service manual

EF738

Ericsson Mobile Phone
Type 1030601-BV

EN/LZB 126 1319 R2A

MOBILE PHONES BY ERICSSON

Service Manual

EF738

Ericsson Mobile Phone 1030601-BV

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Preface

The Ericsson service philosophy includes the ambition that engineers serving our telephones also possess a general knowledge of the system for which they are intended, as well as of the phone itself and its accessories.
This manual contains consequently not only information regarding the actual service work but also additional information as stated below.

Section 1: ***System Introduction***
- network description
- frequency tables

Section 2: ***Technical Description***
- description of the mechanical design
- operational description of the electronic circuitries
- technical specifications

Section 3: ***Test/Service Programs***
- test equipment
- test program
- ETACS service program
- keypad NAM programming
- flash programming

Section 4: ***Service Instructions***
- system connector signals
- disassembly/reassembly
- PCB exchange
- fault finding and alignment

Section 5: ***Accessories***
- technical descriptions of available accessories

Section 6: ***HandsFree Installation***
- installation instructions regarding vehicle handsfree kits

Section 7: ***Spare Parts***
- section reserved for separately distributed spare parts lists

Section 8: ***Service Messages***
- section reserved for separately distributed service messages

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System Introduction

Ericsson Mobile Phone EF738

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The Mobile Telephone Network

A *cellular mobile telephone system* (CMS) controlled by one single exchange is illustrated in *fig. 1*. The basic units of such a system are:

- the *mobile services switching centre (MSC)*
- the *base stations* (BS)
- the *mobile telephones* (MT)

The MSC is the interface between the radio system and the *public switching telephone network* (PSTN). Calls to and from the mobile subscriber are switched by the MSC, which also provides all signalling functions needed to establish the calls.

In order to obtain radio coverage of a given geographical area, a certain number of base stations is required. The number of base stations may range from one up to a hundred or more. Such a geographical area is called an *MSC service area*.

The number of MSCs varies from one country to another, depending on traffic density, the number of base stations, and so on. Each MSC handles calls from one *service area* which, in turn, is divided into radio zones. A service area consists of a number of *radio zones* (or *cells*), each of which is serviced by a base station.

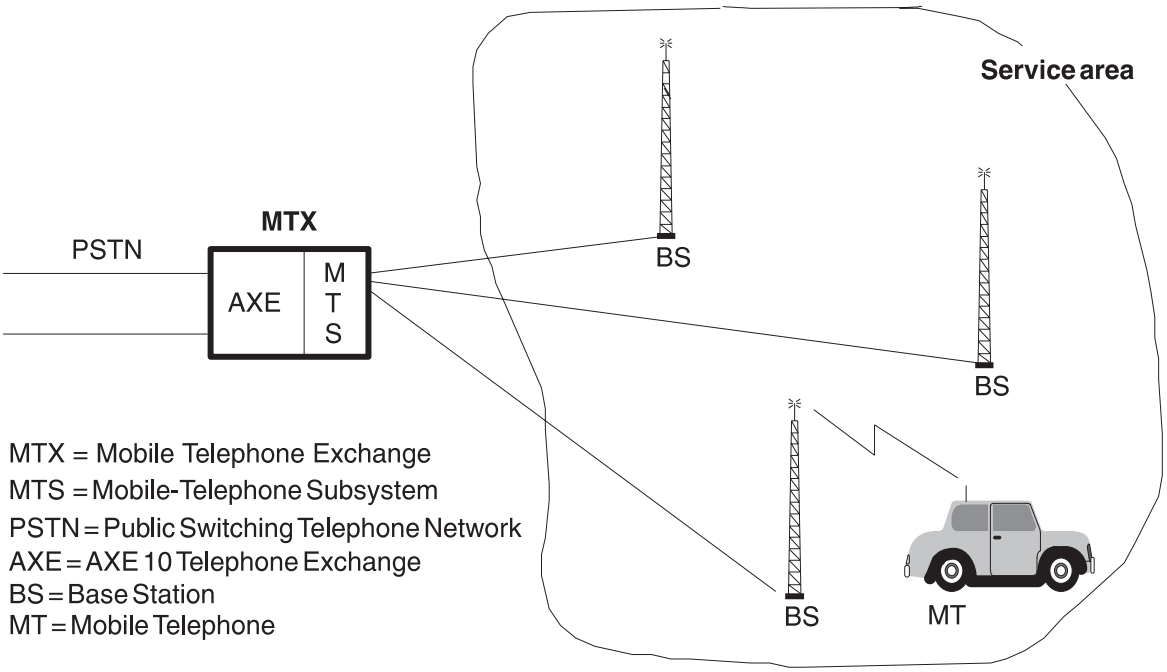

Figure 1: Basic Units in the Mobile Telephone System

Base Station and Cell

A base station is able to communicate with any mobile telephone within a certain area close to it. This area is called a cell.

The base station contains channel units. Each channel unit is equipped with a *radio transmitter*, a *radio receiver*, and a *control unit*. The control unit is used for data communication with the MSC and for data signalling with the mobile telephones on the radio path. A channel uses two separate radio frequencies, one for transmission by the mobile telephone and one for transmission by the base station. Such a channel is called a *duplex channel*. The distance between these two frequencies, the duplex distance, is always the same and is 45 MHz.

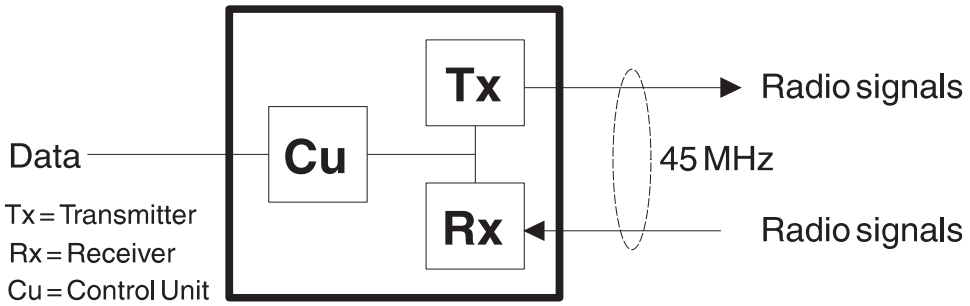

Figure 2: Channel Unit

All base stations within a service area are connected to the MSC via dedicated lines in the public telephone network.

Radio Channels

Two different types of radio channels exist in a base station:

- *voice channels* (VC)
- *control channels* (CC)

The majority of channel units are voice channel units. Such a voice channel unit is engaged in carrying one telephone call at a time. Depending on how many simultaneous calls a base station is required to handle, the number of voice-channel units in some base stations may be only a few, while in others up to a hundred or more.

