five digits are selectable, an overlay text character will be shown at these positions. This overlay text is configured while programming the radio.

The status entry digits replace the selcall digits as shown in the formats described in section 4.8.1. Either format 2, 3 or 4 is used when the status entry mode is selected. Some examples can be found below:

```
  1235     [mode 2] status 1235 selected, no overlay text
 St  5     [mode 2] status 5 selected, overlay text 'St  '
7    45     [mode 3] channel 7, status 45, no overlay text
12 St 45   [mode 3] channel 12, status 19, overlay text 'St  '
A2 St  1   [mode 3] channel A2, status 1, overlay text 'St  '
 99  7     [mode 4] channel 7, status 99
```

### 4.8.3 Scan mode display readout

For the normal scan, priority scan and both normal+priority scan modes, also a number of display formats are available. The display format for scanning is selected from within the programming software. These display formats include:

1. **Standard scan display format**
   The standard format shows the channel number, the scan group number if more than one scan group is available, and the scan mode. Some examples of this standard scan format are:

```
Sc Ch 05 1   channel 05, scan group 1, scan mode
Pr Ch 12 6   channel 12, scan group 6, priority scan mode
SP Ch122 9   channel 122, scan group 9, scan+priority
Sc Ch 16     channel 16, single scan group, scan mode
```

2. **Scan group display format**
   This format is similar to the standard format for scan readout, but the channel number on the large digit field is replaced by the word 'Scan' during active scanning, and is replaced by the actual channel number when stopped. Some examples:

```
Sc Scan  1   scanning, scan group 1, scan mode
SP Ch122 9   stopped on channel 122, scan group 9, scan+priority
Sc Scan      channel, single scan group, scan mode
```

3. **Background scan display format**
In some automatically operated systems, it should be possible to select a selcall address or enter a dialling number while the radio continues scanning. The background scanning method provides this function. Some examples:

```
Sc 59402 1   selcall address 59402, scan group 1, scan mode
Pr    02 3   selcall address 02, scan group 3, priority scan mode
Sc   06-     dialling string '06-' entered, single scan group, scan mode
```

### 4.8.4 Dial number entry mode

The ICM allows entry of up to 28 digits for transmission of numerical data as a selcall packet or as DTMF digits. The entry mode for this is initiated by a so-called encode instruction, triggered by pressing a key. In this dialling entry mode, only the large 5-digit field is used, except within the background scan mode. Examples of this display format include:

```
      2     dialling string '2' entered
  12234     dialling string '12234' entered
   06-4     dialling string '06-4' entered
Sc 0528     dialling string '0528' entered in background scan mode
```

### 4.8.5 Queue entry mode

The queue entry mode shows the current selected queue entry. Up to nine of these queue entries are available, however the queue capacity will be limited (down to four) when many digits are stored for every incoming call. If no queue calls are received, or if all queue entries are erased, the display will show dashes. Otherwise, the display will show the identity of the other party and the channel number (if stored). The following examples show the format of the queue entry mode:

```
12   402 1   channel 12, identity 402, entry 1
91 59328 2   channel 91, identity 59328, entry 2
 2    09 1   channel 2, identity 09, entry 1
      62 1   no channel, identity 62, entry 1
   -----      queue empty
```

While the queue mode is active, the channel symbol will flash (see table in section 4.4).

### 4.8.6 User lock display readout

The user lock function allows radio operation to be locked temporary by the user. By entering a four-digit PIN (Personal Identity Number), the radio can be unlocked. This user lock status is remembered on switching off the radio. The following examples show some possible display formats within this mode:

| | |
|---|---|
| `Loc 1` | user lock mode |
| `12` | two digits of the PIN-code are entered |
| `1234` | all four digits are entered |

### 4.8.7 Scan programming mode

In the scan programming mode, the radio user can include and exclude channels in a scan list and assign priority channels. The display for scan programming has the following format:

| | |
|---|---|
| `P0 Ch 02 9` | channel 02, scan group 9, not in scan list, no pri. channel |
| `P1 Ch 02 8` | channel 02, scan group 8, in scan list, no pri. channel |
| `P1 Ch 32` | channel 32, single scan group, in scan list, no pri. channel |
| `P2 Ch 2 2` | channel 2, scan group 2, in scan list, is pri. channel |

### 4.8.8 Other display formats

Other display formats and messages include:

| | |
|---|---|
| `tonE` | single-tone confirmation mode |
| `Loc 2` | remote stun mode |
| `Err 1` | error 1: hardware fault |
| `Err 2` | error 2: EEPROM data damaged |
| `Err 3` | error 3: PLL out-of-lock |

## 4.9 Miscellaneous functions

The miscellaneous functions within the user interface include the display backlight function, the emergency switch and the external alert facility.

### 4.9.1 Display backlight

Both the portable and mobile radio are equipped with a LCD backlight. To save battery power, it is possible to switch on and off the backlight for the portable. The backlight for the mobile LCD is continuesly on.

The backlight for the portable is normally operated by the LAMP button, however, any key function can be attached to this button. Two backlight-specific key functions are available; these are *lamp on* and *lamp on/off*.

A timer is available which switches the backlight off after a certain period of time. This period of time can be selected from within the programming software. When the lamp is activated, this timer is reset each time a key is pressed to allow convenient operation in the dark.

### 4.9.2 Emergency switch

It is possible to define one of the keys as an emergency button, or to connect an external emergency switch to the mobile.

By pressing this emergency switch for a certain period of time, a special emergency encode format is executed, which can contain various facilities as repeated transmission of a selcall format and live microphone transmission. The period of time before emergency is activated is valid only for key press functions and the external emergency switch. This period of time can be configured from within the programming software.

### 4.9.3 External alert / transfer function

The external alert function is available on the mobile as a facility to alert the radio user when it is not possible to hear the normal alert beep. This external alert output can control a relay for activating a horn or the lights. It is possible also to initiate a call to another mobile or pager (5-tone or 2-tone).

256 rhythms are available to control the horn or lights, which makes the signal easy to recognize. This external alert / transfer facility can be switched on and off by pressing a button on the mobile. When both facilities are available, this button provides three selections: off, ext.alert and transfer.

# 5. OPERATION

In this chapter the operation of all available functions is described. For the examples the default programming, as described in chapter 4, is used.

## 5.1 Power-on

On power-up the radio will sound a confidence tone if the key beep is enabled (see parameter 'key beep'). During the self test and EEPROM contents check, all segments of the Liquid Crystal Display will be activated, which also allow the user to check operation of the LCD. If an error is detected in the hardware or EEPROM contents, an error message will be shown.

The initial operating state is partly depending on the configuration of the programmable parameters. These power-on conditions include:

- Startup channel number, or last selected channel at power-off
- Startup monitor (open or close)
- Startup output power (low or high)
- Startup scanning (yes or no)
- Startup encode definition: allows transmission of logon call
- Keypad operation
  - Channel
  - Selcall
  - Status
  - Normal (select channel/selcall/status first)
- Normal display format
  - Channel
  - Selcall
  - Combined selcall (5 digits) and channel (2 digits)
  - Combined selcall (2 digits) and channel (2 digits)
- Scan display format
  - Normal (channel always displayed)
  - Hidden (channel number is hidden)
  - Background (other operation modes are possible during scan)

It is possible to influence the initial operating state further by including special instructions in a startup encode definition. The parameters mentioned above are described in the following sections.

## 5.2 General operation

Operation facilities can be divided in three categories: facilities which are immediately executed during a very short period of time (e.g. monitor on/off), facilities of which execution takes a certain amount of time (e.g. transmitting a selective call) and facilities which activate a special entry mode.

The entry modes are activated by a key or key sequence (shift-key). The following entry modes are defined:

| | |
|---|---|
| - Channel entry mode | shift-7 |
| - Selcall entry mode | shift-8 |
| - Queue entry mode | shift-9 |
| - Scan mode | shift-5 |
| - Priority scan mode | shift-6 |
| - Status entry mode | shift-4 |
| - Freedial entry mode (selcall or DTMF) | shift-1, shift-2 |
| - Single-tone mode | shift-3 |
| - Key lock mode | (not used) |
| - Code lock mode | shift-B |
| - Scan programming mode | shift-D |

These modes are described in detail later.

### 5.2.1 Parameters related to the user interface

The following parameters are provided to configure the user interface to suit a particular application, and allow selection of some basic facilities:

- Lock code
- Key/alert beep volume
- Keypad operation
- Normal display format
- Scan display format
- Number entry time-out
- Lamp time-out
- Hold delay
- Busy symbol function
- Channel readout mode
- Overlay text channel
- Overlay text selcall
- Overlay text status
- Ext.alert / transfer

The four digit *lock code* parameter allows temporary locking of the radio by the user to prevent unauthorized usage of the radio. This 4-digit lock-code can have any value between 0000 and 9999. By entering an empty string the lock facility can be disabled. See also section 4.8.6 and the description for key function *code lock*.

Parameter *key/alert beep* allows selection of the key beep and alert beep volume. When *off/off* is selected, both key beeps and alerts will not be sounded. Selection *off/low* only sounds the alerts on a low volume, selection *off/high* only sounds the alerts on a high volume, when *low/low* is selected both key beeps and alerts are sounded on a low volume and when *high/high* is selected, both key beeps and alerts are sounded on a high volume.

The *keypad operation* parameter allows selection of the default mode for digit entry, or selection of an idle selection mode. The *selcall* mode allows immediate entry of selcall digits, *channel* mode allows immediate entry of a channel number (numerical only) and *status* mode allows immediate entry of status digits. When *normal* is selected for this parameter, the user must activate one of the available entry modes first before the digit keys operate. In this idle mode, pressing a digit key will sound an error beep. If one of the three immediate modes is selected, the display readout mode will also change to the correct format when pressing a digit key to show the entered digits.

The *normal display format* parameter selects the default display format. These are described in detail in section 4.8.1. The following selections are available: *channel*, *selcall*, *both* (5-tone selcall, 2-digit channel), and *combined* (2-tone selcall and 5-digit channel readout).

The *scan display format* parameter selects the display format while scanning is activated. The possible configurations are described in section 4.8.3. When *normal* is selected, the selected channel number is always visible during scanning. Selection *scan text* will hide the channel number while scanning but not stopped on a radio channel. Selection *background* allows entry of selcall address or dialling a number while scanning.

The *number entry timeout* defines the period of time after activation of one of the available entry modes (e.g. selcall address entry, dial number entry) after which the radio returns to the idle operating mode, so the default display format is shown again. This parameter value is selectable between 1 and 255 seconds in 1 second steps. When set to 0, this timeout is disabled, so the radio will remain in the selected entry mode until a new mode is selected.

The *lamp timeout* parameter allows selection of the period of time the lamp is switched on after activating the lamp. This timeout is restarted every time a key is pressed while the lamp is switched on. This timeout is selectable between 1 and 255 seconds in 1 second steps, and when set to 0, this timeout does not operate.

The *hold delay* parameter selects the period of time the externally connected emergency and/or button flagged with 'Hold Delay' in the press-column must be pressed before the function specified in the hold-column is executed. The hold delay value is selectable in 10 ms steps between 0 and 2550 ms.

The *busy symbol* parameter selects the function of the busy-symbol on the display. For most applications, selection *carrier* must be used to indicate the user of the radio that the channel is occupied. For application such as sub-tone driven repeater systems, it is preferred however to activate the busy symbol only when a carrier without SAT or with a wrong SAT is received. This can be selected by choosing *SAT-busy*.

The *channel readout* mode selects if the selected channel is displayed in a numerical format or in a text format. *Numerical* selects the numerical format, which is three digit wide and includes digits 0 to 9, A, B, C, D, - and <space>. *Alphanum* selects the alphanumerical format, which is five characters wide and supports numbers, letters and special symbols. Note than the alphanumerical mode requires 4 extra bytes per channel block, so less channels can be configured in the radio when this facility is used.

Parameter *overlay text channel* defines the text to be shown on non-displayed positions of the channel number in numerical mode. When channel readout mode is set to alphanum., this parameter has no function. In the numerical mode, the leftmost two characters in the channel mode are defined by this text, but also more than two characters can be used if on those positions the channel readout is entered as # characters. The most frequently used text for this parameter is 'Ch-' or 'ch-'. In this field, five ASCII characters can be entered.

Parameter *overlay text selcall* defines the text to be shown on non-selectable digits positions when the selcall entry mode is activated. For example, if two digits are selectable, the left three digits can be displayed as 'Sel' to clearly identify the selcall entry mode. In this field, five ASCII characters can be entered.

Parameter *overlay text status* defines the text to be shown on non-selectable digits positions when the status entry mode is activated. For example, if two digits are selectable, the left two digits can be displayed as 'St' to clearly identify the status entry mode. In this field, five ASCII characters can be entered.

Parameter *ext.alert/transfer* selects the available operating modes for alerting the user of the radio when away from the radio. Two applications exist: alerting the user by activating the horn or the lights of the vehicle or by callling another mobile (transfer) or tone sequence pager (5-tone as well as 2-tone). *None* allows selection of neither application, *ext.alert* provides selection of external alert on/off, *transfer* provides selection of transfer on/off, and parameter selection *ext/trans* provides selection between off, external alert and transfer.

### 5.2.2 Key functions related to the user interface

The following key functions are related to basic operations of the radio:

- Digits 0 to 9
- Clear digit
- Shift
- Unshift
- Digit 1x
- Digit 10x
- Digit up
- Digit shift
- Mode select
- Mode reset
- Lamp on/off
- Lamp on
- Key lock
- Code lock
- Power select
- Channel entry
- Status entry
- Selcall entry
- Queue mode
- Queue next
- Queue select
- Mon.unmute
- Mon.mute
- Mon.toggle
- Clear all
- Scan prog.
- Ext/transfer
- Hold delay
- Beep volume
- Alert volume

A more detailed description of these key functions is found further is this section. Some key functions are described also in other sections when they are also relevant for other operation facilities, e.g. selcall.

The *decimal digits 0..9* are used for several purposes. The selcall-related purposes are described in section 5.5.5. In section 5.3.1, the operation in the channel entry mode is described.

Key function *clear digit* is used for many entry modes. For selcall-related entry modes, see the description of this key function in section 5.5.5. The operation of the clear key in the channel entry mode is described in section 5.3.1.

Key function *shift* should be attached to the function-shift button, if provided on the radio. The function-shift facility allows selection of secondary functions by pressing the shift button first and then press another key or button. By assigning key function *unshift* in the shift column of the same key within the key definition table, the shift-function can be deactivated by pressing the same key once more.

Key functions *digit 1x*, *digit 10x*, *digit up*, *digit shift*, *mode select*, *mode reset* and *selcall entry mode* are all related to the selcall entry mode, and are therefore described in detail in the relevant section 5.5.4.

Key function *lamp on/off* toggles the LCD backlight on and off. Key function *lamp on* operates similar, but will only turn the lamp on. When the lamp is activated, it will remain on for the period of time as defined by parameter *lamp timeout*. This timeout will be restarted if any key is pressed while the lamp is on. Because the LCD backlight in the mobile is continuesly on, this key function does not operate for the mobile.

Key function *key lock* disables operation of the keypad (buttons 0 to 9, *, # and A, B, C and D keys). When this key function is executed again, the keypad will be enabled again. This key lock function may not be assigned to one of the buttons on the keypad, otherwise the radio could be locked forever. Its main purpose is for portables, where the keys on the keypad can be pressed while carrying the portable in a case.

The *code lock* key function activates the PIN-code (Personal Identity Number) lock facility. By activating the code lock, the portable cannot be used by unauthorized persons. When the code lock is activated, the user must enter a four digit PIN number, after which the radio is activated again when the code is entered correctly. If the code is not entered correctly, the portable will sound an alert beep, and the user is requested to try again. See also description of display format for user lock, section 4.8.6.

The *power select* key function allows selection between low and high output power. If selection of power is not allowed, this function is ignored. Note that this function is supported only by the RF hardware and ICM for the portable radio.

The *channel entry mode* key function is related to channel selection. This parameter is described in section 5.3.2.

The *selcall entry mode* and *status entry mode* key functions are related to selcall encode functions, and will be described in more detail in section 5.5.4.

Key functions *queue mode*, *queue next* and *queue select* are described in detail in section 5.5.5.

Key functions *mon.unmute*, *mon.mute* and *mon.toggle* operate the squelch monitor. Using these functions it is possible to monitor a channel shortly e.g. to determine if it is possible to transmit a call. It is possible to link these key functions to one button so that this button causes the radio to unmute while the button is pressed. Such a facility is frequently found on other radios using a key on the side of the portable or operated by a key on the microphone. For this kind of operation, function mon.unmute should be linked to the press-action for this button, and function mon.mute should be attached to the release-action for the same button.

A description of key function *scan prog.* (scan programming) can be found in section 5.4.1.

The *ext/transfer* key function is used to toggle the external alert facility and/or transfer facility on and off. See section 4.9.3.

The *hold delay* key function changes the hold delay duration to the value specified for parameter *hold delay* in the setup menu. This key function is useful to extend the duration of the key hold period, e.g. to extend the required time to press an emergency foot switch by at least 1.5 second.

The *beep volume* key function selects the volume of the key beep. It is possible to select between off, low and high key beep volume. After selection, a short beep will follow to indicate the selected volume setting. The adjusted key beep volume setting is stored in EEPROM, so it is remembered at power-off of the radio.

The *alert volume* key function selects the volume of the call alert beeps. It is possible to select between low and high alert volume. After selection, a short beep will follow to indicate the selected volume setting. The adjusted key beep volume setting is stored in EEPROM, so the alert volume is remembered at power-off of the radio.

### 5.2.3 Introduction to the encode and decode format concept

The encode and decode format concept within the 2nd generation ICM software offers a very powerful and flexible method to define signalling formats. In addition, it can be used to configure additional facilities as transmit and sub-audible tone signalling lockouts.

An example of a simple encode format is shown below:

ERRX1 XCARR TXM

The encode format is entered in the programming software as text, and then compiled by the software to instructions which are understood by the ICM software within the radio.

An encode format must be given a name, which is used in other menus within the programming software to link this encode format to a key function, to another encode format, or to a decode format.

The encode format as shown above is designed to be linked to the PTT-press action. A short explaination of this encode format: instruction ERRX1 tells the radio to sound an error beep when an exit instruction causes the interpreter to exit the encode string. Instruction XCARR exits the encode format when a carrier is detected, and will thus initiate an error beep if so. If the encode format is continued, the TXM instruction will then switch the radio to the transmit mode with the microphone enabled.

In the following sections, a comprehensive number of encode instructions are described, divided in groups per section, e.g. for selective calling, DCS/CTCSS and DTMF.

Decode formats are similar to encode formats, however they are used only for decoding selcall messages. Also here a comprehensive number of instructions are available which offer a wide range of capabilities.

## 5.3 Channel selection

Channel selection operation, parameters and key functions related to channel selection, and instructions used for transmitting and receiving are described in this section.

### 5.3.1 Operation of channel selection

Two methods for channel selection are provided: by turning the channel knob and by decimal entry of the channel number on the keypad. Decimal entry is possible only on the mobile when a keypad/microphone is attached, and on the portable when the add-on keypad is fitted.

Channel selection by channel knob is best suited for selection between a small number of channels. The channel knob allows fast selection of channels without any key press action. Channel readouts which include alphanumerical characters can only be selected by the channel knob. By turning the channel knob rightwise, the following channel will be selected, and by turning the knob leftwise, the previous channel will be selected. The channel list is organized as a circular list, so it is possible to pass the first and last channel in the list. By turning the channel knob, the radio will automatically abort any entry mode and will be forced to the channel readout mode.

For decimal entry of a channel, the channel entry mode must be selected first. Note that the channel entry mode can also be activated automatically when pressing a numerical button in the idle mode (see parameter *keypad operation*, section 5.2.1). Depending on the number of channel digits programmed (see parameter *number of ch. digits*, section 5.3.2), the user is requested to enter one, two or three digits. After entry of these digits, the radio will check if the channel number is available. If available, the radio will switch to that channel, if not, the radio will sound an error beep, and stays on the current channel. Using the *clear digit* key, the rightmost digit can be erased and corrected.

If the channel numbers are within the range of 0 and 9, it is suggested to use one-digit selection, if within the range of 00 to 99, two-digit selection is suggested and if within the range if 000 and 199, three-digit selection is necessary. It is possible to configure more selectable digits than needed.

### 5.3.2 Parameters and key functions related to channel selection

The following parameters are related to channel selection:

General parameters:
- Startup power
- Startup channel
- Save channel number
- Number of channel digits

System group parameters:
- Power selectable
- Fixed power selection

Channel parameters:
- Transmit frequency
- Receive frequency
- Channel readout string

The following key function is related to channel selection:
- Channel entry

Parameter *startup power* defines the power level when switching on the radio. The default startup power can be set to *Low* or *High*. Note that this default selection is not applicable when a system group is selected where the output power is forced to either low or high.

