LTR + US Signalling

Software Option   897 093

Operating Instructions

38_ltrus   Doc. Version: 9508-120-A

Contents

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☞ **For differences from former software versions:** see the Lifeline at the end of this supplement.

Introduction

The "LTR + US Signalling" system program permits testing certain coded squelch radio sets (PL = Private Line and DPL = Digital Private Line) as well as some conventional carphone signalling formats (LTR = Logic Trunked Radio, MTS = Mobile Telephone System and IMTS = Improved MTS) that are widespread in North America. While the coded squelch tests are duplex tests (both encode and decode), the carphone tests are encode only (they test the phone's ability to respond to the formats generated).

"Private Line" und "Digital Private Line" are trademarks of Motorola Inc., USA. "LTR" is a trademark of E. F. Johnson Co., USA.

What tests are possible with the system program?

Depending on the system that is selected, the program will handle the signalling that is necessary for connection setup or it decodes the arriving codes. In this way all the signalling functions of a device under test can be checked out. As soon as the connection is set up, you can call up the basic DUPLEX or RX mask and carry out the usual standard measurements like receiver sensitivity or modulation sensitivity. If you call up the basic TX mask, the connection will be terminated.

What are the special requirements?

1. The system program can only be used with STABILOCK firmware ≥ 2.50.
2. STABILOCK has to be fitted with the options DATA module and Duplex FM/ΦM stage.

How is the device under test connected?

If the device under test is only to be examined at signalling level (functioning of decoder and possibly encoder), the RF connection is enough between the antenna terminal of the device under test and the RF socket of STABILOCK. If the standard measurements described in Chapter 4 or 5 (small manual) are to be performed as well, the cabling shown there under "Test setup" will be necessary too.

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How is the program started?

1. Call up the GENERAL PARAMETERS mask and enter the required RF parameters (see also Chapter 12 or 4 (small manual), GENERAL PARAMETERS foldout).

2. Call up the DUPLEX mask, select FM and connect to the RF socket. Enter the required transmit or receive frequency or the channel number in the `RF Frequency` fields (see also Chapter 12 or 4, basic DUPLEX mask). Declare `Level/50`Ω or `Level/EMF` for the RF level.

3. Install the "LTR + US Signalling" SYSTEM card. Strike the [AUX] key and then the (DATA) softkey. After a brief time for loading the monitor will show the first test mask of the system program. The declarations made in the GENERAL PARAMETERS mask are not transfered to the SYSTEM card. So the RF parameters should be checked each time before starting the program.

Selecting a system

The first test mask offers the systems `DPL`, `LTR`, `PL` and `MTS`. (ETC) calls up the second test mask. Here the `IMTS` system is also offered. (HELP) shows that before every system name there is a scroll field with the scroll variables " " (space) and "X". The selected system is the one marked with "X" (see also Chapter 3, "Selecting scroll variables").

If you change to another system, make sure that the previously set RF parameters are still applicable.

Entering frequency deviation and RF level

The two test masks show two entry fields at the top which can be positioned on in the usual way with the cursor. The entry in the two-digit numeric field `Dev` sets the frequency deviation of the signalling (permissible values: 0.0 to 9.9). The entry in the mixed numeric field `RF-Level` is for the RF level of the STABILOCK. The unit of the level (`dBm`, `dBµ` or `µV/mV`) can be altered like in the basic RX or DUPLEX mask.

Fig. 10.1: First test mask. Softkey (ETC) takes you to the second test mask.

```
┌──────── STANDARD AMERICAN SYSTEMS ────────┐
│   Dev. = 0.5 kHz        RF-Level = - 60.0 dBm │
├───────────────────────────────────────────┤
│  DPL      Encoding: 043                    │
│           Decoding:                        │
├───────────────────────────────────────────┤
│                 A-TR-HR-IDC-FR CRC         │
│  X LTR    Encoding: 0-11-10-051-02   Continuous │
│           Decoding: 0-31-10-024-31 33  Inverted │
├───────────────────────────────────────────┤
│  PL       Common PL Tones       M4 : 225.7 Hz │
│                              Def.Tone: 228.1 Hz │
├───────────────────────────────────────────┤
│  MTS      Freq. 1 :  600 Hz    Freq. 2 : 1500 Hz │
│           Dial Pulse Width :  100 ms       │
│           Interdigit Time  :  100 ms       │
│           Dial Number      : 1234567890    │
└───────────────────────────────────────────┘
```