There is normally only one control channel in each cell. A mobile telephone being within a cell, and not in the conversation state, is always tuned to the control channel of this cell. The telephone supervises the continuous data stream.

The total number of channels available in a mobile telephone system is limited. As the radio waves only reach so far from the base station, however, identical channel frequencies can be used by several base stations, provided the distance between them is sufficient to prevent interference. This method is used to increase the capacity of the system.

Radio Coverage

The coverage (or the transmitting power) of the base station is adjusted to the amount of traffic, so less power is used in cities and other areas where the traffic is heavy. The covered area in these cases may be limited to about two kilometers. More power is permissible in less populated areas. The range in these areas may amount to about 40 kilometres.

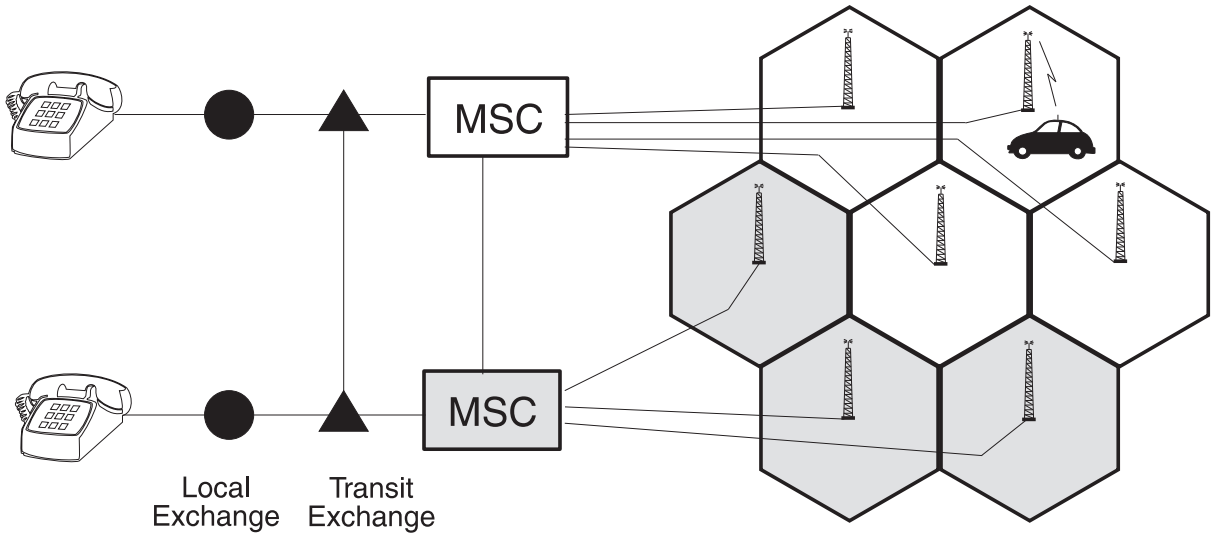

Figure 3: Service Areas with Radio Zones and Base Stations

A method known as the *small-cell technique* may be applied in areas with an extreme demand on radio capacity. With this technique the service area to be covered is divided into a number of radio zones (see *fig. 3*). Each radio zone is covered by a base station, which includes a transmitter (Tx) and a receiver (Rx). For such a system to operate, without the base stations interfering with each other, the available frequency band is split up, for example into six different groups (A-F), with a certain number of frequencies in each group. Allocating these groups in such a way that no radio zone operating on a particular group of frequencies adjoins another operating on the same frequencies makes it possible to cover an entire service area, without any interference between the base stations. *Fig. 4* shows an example of channel allocation.

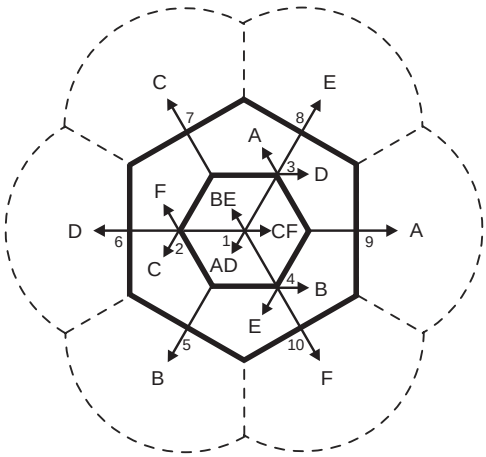

Figure 4: Channel Allocation

In order to reduce the risk of interference still further, and to remove noise, the system uses the *compander* technique. Basically, this method improves the signal/noise ratio of the radio channel by compressing the signal before transmission, and expanding the signal on reception.

The ETACS system features *full duplex* operation, with a *duplex separation* of 45 MHz. Full duplex means that a conversation can progress simultaneously in both directions, as it does on an ordinary telephone. The duplex separation is the frequency separation between the transmitter and receiver operating frequencies. The 900 MHz-band has been divided into an upper and a lower frequency band. The lower band (872.0125 - 904.9875 MHz) contains the mobile telephone transmitter channels, and the upper band (917.0125 - 949.9875 MHz) contains the corresponding mobile telephone receiver channels.

Transmission Control and Communication

The heavy traffic and the many functions applied in the system requires the telephone exchanges to be program-controlled. The exchange has to observe which base station is now serving the mobile telephone. When the car moves away from the original base station and comes closer to another, the exchange must request a switch-over to the more favourable station. This must occur without interrupting or cancelling the call. Switching a call in progress from one base station to another is called *Handoff* or *Handover.* Before transferring the communication line to a new base station, the exchange makes sure that this is really the station that will provide the best conditions for transmission and reception.

To enable the exchange to supervise transmission as indicated above, there is a continuous flow of data between the mobile telephones and the exchange via the base stations. This information, which cannot be heard in the telephone, concerns channel selection, transmission power, identification of sender and receiver, start and termination of call, and so on. The information enables the exchange that holds the subscriber registered to follow the movements of the mobile telephone. Should the subscriber's unit come into the control area of a different exchange, this exchange will immediately report the new location to the home exchange.

When a mobile telephone approaches the limit of the system's coverage, or when neighbouring base stations cannot offer a free channel, conversation shall continue on the active channel until reception quality gets below a specified level.

The channels of the system are automatically scanned and analyzed with regard to channel number, voice channel, control channel and service area. Normally, the mobile telephone is locked on a control channel in the service area where it is located. If the telephone becomes unlocked, it will immediately start scanning for another control channel .