The selected channel on startup is configured using parameter *startup channel*. The channel number should be entered as a logical number, which can be found in the channel parameter menu. The valid range is 1 to 250. If a non-existing channel number is selected, channel 1 will be selected on startup.

The *save channel number* parameter selects whether or not the channel number is stored in EEPROM each time when selecting another channel number. To prevent EEPROM wear-out, the channel number is stored after a timeout of 5 seconds (important for selection of the channel number by the channel turn-knob), and a circular buffer of 32 locations is used for storing the channel number. This guarantees reliable storage of the startup channel for around 300000 channel change actions.

The *number of channel digits* parameter configures the number of digits required to enter for selection of a numerical channel number. Four selections are available: *none*, *one*, *two* and *three*. Selection *none* blocks the channel entry mode, thus no other channels can be selected, and selection is possible only using the channel turnknob. By using selection *one*, only channel numbers 0 till 9 can be entered, which is useful when less than 10 channels are programmed. For channels ranging from 00 to 99, selection *two* is most convenient, and *three* is required for selection of channel numbers above 99.

The *power selectable* parameter defines whether or not the output power level is selectable by the user or not. If set to *fixed*, the output power is fixed as specified in parameter field *fixed power selection*. When set to *select*, the output power is selectable between low and high. This parameter can be configured for each system group.

Parameter *fixed power selection* defines the output power when parameter *power selectable* is set to *fixed*. Possible selections are *low* for low power and *high* for high power. This parameter can be configured for each system group.

The *transmit frequency* parameter selects the radio frequency used for transmitting speech and signalling information. The frequency is entered as a number in MHz. The entered frequency will be rounded off to the nearest 5.00 or 6.25 KHz divisible frequency, and must fit in the radio band selected.

The *receive frequency* parameter selects the radio channel for receive. The frequency is entered as a number in MHz. The entered frequency will be rounded off to the nearest 5.00 or 6.25 KHz divisible frequency, and must fit in the radio band selected.

The *channel readout* parameter has two different formats: it can consist of a three digit numerical format and a five digit alphanumerical format, depending on the selected format. The three digit format accepts the digits 0 to 9, the letters A, B, and C, the - (dash) symbol and <space>. The alphanumerical mode accepts any five-character sequence.

The *channel entry mode* key function allows manual selection of the operating channel. Depending on the parameter *number of channel digit*, up to three digits can be entered. See section 5.3.1 for additional information.

### 5.3.3 Encode instructions related to channel selection

The following encode instructions are related to the basic channel selection and receive/transmit switching functions:

- TXS, TXD, TXM, RX, TXP, TXF, RXF
- ERRX0, ERRX1, XCARR

Instruction *TXS* is used to switch to the transmit mode with selcall encode enabled. It is also used to mute the transmit audio path for a period of time using the DEL instruction. See section 5.5.5 for a detailed description of the TXS and DEL instructions.

Instruction *TXD* is used to switch to the transmit mode with DTMF encode enabled. See section 5.7.2 for a detailed description.

Instruction *TXM* is used to switch to the transmit mode with the microphone enabled. This instruction is normally used in encode formats linked to the PTT-press function, or within encode formats with live-microphone transmission included in an emergency call procedure.

Instruction *RX* switches the radio from transmit mode to receive mode. A typical application is a leadout delay on PTT-release.

The *TXP* instruction is similar to the other transmit functions, however, it does not change the current transmit audio path selection (selcall, DTMF or microphone). The programmed transmit frequency for the selected channel will be used.

The *TXF* instruction can be used to transmit on any valid frequency within the selected frequency band. This instruction is useful to e.g. transmit a pager call on a specific frequency. The syntax of this instruction is TXF rf-freq where *rf-freq* is a valid frequency in MHz within the selected radio band.

The *RXF* instruction can be used to switch to receiver to any valid frequency within the selected frequency band. This instruction is useful to e.g. listen to a reponse on a specific frequency. The syntax of this instruction is RXF rf-freq where *rf-freq* is a valid frequency in MHz within the selected radio band.

The *ERRX0* instruction will prevent that an error beep is sounded when the current encode format is aborted due to a exit command (e.g. XCARR).

The *ERRX1* instruction will cause an error beep to be sounded when the current encode format is aborted due to a exit command (e.g. XCARR).

On execution of *XCARR*, the radio will continue the encode format when no carrier is detected, and abort the encode format when a carrier is detected. This instruction can be used to create a carrier-lockout facility.

## 5.4 Channel scanning

In this section operation of channel scanning, the scan group concept, the user scan programming facility and all scan-related parameters are described.

### 5.4.1 Operation of channel scanning

The ICM supports a wide range of applications for channel scanning, based on different scan configurations which are selectable per system group or per scan group.

#### Basic scan functions

The basic scan functions include normal scan and priority scan modes. In the normal scan mode, two ore more channels are checked for activity, and when the scan condition is met on one of these channels, the radio will stop on that channel.

In the priority scan mode, the radio checks for activity on a different channel than the currently selected channel, normally in intervals of 500 to 2500 ms. If the channel activity meets the scan condition, the radio will remain on the priority channel until the scan condition is released.

The normal scan and priority scan modes can also be combined. In this combined scan mode, the radio will scan all channels in the scan list for activity, and check for activity on the priority channel only when the radio has stopped temporary on a non-priority channel.

For the normal scan mode, the scan speed and scan wait time can be selected per system group. This allows selection of parameter values which operate reliable with the selected scan configuration for that system group.

Possible scan configuration include carrier scanning, SAT (CTCSS/DCS) scanning, selcall 1st tone scanning and both SAT/selcall scanning. Also a no-carrier scan mode is provided.

The scan list determines the channels which are included per scan group. This scan include flag is selected per channel. Also the priority channel and the priority scan interval are set seperately for each scan group. It is possible to include a channel in more than one scan group.

#### Scan dwell facility

The scan dwell facility forces the radio to continue scanning when the channel activity meets the scan condition for a long time. This scan dwell facility is conifgured per system group.

### Scan group concept

The ICM allows programming of up to 10 scan groups. Each of the scan group has its own scan list, a priority channel, a priority scan interval timeout, a preference channel and a user scan programming flag.

Because it is possible to include any channel within a scan list, it is possible to scan for different conditions, as specified per system group, within one scan group. For example, a scan list can contain channel 01, 02, 05, 08, 09 and 10 where channel 01, 02 and 05 are checked for carrier activity, channel 08 and 09 for selcall 1st tone detection, and channel 10 for sub-audible tone activity (CTCSS or DCS).

Because the scan list flags are configured per channel, the maximum number of channels within a scan group is limited only by the maximum number of channels. For example, if 210 channels are configured, it is possible to include all channels in the scan list, if desired of course.

Except for the background scan facility, selection of the scan group is possible by pressing one of the digit keys while scanning. The matching scan group, numbered from 1 to 9 and 0, is then selected. In the background scan facility, the scan group is selected when starting scanning.

### Behaviour of PTT while scanning

The behaviour of the Push-to-Talk button can be configured in a number of ways for use in scanning systems. Some examples:

- When scanning, the PTT-button is ignored and an error beep will be sounded
- When scanning, pressing the PTT-button will cause an error beep to be sounded, and the radio will cancel channel scanning
- When pressing the PTT-button while scanning, the radio will transmit on the preference channel if the radio is not waiting on a channel, and the radio will transmit on the channel if it is waiting on that channel
- When pressing the PTT-button while scanning, the radio will transmit always on the preference channel

### Scan display formats

The ICM supports three different scan display formats. The normal scan display format shows the channel number continuesly, the hidden scan format shows a 'Scan' text while scanning, and the background scan format allows operation of other facilities while scanning continues on the background.

### User scan programming

The user scan programming facility allows the user of the radio to include or exclude channels for the selected scan group, and to assign the priority channel to one of the available channels. A seperate user interface is provided for this facility, of which the display format is described in section 4.8.7. Scan programming is possible only from the keypad. The functions of the keys within the user scan programming mode are fixed as described below:

| | |
|---|---|
| 0..9 | select channel number (as channel entry mode) |
| # | select next scan group |
| shift-# | select previous scan group |
| * | select next channel |
| shift-* | select previous channel |
| D | select channel include/exclude |
| shift-D | assign selected channel as priority channel |
| shift-C | exit scan programming mode |

## 5.4.2 Parameters and key functions related to channel scanning

To configure the functions described, the following parameters are provided:

General parameters:
- Startup scan

System group parameters:
- Scan speed
- Scan wait
- Scan dwell time
- Scan configuration

Scan group parameters:
- Priority channel
- Preference channel
- Priority scan interval
- User programming

Channel parameters:
- Scan include list

Key definitions:
- Scan on/off
- Priority scan on/off
- Scan+Priority on/off
- Scan on
- Priority scan on
- Scan+Priority on

Parameter *startup scan* determines if channel scanning is activated when switching on the radio. If set to *enable*, the radio will automatically start normal and priority scanning using scan group 1. If set to *disable*, the radio will startup in its default configuration with scanning disabled.

The *scan speed* parameter selects the sensing time per channel to decide if the scan stop condition applies. This parameter is selectable between 0 and 2550 ms in 10 ms steps. For carrier or selcall scanning, the value is normally set around 100 ms, for SAT scanning the value for *scan speed* must be increased to at least 250 ms.

The parameter *scan wait* selects the period of time the radio keeps waiting on a channel after the scan stop condition is removed. The value of this parameter is selectable between 0 and 25500 ms (25.5 seconds) in 100 ms steps.

The *scan dwell time* parameter selects the period of time after which scanning is forced to restart on a channel where the scan stop condition applies. Selectable in 1 second units between 0 and 255 second. This scan dwell feature is disabled by assigning value 0 to this parameter.

Parameter *scan configuration* selects the scan wait condition. If *carrier* is selected, the radio stops on a channel when a carrier is received on that channel (noise squelch operated). Using selection *SAT*, the radio stops of a channel when a valid CTCSS or DCS tone is received on the channel. Selection *selcall* causes the radio to stop on a channel when the tone matches to the first tone of the primary receive address. SAT and selcall scanning are combined in the *both* scanning configuration. *Selcall/st* is similar to selection selcall, but causes the radio to stop after receiving a call until a key is pressed. Selection *both/st* is similar to both, but also causes the radio to stop until a key is pressed. The *no-carrier* scan condition stops on a channel when no carrier is detected on that channel. Note that for SAT-operated scan configurations (SAT, both and both/st), the SAT condition will be replaced by carrier detect when no SAT decode is assigned for the channel.

One *priority channel* is available per scan group. The priority channel facility is normally used to 'watch' activity on an important channel. Sensing of the priority channel is possible during scanning, when listening to another channel or during a conversation on another channel. For the priority channel the logical channel number should be used, which can be found in the channel parameter menu.

The *preference channel* parameter selects a special channel, which can be used for different purposes in the scan mode. In most applications, this preference channel is used for transmission of speech when the PTT button is pressed during scanning. See also description of encode definitions *PREFA* and *PREFS*. For the preference channel the logical channel number should be used, which can be found in the channel parameter menu.

The *priority scan interval* parameter selects the interval period between the checks of activity on the priority channel. This parameter can be selected between 0 and 2550 ms in 10 ms steps.

The priority channel and include flags for each channel pointing to a scan group can be changed by the user of the radio. For this purpose a scan programming mode is defined. Whether or not this user programming mode can be activated can be configured per scan group by assigned YES or NO to parameter *user programming*.

For each of the ten scan groups, a scan include flag is defined for all channels. This enables assigning any number of channels to a single scan group. Although the scan process will be disturbed by assigning too many channels to a scan group because of the long duration of the scan turnaround time, it is allowed to include all channels into a scan group. These include flags or organized per channel via parameter *scan include list*.

Key function *scan on/off* allows the user to toggle channel scanning on and off using a single key. Using key function *priority scan on/off*, the user is able to toggle priority scan on and off by pressing a single key. Normal scan and priority scan can be simultaneously toggled on and off using key function *scan+priority on/off*.

A non-toggle function is also available for all of the mentioned key functions. These are *scan on*, *priority scan on* and *scan+priority on*.

### 5.4.3 Encode instructions related to channel scanning

The following encode instructions are related to channel scanning:

- STOPS
- STOPP
- PREFA
- PREFS
- SPREV
- XSCAN
- XPRI
- XSENS

Instruction *STOPS* cancels the channel scanning mode if active. This instruction can be used in encode formats to cancel scanning modes before transmitting speech or transmitting a call.

Instruction *STOPP* cancels the priority scan mode if active. Also this instruction is frequently used in encode formats to cancel scanning modes before transmitting.

The *PREFA* instruction select the preference channel in the channel scanning mode, both when scanning and when waiting on a scan channel. This instruction is ignored when channel scanning is not activated.

The *PREFS* instruction select the preference channel in the channel scanning mode, but only when not temporary stopped on a channel. This instruction is ignored when channel scanning is not activated, or when the radio is waiting on a scan channel.

The *SPREV* instruction selects the previously manually selected channel. By using this instruction, the channel number last used is selected e.g. when scanning is cancelled before transmitting speech or a call.

The *XSCAN* instruction quits the currently executed encode format when the normal scan mode is active, with or without an error beep (see instructions ERRX0 and ERRX1). If not scanning, the XSCAN instruction is ignored.

The *XPRI* instruction quits the currently executed encode format when the priority scan mode is active, with or without an error beep (see instructions ERRX0 and ERRX1). If priority scanning is not active, this instruction is ignored.

The *XSENS* instruction quits the currently executed encode format when scanning is active, and the radio is not waiting on a channel, with or without an error beep. This instructions is ignored if the radio is not scanning or when the radio is waiting on a channel while scanning.

Some examples of encode formats using the encode instructions described:

- ERRX1 XSCAN TXM
  If scanning is active, this encode format is cancelled and an error beep is sounded. When scanning is not active, the radio is switched to the transmit mode with the microphone enabled.

- ERRX1 STOPS STOPP XSCAN XPRI TXM
  Exits with error beep when either normal scan or priority scan is active. Before quitting this encode format, both normal scan and priority scan is switched off (Note that the XSCAN and XPRI instructions check the state at the time the encode format is started). If both normal and priority scan were inactive when executing this encode format, the transmitter will be activated with the microphone enabled.

- PREFS TXM
  While scanning and not waiting on a channel, the preference channel will be selected. TCM switches on the radio with the speech path enabled.

## 5.5 Selective calling

The ICM concept offers a comprehensive set of selective call (selcall) facilities. These facilities range from transmitting and receiving simple 5-tone calls to operation within advanced selcall operated trunked radio systems.

### 5.5.1 Introduction to selcall

Selective calling allows radios to be called individually or within a group by transmitting a sequence of short tones within the AF-range (typical 800 to 3000 Hz). Basic 5-tone selcall applications are found around the world, but primary in Europe and Australia. Based on the 5-tone selcall standard, many system solutions have been developed by manufacturers. These solutions range from smart solutions for group calling, automatic-close and status transmission to sophisticated trunked radio systems.

Because every manufacturer has defined its own standard, it is virtually impossible to support them all. The ICM concept, however, offers a method to build signalling formats which can emulate operation in most of these systems.

### 5.5.2 Selcall applications

As noted before, a wide range of applications can be supported by selective calling systems. In this section a number of important selcall applications are explained.

#### Transmit & receive 5-tone

The most basic operation of selcall is transmitting and receiving calls in the standard 5-tone format. In most radio networks, a part of this 5-tone is fixed and the other digits are selectable. When a user of the radio wants to speak to another person, he or she selects the identity of the radio unit of that person, and presses the *call* button. A 5-tone selcall message is transmitted, received by the other unit, decoded, and if it matches the own identity of that radio unit, the radio will sound an alert tone and the radio will be unmuted. It is possible now to start a speech conversation.

For transmitting a standard call, the radio must at least be equipped with a *call* button. If selection of another party is required (it is also possible to allow calls to one radio address only, e.g. to a despatcher), the radio must have *up/down keys* for the selectable digits or a *keypad* to enter the identity of that other party. To allow monitoring of the channel before a call is transmitted, most radio units offer a *monitor* or *open/close* button.

When receiving a valid call, the radio automatically unmutes. To close the radio after finishing the conversation, the *monitor* or *open/close button* is operated by both parties to mute the radios.

The 5-tone format allows division of radios into groups. The size of the user group can vary to by assigning more or less selectable digits. Normally the rightmost digits in the 5-tone format are selectable, and the first digits are fixed. For example, a fleet of 100 users occupies identities between 59400 and 59499, and a fleet of 10.000 users occupies the numbers between 40000 and 49999. By restricting the number of selectable digits, the user cannot call radios within another fleet.

**Group calls**

Group calls are used to announce a message to several users simultaneously or when a conversation is requested between multiple users. The most widely used group calling system is the so-called *A-digit group calling system*. This group calling algorithm allows any digit to be replaced by a group digit, so that all units matching the 5-tone except on the positions of the A-tone will be called.

For example, all radios with identity 59400 to 59409 can be called simultaneously by transmitting 5940A; all radios numbered from 59400 to 59499 can be called by transmitting 594AA. It is possible also to assign A-digits on other positions within the 5-tone address, e.g. 594A2 so that radio 59402, 59412, 59422, 59432 and so on are called.

Another frequently used standard uses the *0-digit as group tone* instead of the A-digit. Because most mobile and portable radios cannot transmit A-tones but can transmit 0 tones, this facility also allows mobile users to transmit group calls. For systems using the A-tone instead, this is normally possible only on the fixed station radio. A disadvantage of this system is the reduced number of addresses in the radio network (9 instead of 10 values per digit).

In some systems, a group tone is always transmitted on a fixed position of the 5-tone format and uses a longer tone to allow the decoder sufficient time to decode another tone than expected. This *prolonged A-tone group tone* format is frequently used in Australia.

It is possible also to create user groups using *multiple decode identities*. The radio will regard a matching call, except for the primary address, as a group call. The advantage of this solution is the flexible size of such a group, because it can contain any number of users, ranging from 2 to all units.

The ICM concept supports all group call facilities as explained.

### Repeat tone

In almost all selcall standards a repeat tone is defined. This repeat tone is transmitted on a position within the sequence were the digit is the same as previously transmitted. By using a repeat tone, a sequence cannot include a single tone with the duration of multiple tones, which could be decoded as a single digit instead. For the repeat tone digit value E is normally assigned. Some examples of sequences which include repeat tones:

- sequence 59422 becomes 5942E
- sequence 59444 becomes 594E4
- sequence 59902 becomes 59E02
- sequence 55555 becomes 5E5E5

### Remote-close

In addition to unmute the radio automatically after receiving a call, it is possible also in some system to remotely close a radio. Such a remote-close call is normally transmitted by the despatcher to close one or more radio units after finishing a conversation.

The widely used PYE/Philips remote-close standard uses an extra 6-th C-digit in addition to the standard 5-tone sequence to close one or more radio units. For the first 5 tones the same rules apply as previously explained, so it is possible also to include group digits and repeat digits. For example, to remotely close radio unit 59402, sequence 59402C should be send, and to close all radios belonging to fleet 594xx, sequence 594AEC should be send.

Another method of implementing remote-close is to use another seperate 5-tone address as remote-close address. This can be an individual address (e.g. radio unit 59402 uses address 59452 as remote-close) or an address used by multiple radio units (e.g. units 59402, 59403 and 59404 all use 59499 as remote-close). Advantage of this method is that also standard 5-tone equipped radios can be used to transmit a remote-close. This remote-close method is frequently used in Motorola radios and systems.

Other remote-close formats include the PYE/Philips 9-tone format with a separate status digit value for remote-close. All formats described can be emulated by the ICM.

### Auto-close

The auto-close facility causes a radio unit to close automatically after receiving a non-matching selective call. So, if a despatcher calls a particular radio unit, all other radio units receiving the 5-tone sequence will be closed immediately.

To prevent that any 5-tone is decoded as an auto-close, including calls received from radios and despatchers of other fleets, most radios equipped with auto-close will only process calls with addresses belonging to their own fleet. For example, if a fleet uses all identities between 59400 and 59499, the radios in that fleet will auto-close only after receiving 594. When the received call matches the own identity of the radio, it will alert and open again.

The ICM offers also auto-close, which is supported by a number of additional features to improve operation of this facility.

**Status call**

A status call facility is also often found in selective call based systems and radios. Selcall has some advantages over data to transfer small messages, which include reliable operation when the radio connection is poor, and less signalling overhead compared to data (no preamble and sync message needed).

Frequently used formats include 6-digit status transmission, where the first five tones identify the radio unit, and the 6th tone is used to transfer the status digit. In this format 10 states can be transferred, without additional error checking.

When more than 10 different status messages should be transferred, the 5-tone message can be extended with two or more status digits. If protection is needed against false decoding, a checksum digit could be added.