`-ETC-` `SHOW ALL` `DECODE` `CLEAR` `SEND` `RETURN`

Fig. 10.2: Second test mask. (ETC) now takes you back to the first test mask.

```
┌──────── STANDARD AMERICAN SYSTEMS ────────┐
│   Dev. = 0.5 kHz        RF-Level = -100.0 dBm │
├───────────────────────────────────────────┤
│  X IMTS   Seize Tone: 1800 Hz Idle Tone: 2000 Hz │
│           Dial Pulse-Break Time:  100 ms   │
│           Dial Pulse-Make  Time:  100 ms   │
│           Interdigit Time      :  300 ms   │
│           Dial Number          : 123ABC5697 │
│                                            │
│                                            │
│                                            │
│                                            │
│                                            │
└───────────────────────────────────────────┘
```

`-ETC-` `SHOW ALL` `DECODE` `CLEAR` `SEND` `RETURN`

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Testing DPL sets

When testing DPL sets the STABILOCK works continuously as an encoder or decoder of the 3-digit DPL codes. Transmission is NRZ-coded at a baud rate of 134 Bd. Codes other than those recommended by Motorola are also permissible.

DPL-Codes (standard codes) recommended by Motorola											
023	025	026	031	032	033	047	051	054	065	067	071
072	073	074	114	115	116	125	131	132	134	143	152
155	156	162	165	172	174	205	223	226	243	244	245
251	261	263	265	271	306	311	315	331	343	346	351
364	365	371	411	412	413	423	431	432	445	464	465
466	503	506	516	532	546	565	606	612	624	627	631
632	654	662	664	703	712	723	731	732	734	743	754

Sending DPL code

Place the cursor on the numeric field Encoding with the cursor keys and enter the required DPL code. (SEND) triggers the continuous transmission of the code. (CLEAR) sends the 134-Hz clear signal for 208 ms and causes the transmission to be terminated. As long as the DPL code is being sent, the green LED above the [GEN B] key will illuminate (above the [B/SAT] key from STABILOCK serial number 0688000 onwards). Striking [GEN B] or [B/SAT] will also stop the transmission, without first having to send the clear signal.

If the frequency deviation (Dev field), the RF output level (RF-Level field) or the DPL code itself (Encoding field) is altered during the continuous transmission of a DPL code, the alterations will be adopted immediately in the transmission. You do not have to stop, alter and then strike (SEND) again.

Decoding standard DPL code

Start the decoding with $(\overline{\text{DECODE}})$ and press the PTT on the radio set. If the radio set is transmitting a standard code, this will be displayed in decimal form at the beginning of the Decoding field. The code is followed by a 23-digit bit string, the meaning of which is as follows:

Bit	1 2 3	4 5 6	7 8 9	10 11 12	13	14	15	16	17	18	19	20	21	22	23

11 redundant bits

Always binary code 001
Binary code of first DPL code digit
Binary code of second DPL code digit
Binary code of third DPL code digit

In the binary display the DPL code appears mirrored, ie the last DPL code digit first. This mirroring also applies to the weighting factors (1 2 4 instead of 4 2 1).

Example: Decoding: 306 011000110001XXXXXXXXXXX

             011 = (0x1)+(1x2)+(1x4) = 6
             000 = 0
             110 = (1x1)+(1x2)+(0x4) = 3

             001 = (0x1)+(0x2)+(1x4) = 4

The decoded standard DPL code is also automatically entered in the Encoding field so that, after decoding, transmission can immediately be started again with $(\overline{\text{SEND}})$.

If the STABILOCK cannot decode the DPL code that it receives, the Decoding field will just show dashes.

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Decoding random DPL code

If the radio set is not transmitting a standard code, the expected DPL code will first have to be entered in the Encoding field before decoding can be started with (DECODE). If the expected and the actual code do not correspond, no decoding will be possible and the Encoding field shows dashes.

Result callup with IEEE controller

RESULt1 fetches the 3-digit DPL code from the Decoding field. The 23-digit bit string is fetched with RESULt2 and RESULt3.