Each base station sends a *search signal* over the *control channel*. When a call is made to a mobile telephone, the setup information will be transmitted over this control channel. Once the mobile telephone has responded to the call, the base station searches for a free voice channel and orders the mobile to switch to the chosen voice channel, after which the mobile subscriber will hear a ringing signal on the mobile telephone. The entire conversation between the two subscribers takes place over the voice channel selected by the base station. If a zone boundary is passed during the call, the channel will be switched over automatically to the new base station and the call will continue without any disturbance.

If the mobile telephone makes a call, a call request will be sent to the area base station, which will select a voice channel and direct the mobile to the selected channel. As in the previous case, the call will be transmitted over the selected voice channel, until a zone boundary is passed.

The mobile telephone uses the *control channel* for different purposes, namely to report to the system when it passes from one service area into another. One of the purposes is for page response, which is an answer to a cell access from a mobile station , that is a call from the mobile phone or an order confirmation. When messages are sent to all mobile phones being tuned to a control channel, this is called *overhead message.* The system parameters are transmitted during this message and contain for instance the following information about the cellular system:

- AID (Area Identity) indicates system A or B, system identity number, MSC service area and location area.
- DCC (Digital Colour Code) identifies which group of cells the message belongs to.

Quality Control

Each time a connection is established, the exchange automatically measures the field intensity of the mobile telephone. During conversation, the signal-to-noise ratio is continuously measured by a monitoring signal, SAT (Supervisory Audio Tone), sent out by the base station and returned by the mobile telephone. If the base station finds that the signal strength is below a certain value, it alerts the exchange. The exchange now requests neighbouring base stations to transmit their monitoring signals and measure the signal strength. The exchange then decides which base station provides the best conditions, and orders the mobile telephone to switch to a channel of this base station instead. The mobile sends a signalling tone (ST) as response or synchronization to the base station, for instance during call setup and during handoff.

Data Transmission

Many types of signalling are used between the different parts of the ETACS system. The signalling has the following main objectives:

- **MSC - MT**
  - setting up and clearing of calls
  - switching of call in progress
  - updating
  - ordering of power reduction
- **MSC - BS**
  - remote control of base station
  - transmission of alarm
- **MSC - MSC**
  - updating of subscriber register and roaming register
  - transfer of call to roaming subscriber
- **MSC - PSTN**
  - setting up of calls
- **BS - MT**
  - supervision of transmission quality

The messages and orders between the different units are sent in the form of so-called words. All words have the same length. Each word is divided into a number of fields, each of which contains a given type of information. The mobile telephone has a systems section where the frames are coded and decoded. The transmission is performed by means of FSK (*Frequency Shift Key*) modulation, where a logic *1* is represented by a constant frequency above the carrier frequency of the transmitter. A logic *0* is represented by a constant frequency below the carrier frequency. The speed of transmission is 8 kbits/s.

Frequency Tables

A mobile telephone for the ETACS system operates in full duplex and provides 1320 channels with a channel spacing of 25kHz (0.025MHz) and a duplex separation of 45MHz.
The 900MHz band has been divided into an upper and a lowerband. The lower sub-band, 872.0125 - 904.9875MHz, covers the 1320 transmitting channels in the hand-held telephone, while the upper sub-band, 917.0125 - 949.9875MHz, covers the corresponding 1320 receiving channels.
The channels are numbered from 1329 to 2047 and from 0 to 600.

The following formulas can be used to calculate the frequencies (f,MHz) associated with a certain channel number (N = channel number).

Frequencies, channels 1329 - 2047 (see table 1):

f_{Tx} = 872.0125 + (N-1329) x 0.025 MHz
f_{Rx} = 917.0125 + (N-1329) x 0.025 MHz

Frequencies, channels 0 - 600 (see table 2):

f_{Tx} = 889.9875 + N x 0.025 MHz
f_{Rx} = 934.9875 + N x 0.025 MHz

Table 1: Channels 1329 - 2047

Channels 1329 - 1478

Ch.	Tx	Rx	Ch.	Tx	Rx	Ch.	Tx	Rx
1329	872.0125	917.0125	**1379**	873.2625	918.2625	**1429**	874.5125	919.5125
1330	872.0375	917.0375	**1380**	873.2875	918.2875	**1430**	874.5375	919.5375
1331	872.0625	917.0625	**1381**	873.3125	918.3125	**1431**	874.5625	919.5625
1332	872.0875	917.0875	**1382**	873.3375	918.3375	**1432**	874.5875	919.5875
1333	872.1125	917.1125	**1383**	873.3625	918.3625	**1433**	874.6125	919.6125
1334	872.1375	917.1375	**1384**	873.3875	918.3875	**1434**	874.6375	919.6375
1335	872.1625	917.1625	**1385**	873.4125	918.4125	**1435**	874.6625	919.6625
1336	872.1875	917.1875	**1386**	873.4375	918.4375	**1436**	874.6875	919.6875
1337	872.2125	917.2125	**1387**	873.4625	918.4625	**1437**	874.7125	919.7125
1338	872.2375	917.2375	**1388**	873.4875	918.4875	**1438**	874.7375	919.7375
1339	872.2625	917.2625	**1389**	873.5125	918.5125	**1439**	874.7625	919.7625
1340	872.2875	917.2875	**1390**	873.5375	918.5375	**1440**	874.7875	919.7875
1341	872.3125	917.3125	**1391**	873.5625	918.5625	**1441**	874.8125	919.8125
1342	872.3375	917.3375	**1392**	873.5875	918.5875	**1442**	874.8375	919.8375
1343	872.3625	917.3625	**1393**	873.6125	918.6125	**1443**	874.8625	919.8625
1344	872.3875	917.3875	**1394**	873.6375	918.6375	**1444**	874.8875	919.8875
1345	872.4125	917.4125	**1395**	873.6625	918.6625	**1445**	874.9125	919.9125
1346	872.4375	917.4375	**1396**	873.6875	918.6875	**1446**	874.9375	919.9375
1347	872.4625	917.4625	**1397**	873.7125	918.7125	**1447**	874.9625	919.9625
1348	872.4875	917.4875	**1398**	873.7375	918.7375	**1448**	874.9875	919.9875
1349	872.5125	917.5125	**1399**	873.7625	918.7625	**1449**	875.0125	920.0125
1350	872.5375	917.5375	**1400**	873.7875	918.7875	**1450**	875.0375	920.0375
1351	872.5625	917.5625	**1401**	873.8125	918.8125	**1451**	875.0625	920.0625
1352	872.5875	917.5875	**1402**	873.8375	918.8375	**1452**	875.0875	920.0875
1353	872.6125	917.6125	**1403**	873.8625	918.8625	**1453**	875.1125	920.1125
1354	872.6375	917.6375	**1404**	873.8875	918.8875	**1454**	875.1375	920.1375
1355	872.6625	917.6625	**1405**	873.9125	918.9125	**1455**	875.1625	920.1625
1356	872.6875	917.6875	**1406**	873.9375	918.9375	**1456**	875.1875	920.1875
1357	872.7125	917.7125	**1407**	873.9625	918.9625	**1457**	875.2125	920.2125
1358	872.7375	917.7375	**1408**	873.9875	918.9875	**1458**	875.2375	920.2375
1359	872.7625	917.7625	**1409**	874.0125	919.0125	**1459**	875.2625	920.2625
1360	872.7875	917.7875	**1410**	874.0375	919.0375	**1460**	875.2875	920.2875
1361	872.8125	917.8125	**1411**	874.0625	919.0625	**1461**	875.3125	920.3125
1362	872.8375	917.8375	**1412**	874.0875	919.0875	**1462**	875.3375	920.3375
1363	872.8625	917.8625	**1413**	874.1125	919.1125	**1463**	875.3625	920.3625
1364	872.8875	917.8875	**1414**	874.1375	919.1375	**1464**	875.3875	920.3875
1365	872.9125	917.9125	**1415**	874.1625	919.1625	**1465**	875.4125	920.4125
1366	872.9375	917.9375	**1416**	874.1875	919.1875	**1466**	875.4375	920.4375
1367	872.9625	917.9625	**1417**	874.2125	919.2125	**1467**	875.4625	920.4625
1368	872.9875	917.9875	**1418**	874.2375	919.2375	**1468**	875.4875	920.4875
1369	873.0125	918.0125	**1419**	874.2625	919.2625	**1469**	875.5125	920.5125
1370	873.0375	918.0375	**1420**	874.2875	919.2875	**1470**	875.5375	920.5375
1371	873.0625	918.0625	**1421**	874.3125	919.3125	**1471**	875.5625	920.5625
1372	873.0875	918.0875	**1422**	874.3375	919.3375	**1472**	875.5875	920.5875
1373	873.1125	918.1125	**1423**	874.3625	919.3625	**1473**	875.6125	920.6125
1374	873.1375	918.1375	**1424**	874.3875	919.3875	**1474**	875.6375	920.6375
1375	873.1625	918.1625	**1425**	874.4125	919.4125	**1475**	875.6625	920.6625
1376	873.1875	918.1875	**1426**	874.4375	919.4375	**1476**	875.6875	920.6875
1377	873.2125	918.2125	**1427**	874.4625	919.4625	**1477**	875.7125	920.7125
1378	873.2375	918.2375	**1428**	874.4875	919.4875	**1478**	875.7375	920.7375