Also for status calling, the ICM can be configured for almost any application.

**Emergency call**

A large number of different formats for emergency calling, based on selective call standards, are in use worldwide. Almost every manufacturer has specified an own standard.

An emergency call format frequently used in Europe is the PYE/Philips 6-th C-tone format, which thus is identical to the PYE/Philips remote-close format. When an emergency button or foot switch is pressed, the radio unit will transmit its own 5-tone identity plus C-tone, e.g. radio unit 59402 will transmit 59402C. The identity will be decoded on the base station console, so the despatcher is able to take appropiate action.

In some systems, this 6-tone format is followed by a period of say 10 seconds live speech transmission, without the need for the user of the mobile or portable radio to press the PTT switch. This allows the depatcher to listen what is happening. If required, such a call plus live microphone period can be repeated until a reset call is received from the despatcher (same 6-tone format).

Other systems include the Bosch emergency call format, which uses a repeated single-tone while the live speech message is transmitted.

The number of different standards for emergency calling is quite extensive, and only a few of them are published by the manufacturer. Most of them can however be emulated by the ICM, including the more complicated repeated call plus live speech format.

### Who-has-called (WHC)

The who-has-called facility allows a user of a radio unit to retrieve the identity of the other party which has previously called. In some radios, it is possible to store more than one calling identity.

A frequently used format for WHC is the 2-by-5-tone format, which uses two successive 5-tone messages. The first 5-tone is the selected address, and thus opens the called radio, and the second 5-tone is the own identity of the calling radio. The gap between the two successive 5-tone sequences is around 200 to 300 ms. For example, if the user of radio unit 59402 calls radio unit 59435, then 59435F59402 is transmitted by radio unit 59402; the F-digit identifies the so-called intersequence gap. Radio unit 59435 will then shown (a part of) the identity of the calling radio unit on the display.

Another WHC standard uses a 7-tone format. The first 5 tones identify the unit to be called, and the two tones immediately following identify the two last digits of the calling party. For example, if the user of radio unit 59402 calls radio unit 59435, then 5940235 is transmitted. Because the fixed digits are the same within the fleet, these digits are added and eventually shown on the display for call-back.

Also for WHC, many manufacturer-specific systems are in use. The ICMs support the mentioned standards, but can also be configured to emulate others. In addition to remembering four WHC identities, the ICM can also transfer a stored identity to the calling register for automatic call-back.

### Free-dialling using selcall

In some systems the PMR base station is connected to a PABX or PSTN via a telephone interconnect unit. Simple systems use DTMF signalling for dialling into a PABX/PSTN network, but there are also systems installed worldwide, which use 5-tone formats for dialling. In addition to translating standard 5-tone calls into pre-defined PABX/PSTN numbers, it is possible also in some systems to transfer a free-dial telephone number.

A signalling format introduced by Rohill, and now in use by many companies and organizations around the world, uses a sequence of selcall digits to transfer a telephone number.

Additional length identifiers and checksum digits are included to protect the message against false decoding. An example of this sequence, transmitted by radio unit 59402 if number 0528063355 is dialled, is: 59492705280633555. The 6th digit (value 7) is calculated as the total length modulo 10 (17 MOD 10), and the last 17th digit (value 5) is calculated as the sum of all digit modulo 10 (75 MOD 10).

Because some radios can find within such a message their own 5-tone identity and thus will alert, a so-called transparancy mode is introduced. This transparancy mode uses D-digits inserted at any fifth position within the dialling string. Sequence 59492705280633555 therefore becomes 59492D7052D8063D3555. The D-digits will not be included in the checksum and length calculation.

This format, but also formats to control other telephone interconnect systems, are supported by the ICM. Any telephone number of a length between 0 and 28 digits can be entered, edited and transmitted by the radio unit.

**Remote control functions**

Selective call sequences can also be used to remotely operate miscellaneous functions of a radio unit. For example, remote stun and revive are used in some mobile and portable radios to prevent operation of a radio unit when it is stolen, lost or when the rent is not paid by the user. Remote kill is an ICM-specific function to prevent unauthorized use in security-sensitive areas (police, military).
Because the remote control functions should not be interpreted too easily by the receiving unit to prevent false decoding, normally a more complicated format is used for these functions.

It is recommended to use at least multiple successive sequences, for example 5-tone plus 7-tone. A possible format could consist of the 5-tone address of the called unit, a intersequence gap of 300 ms, and a 7-tone special sequence consisting of a unique 5-digit sequence, a control digit and a checksum digit. For example, the following formats could be defined for remotely controlling radio unit 59402:

- Remote stun 59402F3425116
- Remote revive 59402F3425127
- Remote kill 59402F3425138

In the example above the 6th digit of the second 7-tone sequence identify the remote control command (1=stun, 2=revive, 3=kill) and the 7th digit is the checksum digit of the preceding 6 digits.

In addition to the proposed standard explained above, is is possible also to configure the ICM for other standards in use.

### Single-tone

The single-tone (or long-tone) capability is frequently used to control repeater stations, or to open or close a group of radios in older selcall based systems.

Repeater stations operated by a single-tone can be activated by transmitting a tone of a specific length with a specific frequency, e.g. a tone of 1400 Hz during 1 second. After receiving this single-tone, the repeater stays activated when a carrier is received from either party. The repeater will fallback to standby after a certain timeout.

Older selcall based radios did not have the capability to decode group calls or all-calls. To overcome this problem, an additional filter and decoder was build in to decode single-tones, also with a specific frequency and tone duration. If such a tone is received by the radio unit, it will open and the radio unit will sound an alert tone. The same principle is possible for remote-close. Earlier Bosch and Ascom radios were equipped with this facility.

The ICM offers single-tone transmission of any tone between 300 and 3000 Hz with any duration between 1 and 7000 ms in 1 ms steps. Also multiple single-tone encodes can be defined. This should cover almost any application for single-tone.

In addition, the single-tone facility can also be used to transmit calls to fixed addresses of 2-tone pagers according the Motorola and GE standards, frequently used in the United States.

## 5.5.3 Parameters related to selcall

To configure the ICM for all applications as previously described, a large number of programmable parameters and encode/decode instructions are provided. These can be entered, edited, compiled and stored in the radio unit using the programming software package.

The parameters related to selcall are described in this section. The key definitions, encode format instructions and decode format instructions are described in the following sections.

A comprehensive list of selcall-related parameters is given below:

General and setup radio parameters:

- Addresses per channel
- Startup encode definition
- Startup monitor
- Start delimiter required
- Digit entry method
- Copy from default tx

System group parameters:
- Selcall toneset standard
- Receive gap period
- Selectable selcall digits
- Selectable status digits
- Automatic close
- Monitor function
- Decode format
- Encode button #1 [normal call]
- Encode button #2 [free-dial selcall]
- Encode button #3 [free-dial DTMF]
- Encode button #4 [single-tone]
- Encode button #5 [status call]
- Encode button #6 [emergency call]
- Encode PTT-press
- Encode PTT-release
- Encode DTMF overdial
- Encode channel select
- Encode on hook
- Encode off hook

Related channel parameters:
- Default tx address
- Primary rx address
- Secondary rx address
- Third rx address

Depending on the application, a number of decode and encode addresses are needed. These addresses are stored seperately for each channel. Because each 5-tone selcall address requires 2.5 byte (20 bits), the storage space needed for four selcall addresses will exceed the EEPROM capacity for more than around 120 channels. Because normally only one or two channel-depended selcall addresses are necessary, the ICM can be configured for less selcall addresses, so more channels are available. The *addresses per channel* can be entered in the setup radio menu, and can be selected between 0 (no 5-tone addresses) till 20 (four 5-tone addresses) in steps of 2 digits. In the channel editing menu the non-selectable digits are marked as squares.

The *startup encode definition* parameter allows a selective call sequence to be transmitted on power-on. It is possible to include instructions for transmit-lockout, SAT encode, single-tone and so on. See section 5.5.5 for a more detailed description of encode definitions.

The *startup monitor* parameter determines if the selcall mute function is initially open or closed after switching on the radio. If set to *enable*, selcall mute will be open on startup, and when set to *disable*, selcall mute is closed on startup.

The *start delimiter required* parameter selects whether or not a period of no-tone is required at the beginning of a selcall message. If set to *enable*, the message must match exactly to the sequence in the decode definition. If set to *disable*, at maximum 3 other preceeding digits are allowed to a message which otherwise matches the sequence in the decode definition.

The *digit entry method* parameter offers two procedures to enter and change the keypad selectable digits. For a small number of selectable digits (1 or 2 digits) it is most convenient to overwrite the default selcall address. For more selectable digits (3, 4 or 5), it is preferred to overwrite the previously entered selcall address. The first method is referred to as *replace* and the second method is called *overwrite*.

The *copy from default tx* parameter selects whether or not the selectable digits are overwritten by the channel-related default tx address when selecting another channel. If set to *Enable*, the selectable digits are overwritten, and if set to *Disable*, the selectable digits will not change.

The toneset standard for reveiving selcall messages is selected in field *selcall toneset standard*. At maximum 12 tonesets are available, of which eleven are standard and one is optional. The standard tonesets supported are:

- ZVEI Germany, Austria, Italy, Netherlands, Belgium
- CCIR United Kingdom, France, Sweden, Norway, Finland, Italy
- DZVEI Germany
- EEA United Kingdom
- ZVEI2 Australia
- PZVEI Philips derivative of ZVEI
- PCCIR Philips derivative of CCIR
- PDZVEI Philips derivative of DZVEI
- EIA France, United States, Australia
- Natel Switzerland, Sweden, Norway
- AP369 Denmark, Sweden

Note that this parameter only selects the toneset standard for decoding; for encoding the appropriate encode instructions must be used to select a specific toneset. The selcall standard parameter is selectable per system group.

The *receive gap period* parameter selects the period of time the selcall decode algorithm requires a 'no-tone' condition after the last valid tone of a selective call tone sequence has been received. Normally this value is set to 1.5 times the duration per tone, so for CCIR 100 ms, this value is set to 150 ms. This parameter is selectable in 2.5 ms units between 0 and 628 ms. As for the toneset parameter, the receive gap period is selectable per systems group.

The parameter *selectable selcall digits* selects the number of digits which can be changed by the user via the keypad or up/down buttons. These selectable digits are normally included in the selcall transmit encode definition.

Possible values are: *none*, *one*, *two*, *three*, *four* and *five*. Because this parameter can be set seperately for each systems group, it is possible to use different settings for different applications within one radio.

The parameter *selectable status digits* selects the number of digits which can be changed by the user via the keypad or up/down buttons, to be used for status calls. These selectable digits are normally included in the encode definition for status calls. Possible values are: *none*, *one*, *two*, *three*, *four* and *five*. Because this parameter can be set seperately for each systems group, it is possible to use different settings for different applications within one radio.

The *automatic-close* parameter determines the number of digits from the start of the sequence that have to match the primary receive address in order to close the portable. When *none* is selected, the automatic close facility is disabled. Other values are: *two*, *three* and *four*.

The *monitor function* parameter defines the function of the monitor button for each system group seperately. The following selections are possible: *none*, *selcall*, *SAT*, *both* and *reset*. When *none* is selected, monitoring is not possible for selcall as well as SAT. If *selcall* is choosen, it is possible only to manually bypass the selcall mute function (also called open/close). When *SAT* is used, it is possible only to bypass the SAT mute function. When *both* is selected, the monitor button toggles selcall and SAT monitor simultaneously. The *reset* selection forces the radio to close.

Per system group one *decode format* can be selected. A decode format contains instructions to check for incoming call and selcall-driven facilities as remote-close, remote stun, secondary address group calls and so on. The decode format will be executed when a full sequence of selcall digits has been received. See section 5.5.6 for further details on decode formats.

Per systems group ten *encode formats* can be selected. These encode formats are linked to key definitions or are triggered by certain conditions. The following system-group related encode format entries are available:

- *Encode button #1* (normal call)
- *Encode button #2* (free-dial selcall)
- *Encode button #3* (free-dial DTMF)
- *Encode button #4* (single-tone)
- *Encode button #5* (status call)
- *Encode button #6* (emergency call)
- *Encode PTT-press*
- *Encode PTT-release*
- *Encode DTMF overdial*
- *Encode channel select*
- *Encode on hook*
- *Encode off hook*

For each of these format entries one of the seperately defined encode formats can be selected. See section 5.5.5 and 5.5.6 for further details on encode and decode formats. In section 5.5.4 the key definitions linked to the entries 'encode button #1' to 'encode button #6' are explained.

The format selection for *encode PTT-press* is intended for applications as transmit lockout, SAT selection and transmitting an ident message on every PTT press. The *encode PTT-release* format selection can be used for SAT trailing noise supression and ident message on PTT-release. The *encode DTMF overdial* format will be executed each time a key is pressed on the keypad while the PTT button is pressed. The *encode channel select* format will be executed on selection of a channel which refers to this system group. This encode format will be executed for manual selection of the channel as well as while scanning.

If a decode or encode format is not required for one or more of the parameters explained, selection [OFF] can be entered.

Four 5-digit selcall addresses are available for each channel. This allows programming of selcall identities on a per-channel basis. Although the application is fully defined by the programmed encode and decode formats, the default assignment for these selcall addresses are:

- *Default tx address*
- *Primary rx address*
- *Secondary rx address*
- *Third rx address*

The *default tx address* is used to assign the default values of the user selectable digits. Depending on the status of parameter *copy from default tx*, the contents of this address is copied to the selectable selcall digits on power-up only or on any channel change. The default tx address is also copied to the selectable address digits when a new identity is entered and *digit entry method* is set to *replace*. These address digits can be accessed in any encode or decode format by using the ^D pointer; see section 5.5.5.

The *primary rx address* is used normally to define the own identity of the radio unit. In addition, these five digits are used for the automatic-close facility (matching of an incoming sequence to this primary rx address), and the first digit is used also for 1st tone selcall scanning. The primary rx address digits can be accessed from within any encode or decode format by using the ^P pointer; see section 5.5.5 for further details.

The *secondary rx address* is used normally to define a second receive identity. In most applications, such a secondary rx identity is handled as a group call. The first digit is used also for 1st tone selcall scanning. The secondary rx address digits can be accessed from within any encode or decode format by using the ^S pointer character; see section 5.5.5 for further details.

The *third rx address* is used as a third receive address in most applications. However, also this five-digit selcall address field can be used for other purposes. These digits can be accesses from within any encode and decode format by using the ^T pointer character; see section 5.5.5 for further details.

Note that a part the channel-block related address digits can be disabled (see parameter *addresses per channel*) to save EEPROM space and thus allow more channels to be configured. These non-selectable digits are marked as squares, and are retrieved as F's in the encode and decode formats.

### 5.5.4 Key functions related to selcall

For selcall applications a number of key functions are provided. Note that some of these key functions are also used for other purposes, e.g. *decimal digits* and *monitor both*. The following key functions are related to selcall:

- Digits 0..9
- Clear digit
- Group digit
- Monitor selcall
- Monitor both
- Selcall reset
- Digit 1x
- Digit 10x
- Digit up
- Digit shift
- Mode select
- Mode reset
- Selcall entry
- Status entry
- Queue mode
- Queue next
- Queue select
- Encode button #1 [normal call]
- Encode button #2 [free-dial selcall]
- Encode button #3 [free-dial DTMF]
- Encode button #4 [single-tone]
- Encode button #5 [status call]
- Encode button #6 [emergency call]
- Clear all

The *decimal digits 0..9* are used for several purposes within selcall applications. These are:

- Entry of selcall address
- Entry of status number
- Entry of free-dial number
- Selection of a queue entry

Both the selectable number of digits for the selcall address and status number can be configured from 0 till 5. The size of the free-dial number can vary from 0 till 28 digits. This free-dial number can be entered and edited before the call is transmitted.

By executing the *clear digit* key function in the selcall mode, the selectable digits will be initialized to the default cx address. In the status number entry mode, the *clear digit* key function will reset all status digit to 0. In the free-dial entry mode, the *clear digit* key function will erase the latest entered digit. The *clear digit* key function is normally attached to the C-button on the keypad.

The *group digit* can be used only in the selcall address entry mode. It will enter an A-digit at the selected position. When no entry mode is selected, executing the *group digit* key function will automatically select the selcall entry mode, provided that one or more digits are selectable, otherwise an error beep will be sounded. The *group digit* is normally attached to Shift-A.

The *monitor selcall* key function is used to toggle the selcall mute between open and close. It will not affect the SAT monitor status. Normally this key function is attached to the # button.

The *monitor both* key function toggles both the selcall and SAT mute between open and close. The following table can be used to determine the status after executing this key function:

| | |
|---|---|
| - Selcall close, SAT close | Selcall open, SAT open |
| - Selcall close, SAT open | Selcall open, SAT open |
| - Selcall open, SAT close | Selcall close, SAT close |
| - Selcall open, SAT open | Selcall close, SAT close |
| - Selcall close, no SAT | Selcall open |
| - Selcall open, no SAT | Selcall close |
| - SAT close, no selcall | SAT open |
| - SAT open, no selcall | SAT close |

The *selcall reset* key function closes the selcall mute. This key function does not allow the user to bypass the selcall mute function, unless the radio is called.

The *digit 1x* key function increments the 5-th digit of the selectable selcall address or the 5-th digit of the status number, depending on which entry mode is selected. If neither the selcall entry mode nor the status entry mode is active, the selcall entry mode will be activated when pressing this key.

The *digit 10x* key function increments the 4-th digit of the selectable selcall address or the 4-th digit of the status number, depending on which entry mode is selected. If neither the selcall entry mode nor the status entry mode is active, the selcall entry mode will be activated when pressing this key.

The *digit up* key function increments the currently selected digit of the selectable selcall address or the currently selected digit of the status number, depending on which entry mode is selected. The flashing digit indicates the currently selectable digit. If neither the selcall entry mode nor the status entry mode is active, or the digit selection mode (indicated by the flashing digit) is inactive, pressing this key will sound an error beep.

The *digit shift* key function selects the next digit of the selectable part of the selcall address or status number. The selectable digit is shifted from right to left each time this key function is executed. The flashing digit indicates which digit is currently selectable. If neither the selcall entry mode nor the status entry mode is active, or the digit selection mode (indicated by the flashing digit) is inactive, pressing this key will select the rightmost digit of the selcall address.

The *mode select* button switches between the two most frequently used entry modes, which are the channel entry and selcall entry modes. If no mode is selected, the non-default display mode will be selected (e.g. if normally the channel number is visible, the selcall entry mode will be selected). If either the selcall or channel entry mode are selected, the other mode will be selected. From within the queue entry mode, it will copy the selcall and channel information from the currently selected queue entry and allow editing by the user. From within any other operating mode, this key does not operate.

The *mode reset* button switches to the idle status. The display will show the default display format.

The *selcall entry* mode allows editing of the selectable address digits. These digits can be used in encode formats to define transmit selcall messages. Depending on the system-group related *selectable selcall digits* parameter, the number of selectable digits can be set between 0 and 5. If 0 is assigned for the system group linked to the current channel, an error beep will be sounded when executing this key function, and the previously selected entry mode will be retained.

The *status entry* mode allows editing of the status number. These digits can be used in encode formats to define a status transmit message. Depending on the system-group related *selectable status digits* parameter, the number of selectable digits can be set between 0 and 5. If 0 is assigned for the system group linked to the current channel, an error beep will be sounded when executing this key function, and the previously selected entry mode will be retained.

The *queue mode* key function activates the queue readout mode. The display format for the queue readout mode is explained in section 4.8.5. By pressing key *1..9*, the appropiate queue entry will be selected.

The *queue next* key function selects the next available queue entry in the queue. If the queue mode was not activated before, the *queue next* key function selects the queue readout mode first and the first entry will appear on the display. If the last entry is passed, the first entry will appear again.

The *queue select* key function selects the next available queue entry in the queue, or selects the default operation mode when the last queue entry is passed. If the queue mode was not activated before, the queue readout mode will be selected with the first entry shown.

It is possible to transmit a call from within the queue mode; the selectable digits will then be copied from the queue entry. It is possible as well to transfer the selcall identity to the selectable address register and leaving the queue using queue function *mode select*. Key function *clear digit* will erase the current selected queue entry. Key function *clear all* erases all queue entries.

The six available *encode button #1..#6* key functions are linked to the six system-group related encode formats. These six call formats and the default functions attached to them are listed in the previous paragraph.

The *clear all* key function operates in the queue mode and free-dial entry mode. In the free-dial entry mode it will erase the full number. This key function is normally attached to Shift-C.