Testing LTR radio sets

The following functions are available for testing LTR radio sets and LTR re-
peaters:

● Continuous output of a declared message.

● Incoming messages are continuously decoded. After the test is halted, a
  results mask shows the last 20 messages decoded including the checksum
  (CRC).

● Decoding and acknowledgement of incoming messages. This handshake
  operation maintains the connection with the mobile and permits the checking
  of standard RF and AF functions in DUPLEX mode.

The (CLEAR) softkey has no effect in these tests.

Select data state

In the LTR sector of the first test mask there is a scroll field to select the data state
(scroll variables normal and inverted). The selected data state is valid only
for decoding LTR messages. You may change the scroll variable during the
sending of a message and in the handshake mode which is described later
(changes are effective at once).

Sending LTR messages

Enter the required message data in the fields of the Encoding line. The
meanings of the various entry fields are as follows:

A   Area, ie radio-zone identification (permissible entries: 0 or 1)

TR   Go to repeater or repeater in use (permissible entries: 01 through 20 or
       31)

HR   Home repeater (permissible entries: 01 through 20)

IDC   Identification code (permissible entries: 001 through 255)

FR   Free repeater (permissible entries: 00 through 20 or 31)

Further details of the meaning of the message fields are contained in the
publication "E. F. Johnson, Clearchannel LTR, Application Note", obtainable from
E. F. Johnson Company, 299 10th Avenue S.W., Waseca, Minnesota 56093 (USA).

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(SEND) triggers continuous transmission of the declared message. As long as you
are sending, the green LED above the [GEN B] key is illuminated (from
STABILOCK serial number 0688000 onwards above the [B/SAT] key). Striking
[GEN B] or [B/SAT] stops the transmission.

```
┌──────── STANDARD AMERICAN SYSTEMS ────────┐
│   Dev. = 0.5 kHz        RF-Level = - 60.0 dBm │
├───────────────────────────────────────────┤
│  DPL     Encoding: 043                      │
│          Decoding:                          │
├───────────────────────────────────────────┤
│              A-TR-HR-IDC-FR CRC             │
│  X LTR   Encoding: 0-11-10-051-02   Handshake│
│          Decoding:                  ▐ Normal ▌│
├───────────────────────────────────────────┤
│  PL      Common PL Tones         M4 : 225.7 Hz│
│                             Def.Tone: 228.1 Hz│
├───────────────────────────────────────────┤
│  MTS     Freq. 1 :  600 Hz    Freq. 2 : 1500 Hz│
│          Dial Pulse Width :  100 ms         │
│          Interdigit Time  :  100 ms         │
│          Dial Number      : 1234567890      │
└───────────────────────────────────────────┘
Continuous sending in background
▐-ETC-▌ ▐SHOW ALL▌ ▐DECODE▌ ▐CLEAR▌  ▐SEND▌  ▐RETURN▌
```

Fig. 10.3: First test mask during continuous transmission of a message.

During continuous transmission of a message, you can alter the frequency deviation (`Dev` field), the RF output level (`RF Level` field) or the message data themselves. As soon as you confirm entries with (ENTER), the alterations take effect in the ongoing transmission. It is also permissible to call up the basic RX or DUPLEX mask; the transmission of the message will then continue in the background.

Continuous decoding of LTR messages

Locate the scroll field at the righthand margin, set the `Continuous` scroll variable and start decoding with (DECODE). All incoming messages will then be decoded in realtime. The `Decoding` field shows the data of the message just decoded. If no (or no more) messages arrive, only dashes are displayed. Meaning of message data:

A   Area

TR   Go to repeater

HR   Home repeater

IDC   Identification code

FR   Free repeater

CRC   Checksum (cyclic redundancy check)

(STOP) halts decoding. Then you can call up a results mask with (SHOW ALL) that gives you the data of the last 20 decoded messages.

The * character next to the checksum marks a message received with errors (received and computed checksum do not correspond).