Channels 1479 - 1628

Ch.	Tx	Rx	Ch.	Tx	Rx	Ch.	Tx	Rx
1479	875.7625	920.7625	**1529**	877.0125	922.0125	**1579**	878.2625	923.2625
1480	875.7875	920.7875	**1530**	877.0375	922.0375	**1580**	878.2875	923.2875
1481	875.8125	920.8125	**1531**	877.0625	922.0625	**1581**	878.3125	923.3125
1482	875.8375	920.8375	**1532**	877.0875	922.0875	**1582**	878.3375	923.3375
1483	875.8625	920.8625	**1533**	877.1125	922.1125	**1583**	878.3625	923.3625
1484	875.8875	920.8875	**1534**	877.1375	922.1375	**1584**	878.3875	923.3875
1485	875.9125	920.9125	**1535**	877.1625	922.1625	**1585**	878.4125	923.4125
1486	875.9375	920.9375	**1536**	877.1875	922.1875	**1586**	878.4375	923.4375
1487	875.9625	920.9625	**1537**	877.2125	922.2125	**1587**	878.4625	923.4625
1488	875.9875	920.9875	**1538**	877.2375	922.2375	**1588**	878.4875	923.4875
1489	876.0125	921.0125	**1539**	877.2625	922.2625	**1589**	878.5125	923.5125
1490	876.0375	921.0375	**1540**	877.2875	922.2875	**1590**	878.5375	923.5375
1491	876.0625	921.0625	**1541**	877.3125	922.3125	**1591**	878.5625	923.5625
1492	876.0875	921.0875	**1542**	877.3375	922.3375	**1592**	878.5875	923.5875
1493	876.1125	921.1125	**1543**	877.3625	922.3625	**1593**	878.6125	923.6125
1494	876.1375	921.1375	**1544**	877.3875	922.3875	**1594**	878.6375	923.6375
1495	876.1625	921.1625	**1545**	877.4125	922.4125	**1595**	878.6625	923.6625
1496	876.1875	921.1875	**1546**	877.4375	922.4375	**1596**	878.6875	923.6875
1497	876.2125	921.2125	**1547**	877.4625	922.4625	**1597**	878.7125	923.7125
1498	876.2375	921.2375	**1548**	877.4875	922.4875	**1598**	878.7375	923.7375
1499	876.2625	921.2625	**1549**	877.5125	922.5125	**1599**	878.7625	923.7625
1500	876.2875	921.2875	**1550**	877.5375	922.5375	**1600**	878.7875	923.7875
1501	876.3125	921.3125	**1551**	877.5625	922.5625	**1601**	878.8125	923.8125
1502	876.3375	921.3375	**1552**	877.5875	922.5875	**1602**	878.8375	923.8375
1503	876.3625	921.3625	**1553**	877.6125	922.6125	**1603**	878.8625	923.8625
1504	876.3875	921.3875	**1554**	877.6375	922.6375	**1604**	878.8875	923.8875
1505	876.4125	921.4125	**1555**	877.6625	922.6625	**1605**	878.9125	923.9125
1506	876.4375	921.4375	**1556**	877.6875	922.6875	**1606**	878.9375	923.9375
1507	876.4625	921.4625	**1557**	877.7125	922.7125	**1607**	878.9625	923.9625
1508	876.4875	921.4875	**1558**	877.7375	922.7375	**1608**	878.9875	923.9875
1509	876.5125	921.5125	**1559**	877.7625	922.7625	**1609**	879.0125	924.0125
1510	876.5375	921.5375	**1560**	877.7875	922.7875	**1610**	879.0375	924.0375
1511	876.5625	921.5625	**1561**	877.8125	922.8125	**1611**	879.0625	924.0625
1512	876.5875	921.5875	**1562**	877.8375	922.8375	**1612**	879.0875	924.0875
1513	876.6125	921.6125	**1563**	877.8625	922.8625	**1613**	879.1125	924.1125
1514	876.6375	921.6375	**1564**	877.8875	922.8875	**1614**	879.1375	924.1375
1515	876.6625	921.6625	**1565**	877.9125	922.9125	**1615**	879.1625	924.1625
1516	876.6875	921.6875	**1566**	877.9375	922.9375	**1616**	879.1875	924.1875
1517	876.7125	921.7125	**1567**	877.9625	922.9625	**1617**	879.2125	924.2125
1518	876.7375	921.7375	**1568**	877.9875	922.9875	**1618**	879.2375	924.2375
1519	876.7625	921.7625	**1569**	878.0125	923.0125	**1619**	879.2625	924.2625
1520	876.7875	921.7875	**1570**	878.0375	923.0375	**1620**	879.2875	924.2875
1521	876.8125	921.8125	**1571**	878.0625	923.0625	**1621**	879.3125	924.3125
1522	876.8375	921.8375	**1572**	878.0875	923.0875	**1622**	879.3375	924.3375
1523	876.8625	921.8625	**1573**	878.1125	923.1125	**1623**	879.3625	924.3625
1524	876.8875	921.8875	**1574**	878.1375	923.1375	**1624**	879.3875	924.3875
1525	876.9125	921.9125	**1575**	878.1625	923.1625	**1625**	879.4125	924.4125
1526	876.9375	921.9375	**1576**	878.1875	923.1875	**1626**	879.4375	924.4375
1527	876.9625	921.9625	**1577**	878.2125	923.2125	**1627**	879.4625	924.4625
1528	876.9875	921.9875	**1578**	878.2375	923.2375	**1628**	879.4875	924.4875