### 5.5.5 Encode instructions related to selcall

The selcall related encode definitions are:
- SEND, SLEN, SCHK, SDIAL
- TXS
- TSET, TONE, LEN, DEL
- RIGN, RACK, RSMS, RSML
- EMGON, DUPX, REP
- TPE, TPD
- SELT, SELD, SELS
- OPEN, CLOSE, XOPEN, XCLOS, XNOT
- SBUSY, WAITR

The available selcall-related encode instructions offer a very flexible solution to define transmit and receive selcall formats. Almost any existing selcall format can be emulated with the encode/decode format concept. In addition, lockout-conditions and sub-audible tone generation can be controlled from within encode formats.

Some examples are included to explain some of the applications and the use of this category of encode and decode instructions.

The first category of encode instruction transmit one or multiple selcall digits. These instructions are: *SEND*, *SLEN*, *SCHK* and *SDIAL*.

The *SEND* instruction is used to transmit a single or multiple digits in a row with the same tone duration. Immediate as well as indexed digits can be transmitted. The available immediate digits range from 0 till 9, A, B, C, D and E. For example, to transmit digit 2 the following sequence is entered: 'SEND #2'. Also multiple digits can be send, e.g. 'SEND #59402' to transmit fixed sequence 59402.

Indexed digits (also called 'indirect digits') are preceeded with a pointer symbol and field designator. For example, to transmit the 1st and 3rd digit from the default transmit address, 'SEND ^D13' should be entered. The following indirect pointer fields are available:

- ^D Default transmit address
  ^P Primary receive address
- ^S Secondary receive address
  ^T Third receive address
- ^Q Temporary queue entry
- ^U Status number
- ^M Miscellaneous digits
- ^K Keypad selectable digits

Some examples of encode sequences using the SEND instruction:

| | | |
|---|---|---|
| - | SEND #12345 | Send fixed sequence 12345 |
| - | SEND #123^K45 | Send fixed 123 plus 2 last selectable digits |
| - | SEND ^D123^K45 | Send first three digits of default tx address plus two keypad selectable digits |
| - | SEND ^K12345 | Send full 5-digit selectable address |

The *SLEN ofs* instruction transmits the MOD 10 result of the free-dial string length added to the offset *ofs*. The instructions is used within encode definitions to transfer free-dial number information to a telephone interconnect. It provides additional protection against false decoding. Three examples:

- Dialling string '1234567' (length 7), instruction SLEN 3
  $(7+3)$ MOD 10 = 0

- Dialling string '456376247623' (length 12), instruction SLEN 9
  (12+9) MOD 10 = 1
- Dialling string '' (length 0), instruction SLEN 5
  (0+5) MOD 10 = 5

The *SCHK* instruction transmits the MOD 10 result of the sum of all preceeding digits. The checksum result is reset to 0 at the start of the sequence. To reset the checksum within a sequence, a DEL or LEN instruction should be inserted. A few examples:

- Dialling string '1234567', sum is 1+2+3+4+5+6+7=28, result is 8
- Dialling string '0528063355', sum is 37, result is 7

The *SDIAL* instruction transmits the free-dial string as individual selcall digits. The length of this free-dial string can vary from 0 till 28 digits. Together with the SLEN and SCHK instructions, SDIAL can be used to transmit a telephone number to a telephone interconnect according the Rohill standard. For this standard, the following encode definition is used:

SEND #59492 SLEN 7 SDIAL SCHK

Some examples of transmitted sequences using the encode format as specified above:

| | |
|---|---|
| - Dial '0528063355' | 594927052806335 53 |
| - Dial '061234' | 5949230612348 |
| - Dial '' (no digits) | 5949276 |

The *TXS* instruction switches the radio to transmitting with the selcall path enabled. All digit transmit functions will be translated to tones according the selected selcall standard. The microphone will be muted during selcall transmission.

The *TSET* instruction selects the toneset for transmission. The following eight standard tonesets are available: ZVEI, CCIR, DZVEI, EEA, ZVEI-2, PZVEI, PCCIR and PZVEI. See the explaination for system group related parameter selcall standard for a comprehensive description. For example, to select toneset ZVEI, this instruction is used as 'TSET ZVEI'.

The *TONE* instruction is used to transmit a single-tone or a number of fixed tones in a sequence. Applications for this facility include transmitting of all-calls, group calls, to activate a repeater and transmitting calls to a fixed identity 2-tone pager (Motorola or GE standards, frequently used in the USA). The syntax of this instruction is TONE af-freq where *af-freq* is any single-tone frequency between 300 and 3000 Hz. The duration of the tone is set by the instruction LEN, of which the description will follow.

The duration of selcall or DTMF digits and single-tones is set using the *LEN* instruction. This instruction must be placed before the transmit digit/tones instructions as SEND and TONE. The syntax is LEN xtime where *xtime* is a number between 1 and 7000 specifying the duration per tone in 1 ms units.

The *DEL* instruction executes a delay. The duration of the delay can vary between 1 and 7000 ms. Applications for these instructions include lead-in and lead-out delays, and no-tone delays between multiple 5-tone sequences for e.g. 2*5-tone and 3*5-tone formats. The syntax is DEL xtime where xtime is a number between 1 and 7000 specifying the duration of the delay in 1 ms units.

The *RIGN* instruction can be used to ignore receiption of selcall digits during a period of time. The most important application for this facility is to prevent the radio were a call is initiated from to close by the automatic-close after receiving the transpond message from the called radio. The syntax is RIGN stime where stime is a period of time between 10 and 2550 ms in 10 ms units.

The *RACK* instruction is used to check for a response from another radio after transmitting a call. Because a specific decode format can be linked, it is possible to check for a reply in any format.
For example, the calling radio can check for a transpond message after transmitting a call, and show an acknowledge symbol when the call has been successfully send. The syntax is RACK stime dec where *stime* is the period of time the decode sequence is valid, and *dec* is the linked decode format. After receiving a selcall sequence, the radio will always check first for an active decode format triggered by RACK and after executing this decode format without success, it will try the standard decode format.

Instruction *RSMS* (Resume Short) is used to restart the encode format after a certain period of time. The RSMS instruction is used together with the REP (repeat) instruction to create encode formats which are repeated for a number of times. Applications for these instructions include repeated emergency call transmissions and call retry until acknowledged. The syntax is RSMS stime where *stime* is the period of time after which the current encode format is restarted if the number of repeats is not exceeded. Parameter *stime* can be set between 0 and 2550 ms in 10 ms steps.

Instruction *RSML* (Resume Long) has a similar function. The syntax of this instruction is RSML ltime where *ltime* is the period of time in seconds. This parameter can be configured between 0 and 255 seconds.

Using instruction *EMGON* (Emergency On), the display contents will be cleared, the LED will be switched off (portable only) and audio will be muted. When used in an emergency call encode format, it prevents that while an incident is occuring it is not visible that an emergency call or surrounding speech is transmitted after triggering the emergency call (e.g. using a foot switch).

The emergency condition will remain active until the number of calls (using REP) has exceeded the maximum, or when a special call format is received which triggers decode function EMGOF.

Using instruction *DIFIX* (Display Fix), the display contents will be freezed, the LED will be switched off (portable only) and audio will be muted. When used in an emergency call encode format, it prevents that while an incident is occuring it is not visible that an emergency call or surrounding speech is transmitted after triggering the emergency call (e.g. using a foot switch). The emergency condition will remain active until the number of calls (using REP) has exceeded the maximum, or when a special call format is received which triggers decode function EMGOF.

The *REP* instruction is used to create an encode format of which execution is repeated until a certain condition exists. Applications are already mentioned in the description for instruction RSMS, and include emergency call transmission and repeating a call until an acknowledgement is received. The syntax of this instruction is REP repeatfactor where *repeatfactor* is the number of repeats executed. Using RSMS and RSML, a period of time can be inserted before the current encode format is repeated. The repeated encode format is either stopped after exceeding the number of repeats, or after executing the decode instruction REPOF on a matching incoming call.

The *TPE* and *TPD* instructions are used to switch on and off the transparancy mode. By switching on the transparancy mode, a D-digit will be inserted after every four tones, to prevent that a long string of tones includes valid selcall addresses. The transparancy mode is switched on using TPE (Transparancy Enable) and switched off using TPD (Transparancy Disable). See also the description for application *free-dialling using selcall*.

The *SELT* instruction requests the user to press * to confirm a single-tone transmission. When executed, 'tone' will be displayed on the LCD. After pressing * this message will disappear and the encode format will be continued.

The *SELD* instruction requests the user to enter and/or edit a free dialling string. It will show initially a blank display. When pressing digits, the digits will be added to the dialling number and will be shifted on the display from right to left. If more than four digits are entered, only the last four digits will be shown. Key # will cause a B digit to be added, which is used to identity a wait-on-dialtone condition. Key C erases the rightmost digit. After pressing button *, the dialled number will disappear and the encode format will be continued.

The *SELS* instruction is used for status digit entry. After execution of this instruction, the message 'St n' will be shown on the display, where n is the current selected status digit. By pressing a numerical key the status number can be overwritten.

Using key C the status digit can be reset to 0. By pressing button *, the status message will disappear and execution of the encode format will be resumed. Note that this single digit status entry mode is different from the 5-tone status selection facility, which is triggered by key function *status entry*.

Instruction *OPEN* selects the selcall mute open state from within an encode format. This instruction can be used to force listening to the radio channel before a call is transmitted while the radio is in the closed-mode. See also instruction XCLOS.

Instruction *CLOSE* selects the selcall mute close state from within an encode format. Its main purpose is to close the selcall mute function when a kind of disconnect call is transmitted (sometimes used in selcall based automatically controlled systems).

Instruction *XOPEN* exits the current active encode format and sounds an error beep (if selected by ERRX1) when the selcall mute state is OPEN. Useful to ignore calls made while a connection exist (sometimes used in selcall based automatically controlled systems).

Instruction *XCLOS* exits the current active encode format and sounds an error beep (if selected by ERRX1) when the selcall mute state is CLOSE. Can be used to prevent that a user does not listen first to activity on the channel before the call is made.

Instruction *XNOT* exits the current active encode format when the transfer facility is switched off by the user. Use ERRX0 to prevent an error beep to be sounded. Can be used to trigger transmission of a call to another radio or pager, depending on the state of the ext/transfer key function.

Instruction *SBUSY* skips the following SEND instructions when a carrier is detected at the time the encode format was started. This instruction can be used to skip transmission of lead-in digits when a carrier is detected at the time the call button is pressed, e.g. to activate a selcall-controlled repeater system.

Instruction *WAITR* delays execution of the next encode instruction until the currently pressed key is released. This encode instruction can be used to prolonge transmission of DTMF tones in the DTMF overdial mode.

### 5.5.6 Decode instructions related to selcall

Selcall related decode instructions include:
- CMP, STO
- GRPN, GRPA, GRP0, GRP0A
- MONO, MONC, MONF
- RSTUN, RVIVE, RKILL
- EMGOF, REPOF, QUEUE, QUEID, DISPQ
- BEEP, BEEPI, BEEPG
- ENCA, ENCI, ENCG
- DECA, DECI, DECG, DECF
- DECAT, DECIT, DECGT
- EXTAL, XPASS, ERASE

Decode formats are used to define sequences for receiving selective calls. Incoming selective call messages can be compared to one or more formats, and when a matching format is found, certain instructions can be executed, e.g. to open the radio or to sound an alert beep.

The number of tones for an incoming call can be defined from 1 to 15. Fixed digits as well as variable digits can be included in a format. The variable digits can be stored in a queue entry if required.

Selcall formats consisting of two or more sequences seperated by gaps can also be defined and decoded. An example of such a format is the 2*5-tone repeater access format, frequently used in France.

Decode instructions are also available for initiating a call when a matching call has been received (transpond), or to link to other decode formats when very complicated decode formats are required. Using this facility an almost unlimited number of decode addresses can be defined.

Furthermore, a selection of 24 alert sequences are available so that the user can quickly determine the kind of call received (individual call, group call, all call, secondary address call, remote close call, and so on). Finally, a number of special decode instructions are available e.g. for storing a queue entry, remote stun, remote revive and remote kill.

Execution of decode formats is triggered by two conditions:
- When a no-tone condition occurs (time-out after the last tone within a selcall sequence has been received)
- When the selcall tone buffer of 16 digits is filled

For every system group a seperate *decode format* is defined which points to the decode format to be executed. It is possible also that a temporary decode format is activated by a RACK instruction (see section 5.5.5). Such a temporary decode format is always executed first, and if no matching sequence is decoded, the standard decode format will be executed.

The *CMP* instruction (for COMPARE) is the most frequently used decode instruction. It compares one or more incoming selcall digits to a number of fixed digits. This is continued until an 'executable' instruction is passed, which then tests whether or not the incoming sequences matches the fixed sequence.

The fixed digits can consist of immediate and indexed digits. Immediate digits are fixed from within the decode format, so they cannot be different for a single or a group of channels. An example of a compare immediate sequence is 'CMP #59402' where incoming calls are compared to the fixed address '59402'.

Indexed digits are preceeded with a pointer symbol and field designator. These indexed digits are retrieved from one of the eight 5-tone addresses, of which four are defined per channel. For a list of indexed digits, see the description of the SEND instruction in section 5.5.5. Also for CMP, immediate and indexed digits can be used after one CMP instruction.

The CMP instruction also accepts group digits. A group decode flag is set when such a group digit is received. This group decode flag is checked by some executable decode instructions as BEEP, BEEPI and BEEPG. It is possible to select 0 and A as group digit, which can be configured per sequence or even per tone (see GRPN, GRPA etc. instructions).

The *STO* instruction (for STORE) can be used on positions were variable digits are expected. The STO instruction can be preceeded or followed by CMP instruction to create a decode sequence with fixed and variable digits. The STO instruction accepts all digits from 0 and 9. If another digit is received (e.g. B), then the STO command will mark the executed format as non-matching. Some examples of CMP/STO sequences:

- CMP #59402 STO 45 CMP #F
  Matches to a sequence consisting of 7 tones, starting with '59402' and both last digits between 0 and 9. The last two digits are store at position 4 and 5 of the temporary buffer.
- CMP #59 STO 4 CMP #0 STO 5
  Matches to sequence '59v0v' where v is a variable digit with a value between 0 and 9. The first variable digit is stored in position 4 of the temporary buffer and the second variable digit is store in the 5th position of the temporary buffer.
- STO 12345 CMP #F
  Matches to any 5-tone sequence consisting of digits between 0 and 9. All digits are stored in the temporary buffer. Longer sequences are not accepted (CMP #F).
- CMP #1 STO 2 CMP #345 STO 4531
  Matches to sequence '1v345vvvv' where the variable tones are stored in the temporary buffer at the positions 2, 4, 5, 3 and 1 from left to right.

If the sequence is matching, decode instruction QUEUE or QUEID can be used to copy the contents of the temporary buffer to the queue table. It is possible also to use the contents of the temporary buffer in encode formats, e.g. to create a transpond message.

Using the instructions *GRPN*, *GRPA*, *GRP0* and *GRP0A*, the digits which are accepted as group digits can be selected. After execution of *GRPN*, no group digits are accepted. Using *GRPA*, A-tones are accepted as group digits, using *GRP0*, 0-tones are accepted as group digits and by executing *GRP0A*, both 0's and A's are accepted as group digits.

It is possible to mix CMP and GRP instructions to allow group digits on certain positions of the decoded sequence. Some examples:

- GRPN CMP #594 GRPA CMP #02
  Matches to incoming 5-tone sequence '59402', where the latest two digits can be A-tone group digits.
- GRPA CMP #594 GRP0A #12
  Matches to incoming 5-tone sequence '59412', where on all positions the A-tone is accepted as group digit, and the 0-tone is accepted as group digit in the last two positions.

Executing the *MONO* instruction will open the radio when the incoming sequence matches the defined sequence. Individual as well as group calls are accepted. When the MONO instruction is executed after a no-match condition occured, nothing will happen.

The *MONF* instruction is similar to the MONO instruction, but the CALL indicator will also start to flash. This visual indication alerts the user that an incoming call has been received.

Instruction *MONC* performs exactly the opposite function as MONO: it will close the radio when a matching call is received.

The ICM supports three instructions to sound an alert tone on a matching incoming call. These are: *BEEP*, *BEEPI* and *BEEPG*. Instruction BEEP sounds an alert tone for both individual (no group tones found) and group (group tones found) calls. BEEPI is only executed when an individual call is received, and BEEPG will only operate when a matching group call is received. Using the BEEPI and BEEPG instructions, a distinctive alert can be generated so the user can quickly determine what kind of call is received. All three instructions have the syntax BEEPn num, where *num* is the beep number between 1 and 32. In general, beep numbers 9 to 32 are used for alerts. In appendix G an overview of the alert sequences can be found.

Using the *ENC* series of instructions, a specific encode format can be executed on a matching incoming call. This instruction can be used to initiate a transpond message when receiving a call. Instruction *ENCI* is executed only when a matching individual call is received, *ENCG* is executed only when a matching group call is received and *ENCA* is executed for both individual and group calls. The syntax for these instructions is ENCn dec where *dec* is the linked decode format. Later in this section some examples can be found which explain these instructions.

The *DEC* series of instructions are used to link multiple decode formats for more complicated selcall sequences, normally required when the storage space of 64 bytes for a single decode format is not sufficient.

When the matching condition is true, the decode sequence is immediately started, and the rest of the current decode format is not executed. The *DECA* instruction is executed when a matching group or individual call is received, *DECI* is executed only on individual calls, *DECG* is executed only on group calls and *DECF* is executed only when no match has occured. All instruction have the syntax DECn enc where *enc* is the specified encode format. Examples are found later in this section.

Using the timed decode instructions *DECAT*, *DECIT* and *DECGT*, a second decode format can be activated during a period of time. These instructions can be used to check for multiple selcall sequences, like 2*5-tone and 3*5-tone. DECAT is executed on both group and individual calls, DECIT on individual calls only and DECGT on group calls only. The syntax for these instructions is: DECAT time dec, where *time* is a time-out value of 0 to 2550 ms in 10 ms units and *dec* is the decode format to activate. The syntax for DECIT and DECGT is the same. Examples are given later in this section.

Instruction *QUEUE* is used to copy the contents of the temporary buffer (see also STO-instruction) to one of the available queue entries. This instruction is only executed when an incoming match (group or individual call) condition exists. The temporary buffer is copied to the top queue entry, and existing entries will shift downwards. If the queue storage area is full, the earliest entry will be lost. Instruction QUEUE stores the 5-tone identity as well as the channel number where the call is received on, and allows duplicated storage. Operation of QUEUE is identical to operation of QUE1.

Instructions *QUE1*, *QUE2*, *QUE3*, *QUE4*, *QUE5*, *QUE6*, *QUE7* and *QUE8* operate similar to instruction QUEUE, but provide different methods of storage. By selection of the appropiate QUE instruction, it is possible to store the identity with or without channel number, allow or not allow duplicate entries (two or more entries with the same channel number and identity), and use the FIFO (First In First Out) or FILO (First In Last Out) storage and retrieval method. In the following table, all combinations are shown:

| Instruction | Storage order | Duplicate | Store channel |
|---|---|---|---|
| QUE1 | FILO | YES | YES |
| QUE2 | FILO | YES | NO |
| QUE3 | FILO | NO | YES |
| QUE4 | FILO | NO | NO |
| QUE5 | FIFO | YES | YES |
| QUE6 | FIFO | YES | NO |
| QUE7 | FIFO | NO | YES |
| QUE8 | FIFO | NO | NO |

The *DISPQ* instruction will activate the queue mode, and thus will immediately display the first queue entry after executing this instruction. This instruction is executed only when a match condition exist. When preceeded by the QUELE or QUEID instruction, after receiving a call in a WHC (Who Has Called) format, the identity of the calling party will be displayed immediately.

The *EMGOF* instruction de-activates the emergency mode. EMGOF is executed only when a match condition exist, otherwise it will be ignored. The emergency mode is activated by encode instruction EMGON, which is described in section 5.5.5. The EMGOF is normally used in a decode format, which is activated by a emergency encode format, and thus makes it possible to remotely reset the emergency mode by the despatcher.

The *REPOF* instruction stops a repeating encode format. REPOF is normally used in a decode format directly linked to an encode format. Purposes of such an encode/decode format include a repeated emergency call and repeated call transmitting until an acknowledge is received. The REPOF instruction is executed only when a match condition exist, otherwise it will be ignored.

The remote control instructions *RSTUN*, *RVIVE* and *RKILL* can be used to temporary or forever disable operation of a radio. The remote stun instruction RSTUN de-activates operation of a radio when triggered by a matching call. In the remote stun mode the display will show 'Loc2', and operation of the transmitter is not possible. Also the audio will be muted. The radio is activated again after executing the RVIVE (remote revive) instruction. The RKILL (for remote kill) destroys the contents of the EEPROM, so the radio has to be returned to the service shop for reprogramming. The remote kill feature is especially useful for secure application e.g. for police forces, where operation of a lost or stolen radio is undesired.