Fig. 10.4: When testing LTR systems, (SHOW ALL) presents this results mask. It shows up to 20 received LTR messages and their checksum (CRC).

```
┌──────── STANDARD AMERICAN SYSTEMS ────────┐
│                                           │
│    A-TR-HR-IDC-FR CRC      A-TR-HR-IDC-FR CRC  │
│  1:0-10-10-051-31 58     11:0-10-10-051-31 58  │
│  2:0-10-10-051-31 58     12:0-10-10-051-31 58  │
│  3:0-10-10-051-31 58     13:0-10-10-051-31 58  │
│  4:0-10-10-051-31 58     14:0-10-10-051-31 58  │
│  5:0-10-10-051-31 58     15:0-10-10-051-31 58  │
│  6:0-10-10-051-31 58     16:0-10-10-051-31 58  │
│  7:0-10-10-051-31 58     17:0-10-10-051-24 18X │
│  8:0-10-10-051-31 58     18:0-31-10-051-31 53  │
│  9:0-10-10-051-31 58                       │
│ 10:0-10-10-051-31 58                       │
│                                           │
│                                           │
│                                           │
│                                           │
└───────────────────────────────────────────┘
              ████████ RETURN ████████
```

Decoding and sending acknowledgement messages

Locate the scroll field at the righthand margin, set the Handshake scroll variable and start the test with (DECODE). A message in the status line at the bottom edge of the screen tells you that the STABILOCK is now in handshake mode. In other words, the encoder and decoder are standing by and you can, for example, call up the basic DUPLEX mask to carry out the usual RF and AF tests.

As soon as the transmit key is operated on the mobile, the decoder decodes the arriving message and the encoder automatically sends an acknowledgement message (the message declared in the Encoding line is of no significance in this case). The connection setup is thus completed and tests like measuring modulation sensitivity can be run (see Chapter 4). In the background the decoder will at the same time check all incoming messages for the turn-off code. This is sent by the mobile as soon as its transmit key is released. When this terminating message is received, it is also acknowledged by the STABILOCK and thus the connection is correctly cleared down. To set up the connection again, all you have to do is press the transmit key on the mobile.

To halt the test, strike the (GEN B) or (B/SAT) key. Then press (SHOW ALL) to call up the results mask. This shows you the first message received and the turn-off message.

Calling up results with IEEE controller

RESULt1 transfers the decoded message including the checksum from the test mask (Decoding line).

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Testing PL sets

When testing PL sets the STABILOCK continuously transmits the agreed PL code (subaudio frequency). Codes other than those recommended by Motorola are also permissible. The (DECODE) and (CLEAR) softkeys serve no purpose in this test.

PL codes (standard codes) recommended by Motorola			
67,0 Hz = XZ	94,8 Hz = ZA	131,8 Hz = 3B	186,2 Hz = 7Z
69,3 Hz = WZ	97,4 Hz = ZB	136,5 Hz = 4Z	192,8 Hz = 7A
71,9 Hz = XA	100,0 Hz = 1Z	141,3 Hz = 4A	206,5 Hz = 8Z
74,4 Hz = WA	103,5 Hz = 1A	146,2 Hz = 4B	203,5 Hz = M1
77,0 Hz = XB	107,2 Hz = 1B	151,4 Hz = 5Z	210,7 Hz = M2
79,7 Hz = WB	110,9 Hz = 2Z	156,7 Hz = 5A	218,1 Hz = M3
82,5 Hz = YZ	114,8 Hz = 2A	162,2 Hz = 5B	250,3 Hz = M7
85,4 Hz = YA	118,8 Hz = 2B	167,9 Hz = 6Z	225,7 Hz = M4
88,5 Hz = YB	123,0 Hz = 3Z	173,8 Hz = 6A	229,1 Hz =)Z
91,5 Hz = ZZ	127,3 Hz = 3A	179,9 Hz = 6B	

Sending standard PL code

Set the scroll variable Common PL Tones in the scroll field to the right of the system name PL. Move the cursor to the right to the next scroll field and then turn the spinwheel to call up the required scroll variable (standard PL code). (SEND) triggers the continuous transmission of the code.

As long as the PL code is being sent, the green LED above the [GEN B] key will illuminate (above the [B/SAT] key from STABILOCK serial number 0688000 onwards). Striking [GEN B] or [B/SAT] stops the transmission.

If the frequency deviation (Dev field), the RF output level (RF-Level field) or the PL code itself is altered during the continuous transmission of a PL code, the alterations will be adopted immediately in the transmission. This also applies when you switch over to transmitting random PL codes. You do not have to stop, alter and then strike (SEND) again.