Channels 1629 - 1778

Ch.	Tx	Rx	Ch.	Tx	Rx	Ch.	Tx	Rx
1629	879.5125	924.5125	**1679**	880.7625	925.7625	**1729**	882.0125	927.0125
1630	879.5375	924.5375	**1680**	880.7875	925.7875	**1730**	882.0375	927.0375
1631	879.5625	924.5625	**1681**	880.8125	925.8125	**1731**	882.0625	927.0625
1632	879.5875	924.5875	**1682**	880.8375	925.8375	**1732**	882.0875	927.0875
1633	879.6125	924.6125	**1683**	880.8625	925.8625	**1733**	882.1125	927.1125
1634	879.6375	924.6375	**1684**	880.8875	925.8875	**1734**	882.1375	927.1375
1635	879.6625	924.6625	**1685**	880.9125	925.9125	**1735**	882.1625	927.1625
1636	879.6875	924.6875	**1686**	880.9375	925.9375	**1736**	882.1875	927.1875
1637	879.7125	924.7125	**1687**	880.9625	925.9625	**1737**	882.2125	927.2125
1638	879.7375	924.7375	**1688**	880.9875	925.9875	**1738**	882.2375	927.2375
1639	879.7625	924.7625	**1689**	881.0125	926.0125	**1739**	882.2625	927.2625
1640	879.7875	924.7875	**1690**	881.0375	926.0375	**1740**	882.2875	927.2875
1641	879.8125	924.8125	**1691**	881.0625	926.0625	**1741**	882.3125	927.3125
1642	879.8375	924.8375	**1692**	881.0875	926.0875	**1742**	882.3375	927.3375
1643	879.8625	924.8625	**1693**	881.1125	926.1125	**1744**	882.3875	927.3875
1645	879.9125	924.9125	**1695**	881.1625	926.1625	**1745**	882.4125	927.4125
1646	879.9375	924.9375	**1696**	881.1875	926.1875	**1746**	882.4375	927.4375
1647	879.9625	924.9625	**1697**	881.2125	926.2125	**1747**	882.4625	927.4625
1648	879.9875	924.9875	**1698**	881.2375	926.2375	**1748**	882.4875	927.4875
1649	880.0125	925.0125	**1699**	881.2625	926.2625	**1749**	882.5125	927.5125
1650	880.0375	925.0375	**1700**	881.2875	926.2875	**1750**	882.5375	927.5375
1651	880.0625	925.0625	**1701**	881.3125	926.3125	**1751**	882.5625	927.5625
1652	880.0875	925.0875	**1702**	881.3375	926.3375	**1752**	882.5875	927.5875
1653	880.1125	925.1125	**1703**	881.3625	926.3625	**1753**	882.6125	927.6125
1654	880.1375	925.1375	**1704**	881.3875	926.3875	**1754**	882.6375	927.6375
1655	880.1625	925.1625	**1705**	881.4125	926.4125	**1755**	882.6625	927.6625
1656	880.1875	925.1875	**1706**	881.4375	926.4375	**1756**	882.6875	927.6875
1657	880.2125	925.2125	**1707**	881.4625	926.4625	**1757**	882.7125	927.7125
1658	880.2375	925.2375	**1708**	881.4875	926.4875	**1758**	882.7375	927.7375
1659	880.2625	925.2625	**1709**	881.5125	926.5125	**1759**	882.7625	927.7625
1660	880.2875	925.2875	**1710**	881.5375	926.5375	**1760**	882.7875	927.7875
1661	880.3125	925.3125	**1711**	881.5625	926.5625	**1761**	882.8125	927.8125
1662	880.3375	925.3375	**1712**	881.5875	926.5875	**1762**	882.8375	927.8375
1663	880.3625	925.3625	**1713**	881.6125	926.6125	**1763**	882.8625	927.8625
1664	880.3875	925.3875	**1714**	881.6375	926.6375	**1764**	882.8875	927.8875
1665	880.4125	925.4125	**1715**	881.6625	926.6625	**1765**	882.9125	927.9125
1666	880.4375	925.4375	**1716**	881.6875	926.6875	**1766**	882.9375	927.9375
1667	880.4625	925.4625	**1717**	881.7125	926.7125	**1767**	882.9625	927.9625
1668	880.4875	925.4875	**1718**	881.7375	926.7375	**1768**	882.9875	927.9875
1669	880.5125	925.5125	**1719**	881.7625	926.7625	**1769**	883.0125	928.0125
1670	880.5375	925.5375	**1720**	881.7875	926.7875	**1770**	883.0375	928.0375
1671	880.5625	925.5625	**1721**	881.8125	926.8125	**1771**	883.0625	928.0625
1672	880.5875	925.5875	**1722**	881.8375	926.8375	**1772**	883.0875	928.0875
1673	880.6125	925.6125	**1723**	881.8625	926.8625	**1773**	883.1125	928.1125
1674	880.6375	925.6375	**1724**	881.8875	926.8875	**1774**	883.1375	928.1375
1675	880.6625	925.6625	**1725**	881.9125	926.9125	**1775**	883.1625	928.1625
1676	880.6875	925.6875	**1726**	881.9375	926.9375	**1776**	883.1875	928.1875
1677	880.7125	925.7125	**1727**	881.9625	926.9625	**1777**	883.2125	928.2125
1678	880.7375	925.7375	**1728**	881.9875	926.9875	**1778**	883.2375	928.2375