Instruction *EXTAL* controls the external alert facility. On a matching sequence this instruction is executed only when the external alert facility has been activated by the user. The horn or lights, connected via a relay to the external alert output of the radio, can be driven with a specific rhythm, so that the user can easily distinguish a call alert from other events.

This rhythm consist of eight slots of 500 ms duration each, specified as a series of eight 0s and 1s. For example, EXTAL 11011011 outputs three horn blasts of 1 second each with pauses of 0.5 second in between the blasts.

Instruction *XPASS* aborts execution of the decode format on a matching sequence. This instruction is useful to ignore subsequently specified compare sequences when the previous sequence compares succesfully, e.g. to avoid storage of a sequence into the temporary queue buffer.

Instruction *ERASE* erases the contents of the temporary buffer after the socified number of milli-seconds. The syntax is ERASE time, where parameter *time* specifies the timer duration from 0 to 2550 ms in 10 ms units. After this timeout is elapsed, the contents of the buffer will by replaced by F-digits.

Some examples of decode formats:

- CMP #59402 MONO BEEP 12 ENCI Transpond
  This format compares an incoming selcall sequence to 59402, opens the radio (MONO) when a matching call is received, sounds alert sequence 12 when a matching call is received (BEEP 12), and initiates execution of encode format *Transpond* when no group digits are found in the matching call address.

- CMP #12345 MONF BEEPI 15 BEEPG 16 ENC Transpond
  This format compares an incoming selcall sequence to 12345, opens the radio with the CALL indicator flashing, and sounds alert 15 if it is an individual call and alert 16 if the incoming sequence contained group digits. Encode format *Transpond* is triggered for both individual and group calls.

- CMP ^P12345 #F MONF BEEP 8 CMP ^P12345 ^CF MONC
  If a 5-tone call is received with an identity matching to the primary receive address (^P pointer digits), then the radio will open, the CALL indicator will flash and alert beep 8 will be sounded. If the same 5-tone identity plus C-tone is received, the radio will be closed. This remote close format is frequently used in PYE/Philips systems.

- CMP ^P123 STO 45 CMP #F QUEUE MONO BEEP 12
  This decode sequence first checks is the three digits received first match the first three digits of the primary code, then it stores the 4th and 5th digit of the received selcall sequence in the temporary buffer if they both are digits between 0 and 9, and checks for a no-tone condition. If the incoming sequence matches the format, the temporary buffer is copied to the queue, the radio opens and alert 12 is sounded.

- CMP #59420 RSTUN CMP #59421 RVIVE DECF DecSecond
  This decode format compares the incoming sequence first to 59420. If it matches, radio operation will be disabled (remote stun). The radio can be activated again by sequence 59421 (remote revive). If the second compare fails, decode sequence DecSecond is executed, which can contain further decode instructions

- CMP #592 DECA Decode592 CMP #5940 STO 5 QUEID MONO BEEP 9
  Any received selcall sequence starting with 592 will be decoded further in decode format Decode592. In the subsequent compare instruction, the first four digits of the incoming selcall sequence are compare to 5940, and the 5-th tone will be stored in the temporary buffer if between 0 and 9. If the call matches the sequence, the digit will be stored in the queue, the radio will open and alert 9 is sounded.

- [1] CMP #59403F DECAT 1500 DecNextFive
  [2] STO 12345 CMP #F MONO QUEUE DISPQ BEEP 12 ENC Transp
  The first decode format compares an incoming sequence to 59403, the own identity of the radio. If the call matches, decode format *DecNextFive*, shown as [2] will be active during 1.5 second. If another 5-tone call is received within these 1.5 seconds, all 5 digits will be stored in the temporary buffer. If all digits are valid, the radio will open (MONO), the identity will be stored in the queue (QUEUE), the queue entry will pop up on the display (DISPQ), alert beep 12 is sounded and encode format *Transp* is executed.

- CMP #59403F QUE1 DISPQ MONF BEEP 9 XPASS STO 12345 ERASE 800
  This example shows a decode format for a two-by-five tone format with storage of the first 5-tone into the queue when the second 5-tone matches the unit own address. If a 5-tone sequence is received which is different from sequence 59403, it will be stored in the temporary buffer and a timer is started for erasing this temporary buffer after 800 ms. If within these 800 ms a 59403 sequence is received, the contents of this temporary buffer will be copied to the queue, and the queue contents will be shown on the display (DISPQ). The radio will open with the OPEN sign flashing (MONF) and an alert beep is generated (BEEP 9). The decode format is aborted by the XPASS instruction on a succesfull match, so storage of the 59403 sequence in the temporary buffer is avoided.

## 5.6 CTCSS/DCS transmit/receive

The ICM for the Kenwood mobile and portable radios should support both CTCSS and DCS signalling. Because the applications for both CTCSS (Continues Tone Coded Squelch System) and DCS (Digital Coded Squelch) are almost identical, CTCSS and DCS will be both called SAT (for Sub Audible Tone) further in this section. Both systems employ the audio frequency band below 300 Hz.

### 5.6.1 Applications for sub-audible tone signalling

The CTCSS and DCS sub-audible signalling standards are mainly used for the following purposes:

- Repeater access
- Closed user group communications

These applications and other capabilities of CTCSS and DCS are expained in the following paragraphs.

**Repeater access**

Both CTCSS and DCS are transmitted continuesly while transmitting speech. In a repeater application, the repeater will be activated when a carrier is received with a valid SAT. The repeater will then re-transmit the received signal further to increase the operating range of mobile and handportable radios. Because of this, all radios must be programmed with a semi-duplex frequency.

A SAT-driven repeater can use multiple decoders for CTCSS and/or DCS to allow operation by multiple user groups. This is called a community repeater. Every subscriber has two or more radios with a fixed SAT code, which then can communicate through the repeater station. Using CTCSS, 38 codes are available, and DCS offers 83 codes.

**Closed user groups**

SAT signalling can be used also in radios on a simplex frequency without a repeater site. In such an application, a single SAT encode/decode frequency is programmed in all radios within a user group. During transmission both the speech and the SAT is continuesly send. When the SAT matches the programmed decode SAT in the receiving radio, the audio will be unmuted and the user can hear the conversation. Other radios listening to the same frequency, but with other SAT decode frequencies programmed, will not be unmuted.

An obvious advantage of this application is the improved privacy.

### SAT lockout

SAT lockout can be used for both repeater access and closed user group communications. By using specific encode instructions, it is possible to prevent transmission of speech and/or calls when a SAT code is received different from the own decode SAT code.

By using SAT lockout in all radios operating in a repeater system, this facility prevents that a user outside the group currently using the repeater site, is able to take over operation of the repeater. All other parties have to wait until the repeater is free, and then are able to start a conversation. A repeater busy condition is normally visible on the display of the radio.

### Suppression of trailing noise

In two-way simplex operated radio communications, the receiving radio will sound trailing noise after the PTT is released of the transmitting radio. This annoying noise burst can be suppressed by continueing transmitting for a short while without CTCSS, so the receiving radio will mute before the carrier disappears. In DCS systems a special continues tone is defined for this purpose, which is shortly send after releasing the PTT button.

For CTCSS, suppression of trailing noise can be implemented using an encode format linked to PTT-release. For DCS this feature is standard operating.

### Increased immunity to adjacent channel signalling

When multiple channels in a system are used with frequencies near eachother, the operation of radios can be disturbed by signalling and speech on nearby operated channels. Signalling and speech on these nearby channels can be suppressed effectively using sub-audible tone signalling, so the radio will not be unmuted or called unnecessary.

## 5.6.2 Parameters related to sub-audible tone signalling

Every channel can be independently configured for any of the available CTCSS frequencies or DCS codes, for decode as well as encode. It is possible as well to select seperate codes or frequencies for encode and decode, or to select e.g. DCS for encode and CTCSS for decode.

On a per channel basis, parameter *SAT encode* selects the required CTCSS frequency or DCS code for transmitting. Using specific encode instructions, which are explained in section 5.6.3, CTCSS and DCS can be activated and de-activated from within an encode format. For *CTCSS* the exact frequency in Hz should be entered, or one of the avialable call signs. These can be found in appendix D.

For *DCS* one of the available three digit octal code is entered, which can be found in appendix E. When this field is cleared or when OFF is entered in this field, DCS and CTCSS signalling are both switched off. It is possible also to enter an I plus a valid three-digit DCS code to obtain inverted DCS codes.

Parameter *SAT decode* selects the required CTCSS frequency or DCS code for receiving. For *CTCSS* the exact frequency in Hz should be entered, or one of the avialable call signs. These can be found in appendix D. For *DCS* one of the available three digit octal code is entered, which can be found in appendix E. When this field is cleared or when OFF is entered in this field, DCS and CTCSS decoding are both switched off. It is possible also to enter an I plus a valid three-digit DCS code to check for inverted DCS codes.

The *monitor function* parameter defines the function of the monitor button for each system group seperately. Two of the selections allow operation of SAT monitor. The operation of this parameter is described in detail in section 5.5.3.

The *DCS error-correcting* parameter selects the error correcting capability of the DCS decoding software. Selections include Mode 1, Mode 2, Mode 3 or Mode 4. The modes have the followinf characteristics:

| | |
|---|---|
| Mode 1 | Excellent error protection, high speed, low sensitivity |
| Mode 2 | High error protection, high speed, medium sensitivity |
| Mode 3 | Medium error protection, high speed, high sensitivity |
| Mode 4 | High error protection, medium speed, high sensitivity |

### 5.6.3 Key definitions related to sub-audible tone signalling

In the programming software it is possible to configure a button or key on the mobile or portable for *SAT monitor*. By pressing this key it is possible to bypass the sub audible tone squelch and thus listen to activity on the radio channel. By pressing this key again, the audio is muted again.

The *monitor both* key function operates both selcall and SAT mute. Its operation is described in detail in section 5.5.4.

### 5.6.4 Encode instructions related to sub-audible tone signalling

A number of encode instructions are related to SAT signalling. These instructions can be used in encode formats linked to call buttons, PTT-press and PTT-release. A few examples are included at the end of this section to explain the applications of these instructions. A description of the following encode instructions is included in this section:

- SCTP, SCT
- SCRP, SCR
- SCOFF, SCPH0, SCPH1
- XCTCN, XCTCW

Instruction *SCTP* activates SAT transmission (either CTCSS or DCS) from within an encode format. The programmed SAT frequency or code will be used. Normally this instruction is used at the position after TXS or TXM (transmitter on). By omitting this instruction for certain encode formats, it is possible to transmit e.g. selcall messages without a sub-audible tone.

Instruction *SCT* activates SAT transmission from within an encode format using the CTCSS frequency or DCS code specified. This allows transmission of a SAT frequency or code different from the fixed SAT for the selected channel. The syntax of this instruction is *SCT* st-tone, where *st-tone* is the CTCSS frequency in Hz, a D followed by a valid 3-digit code for DCS, or an I followed by a valid 3-digit code for inverted DCS.

Instruction *SCRP* selects the SAT frequency or code for receiving as configured for the current channel. This instruction is useful only for applications were the encode format causes the radio to temporary switch back to receive.

Instruction *SCR* is similar to SCRP, but for SCR a specific SAT frequency or code can be specified. The syntax of this instruction is *SCR* st-tone, where *st-tone* is the CTCSS frequency in Hz, a D followed by a valid 3-digit code for DCS, or an I followed by a valid 3-digit code for inverted DCS.

Instruction *SCOFF* can be used to switch off SAT encode from within a sequence. This instruction can be used to mute the radio of the receiving party while the transmitter continues to operate, and thus suppress the trailing noise. See example encode formats. Both instructions *SCPH0* and *SCPH1* are not supported by the hardware of the CTCSS/DCS chip used, and therefore cannot be implemented. These instruction names and their codes are reserved for possible future software and hardware releases of the ICM.

When instruction *XCTCN* is executed from within an encode format, this encode format will be quit when a carrier is received without SAT or carrier with the wrong SAT. This instruction can be used to define a SAT lockout.

Instruction *XCTCW* works similar, but also quits the encode format when no carrier is received. This means that execution is only continued when the correct SAT is received.

Examples of encode formats:

- TXM SCTP
  Encode format for PTT-press. Selects transmit microphone mode and switches on the sub-audible tone.

- ERRX1 XCTCN TXM SCT 100.0
  Exits the current encode format when a carrier is received without SAT or with a wrong SAT. If the channel is free or the correct SAT is received, the transmitter is activated, and a CTCSS frequency of 100 Hz is transmitted, irrespective of the selected encode SAT for the current channel.

- TXS SCOFF DEL 200 RX
  Linked to PTT-release to prevent trailing noise to be heard at the receiving radio. Transmitter is switched to muted audio, SAT is switched off and the radio continues transmitting for 200 ms before switching to receive mode.

## 5.7 DTMF encode

The DTMF encode facility allows transmission of DTMF (Dual Tone Multiple Frequencies) tones from the radio. Transmission of DTMF tones is fully controlled from within encode formats.

### 5.7.1 Operation of DTMF encode

The digits can be transmitted one-by-one from the keypad, or a number of digits can be entered and edited in a buffer before the number is send as seperate digits.

The most frequently used operation of DTMF encode is the *overdialling* method. By pressing the Push-to-Talk button, and then pressing a key on the keypad while keeping the PTT button pressed, a DTMF tone can be send. By using encode formats, the duration of the tone can be fixed and also a pause can be inserted between the digits. The ICM software buffers entered digits in the overdialling mode when another key is pressed before the previous DTMF tone is fully transmitted.

The so-called *off-hook dialling* method makes entry and editing of a full telephone number possible before the digits are transmitted as DTMF digits. To operate this dialling method, first the button for off-hook dialling is pressed. The LCD will now be cleared, and a number can be entered using the 0-9, * and # keys. The rightmost digit can be erased by pressing button C (clear digit). If the number is considered correct, the call button is pressed and the DTMF digits will be transmitted in a row with a fixed DTMF tone duration and pause duration.

The off-hook dialling encode format can also include operation of other signalling standards as selcall, CTCSS and DCS. Sometimes this is needed for operation of e.g. a telephone interconnect unit.

### 5.7.2 DTMF related parameters and instructions

Because all DTMF functions are executed from within encode formats, there is only one DTMF specific parameter defined.

Parameter *encode DTMF overdial* in each system group is used to link an encode format to the overdialling function. The linked encode format will be triggered each time a key on the keypad (0 to 9, *, # and A to D) is pressed while the Push-to-Talk button is held down. See also example DTMF overdialling encode format.

The following encode format instructions are related to DTMF encode functions:

Instruction *TXD* connects the transmit audio path to the DTMF chip. In this mode, all digits send as for selcall are now send as DTMF digits. During this mode the microphone will be muted. In section 5.5.5 the send instructions for selcall encode are explained. These are: *SEND*, *SLEN*, *SCHK* and *SDIAL*.

For overdialling, a special digit within the miscellaneous 5-tone address is reserved. The 2nd digit, pointed to by ^M2, is used for this facility. The value of this digit will be updated each time a new key is pressed on the keypad in the overdialling mode. Note that entered digits are buffered to prevent that this digit is overwritten too soon.

The *SELD* instruction executes the free-dial entry mode for numbers up to 28 digits. Operation of this mode is also explained in detail in section 5.5.5.

Examples of encode formats for DTMF transmission:

- TXD DEL 100 LEN 200 SEND ^M2 DEL 100 TXM
  This encode format for DTMF overdialling first selects the DTMF transmit mode, executes a delay of 100 ms, and then transmits the selected DTMF tone during 200 ms. A delay of 100 ms follows, after which the microphone is enabled again.

- SELD TXD DEL 200 LEN 80 DEL 50 SDIAL DEL 50 RX
  This encode format can be used for DTMF off-hook dialling. First the free-dial entry mode is selected by SELD. After entry and confirmation, the transmitter is activated with the DTMF audio path enabled. A lead-in delay of 200 ms in executed, after which the duration per tone is set to 80 ms. The second DEL instruction selects the interdigit pause (the value of the latest DEL instruction executed is used as reference for this interdigit pause). Instruction SDIAL transmits all digits in a row. After transmission of the digits, a lead-out delay of 50 ms is executed and the radio is switched to the receive mode.

## 5.8 Miscellaneous

In this chapter a number of miscellaneous functions of the ICM are described.

### 5.8.1 Return-to-Standby

Using the Return-to-Standby facility, the behaviour of the radio can be configured such that the user cannot or is discouraged to use the radio without 'permission' of the despatcher. Listening only to a radio channel becomes quite difficult as well. The Return-to-Standby facility is supported by multiple parameters and encode/decode instructions to optimize this facility for a given application.

The following parameters and encode format instructions are used to configure the Return-to-Standby facility:

Related general parameters:
- Return-to-Standby listen period
- Return-to-Standby active period

Related system group parameters:
- Return-to-Standby mode
- Carrier detect ignore

Related encode format instructions:
- RTSL
- RTSA
- RTSO
- XIDLE
- XLIST

The *Return-to-Standby listen period* parameter specifies the period of time the user of the radio is able the monitor channel before transmitting a call. Such a monitoring facility is required in some countries for transmitting selective calls on conventional channels. The Return-to-Standby listen mode can be activated by pressing the button for open/close. After the RtS listen period expires, the radio will automatically closed again. Using certain encode format instructions, operation of the PTT and call buttons can be customized. Normally the PTT is ignored in the RtS listen period to prevent the user to start a conversation in this mode. The RtS listen period will not be reset by a carrier or while transmitting as for the RtS active period. The *Return-to-Standby listen period* can be set between 0 and 255 seconds in 1 second steps.

The *Return-to-Standby active period* parameter specified the period of time after which the radio is closed when either the PTT is not pressed and the channel is not occupied. This timer is reloaded while the PTT is pressed, and while the channel is occupied. If a SAT decode tone or code is assigned for the selected channel, the channel is regarded occupied while the correct SAT is received, otherwise this function will be noise squelch driven. The value of this parameter can be set between 0 and 255 seconds in 1 second steps.

The *Return-to-Standby mode* parameter selects whether or not the RtS facility is used by the channels belonging to the system group. If set to *disable*, RtS does not operate. If set to *Tx-only*, the RtS timer is retriggered while transmitting in the active mode. If set to *RxTx*, the RtS timer is retriggered while transmitting as well as receiving (carrier detect or SAT operated).

The *Carrier detect ignore* parameter selects the minimum duration of the carrier detect condition before the channel is considered busy. Using a specific value (normally around 500 ms), short carrier detect periods (spikes) will not cause the radio to remain open.

Encode instruction *RTSL* reloads the Return-to-Standby timer to the period of time as specified for *RtS listen period* if the RtS mode is currently not active, and will reload the Return-to-Standby timer to the period of time as specified for *RtS active period* if the RtS mode is currently active.

Encode instruction *RTSA* reloads the Return-to-Standby timer to the period of time as specified for *RtS active period*, and will also select the RtS active mode.

Encode instruction *RTSO* reloads the Return-to-Standby timer to the period of time as specified for *RtS active period*, only when already in the active mode. In the idle or listen (monitor) state, the RtS timer will not be set.

Encode instruction *XIDLE* will quit the currently executed encode sequence when the RtS mode is set to idle. This instruction will be ignored when the RtS mode is set to listen (monitor) or active or when the RtS mode is disabled for the system group in use.

Encode instruction *XLIST* will quit the currently executed encode sequence when the RtS mode is set to idle or listen (monitor). The instruction will be ignored when the RtS mode is set to active or when the RtS mode is disabled for the system group in use.

### 5.8.2 PTT timeout

The PTT timeout facility limits the period of time a user is able to transmit continuesly. This prevents damage (overheating) of the RF power amplifier and blocking of a radio channel for a long time when the Push-to-Talk button is pressed continuesly. The parameter *transmit timeout* is selectable between 1 and 255 seconds, and its operation is valid for each channel. It is possible to disable operation of the PTT timeout facility by entering 0 into this parameter.

Parameter *transmit warning* allows selection of a period of time the radio sounds an alert beep before the PTT timer times out. For example, if this parameter is set to 5 seconds, and the PTT timeout is set to 60 seconds, the radio will sound an alert at the 55th second while pressing the PTT button. This parameter is also selectable in 1 second steps between 1 and 255 seconds. Value 0 disables this alert beep function. This parameter is valid for any channel programmed.

Parameter *transmit inhibit timeout* selects a period of time the user is not able to transmit after the PTT timeout has been expired. It prevents users to occupy a radio channel by releasing and pushing again the PTT button as soon the PTT timeout switches off the transmitter. This facility is sometimes required for operation of the radio in community repeater systems. This value of this parameter is selectable between 0 and 255 seconds in 1 second steps. Value 0 disables this facility. Also this parameter is valid for all programmed channels.