Sending random PL code

Set the scroll variable Free defined Tone in the scroll field to the right of the system name PL. Move the cursor to the entry field Def. Tone and enter the required 4-digit PL frequency. (SEND) triggers the continuous transmission of the PL code.

During transmission individual parameters may be altered as described above.

Testing MTS sets

When testing MTS phones the STABILOCK transmits the entered MTS call number. The FSK frequencies, the pulse duration and the pause duration between two call digits can be matched to requirements. For the pulse and pause duration the minimum values are 3 ms. If a smaller value is entered, it will be increased automatically to the minimum value during transmission. A call digit is transmitted by frequency-shift keying, the number of shifts corresponding to the call digit (see example).

The (DECODE) softkey serves no purpose in this test.

Sending MTS call number
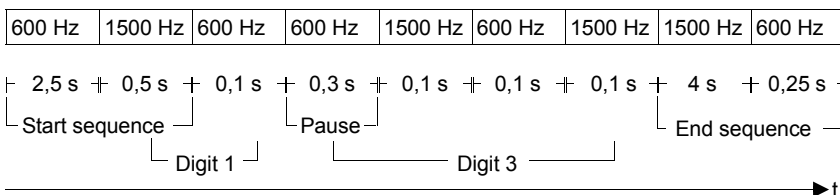
First fill in the following five entry fields:

Freq.1	Value for frequency 1 (4-digit)
Freq.2	Value for frequency 2 (4-digit)
Dial Pulse Width	Pulse duration ≥ 3 ms (4-digit)
Interdigit Time	Pause duration ≥ 3 ms between two call digits (4-digit)
Dial Number	MTS call number (10-digit, hexadecimal)

(SEND) produces transmission of the MTS call number with the declared specifications. During transmission the (RETURN) softkey takes on the label (STOP) (terminate transmission).

Example:

Freq.1	600 Hz
Freq.2	1500 Hz
Dial Pulse Width	100 ms
Interdigit Time	300 ms
Dial Number	13

FSK signalling of MTS call number 13

600 Hz	1500 Hz	600 Hz	600 Hz	1500 Hz	600 Hz	1500 Hz	1500 Hz	600 Hz

2,5 s ┼ 0,5 s ┼ 0,1 s ┼ 0,3 s ┼ 0,1 s ┼ 0,1 s ┼ 0,1 s ┼ 4 s ┼ 0,25 s

Start sequence — Pause — End sequence

Digit 1   Digit 3

▶ t

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Sending MTS clear sequence

(CLEAR) sends frequency 2 for 0.5 s.

Testing IMTS sets

When testing IMTS phones the STABILOCK transmits the entered IMTS call number. The FSK frequencies, the pulse break time, the pulse make time and the pause duration between two call digits can be matched to requirements. For all time figures the minimum value is 3 ms. If a smaller value is entered, it will be increased automatically to the minimum value during transmission. A call digit is transmitted by frequency-shift keying, the number of shifts corresponding to the call digit (see example).

The (DECODE) and (CLEAR) softkeys serve no purpose in this test.

Sending IMTS call number

First fill in the following six entry fields:

Seize Tone	Frequency of seize tone (4-digit)
Idle Tone	Frequency of idle tone (4-digit)
Dial Pulse-Break Time	Pulse break time ≥ 3 ms (4-digit)
Dial Pulse-Make Time	Pulse make time ≥ 3 ms (4-digit)
Interdigit Time	Pause duration ≥ 3 ms between two call digits (4-digit)
Dial Number	IMTS call number (10-digit, hexadecimal)

(SEND) produces transmission of the IMTS call number with the declared specifi-cations. During transmission the (RETURN) softkey takes on the label (STOP) (terminate transmission).

Lifeline

The chronological lifeline tells you what modifications have been made to the software (SW) and the operating instructions. After a software update the lifeline helps you to find out quickly about all major changes (see code) in the updated operating instructions that are supplied.

Code: C = Correction, IN = Important Note, NF = New Feature

SW	Doc. Version	Δ pages	Code	Changes
1.00	9401-100-A	all	NF	Layout changed to small pages.
1.10	9504-110-A	10-11	NF	Selection of data state possible (normal or invers).
1.20	9508-120-A	10-11	C	Inverted data state only for decoding messages.

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