Channels 1779 - 1928

Ch.	Tx	Rx	Ch.	Tx	Rx	Ch.	Tx	Rx
1779	883.2625	928.2625	**1829**	884.5125	929.5125	**1879**	885.7625	930.7625
1780	883.2875	928.2875	**1830**	884.5375	929.5375	**1880**	885.7875	930.7875
1781	883.3125	928.3125	**1831**	884.5625	929.5625	**1881**	885.8125	930.8125
1782	883.3375	928.3375	**1832**	884.5875	929.5875	**1882**	885.8375	930.8375
1783	883.3625	928.3625	**1833**	884.6125	929.6125	**1883**	885.8625	930.8625
1784	883.3875	928.3875	**1834**	884.6375	929.6375	**1884**	885.8875	930.8875
1785	883.4125	928.4125	**1835**	884.6625	929.6625	**1885**	885.9125	930.9125
1786	883.4375	928.4375	**1836**	884.6875	929.6875	**1886**	885.9375	930.9375
1787	883.4625	928.4625	**1837**	884.7125	929.7125	**1887**	885.9625	930.9625
1788	883.4875	928.4875	**1838**	884.7375	929.7375	**1888**	885.9875	930.9875
1789	883.5125	928.5125	**1839**	884.7625	929.7625	**1889**	886.0125	931.0125
1790	883.5375	928.5375	**1840**	884.7875	929.7875	**1890**	886.0375	931.0375
1791	883.5625	928.5625	**1841**	884.8125	929.8125	**1891**	886.0625	931.0625
1792	883.5875	928.5875	**1842**	884.8375	929.8375	**1892**	886.0875	931.0875
1793	883.6125	928.6125	**1843**	884.8625	929.8625	**1893**	886.1125	931.1125
1794	883.6375	928.6375	**1844**	884.8875	929.8875	**1894**	886.1375	931.1375
1795	883.6625	928.6625	**1845**	884.9125	929.9125	**1895**	886.1625	931.1625
1796	883.6875	928.6875	**1846**	884.9375	929.9375	**1896**	886.1875	931.1875
1797	883.7125	928.7125	**1847**	884.9625	929.9625	**1897**	886.2125	931.2125
1798	883.7375	928.7375	**1848**	884.9875	929.9875	**1898**	886.2375	931.2375
1799	883.7625	928.7625	**1849**	885.0125	930.0125	**1899**	886.2625	931.2625
1800	883.7875	928.7875	**1850**	885.0375	930.0375	**1900**	886.2875	931.2875
1801	883.8125	928.8125	**1851**	885.0625	930.0625	**1901**	886.3125	931.3125
1802	883.8375	928.8375	**1852**	885.0875	930.0875	**1902**	886.3375	931.3375
1803	883.8625	928.8625	**1853**	885.1125	930.1125	**1903**	886.3625	931.3625
1804	883.8875	928.8875	**1854**	885.1375	930.1375	**1904**	886.3875	931.3875
1805	883.9125	928.9125	**1855**	885.1625	930.1625	**1905**	886.4125	931.4125
1806	883.9375	928.9375	**1856**	885.1875	930.1875	**1906**	886.4375	931.4375
1807	883.9625	928.9625	**1857**	885.2125	930.2125	**1907**	886.4625	931.4625
1808	883.9875	928.9875	**1858**	885.2375	930.2375	**1908**	886.4875	931.4875
1809	884.0125	929.0125	**1859**	885.2625	930.2625	**1909**	886.5125	931.5125
1810	884.0375	929.0375	**1860**	885.2875	930.2875	**1910**	886.5375	931.5375
1811	884.0625	929.0625	**1861**	885.3125	930.3125	**1911**	886.5625	931.5625
1812	884.0875	929.0875	**1862**	885.3375	930.3375	**1912**	886.5875	931.5875
1813	884.1125	929.1125	**1863**	885.3625	930.3625	**1913**	886.6125	931.6125
1814	884.1375	929.1375	**1864**	885.3875	930.3875	**1914**	886.6375	931.6375
1815	884.1625	929.1625	**1865**	885.4125	930.4125	**1915**	886.6625	931.6625
1816	884.1875	929.1875	**1866**	885.4375	930.4375	**1916**	886.6875	931.6875
1817	884.2125	929.2125	**1867**	885.4625	930.4625	**1917**	886.7125	931.7125
1818	884.2375	929.2375	**1868**	885.4875	930.4875	**1918**	886.7375	931.7375
1819	884.2625	929.2625	**1869**	885.5125	930.5125	**1919**	886.7625	931.7625
1820	884.2875	929.2875	**1870**	885.5375	930.5375	**1920**	886.7875	931.7875
1821	884.3125	929.3125	**1871**	885.5625	930.5625	**1921**	886.8125	931.8125
1822	884.3375	929.3375	**1872**	885.5875	930.5875	**1922**	886.8375	931.8375
1823	884.3625	929.3625	**1873**	885.6125	930.6125	**1923**	886.8625	931.8625
1824	884.3875	929.3875	**1874**	885.6375	930.6375	**1924**	886.8875	931.8875
1825	884.4125	929.4125	**1875**	885.6625	930.6625	**1925**	886.9125	931.9125
1826	884.4375	929.4375	**1876**	885.6875	930.6875	**1926**	886.9375	931.9375
1827	884.4625	929.4625	**1877**	885.7125	930.7125	**1927**	886.9625	931.9625
1828	884.4875	929.4875	**1878**	885.7375	930.7375	**1928**	886.9875	931.9875