### 5.8.3 Power save mode

The power-save facility increases the battery operation time by switching off the receiver for small periods of time when the carrier is absence. By choosing a suitable duty-cycle for receiver activity, it is possible to have both save battery power and a acceptable response time on a carrier-detect condition.

For some application this power-save facility is not suitable, e.g. when expecting fast selective call messages. However, if the duration of the first digit is longer, it is possible to use this facility.

The *power save on time* parameter allows selection of the period of time the receiver is switched off. The *power save off time* parameter selects the period of time the receiver is switched on to check whether or not a carrier is received. Both the power save on and off time are selectable between 0 and 2550 ms in 10 ms steps, and both parameters are valid for all channels.

If a carrier is detected, the receiver will be continuesly switched on. After the carrier disappears, the radio will wait for a certain period of time before is switches back to power save, which is configured by parameter *power save delay*. This parameter is selectable between 0 and 255 seconds in 1 second units. Also this parameter is valid for all channels.

Typical values for these parameters are:

| | |
|---|---|
| Power save on time | 400 ms |
| Power save off time | 100 ms |
| Power save delay | 5 seconds |

Per system group it is possible to enable or disable the power save feature. This is selected by the *power save facility* flag.

### 5.8.4 Text output to display

The text output facility is useful for e.g. displaying the serial number of the radio on power on. Text output can be initiated from an encode format using two encode instructions.

Encode instruction *TEXT* 'text' output text string *text* to the display. Any ASCII character can be included in the text string. The text scrolls from the right to left on the display. If more than 5 characters must be displayed, it is possible to scroll the text with slower speed. The shifting speed can be set using the LEN instruction. Instruction *TXTOF* switches the display back to the normal operation mode. Example of an encode format which outputs the text 'HELLO':

```
LEN 100 TEXT '  HELLO' DEL 500 TXTOF
```

# 6. PROGRAMMING

## 6.1 Setup portable

The Setup portable window enables the selection of the radio model to be configured, the serial number and other information related to the portable. After starting up PROGSYS, the parameters in the window must be edited first. The Setup portable window can be selected from the main menu.

Below follows a description of the parameters of the Setup portable window. If no ranges are given, you have to select the relevant value by means of the space-bar or the cursor command keys.

**Model number / series**
This field displays the selected model number and series.

**Frequency range**
If no model number or ordering number is known, selection is possible by choosing the right frequency range and channel spacing. The frequency range of the radio to be configured is selected here.

**Serial number**
Range: 00000000 .. 99999999
Enter the serial number of the portable to be configured. The serial number consists of eight digits and can be found on the back of the portable or at the bottom if the battery is removed.

**Number of scan groups**
Range: 0 .. 10
Determines the required number of scan groups. Select the minimum number of scan groups to save memory space. Enter 0 when scanning is not required.

**Addresses per channel**
Range: 0 .. 20
Determines the number of address digits per channel. Enter the minimum number of address digits possible to save memory space. Enter 0 if selcall is not required or if the selcall addresses that are used are defined as fixed values within the encode and decode formats.

**Lock code**
Range: 0000 .. 9999
Determines the code with which the user can lock and unlock the radio unit. In the locked state, all normal radio functions are disabled, thus preventing unauthorized use of the radio.

DCS error-correcting
Range: Mode 1, Mode 2, Mode 3, Mode 4
Selects the DCS decoding algorithm. A trade-off can be choosen between error correction performance, speed of decoding and sensitivity. The following selections are provided:

| | | | |
|---|---|---|---|
| Mode 1 | Excellent error protection | high speed | low sensitivity |
| Mode 2 | High error protection | high speed | medium sensitivity |
| Mode 3 | Medium error protection | high speed | high sensitivity |
| Mode 4 | High error protection | medium speed | high sensitivity |

Number of channel digits
Range: None, One, Two, Three
This parameter determines the number of digits the user is allowed to enter for channel selection. The radio can be configured to accept the entry of one channel digit (0 to 9), two channel digits (00 to 99) or three channel digits (000 to 250). If required, channel selection can be disabled by choosing None.

Channel readout mode
Range: Numerical, Alphanum.
This parameter determines the type of channel readout. If Numerical is selected, a three digit format is shown on the display as 'Chxxx'. In the Alphanum mode, a full 5 character wide string can be entered per channel to identify the channel. Note that the alphanumerical mode requires four extra bytes per channel, and thus limits the maximum amount of channels.

Key/alert beep volume
Range: off/low, off/high, low/low, low/high, high/low, high/high
The key/alert beep parameter determines the volume of the key beep and alert beep.

Ext.alert / transfer
Range: None, Ext.alert, Transfer, Ext/trans
This parameter selects whether none, either external alert or transfer, or both external alert and transfer can be activated by the user.

Power save on time
Range: 0 .. 2550 ms
This parameter determines the period of time the radio is switched to the power save state when the radio is in the standby state. Suggested value: 400 ms.

Power save off time
Range: 0 .. 2550 ms
This parameter determines the period of time the radio is switched back the power on state when the radio is in the standby state, to check for channel activity. Suggested value: 100 ms.

**Power save delay**
Range: 0 .. 255 s
This parameter determines the period of time the radio waits after a channel busy condition before the radio switches to the power save state. Suggested value: 5 seconds.

**Hold delay**
Range: 0, 10 .. 2550 ms
This parameter determines the period of time the emergency switch or button must be pressed before the energency procedure is activated. Suggested value: 1 second. Enter value 0 if no time-out is required.

**Overlay text channel**
Range: five-character string
This parameter defines the overlay text for the numerical channel readout mode. The five character string will be displayed in a 7-segment form, which approaches the layout of the characters used as much as possible.

**Overlay text selcall**
Range: five-character string
This parameter defines the overlay text for selcall address selection. The five character string will be displayed in a 7-segment form, which approaches the layout of the characters used as much as possible.

**Overlay text status**
Range: five-character string
This parameter defines the overlay text for status number selection. The five character string will be displayed in a 7-segment form, which approaches the layout of the characters used as much as possible.

## 6.2 General parameters menu

The General parameters menu enables the selection of options, such as the radio's startup conditions and user interface (except key definitions). The General parameters are valid for all programmed channels.

**Startup scan**
Range: Disable, Enable
The startup scan parameter determines whether scanning is activated at radio switch-on (Enable) or not (Disable).

**Startup monitor**
Range: Disable, Enable
If startup monitor is set to Enable, selcall mute will be open at radio switch-on. If set to Disable, selcall mute will be closed initially.

Startup power
Range: Low, High
This parameter determines the initial power selection. If set to Low, the radio will transmit initially with low power. If set to High, the radio will use high power. Note that this parameter selection is not in effect when the power selection programmed per group is fixed to low or high.

Startup encode definition
Range: [OFF], <defined encode formats>
This parameter enables the selection of a transmit encode definition to be executed immediately after the radio is switched on. This facility can be used, for example, to register a radio within a system. Selection of a startup encode definition is only possible if the definition has already been entered with the encode format editor.

Startup channel
Range: 1 .. 250
This parameter determines which channel is selected at radio switch-on. The channel number refers to the physical channel number in the channel parameter menu, not the displayed number. The startup channel number is not in effect when the parameter Save channel number is set to Enable (see below).

Save channel number
Range: Disable, Enable
This parameter determines whether or not the last channel number selected before the radio is turned off is automatically selected again at radio turn-on. If set to Disable, the programmed startup channel will be used instead (see above).

Start delimiter required
Range: Disable, Enable
This parameter determines whether a decoded sequence with a matching decode definition is accepted with leading digits (Disable) or is only accepted if preceded by a no-tone period of silence (Enable).

Digit entry method
Range: Replace, Overwrite
If the digit entry method is set to overwrite, the selected selcall address overwrites the previously selected address from right to left. If set to replace, the previously selected selcall address is first replaced by the default transmit address for the selected channel and then overwritten from right to left.

Copy from default tx
Range: Disable, Enable
This parameter determines whether the keypad-selectable selcall address is overwritten by the default tx address each time the user changes the channel number through selection or during scanning (Enable) or remains the same (Disable).

**Keypad operation**
Range: Standard, Channel, Selcall, Status
The keypad operation parameter determines the primary use of the numeric keypad field. If this parameter is set to channel, the radio switches to the channel entry mode as soon as a digit is pressed. If set to selcall, the selcall entry mode is activated instead. If set to status, the status entry mode will be activated. If keypad operation is set to standard, the user has to activate the required entry mode before entering a number. If the user presses a numeric key when no entry mode has been selected, the radio generates an error beep.

**Normal display format**
Range: Selcall, Channel, Both, Combined
Determines the way in which the selcall information and channel number is displayed. If the display format is set to Selcall, the radio will show the selected selcall address in its default state. If set to Channel, the channel number will be shown instead. When set to Both, the radio will show the channel number as well as the selected selcall address. When set to Combined, both the channel number and selcall address will be shown on the large digits in a 2−2 format.

**Scan display format**
Range: Normal, Scan text, Background
Determines the way in which the scan channel and scan group information is displayed. If this display format is set to Normal, the radio will show the channel number continuesly during scanning. If set to Scan text, the channel number will be hidden by the text Scan while not stopped on a channel in the scan mode. When set to Background, it is possible to select other entry modes while scanning.

**Return-to-Standby listen period**
Range: 0 .. 255 s
The Return-to-Standby listen period determines the period of time the user can monitor a channel to initiate a call, before the radio automatically closes again. This facility is used together with selcall encode / decode facilities to prevent unnecessary operation of the equipment. An additional PTT lockout condition is available when the radio is in the listening mode. The suggested value for RtS listen is 10 seconds.

**Return-to-Standby active period**
Range: 0 .. 255 s
The Return to-Standby active period determines the period of time in the active state (conversation mode) after which the radio is closed automatically if no PTT is pressed and no carrier is received. The suggested value for RtS active is 30 seconds.

**Transmit time-out**
Range: 0, 1 .. 255 s
The transmit time-out parameter determines the maximum duration of continued transmitting while the PTT button is pressed. After this transmit time-out period has expired, the portable will sound an error beep, and stop transmitting. Suggested value: 60 seconds. Enter value 0 to disable the transmit time-out facility.

**Transmit warning**
Range: 0, 1 .. 255 s
This parameter determines the period of time an alert beep is sounded before the transmit time-out period expires. If you enter a value that is higher than the transmit time-out value, no transmit warning will be generated. Suggested value: 10 seconds.

**Transmit inhibit time-out**
Range: 0 .. 255 s
The transmit inhibit time-out defines the period of time after the transmit time-out has fully expired, and during which transmitting is not possible. This function is required sometimes by operators of repeater systems. Suggested value: 10 seconds.

**Number entry time-out**
Range: 0, 1 .. 255 s
The number entry time-out determines the period of time the radio stays in the selected entry mode (for example, entry of selcall address or free-dialling telephone number), before switching back to the default operating mode. Suggested value: 30 seconds.

**Lamp time-out**
Range: 0, 1 .. 255 s
This parameter determines the period of time the LCD backlight remains on after having been activated manually. Suggested value: 10 seconds. Enter value 0 if no time-out is required.

## 6.3 System parameters menu

The System parameters menu serves to configure system-dependent parameters. By creating multiple system blocks, you are able to configure the portable radio for operation in different systems. The current section describes all parameters of the System parameters menu.

**Selcall standard**
Range: ZVEI, CCIR, DZVEI, EEA, ZVEI2, PZVEI, PCCIR, PDZVEI, EIA, Natel, AP369, Kenwood
This parameter determines which selcall toneset standard is used for decoding selective call messages.

Note that the selcall standard that is used for encoding is defined within the encode formats. The Philips EEA derivative can be configured by selecting PCCIR and choosing a 40 ms duration per tone for encoding.

**Receive gap period**
Range: 5 .. 638 ms
The reset gap period defines the period of time the selcall decode algorithm requires a 'no-tone' condition after the last valid tone has been received. The recommended value for the receive gap period is 1.5 times the duration per tone, for example, 150 ms for CCIR 100 ms.

**Selectable selcall digits**
Range: None, One, Two, Three, Four, Five
The parameter Selectable selcall digits is used to define the number of digits of the keypad/button selectable address that may be changed by the user. These keypad selectable digits are normally included in the transmit selective call formats.

**Selectable status digits**
Range: None, One, Two, Three, Four, Five
The parameter Selectable status digits is used to define the number of digits of the keypad/button selectable status number that may be changed by the user. These keypad selectable digits are normally included in the transmit selective call formats.

**Busy indication**
Range: Carrier, SAT-busy
This parameter determines the use of the busy symbol on the display. For CTCSS/DCS driven repeater operation, selection SAT-busy should be used. For all other applications, selection Carrier is preferred.

**Return-to-Standby mode**
Range: Disable, Tx-only, Rx/Tx
The Return-to-Standby mode is activated if this parameter is set to Tx-only or RxTx. The Tx-only selection retriggers the RtS timer only when transmitting, the Rx/Tx selection retriggers the RtS timer both when transmitting and receiving. The RtS facility prevents users of portables to use the equipment unnecessary.

**Automatic close**
Range: None, Two, Three, Four
The automatic close parameter determines the number of digits that have to match the primary receive address in order to close the portable. When None is selected, the automatic close facility is disabled. It is recommended to enter the highest number of digits possible for operation of automatic close, for example, Three for a 5-tone decode format with the first three digits fixed and two variable digits.

Power selectable
Range: Disable, Enable
The power selectable parameter defines whether or not the user may change the RF output power for the current system group. If set to Enable, the power is selectable. If set to Disable, the fixed power selection state is used (see below). To enable user selection of RF output power, a key must be assigned to execute this function (see 5.9).

Fixed power selection
Range: Low, High
This parameter determines whether the RF output power is high or low. This parameter only has effect if the power selectable parameter is set to Disable (see above).

Monitor function
Range: Selcall, SAT, Both, Reset, Off
This parameter determines the function of the monitor button. If set to Selcall, the monitor button operates as selcall open / close. If set to SAT, the monitor key operates as SAT monitor. If set to Both, the monitor button operates as combined selcall and SAT monitor. If set to Reset, the monitor button resets the selcall mute. If set to Off, the monitor button has no function.

Scan speed
Range: 10 .. 2550 ms
The scan speed parameter determines the period during which the radio checks for activity on a channel while scanning. If no activity is detected during this period of time, the radio continues scanning. This parameter is normally configured for fastest scanning possible for the selected scanning operating mode. Recommended values are 100 ms for carrier scanning, 80 ms for selcall scanning, and 300 ms for SAT and combined selcall / SAT scanning.

Scan wait
Range: 100 .. 25500 ms
The scan wait parameter selects the period of time after which scanning is resumed if no activity is detected any more. Normally, this parameter is set to a value around 1 second.

Scan dwell time
Range: 0, 1 .. 255 s
The scan dwell time determines the period of time after which scanning is resumed while continuously detecting activity on the channel. If set to 0, the scan dwell facility is disabled.

Scan configuration
Range: Carrier, SAT, Selcall, Both, Selcall-st, Both-st, No carrier
The scan configuration parameter determines the operating mode of scanning defined for the current system group. If set to Carrier, the radio stops on a channel when it receives a carrier.

If set to SAT, the radio stops on receiving a valid CTCSS tone or DCS code (defined per channel as SAT decode). If set to Selcall, the radio stops on receiving a tone that matches the first tone of the Primary rx address defined for that channel. If set to Both, the radio stops on receiving a valid SAT and first tone simultaneously. Operation of Selcall-st and Both-st is similar to Selcall and Both, but the radio remains on the channel until the radio is operated. The No-carrier selection allows scanning for a channel which is not used (opposite of carrier scanning).

Carrier detect ignore
Range: 0 .. 2550 ms
The carrier detect ignore parameter determines the minimum duration of a carrier detect condition before the Return-to-Standby timer is re-triggered. This parameter operates only when the Rx/Tx selection is set for the Return-to-Standby parameter.

## 6.4 Channel parameters

The Channel parameters window enables the selection of channel-related parameters. In this window only the most frequently used parameters can be edited. An additional window can be opened to select other channel-related parameters. See section 5.5 for instructions on how to switch between these windows.

Transmit frequency (tx.freq.)
Range: depending on selected model
The transmit frequency in MHz for the selected channel must be entered here. This parameter can be edited in the channel parameters window as well as in the Channel edit window. Entered frequencies are only accepted if they are valid for the selected radio model and are rounded off to the nearest frequency that is available.

Receive frequency (rx.freq.)
Range: depending on selected model
The receive frequency in MHz for the selected channel must be entered here. This parameter can be edited in the channel parameters window as well as in the channel-edit window. Entered frequencies are only accepted if valid for the selected radio model and are rounded off to the nearest frequency that is available.

SAT encode
Range: 50.0-250.3 Hz, CTCSS callsigns, valid DCS codes, inverted DCS codes
The SAT encode parameter determines the CTCSS tone or DCS code that is used when the radio is transmitting on the selected channel. Editing this parameter is only possible in the channel-edit window. Refer to appendix D for an overview of valid CTCSS tone frequencies and appendix E for an overview of valid DCS codes.

**SAT decode**
Range: 50.0-250.3 Hz, CTCSS callsigns, valid DCS codes, inverted DCS codes
The SAT decode parameter determines the CTCSS tone or DCS code that is used to detect if the right subtone is received on the selected channel. Editing this parameter is only possible in the channel-edit window. Refer to appendix D for an overview of valid CTCSS tone frequencies and appendix E for an overview of valid DCS codes.

**Default tx address**
Range: 00000 .. 99999
The default tx address defines the selectable part of the transmit selcall address. This address is used at radio turn-on, when the channel is selected while the parameter Copy from default tx is set to Enable, or when the contents of the keypad buffer is replaced on entry of another selcall address. This parameter is normally used to define the most frequently called 5-tone identity, but it can also be used for other purposes. To enable selection of this parameter, the parameter Addresses per channel in the Setup portable window must be set to at least 5.

**Primary rx address**
Range: 00000 .. 99999
The primary rx address defines the primary own identity of the portable. In most applications, this parameter is used to define the unit's own 5-tone address. To enable selection of this parameter, the parameter Addresses per channel in the Setup portable window must be set to at least 10.

**Secondary rx address**
Range: 00000 .. 99999
The secondary rx address defines the secondary own identity of the portable. In most applications, this parameter is used to define the unit's own second 5-tone address. To enable selection of this parameter, the parameter Addresses per channel in the Setup portable window must be set to at least 15.

**Third rx address**
Range: 00000 .. 99999
The Third rx address defines a third own identity of the portable. In most applications, this parameter is used to define the unit's own third 5-tone address. To enable selection of this parameter, the parameter Addresses per channel in the Setup portable window must be set to 20.

**Readout string (ds)**
Range: numerical mode: 0..9, A, B, C, -, <space> and # for overlay text
alphanumerical mode: all characters
The Readout string (or display string) parameter determines how the channel number will be displayed to the user. It consists of three digits with a limited number of characters if the numerical format is choosen, or consists of five characters if the alphanumerical format is selected.

**Scan include list**
Range: set of 0 .. 9
The Scan include list parameter defines the scan groups to which the channel belongs. If a digit is shown, the channel is included in that particular scan group. If the channel does not belong to a defined scan group, a dash symbol will be shown at that position. Unused scan groups are shown as squares. Editing this parameter is possible by entering the scan group numbers in one string. For example, enter 156 to include the current channel into scan groups 1, 5 and 6. Of course, this entry (156) is only possible if you have defined at least 6 scan group in the Setup portable window.

**Clock frequency shift**
Range: Disable, Enable
The clock frequency shift facility moves the crystal clock frequency slightly, which may be useful to prevent interference on some radio channels. When this interference is noticed during operation, set this parameter to Disable for the particular channel.

**Group reference**
Range: <available system groups>
The group reference parameter links the currently selected channel to one of the defined system groups. Refer to sections 6.3 for details on System group parameters.

## 6.5 Scan groups

A separate scan group can be defined for each scan application. Each scan group can contain a number of channels, ranging from 2 to all channels defined. The scan include list in the Channel edit window is used to link channels to scan groups. The following parameters are available for each scan group:

**Priority channel (pri)**
Range: 1 .. 200
This parameter determines which channel functions as priority channel. The entered channel number must be listed in the 'ch' column in the Channel-list window.

**Preference channel (pref)**
Range: 1 .. 200
This parameter determines which channel functions as preference channel. The preference channel can be used for various purposes related to scan operation, but is mainly used to force the radio to transmit on this channel when the PTT button is pressed while the radio is in scanning mode. See also section 6.8 for usage of this parameter.

Priority scan interval (interval)
Range: 1 .. 200
The Priority scan interval parameter determines the period of time during which the priority channel is checked for activity. If no activity is detected on the priority channel, the priority scan interval timer is restarted.

User programming (user)
Range: NO, YES
The user programming parameter determines whether the user is allowed to program the scan list and the priority channel for the current scan group (YES) or not (NO).