Channels 1929 - 2047

Ch.	Tx	Rx	Ch.	Tx	Rx	Ch.	Tx	Rx
1929	887.0125	932.0125	**1979**	888.2625	933.2625	**2029**	889.5125	934.5125
1930	887.0375	932.0375	**1980**	888.2875	933.2875	**2030**	889.5375	934.5375
1931	887.0625	932.0625	**1981**	888.3125	933.3125	**2031**	889.5625	934.5625
1932	887.0875	932.0875	**1982**	888.3375	933.3375	**2032**	889.5875	934.5875
1933	887.1125	932.1125	**1983**	888.3625	933.3625	**2033**	889.6125	934.6125
1934	887.1375	932.1375	**1984**	888.3875	933.3875	**2034**	889.6375	934.6375
1935	887.1625	932.1625	**1985**	888.4125	933.4125	**2035**	889.6625	934.6625
1936	887.1875	932.1875	**1986**	888.4375	933.4375	**2036**	889.6875	934.6875
1937	887.2125	932.2125	**1987**	888.4625	933.4625	**2037**	889.7125	934.7125
1938	887.2375	932.2375	**1988**	888.4875	933.4875	**2038**	889.7375	934.7375
1939	887.2625	932.2625	**1989**	888.5125	933.5125	**2039**	889.7625	934.7625
1940	887.2875	932.2875	**1990**	888.5375	933.5375	**2040**	889.7875	934.7875
1941	887.3125	932.3125	**1991**	888.5625	933.5625	**2041**	889.8125	934.8125
1942	887.3375	932.3375	**1992**	888.5875	933.5875	**2042**	889.8375	934.8375
1943	887.3625	932.3625	**1993**	888.6125	933.6125	**2043**	889.8625	934.8625
1944	887.3875	932.3875	**1994**	888.6375	933.6375	**2044**	889.8875	934.8875
1945	887.4125	932.4125	**1995**	888.6625	933.6625	**2045**	889.9125	934.9125
1946	887.4375	932.4375	**1996**	888.6875	933.6875	**2046**	889.9375	934.9375
1947	887.4625	932.4625	**1997**	888.7125	933.7125	**2047**	889.9625	934.9625
1948	887.4875	932.4875	**1998**	888.7375	933.7375			
1949	887.5125	932.5125	**1999**	888.7625	933.7625			
1950	887.5375	932.5375	**2000**	888.7875	933.7875			
1951	887.5625	932.5625	**2001**	888.8125	933.8125			
1952	887.5875	932.5875	**2002**	888.8375	933.8375			
1953	887.6125	932.6125	**2003**	888.8625	933.8625			
1954	887.6375	932.6375	**2004**	888.8875	933.8875			
1955	887.6625	932.6625	**2005**	888.9125	933.9125			
1956	887.6875	932.6875	**2006**	888.9375	933.9375			
1957	887.7125	932.7125	**2007**	888.9625	933.9625			
1958	887.7375	932.7375	**2008**	888.9875	933.9875			
1959	887.7625	932.7625	**2009**	889.0125	934.0125			
1960	887.7875	932.7875	**2010**	889.0375	934.0375			
1961	887.8125	932.8125	**2011**	889.0625	934.0625			
1962	887.8375	932.8375	**2012**	889.0875	934.0875			
1963	887.8625	932.8625	**2013**	889.1125	934.1125			
1964	887.8875	932.8875	**2014**	889.1375	934.1375			
1965	887.9125	932.9125	**2015**	889.1625	934.1625			
1966	887.9375	932.9375	**2016**	889.1875	934.1875			
1967	887.9625	932.9625	**2017**	889.2125	934.2125			
1968	887.9875	932.9875	**2018**	889.2375	934.2375			
1969	888.0125	933.0125	**2019**	889.2625	934.2625			
1970	888.0375	933.0375	**2020**	889.2875	934.2875			
197	888.0625	933.0625	**2021**	889.3125	934.3125			
1972	888.0875	933.0875	**2022**	889.3375	934.3375			
1973	888.1125	933.1125	**2023**	889.3625	934.3625			
1974	888.1375	933.1375	**2024**	889.3875	934.3875			
1975	888.1625	933.1625	**2025**	889.4125	934.4125			
1976	888.1875	933.1875	**2026**	889.4375	934.4375			
1977	888.2125	933.2125	**2027**	889.4625	934.4625			
1978	888.2375	933.2375	**2028**	889.4875	934.4875			

Table 2: Channels 0 - 600

Channels 0 - 149

Ch.	Tx	Rx	Ch.	Tx	Rx	Ch.	Tx	Rx
0	889.9875	934.9875	**50**	891.2375	936.2375	**100**	892.4875	937.4875
1	890.0125	935.0125	**51**	891.2625	936.2625	**101**	892.5125	937.5125
2	890.0375	935.0375	**52**	891.2875	936.2875	**102**	892.5375	937.5375
3	890.0625	935.0625	**53**	891.3125	936.3125	**103**	892.5625	937.5625
4	890.0875	935.0875	**54**	891.3375	936.3375	**104**	892.5875	937.5875
5	890.1125	935.1125	**55**	891.3625	936.3625	**105**	892.6125	937.6125
6	890.1375	935.1375	**56**	891.3875	936.3875	**106**	892.6375	937.6375
7	890.1625	935.1625	**57**	891.4125	936.4125	**107**	892.6625	937.6625
8	890.1875	935.1875	**58**	891.4375	936.4375	**108**	892.6875	937.6875
9	890.2125	935.2125	**59**	891.4625	936.4625	**109**	892.7125	937.7125
10	890.2375	935.2375	**60**	891.4875	936.4875	**110**	892.7375	937.7375
11	890.2625	935.2625	**61**	891.5125	936.5125	**111**	892.7625	937.7625
12	890.2875	935.2875	**62**	891.5375	936.5375	**112**	892.7875	937.7875
13	890.3125	935.3125	**63**	891.5625	936.5625	**113**	892.8125	937.8125
14	890.3375	935.3375	**64**	891.5875	936.5875	**114**	892.8375	937.8375
15	890.3625	935.3625	**65**	891.6125	936.6125	**115**	892.8625	937.8625
16	890.3875	935.3875	**66**	891.6375	936.6375	**116**	892.8875	937.8875
17	890.4125	935.4125	**67**	891.6625	936.6625	**117**	892.9125	937.9125
18	890.4375	935.4375	**68**	891.6875	936.6875	**118**	892.9375	937.9375
19	890.4625	935.4625	**69**	891.7125	936.7125	**119**	892.9625	937.9625
20	890.4875	935.4875	**70**	891.7375	936.7375	**120**	892.9875	937.9875
21	890.5125	935.5125	**71**	891.7625	936.7625	**121**	893.0125	938.0125
22	890.5375	935.5375	**72**	891.7875	936.7875	**122**	893.0375	938.0375
23	890.5625	935.5625	**73**	891.8125	936.8125	**123**	893.0625	938.0625
24	890.5875	935.5875	**74**	891.8375	936.8375	**124**	893.0875	938.0875
25	890.6125	935.6125	**75**	891.8625	936.8625	**125**	893.1125	938.1125
26	890.6375	935.6375	**76**	891.8875	936.8875	**126**	893.1375	938.1375
27	890.6625	935.6625	**77**	891.9125	936.9125	**127**	893.1625	938.1625
28	890.6875	935.6875	**78**	891.9375	936.9375	**128**	893.1875	938.1875
29	890.7125	935.7125	**79**	891.9625	936.9625	**129**	893.2125	938.2125
30	890.7375	935.7375	**80**	891.9875	936.9875	**130**	893.2375	938.2375
31	890.7625	935.7625	**81**	892.0125	937.0125	**131**	893.2625	938.2625
32	890.7875	935.7875	**82**	892.0375	937.0375	**132**	893.2875	938.2875
33	890.8125	935.8125	**83**	892.0625	937.0625	**133**	893.3125	938.3125
34	890.8375	935.8375	**84**	892.0875	937.0875	**134**	893.3375	938.3375
35	890.8625	935.8625	**85**	892.1125	937.1125	**135**	893.3625	938.3625
36	890.8875	935.8875	**86**	892.1375	937.1375	**136**	893.3875	938.3875
37	890.9125	935.9125	**87**	892.1625	937.1625	**137**	893.4125	938.4125
38	890.9375	935.9375	**88**	892.1875	937.1875	**138**	893.4375	938.4375
39	890.9625	935.9625	**89**	892.2125	937.2125	**139**	893.4625	938.4625
40	890.9875	935.9875	**90**	892.2375	937.2375	**140**	893.4875	938.4875
41	891.0125	936.0125	**91**	892.2625	937.2625	**141**	893.5125	938.5125
42	891.0375	936.0375	**92**	892.2875	937.2875	**142**	893.5375	938.5375
43	891.0625	936.0625	**93**	892.3125	937.3125	**143**	893.5625	938.5625
44	891.0875	936.0875	**94**	892.3375	937.3375	**144**	893.5875	938.5875
45	891.1125	936.1125	**95**	892.3625	937.3625	**145**	893.6125	938.6125
46	891.1375	936.1375	**96**	892.3875	937.3875	**146**	893.6375	938.6375
47	891.1625	936.1625	**97**	892.4125	937.4125	**147**	893.6625	938.6625
48	891.1875	936.1875	**98**	892.4375	937.4375	**148**	893.6875	938.6875
49	891.2125	936.2125	**99**	892.4625	937.4625	**149**	893.7125	938.7125