## 6.6 Key definitions

The key definition window allows assignment of key functions to each of the key actions. The key actions are divided into columns and have the following meanings:

| | |
|---|---|
| Press | Function executed immediately after pressing the key |
| Hold | Function executed after holding down the key |
| Shift | Function executed when the key is pressed after activation of the shift function |
| Release | Function executed immediately after releasing a key |

These key actions are available for each of the front panel buttons and the buttons on the keypad (0..9, A..D, * and #).

The following key functions are available for each of the key actions:

| | |
|---|---|
| [OFF] | not assigned |
| 0 | enter digit 0 |
| 1 | enter digit 1 |
| 2 | enter digit 2 |
| 3 | enter digit 3 |
| 4 | enter digit 4 |
| 5 | enter digit 5 |
| 6 | enter digit 6 |
| 7 | enter digit 7 |
| 8 | enter digit 8 |
| 9 | enter digit 9 |
| group digit | enter digit A |
| clear digit | erase one digit |
| mon.selcall | selcall open / close |
| mon.SAT | SAT monitor on / off |
| mon.both | selcall+SAT monitor on / off |
| selcall res. | mute selcall (close) |
| shift | activate shift mode |
| unshift | deactivate shift mode |
| digit 1x | 5th digit up |
| digit 10x | 4th digit up |
| digit up | selected digit up |
| digit shift | select next digit |
| mode select | toggle between channel and selcall entry |
| mode reset | reset to default entry mode |
| scan on/off | toggle scan on / off |
| pri on/off | toggle priority scan on / off |
| scan+pri | toggle priority + scan on / off |
| scan on | start scanning |
| pri on | start priority scanning |
| scan+pri on | start both scan and priority scan |

| | |
|---|---|
| lamp on/off | switch LCD backlight on / off |
| lamp on | switch LCD backlight on |
| key lock | lock front keypad |
| code lock | lock operation of radio by means of 4-digit code |
| power select | select power low / high |
| channel ent. | select channel entry mode |
| selcall ent. | select selcall entry mode |
| status ent. | select status entry mode |
| queue mode | select queue mode |
| queue next | select next queue entry |
| queue select | select next queue entry / default operation mode |
| encode #1 | execute call format #1 (normal call) |
| encode #2 | execute call format #2 (free-dialling using selcall) |
| encode #3 | execute call format #3 (free-dialling using DTMF) |
| encode #4 | execute call format #4 (long tone call) |
| encode #5 | execute call format #5 (status call) |
| encode #6 | execute call format #6 (emergency call) |
| mon.unmute | squelch unmute |
| mon.mute | squelch mute |
| mon.toggle | squelch mute / unmute |
| clear all | clear full dial buffer |
| scan prog | go to scan programming mode |
| ext/trans | switch on/off external alarm and/or transfer function |
| hold delay | change hold delay |
| beep volume | select key beep volume |
| alert volume | select alert beep volume |

## 6.7 Decode formats

Decode formats are series of instructions describing the contents of selective call messages to be received, and the actions to be executed if the incoming message matches the defined sequences.

The sequences of instructions can be entered, edited and compiled within PROGSYS. A suitable name can be assigned to every defined decode format to enable reference to these formats per system group and to other decode formats and / or encode formats. It is possible to define up to 63 decode formats.

| Mnemonic | Description |
|---|---|
| CMP seq | Compare to sequence; immediate or indirect |
| STO index | Store digits for queueing |
| GRPN | No group digit decode |
| GRPA | Decode A-tone as group digit |
| GRP0 | Decode 0-tone as group digit |
| GRP0A | Decode both A-tone and 0-tone as group digit |
| MONO | Monitor open |
| MONF | Monitor open, flash (blink) LED |
| MONC | Monitor close |
| RSTUN | Remote stun |
| RVIVE | Remote revive |
| RKILL | Remote kill |
| EMGOF | Emergency mode off |
| REPOF | Repeat sequence off |
| QUEUE | Queue contents of temporary buffer with channel no. |
| QUE1 | Queue buffer, with channel, duplicate allowed, FILO |
| QUE2 | Queue buffer, w/o channel, duplicate allowed, FILO |
| QUE3 | Queue buffer, with channel, no duplicate allowed, FILO |
| QUE4 | Queue buffer, w/o channel, no duplicate allowed, FILO |
| QUE5 | Queue buffer, with channel, duplicate allowed, FIFO |
| QUE6 | Queue buffer, w/o channel, duplicate allowed, FIFO |
| QUE7 | Queue buffer, with channel, no duplicate allowed, FIFO |
| QUE8 | Queue buffer, w/o channel, no duplicate allowed, FIFO |
| DISPQ | Select queue mode, show first entry |
| BEEP num | Sound alert for individual and group calls |
| BEEPI num | Sound alert for individual calls only |
| BEEPG num | Sound alert for group calls only |
| EXTAL alertseq | Controls external alert output |
| XPASS | Exit if individual or group call match |
| ERASE time | Erases contents temporary buffer after period of time |
| ACK | Show ACK sign |
| ENCA enc | Execute encode format if individual or group call |
| ENCI enc | Execute encode format if individual call |
| ENCG enc | Execute encode format if group call |
| DECA dec | Execute decode format if individual or group call |

| | |
|---|---|
| DECI dec | Execute decode format if individual call |
| DECG dec | Execute decode format if group call |
| DECF dec | Execute decode format if call fail |
| DECAT time dec | Trigger decode format for time ms if individual or group call |
| DECIT time dec | Trigger decode format for time ms if individual call |
| DECGT time dec | Trigger decode format for time ms if group call |

The parameters mentioned are:

| | |
|---|---|
| seq | Sequence of immediate and / or indirect digits:<br>#dig immediate digit<br>^Dptr default transmit address<br>^Pptr primary receive address<br>^Sptr secondary receive address<br>^Tptr third receive address<br>^Qptr temporary queue entry<br>^Uptr selectable status address<br>^Mptr miscellaneous digits<br>^Kptr selectable selcall address |
| dig | Digit: 0 .. 9 and A .. F |
| ptr | Pointer: 1 .. 5 |
| index | Index: 1 .. 5 |
| num | Alert number: 0 .. 32 |
| enc | Encode format |
| dec | Decode format |
| time | Time-out value: 0 .. 2550 ms in 10 ms steps |
| alertseq | External alert sequence: 00000000 .. 11111111 |

**ACK**
On a matching sequence, executing the ACK instruction causes the plus sign on the display to be shown. Applications for this ACK instruction in combination with encode formats are described in section 6.9.

**BEEP num**
On a matching sequence, BEEP alerts the user for an incoming call. Both individual and group calls ('A' digits in the received sequence) are accepted. The valid range of num is 0 to 31. See appendix D for an overview of available alert tones.

**BEEPG num**
On a matching sequence, BEEPI alerts the user for an incoming call with group digits. The valid range of num is 0 to 31. See appendix D for an overview of available alert tones.

**BEEPI num**
On a matching sequence, BEEPI alerts the user for an individually-addressed incoming call. The valid range of num is 0 to 31. See appendix D for an overview of available alert tones.

**CMP seq**
The CMP instruction enables the comparison of decoded digits and defined digits. Defined digits can be immediate digits, which are fixed in the decode format, or indirect digits, which are stored as channel parameters, entered address or status digits. Immediate digits are entered as a hash-sign (#) plus one or more digits. Indirect digits are entered as ^-sign plus pointer character and one or more indexes. In one sequence, up to fifteen digits can be defined, so this allows decoding of sequences up to fifteen digits. CMP and STO instructions can be alternated to define queue formats.

**DECA dec**
On a matching sequence, for both individual and group calls, DECA starts another decode format. The DEC range of instructions enables the linkage of decode sequences when the size of one decode format is insufficient, or when further decoding is required of parts of the received sequence. String dec must be replaced by the name of a previously created decode format.

**DECAT time dec**
On a matching sequence, either with or without group digits, DECAT activates another decode format, but only if another sequence of digits is received within the number of ms specified by time. The timed DEC instructions are used to process multiple selcall sequences, such as two-by-five tone and three-by-five tone.

**DECF dec**
If no matching sequence is found, DECG starts execution of another decode format. DECF is normally used when the size of a decode format is insufficient. String dec must be replaced by the name of a previously created decode format.

**DECG dec**
On a matching sequence with one or more group digits, DECG starts the execution of another decode format, which is indicated by dec. String dec must be replaced by the name of a valid decode format.

**DECGT time dec**
Similar to DECAT, but activated only if the received sequence contains one or more group digits.

**DECI dec**
On a matching sequence without group digits, DECI starts the execution of another decode format, which is indicated by dec. String sec must be replaced by the name of a valid decode format.

**DECIT time dec**
Similar to DECAT, but activated only if the received sequence is without group digits.

**DISPQ**
Select queue entry from within decode format, thus immediately pop up queued identity when call is received. DISPQ will be ignored when no queue entries are available.

**EMGOF**
On a matching sequence, EMGOF switches off the emergency state. The emergency state can be activated by an encode format (see also section 6.9).

**ENCA** enc
On a matching sequence for both individual and group calls, ENCA starts the execution of a specific encode format. The ENC range of instructions are most frequently used to assign a 'transpond' transmission, as acknowledge to a successfully received call. String enc must be replaced by a valid encode format name.

**ENCG** enc
On a matching sequence with one or more group digits, ENCG starts the execution of a specific encode format. String enc must be replaced by the name of a previously created encode format.

**ENCI** enc
On a matching sequence without group digits, ENCI starts the execution of a specific encode format. For transpond applications, the ENCI instruction is more suitable than ENCA and ENCG, because it only responds to individual calls. String enc must be replaced by the name of a previously created encode format.

**ERASE** time
On a matching sequence, the contents of the temporary buffer (filled by STO instructions) will be erased after the specified period of time. Can be used to decode two-by-five tone formats with transmitting order [own-ID] [selected-ID] (as seen from the transmitting radio).

**EXTAL** alertseq
On a matching sequence and when the external alert facility is enabled by the user, the externally connected relay to control the horn or lights will be activated in the specified rhythm. The rhythm alertseq consists of a series of eight 0s and 1s specifying the on/off slots of 500 ms each. For example, a alertseq 11011011 activates the external alert output three times with a 1 second duration, with a pause of 0.5 second in between.

**GRP0**
While executing the following CMP instructions, the 0-tone is recognized as group digit (standard utilized in some Motorola systems).

**GRP0A**
While executing the following CMP instructions, both the 0-tone and the A-tone will be recognized as group digit (both international and Motorola-specific group tone decoding standards).

**GRPA**
While executing the following CMP instructions, the A-tone is recognized as group digit (international standard for group tone decoding).

**GRPN**
While executing the following CMP instructions, no group tones will be recognized.

**MONC**
On a matching sequence, MONC causes the selcall monitor function to close.

**MONF**
The MONF instruction is similar to MONO, but also causes the green selcall monitor LED to blink; this alerts the user visually that a call has been received.

**MONO**
If the incoming selcall sequence matches the preceding CMP / STO definition, the MONO instruction causes the portable to open selcall monitor. The user can then hear the conversation on the channel.

**QUEUE**
On a matching sequence, QUEUE stores digits prepared by previously executed STO instructions and the current selected channel to the queue.

**QUE1**
On a matching sequence, QUE1 (same as QUEUE) stores digits prepared by previously executed STO instructions to the queue. The current selected channel is stored. Duplicated entries are allowed. The entry is stored in FILO order (First-In, Last-Out).

**QUE2**
On a matching sequence, QUE2 stores digits prepared by previously executed STO instructions to the queue. The current selected channel is not stored. Duplicated entries are allowed. The entry is stored in FILO order (First-In, Last-Out).

**QUE3**
On a matching sequence, QUE3 stores digits prepared by previously executed STO instructions to the queue. The current selected channel is stored. Duplicated entries are not allowed. The entry is stored in FILO order (First-In, Last-Out).

**QUE4**
On a matching sequence, QUE4 stores digits prepared by previously executed STO instructions to the queue. The current selected channel is not stored. Duplicated entries are not allowed. The entry is stored in FILO order (First-In, Last-Out).

**QUE5**
On a matching sequence, QUE5 stores digits prepared by previously executed STO instructions to the queue. The current selected channel is stored. Duplicated entries are allowed. The entry is stored in FIFO order (First-In, First-Out).

**QUE6**
On a matching sequence, QUE6 stores digits prepared by previously executed STO instructions to the queue. The current selected channel is not stored. Duplicated entries are allowed. The entry is stored in FIFO order (First-In, First-Out).

**QUE7**
On a matching sequence, QUE7 stores digits prepared by previously executed STO instructions to the queue. The current selected channel is stored. Duplicated entries are not allowed. The entry is stored in FIFO order (First-In, First-Out).

**QUE8**
On a matching sequence, QUE8 stores digits prepared by previously executed STO instructions to the queue. The current selected channel is not stored. Duplicated entries are not allowed. The entry is stored in FIFO order (First-In, First-Out).

**REPOF**
On a matching sequence, REPOF stops repeating encode formats when activated from an encode format (see section 6.9). Applications of the REPOF instructions can be found in decode formats linked to encode formats when an acknowledge message is necessary, for example, for an emergency call.

**RKILL**
On a matching sequence, RKILL destroys the contents of the EEPROM, so that the radio must be returned to the dealer for reprogramming. This facility is normally used for security reasons when the portable has been stolen or is missing.

**RSTUN**
On a matching sequence, RSTUN causes the portable to lock operation of PTT, mute the receiver, and show 'Loc2' on the display. This remote stun facility can be used to take a portable out of service for commercial or security reasons (for example, for not paying an invoice or when the portable has been stolen or is missing).

**RVIVE**
On a matching sequence, RVIVE revives a portable previously taken out of service with the remote stun feature.

**STO index**
STO instructions serve to copy received digits to be copied to a temporary buffer for further processing or queueing. Any digit value is accepted, except no-tone (F). The index pointer points to a position within the internal 5-digit buffer. This 5-digit buffer can by copied to the queue using the QUEUE command. STO and CMP instructions can be alternated in any order to allow single digits to be used for further processing and queueing.

**XPASS**
On a matching sequence, XPASS aborts execution of the currently loaded decode format.

## 6.8 Encode formats

Encode formats are series of instructions which describe the actions and selective call tones and DTMF tones to be transmitted in a sequence. The concept is very similar to that of decode formats, described in the previous section.

Like the decode formats, the sequences of instructions of the encode formats can be entered, edited and compiled within PROGSYS. Every sequence has a name attached to it, and the maximum number of encode formats is 63.

In the following overview, all encode format instructions are described briefly. Here, they are grouped according to their function. Following the overview, these instructions are explained in more detail. In this explanatory part, the instructions are listed in alphabetical order for quicker reference.

| Mnemonic | Description |
|---|---|
| SEND seq | Send sequence of digits, immediate or indirect |
| SLEN ofs | Send length indicator plus offset |
| SCHK | Send checksum digit |
| SDIAL | Send free-dialled string of digits |
| TXS | Switch to transmit, selcall path |
| TXD | Switch to transmit, DTMF path |
| TXM | Switch to transmit, microphone path |
| RX | Switch to receive mode |
| TXP | Switch to transmit using programmed frequency |
| TXF rf-freq | Switch to transmit using in-line frequency |
| RXP | Switch to receive using programmed frequency |
| RXF rf-freq | Switch to receive using in-line frequency |
| SCTP | SAT transmit using programmed frequency |
| SCT st-freq | SAT transmit using in-line frequency |
| SCRP | SAT receive using programmed frequency |
| SCR st-freq | SAT receive using in-line frequency |
| SCOFF | SAT transmit off |
| SCPH0 | CTCSS phase 180 degrees (1) (Reserved) |
| SCPH1 | CTCSS phase 120 degrees (2) (Reserved) |
| TSET toneset | Select toneset |
| TONE af-freq | Send single tone |
| LEN xtime | Select duration per tone |
| DEL xtime | Execute delay |
| RIGN stime | Receive ignore during period of time |
| RACK stime dec | Trigger acknowledge receive during period of time |
| RSMS stime | Resume after short period of time (10 .. 2550 ms) |
| RSML ltime | Resume after long period of time (1 .. 255 s) |
| EMGON | Activate emergency mode |
| DIFIX | Display fix |
| TEXT 'text' | Output text on display |

| | |
|---|---|
| TXTOF | Restore normal display operation |
| WAITR | Wait for key release |
| TPE | Transparency enable |
| TPD | Transparency disable |
| ERRX0 | Error alert on exit off |
| ERRX1 | Error alert on exit on |
| REP rep | Repeat sequence for rep times |
| SELT | Select tone mode |
| SELD | Select free dial mode |
| SELS | Select status entry mode |
| RTSL | Reload RtS with listen or active time-out |
| RTSA | Reload RtS with active time-out |
| RTSO | Reload RtS only when in active mode |
| STOPS | Stop scanning |
| STOPP | Stop priority scan |
| OPEN | Select selcall mute open |
| CLOSE | Select selcall mute close |
| PREFA | Select preference channel when in scan mode |
| PREFS | Select preference channel when in scan mode and scanning |
| SPREV | Select previously selected channel when in scan mode |
| SBUSY | Skip encode send digits if channel busy |
| XCLOS | Exit if selcall mute closed |
| XOPEN | Exit if selcall mute open |
| XSCAN | Exit if in scan mode |
| XPRI | Exit if in priority scan mode |
| XCARR | Exit if carrier detected |
| XCTCN | Exit if no or wrong CTCSS detected |
| XCTCW | Exit if no carrier, no or wrong CTCSS detected |
| XSENS | Exit if scanning, but not stopped on channel |
| XIDLE | Exit if Return-to-Standby idle mode |
| XLIST | Exit if Return-to-Standby idle or listen mode |
| XNOT | Exit if not in transfer mode |

The parameters mentioned are:

| | |
|---|---|
| seq | Sequence of immediate and / or indirect digits<br>#dig immediate digit<br>^Dptr default transmit address<br>^Pptr primary receive address<br>^Sptr secondary receive address<br>^Tptr third receive address<br>^Qptr temporary queue entry<br>^Uptr selectable status address<br>^Mptr miscellaneous digits<br>^Kptr selectable selcall address |
| dig | Digit: 0 .. 9 and A .. F |
| ptr | Pointer: 1 .. 5 |
| ofs | Offset: 0 .. 9 |

| | |
|---|---|
| dec | Decode format |
| time | Time-out value: 0 .. 2550 ms in 10 ms steps |
| rf-freq | Radio frequency: dependent on selected range |
| af-freq | Audio frequency: 300 .. 3000 Hz |
| st-freq | Subtone frequency: 0 .. 63, see appendix B |
| toneset | ZVEI, CCIR, EEA, DZVEI, PZVEI, PCCIR, PDZVEI |
| xtime | Extended time: 1 .. 7000 ms in 1 ms units |
| stime | Standard time: 10 .. 2550 ms in 10 ms units |
| ltime | Long time: 1 .. 255 seconds in 1 second units |
| rep | Repeat factor |
| text | String of characters |

**CLOSE**
The CLOSE instruction forces the selcall mute to the closed state. Note that the related XCLOS and XOPEN instructions will test the selcall mute state at the time the encode format was started, not at the time the XCLOS or XOPEN instruction is executed.

**DEL xtime**
Execution of instruction DEL causes the execution of the encode sequence to be suspended for a period of time, defined by parameter xtime. The range of xtime is 1 to 7000 ms in 1 ms steps, thus allowing a precise pause duration of up to 7 seconds. The DEL instruction can be used to insert an LET (Link Establishment Time) or intersequence gap for e.g. two-by-five tone formats.

**DIFIX**
Instruction DIFIX activates the emergency mode with the display contents freezed. In the emergency mode, selcall encoding and decoding continues, but no activity can be seen on the display and LED, and the speaker will be muted. Deactivation of the emergency mode is possible only by switching off the equipment, or by execution of EMGOF from a decode format.

**EMGON**
Instruction EMGON activates the emergency mode. In the emergency mode, selcall encoding and decoding continue, but no activity can be seen on the display and LEDs, and the speaker will be muted. Deactivation of the emergency mode is possible only by switching off the equipment, or by execution of EMGOF from a decode format.

**ERRX0**
After execution of instruction ERRX0, exiting an encode instruction due to one of the exit conditions (for example, instruction XOPEN) prevents the portable from sounding an error alert.

**ERRX1**
After execution of instruction ERRX1, exiting an encode instruction due to one of the exit conditions (for example, instruction XOPEN) causes the portable to sound an error alert.

LEN xtime
Instruction LEN defines the duration per tone for TONE, SEND, SLEN, SCHK and SDIAL instructions. The range of xtime is 1 to 7000 ms in 1 ms steps, thus allowing a precise tone duration of up to 7 seconds.

OPEN
Instruction OPEN forces selcall mute to the open state. Note that the related XCLOS and XOPEN instruction will rest the selcall mute state at the time when the encode format was started, not at the time when the XCLOS or XOPEN instruction is executed.

PREFA
Instruction PREFA causes the portable to select the preference channel when scanning is activated. The PREFA instruction can be used to choose a predefined channel to transmit on when the PTT button is pressed while in scanning mode, regardless of whether scanning has stopped temporarily or not.

PREFS
Instruction PREFS causes the portable to select the preference channel when checking channels in the scanning mode. The PREFS instruction can be used to choose a predefined channel to transmit on when the PTT button is pressed while in scanning mode but not stopping on a channel.

RACK stime dec
Instruction RACK is used to trigger a decode format when a full selective call sequence is received within a specified period of time. This period is defined by stime, which ranges from 10 to 2550 ms in 10 ms steps. String dec determines which decode format will be triggered. The RACK instruction can be used to check whether a transpond call is returned from the called unit, or to check whether a call is acknowledged before retrying (see also REP instruction). If no ACK instruction is triggered by a linked decode format, the minus sign will be shown on the display after the time-out period has elapsed.

REP rep
Instruction REP can be used to repeat encode format for a specific number of times. Parameter rep defines how often the current encode format will be repeated. Use RSMS or RSMI, to restart a sequence after the defined period of time. Use the decode format instruction REPOF to break off the repetition of encode sequences before the end of the programmed period.

RIGN stime
Instruction RIGN causes the auto-close feature to be disabled during a period of time. The range of stime is 10 to 2550 ms in 10 ms steps. This instruction can be used in combination with the 'automatic close' feature to prevent the unit to close automatically when expecting a transpond call (acknowledge call from another unit when calling that unit).

**RSML** ltime
After passing instruction RSML, execution of the encode sequence is suspended, and restarted from the beginning after a period of time. This period is defined by ltime, which ranges from 1 to 255 seconds in 10 second steps.

**RSMS** stime
After passing instruction RSMS, execution of the encode sequence is suspended, and restarted from the beginning after a period of time. This period is defined by stime, which ranges from 10 to 2550 ms in 10 ms steps.

**RTSA**
Instruction RTSA causes the Return-to-Standby state to be set to active, and resets the Return-to-Standby timer to the active period of time.

**RTSL**
Instruction RTSL causes the Return-to-Standby timer to be set to the listen or active period of time, depending on the current Return-to-Standby state.

**RTSO**
Instruction RTSO causes the Return-to-Standby timer to be set to the active period of time if already in the active Return-to-Standby state. If not in the active mode, the timer will not be set.

**RX**
Switches to receive mode, after which all mute functions apply.

**RXF** rf-freq
Switches to receive mode, using the in-line specified RF frequency. The specified frequency must be within the selected RF band. For example, in a VHF radio, the instruction RXF 149.0500 will cause the portable to receive on 149.0500 MHz.

**RXP**
Switches to receive mode, using the programmed frequency for the selected channel.

**SBUSY**
Instruction SBUSY skips transmission of digits following this instruction when a carrier was present at the time the encode format was started.

**SCHK**
Instruction SCHK sends a checksum digit, the value of which is calculated as the sum of all previous digits MOD 10. The SCHK instruction can also be used to build a data-packet for transmitting dialling information.

**SCOFF**
Instruction SCOFF switches off CTCSS transmission. In a PTT release encode format, a useful application for SCOFF is to switch CTCSS off about 300 ms before transmission is ended (sequence 'SCOFF DEL 300 RX'): this will prevent the trailing noise to be heard on the receiving equipment if CTCSS decoding is used as well.

**SCPH0**
The SCPH0 instruction causes the CTCSS sine wave to skip 180 degrees of phase. This will mute the receiving equipment of the other party quicker than switching off CTCSS only. Note: the SCPH0 instruction is not available yet.

**SCPH1**
The SCPH1 instruction causes the CTCSS sine wave to skip 120 degrees of phase. This will mute the receiving equipment of the other party quicker than switching off CTCSS only. Note: the SCPH1 instruction is not available yet.

**SCR** st-freq
Activates CTCSS receive, using the in-line specified CTCSS receive frequency. This frequency must be entered as a number from 0 to 63 (see appendix D).

**SCRP**
Activates CTCSS receive using the programmed CTCSS receive frequency for the selected channel.

**SCT** st-freq
Activates CTCSS transmit, using the in-line specified CTCSS transmit frequency. The CTCSS frequency must be entered as a number in the range of 0 to 63 (see appendix D).

**SCTP**
Activates CTCSS transmit, using the programmed CTCSS transmit frequency for the selected channel.

**SDIAL**
Instruction SDIAL sends all the digits that are entered as a dialling string. The dialling string can contain up to 28 digits. The SDIAL instruction is used to transmit this dialling information. It is recommended to use SLEN and SCHK in addition to SDIAL, to minimize the occurrence of errors due to bad signalling conditions.

**SELD**
Instruction SELD selects the dialling string entry mode. After execution of SELD, the display will be cleared and a number of up to 28 digits can be entered from the keypad. Execution of the encode format is resumed after the * key is pressed. The contents of the dial buffer can be transmitted later using the SDIAL instruction.

**SELS**
Instruction SELS selects the status digit entry mode. After execution of SELS, the display will shown 'St _', allowing entry of one digit in the range of 0 .. 9. If necessary, this digit can be overwritten or erased by pressing button C. After selection, pressing button * continues execution of the current encode format.

**SELT**
Instruction SELT causes the text 'tONE' to be shown on the display. The instruction can be used to ask for a confirmation of single-tone transmission using the * key.

SEND seq
The SEND range of instructions is used to transmit selective call digits and DTMF tones. The digit or tone values can be fixed in the encode format, the so-called immediate digits, or they can be retrieved from the internal tables, the indirect digits. Immediate digits are entered in a format consisting of a hash-sign (#) followed by one or multiple digits. Indirect digits are entered as ^-sign plus pointer character and one or more indexes. One sequence can contain up to 63 instructions, thus allowing approximately 50 tones to be sent in a sequence. Examples of immediate and indirect reference of digits can be found in section 6.7, under the CMP command.

SLEN ofs
Instruction SLEN causes a digit to be sent as selcall or DTMF, the value of which is determined from the length of the dialled number string. The digit value is calculated as (Length + Offset) MOD 10, and thus has a value ranging from 0 to 9. The SLEN instruction can be used to build a data-packet to transmit dialling information from the portable to an infrastructure connected to the PSTN.

**SPREV**
Instruction SPREV can be used to choose the channel that had been selected before scanning was activated. This instruction can be used to switch off scanning fully from an encode format, just as if switching off scanning manually.

STOPP
Instruction STOPP switches off priority scanning. Note that the related XPRI instruction will test the priority scan state at the time when the encode format was started, not at the time when the XPRI instruction is executed.

STOPS
Instruction STOPS switches off scanning. Note that the related XSCAN instruction will test the scanning state at the time when the encode format was started, not at the time when the XSCAN instruction is executed.

TEXT 'text'
Instruction TEXT outputs text to the display. All characters can be entered, however some characters will be more difficult to read because of the limited displaying capability of characters in the 7-segment format. Characters are shown on the large 5-digit display section and are shifted from the right to the left. The speed of shifting characters onto the display can be set using the LEN command.

TONE af-freq
Instruction TONE allows transmission of any tone between 300 and 3000 Hz. The length of the tone can be defined using the LEN instruction, which must be inserted before the TONE instruction. For example, encode sequence 'LEN 1200 TONE 1550' sends a tone of 1550 Hz during 1.2 seconds. Single-tone transmission is frequently used to operate repeaters or for a group call or all-close in certain selective call systems.

TPD
Deactivates the transparency mode that is activated with TPE.

TPE
Enables the transfer of a large packet of data using selective call tones, without causing other units to be called because of matching sequences. When the transparency mode is activated by TPE, a D-digit will be inserted after every four digits that are transmitted, which will prevent other units to be called. The TPE instruction is normally used in combination with the SDIAL instruction for transferring a dialling string.

TSET toneset
Instruction TSET selects the toneset for transmission of selective call messages. The available tonesets are: ZVEI, CCIR, EEA, DZVEI, PZVEI, PCCIR and PDZVEI. Note that the length per tone is not defined in the TSET Instruction, but must be set separately using the LEN instruction.

TXD
Switches to transmit mode, prepared for DTMF digit transmission. For each following SEND and related instructions, DTMF digits will be sent.

TXF rf-freq
Switches to transmit mode, using the in-line specified RF frequency. The specified RF frequency must be within the selected RF band. For example, in a VHF radio, the instruction TXF 149.0500 will cause the radio to transmit on 149.0500 MHz. The transmit path selection will not change.

TXM
Switches to transmit mode, prepared for speech (microphone) transmission.

**TXP**
Switches to transmit mode, using the programmed frequency for the selected channel. The transmit path selection (selcall, DTMF, microphone) will not change.

**TXS**
Switches to transmit mode, prepared for selcall digit transmission. For each following SEND and related instructions, selective call digits will be sent.

**TXTOF**
The TXTOF instruction restores the display to normal operation after using the display for text output by the TEXT command.

**WAITR**
Wait until key is released. This instruction can be used to prolonge DTMF tones send while a key is pressed in the DTMF overdialling mode.

**XCARR**
The XCARR instruction will abort execution of the current encode format if an RF carrier is detected by the receiver. XCARR can be used to create a carrier lockout condition to prevent speech transmission and / or calls while the channel is occupied.

**XCLOS**
The XCLOS instruction will abort execution of the current encode format if the selcall mute state was 'closed' when the current encode format was started. The following example describes a possible application: to prevent the transmission of an immediate call while the radio is in a 'closed' state, encode sequence 'OPEN XCLOS' will cause the radio to open first and test the selcall mute state before executing OPEN. Execution of this sequence will be aborted if the radio was previously in a closed state.

**XCTCN**
The XCTCN instruction will abort execution of the current encode format if an RF carrier is detected by the receiver without SAT or with a wrong SAT tone received simultaneously. This instruction can be used to look out usage of a repeater station when the repeater is used by another user group.

**XCTCW**
The XCTCW instruction will abort execution of the current encode format if no carrier is detected, or if no SAT or a wrong SAT tone is received. This instruction can be used to allow transmission only if a valid SAT tone has already been received.

**XIDLE**
The XIDLE instruction will abort execution of the current encode format if the Return-to-Standby mode is set to idle. Execution proceeds when the Return-to-Standby mode is set to listen (monitor) or active.

XLIST
The XLIST instruction will abort execution of the current encode format if the current Return-to-Standby is not set to active. This instruction can be used to prevent speech transmission in the Return-to-Standby idle or listen (monitor) state.

XNOT
The XNOT instruction will abort execution of the current encode format if the transfer function is disabled. This instruction can be used to transmit a transfer call or pager call when an incoming call is received, or prevent transmission of such a call if this is function is disabled by the user of the radio.

XOPEN
The XOPEN instruction will abort execution of the current encode format if the selcall mute state was 'open' when the current encode format was started. This instruction can be used to prevent calls while the unit is opened (for example in a dispatch-oriented system).

XPRI
The XPRI instruction will abort execution of the current encode format if priority scanning was activated at the start of the current encode format. See XCLOS example for combining XPRI with STOPP.

XSCAN
The XSCAN instruction will abort execution of the current encode format if scanning was activated at the start of the current encode format. See XCLOS example for combining XSCAN with STOPS.

XSENS
The XSENS instruction will abort execution of the current encode format if the portable is scanning and has not temporarily stopped because of activity on a channel. Thus, XSENS can be used to allow transmission if scanning is not active or if scanning has temporarily stopped on a channel.

## APPENDIX A: Glossary

| | |
|---|---|
| CTCSS | Continues Tone Carrier Squelch System. Sub-audible tone continuesly send. |
| DCS | Digital Coded Squelch. Also DPL or Digital Private Line. |
| DPL | Digital Private Line. Motorola equivalent for DCS. |
| DTMF | Dual Tone Multiple Frequency. Also called touchtone. |
| ICM | Integrated Controller Module. Concept for integrated control of channel switching, channel scanning, selective calling, CTCSS, DCS and DTMF developed by Rohill. |
| LED | Light Emitting Diode. |
| LCD | Liquid Crystal Display. |
| PL | Private Line. Motorola equivalent for CTCSS. |
| PTT | Push-to-Talk. |
| RtS | Return-to-Standby. Facility offered by ICM which caused the radio to close after a period of no-activity on the channel. |
| SAT | Sub audible tone. Includes both CTCSS and DCS, because they use both the sub-audible frequency range from 0 to 250 Hz. |
| Selcall | Selective calling. |

## APPENDIX B: Accessories

The Kenwood TK-709/809 mobile radio can be used with the following accessories:

* Normal microphone (part number KMC-14)
* DTMF microphone (part number KMC-18, KMC-18A)
* Keypad/microphone (part number KMC-19)
* TransLink programming cable (part number KPG-4)

The Kenwood TK-249/349 portable radio can be used with the following accessories:

* Speaker/microphone (part number KMC-11)
* TransLink programming cable (part number KPG-8)

For both the TK-709/809 and TK-249/349 radios the following accessories are available:

* PROGSYS programming software for system engineers (part number xxx)
* PROGSIM programming software for dealers (part number xxx)

## APPENDIX C: Selcall tonesets standards

| Frequencies in Hz | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tone | ZVEI | CCIR | EEA | PZVEI | DZVEI | PCCIR | PDZVEI | ZVEI2 |
| 0 | 2400 | 1981 | 1981 | 2400 | 2200 | 1981 | 2200 | 2400 |
| 1 | 2060 | 1124 | 1124 | 1060 | 970 | 1124 | 970 | 1060 |
| 2 | 1160 | 1197 | 1197 | 1160 | 1060 | 1197 | 1060 | 1160 |
| 3 | 1270 | 1275 | 1275 | 1270 | 1160 | 1275 | 1160 | 1270 |
| 4 | 1400 | 1358 | 1358 | 1400 | 1270 | 1358 | 1270 | 1400 |
| 5 | 1530 | 1446 | 1446 | 1530 | 1400 | 1446 | 1400 | 1530 |
| 6 | 1670 | 1540 | 1540 | 1670 | 1530 | 1540 | 1530 | 1670 |
| 7 | 1830 | 1640 | 1640 | 1830 | 1670 | 1640 | 1670 | 1830 |
| 8 | 2000 | 1747 | 1747 | 2000 | 1830 | 1747 | 1830 | 2000 |
| 9 | 2200 | 1860 | 1860 | 2200 | 2000 | 1860 | 2000 | 2200 |
| A | 2800 | 2400 | 1055 | 970 | 2600 | 1055 | 825 | 886 |
| B | 810 | 930 | 930 | 810 | ~~886~~ | ~~930~~ | ~~886~~ | ~~970~~ |
| C | 970 | 2247 | 2247 | 2800 | ~~886~~ 886 | 2400 | 2600 | ~~2400~~ 2600 ✓ |
| D | 886 | 991 | 991 | 886 | 810 | ~~991~~ | ~~856~~ | ~~N.T.~~ 2800 ✓ |
| E | 2600 | 2110 | 2110 | 2600 | 2400 | 2110 | 2400 | 970 ✓ |
| Period (ms) | | | | | | | | |
| | 70 | 100 | 40 | 70 | 70 | 100 | 70 | 70 |

A = Group tone
C = Default remote close tone
E = Repeat tone
N.T. = No tone specified

# PREFACE



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## APPENDIX E: DCS codes

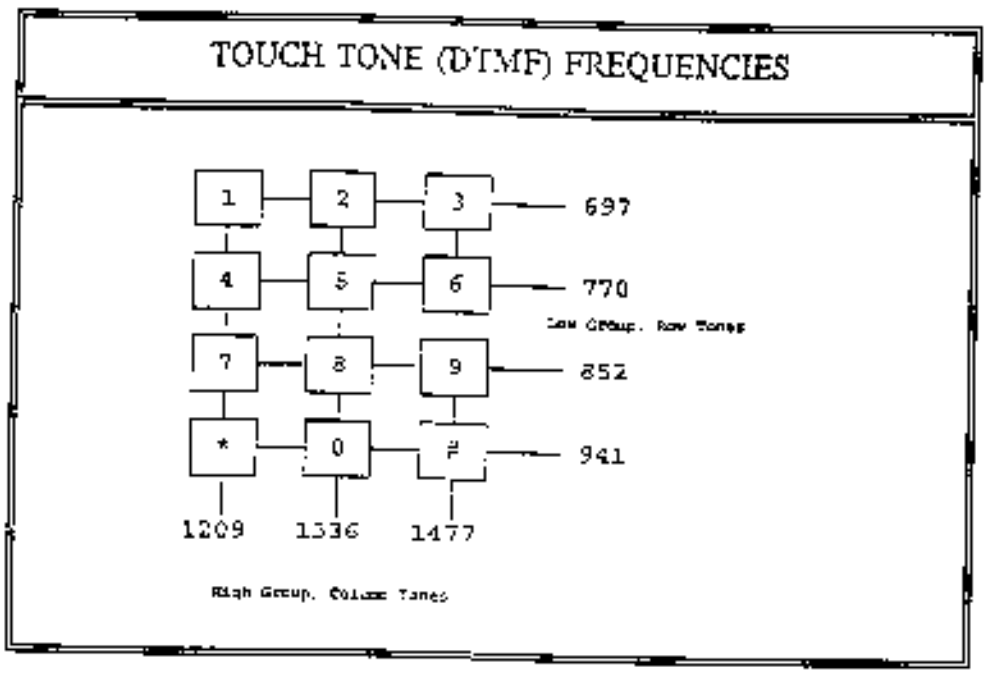
| Standard 83 codes used in the DCS scheme | | | | | | | |
|---|---|---|---|---|---|---|---|
| Low Series | 100 Series | 200 Series | 300 Series | 400 Series | 500 Series | 600 Series | 700 Series |
| 023 | 114 | 205 | 306 | 411 | 503 | 606 | 703 |
| 025 | 115 | 223 | 311 | 412 | 506 | 612 | 712 |
| 026 | 116 | 226 | 315 | 413 | 516 | 624 | 723 |
| 031 | 125 | 245 | 331 | 423 | 532 | 627 | 731 |
| 032 | 131 | 244 | 343 | 431 | 546 | 631 | 732 |
| 043 | 132 | 245 | 346 | 432 | 565 | 632 | 734 |
| 047 | 134 | 251 | 351 | 445 | | 654 | 743 |
| 051 | 143 | 261 | 364 | 464 | | 662 | 754 |
| 054 | 152 | 263 | 365 | 465 | | 664 | |
| 065 | 155 | 265 | 371 | 466 | | | |
| 071 | 156 | 271 | | | | | |
| 072 | 162 | | | | | | |
| 073 | 165 | | | | | | |
| 074 | 172 | | | | | | |
| | 174 | | | | | | |
| Turn off code is 200 ms of 134 Hz | | | | | | | |

DCS employs a fixed octal digit 4 as the first digit, followed by three octal digits shown in table. Code words are 23 bits long strings: 12 bits of octal code (9 bits address, 3 bits synchronisation code), followed by 11 bits of CRC. Each bit 7.5 ms, just over 170 ms per word.

## APPENDIX D: CTCSS frequencies

| Call sign | Frequency (Hz) |
|---|---|
| XZ | 67.0 |
| XA | 71.9 |
| ~~UA~~ | 74.4 |
| XB | 77.0 |
| SP | 79.7 |
| YZ | 82.5 |
| YA | 85.4 |
| YB | 88.5 |
| ZZ | 91.5 |
| ZA | 94.8 |
| ZB | 97.4 |
| 1Z | 100.0 |
| 1A | 103.5 |
| 1B | 107.2 |
| 2Z | 110.9 |
| 2A | 114.8 |
| 2B | 118.8 |
| 3Z | 123.0 |
| 3A | 127.3 |
| 3B | 131.8 |
| 4Z | 136.5 |
| 4A | 141.3 |
| 4B | 146.2 |
| 5Z | 151.4 |
| 5A | 156.7 |
| 5B | 162.2 |
| 6Z | 167.9 |
| 6A | 173.8 |
| 6B | 179.9 |
| 7Z | 186.2 |
| 7A | 192.8 |
| M1 | 203.5 |
| M2 | 210.7 |
| M3 | 218.1 |
| M4 | 225.7 |
| M5 | 233.6 |
| M6 | 241.8 |
| M7 | 250.3 |

## APPENDIX F: DTMF frequencies




MOBILE RADIO 2VE1-1 10_3C1
PORTIK Family 2VE1-1 10_3C1

=

PHONE: GF34C 10_3C8
PHONE TK-949 10_3C9
IK-8C9 10_3C1

BASE:

ELK 10_3C6

STUN CODE: KENWOOD: TG. GF34C - 8 0_3C1 { PHONE STANDARD ONLY }
TK949 - 9 0_3C1