Channels 150 - 299

Ch.	Tx	Rx	Ch.	Tx	Rx	Ch.	Tx	Rx
150	893.7375	938.7375	**200**	894.9875	939.9875	**250**	896.2375	941.2375
151	893.7625	938.7625	**201**	895.0125	940.0125	**251**	896.2625	941.2625
152	893.7875	938.7875	**202**	895.0375	940.0375	**252**	896.2875	941.2875
153	893.8125	938.8125	**203**	895.0625	940.0625	**253**	896.3125	941.3125
154	893.8375	938.8375	**204**	895.0875	940.0875	**254**	896.3375	941.3375
155	893.8625	938.8625	**205**	895.1125	940.1125	**255**	896.3625	941.3625
156	893.8875	938.8875	**206**	895.1375	940.1375	**256**	896.3875	941.3875
157	893.9125	938.9125	**207**	895.1625	940.1625	**257**	896.4125	941.4125
158	893.9375	938.9375	**208**	895.1875	940.1875	**258**	896.4375	941.4375
159	893.9625	938.9625	**209**	895.2125	940.2125	**259**	896.4625	941.4625
160	893.9875	938.9875	**210**	895.2375	940.2375	**260**	896.4875	941.4875
161	894.0125	939.0125	**211**	895.2625	940.2625	**261**	896.5125	941.5125
162	894.0375	939.0375	**212**	895.2875	940.2875	**262**	896.5375	941.5375
163	894.0625	939.0625	**213**	895.3125	940.3125	**263**	896.5625	941.5625
164	894.0875	939.0875	**214**	895.3375	940.3375	**264**	896.5875	941.5875
165	894.1125	939.1125	**215**	895.3625	940.3625	**265**	896.6125	941.6125
166	894.1375	939.1375	**216**	895.3875	940.3875	**266**	896.6375	941.6375
167	894.1625	939.1625	**217**	895.4125	940.4125	**267**	896.6625	941.6625
168	894.1875	939.1875	**218**	895.4375	940.4375	**268**	896.6875	941.6875
169	894.2125	939.2125	**219**	895.4625	940.4625	**269**	896.7125	941.7125
170	894.2375	939.2375	**220**	895.4875	940.4875	**270**	896.7375	941.7375
171	894.2625	939.2625	**221**	895.5125	940.5125	**271**	896.7625	941.7625
172	894.2875	939.2875	**222**	895.5375	940.5375	**272**	896.7875	941.7875
173	894.3125	939.3125	**223**	895.5625	940.5625	**273**	896.8125	941.8125
174	894.3375	939.3375	**224**	895.5875	940.5875	**274**	896.8375	941.8375
175	894.3625	939.3625	**225**	895.6125	940.6125	**275**	896.8625	941.8625
176	894.3875	939.3875	**226**	895.6375	940.6375	**276**	896.8875	941.8875
177	894.4125	939.4125	**227**	895.6625	940.6625	**277**	896.9125	941.9125
178	894.4375	939.4375	**228**	895.6875	940.6875	**278**	896.9375	941.9375
179	894.4625	939.4625	**229**	895.7125	940.7125	**279**	896.9625	941.9625
180	894.4875	939.4875	**230**	895.7375	940.7375	**280**	896.9875	941.9875
181	894.5125	939.5125	**231**	895.7625	940.7625	**281**	897.0125	942.0125
182	894.5375	939.5375	**232**	895.7875	940.7875	**282**	897.0375	942.0375
183	894.5625	939.5625	**233**	895.8125	940.8125	**283**	897.0625	942.0625
184	894.5875	939.5875	**234**	895.8375	940.8375	**284**	897.0875	942.0875
185	894.6125	939.6125	**235**	895.8625	940.8625	**285**	897.1125	942.1125
186	894.6375	939.6375	**236**	895.8875	940.8875	**286**	897.1375	942.1375
187	894.6625	939.6625	**237**	895.9125	940.9125	**287**	897.1625	942.1625
188	894.6875	939.6875	**238**	895.9375	940.9375	**288**	897.1875	942.1875
189	894.7125	939.7125	**239**	895.9625	940.9625	**289**	897.2125	942.2125
190	894.7375	939.7375	**240**	895.9875	940.9875	**290**	897.2375	942.2375
191	894.7625	939.7625	**241**	896.0125	941.0125	**291**	897.2625	942.2625
192	894.7875	939.7875	**242**	896.0375	941.0375	**292**	897.2875	942.2875
193	894.8125	939.8125	**243**	896.0625	941.0625	**293**	897.3125	942.3125
194	894.8375	939.8375	**244**	896.0875	941.0875	**294**	897.3375	942.3375
195	894.8625	939.8625	**245**	896.1125	941.1125	**295**	897.3625	942.3625
196	894.8875	939.8875	**246**	896.1375	941.1375	**296**	897.3875	942.3875
197	894.9125	939.9125	**247**	896.1625	941.1625	**297**	897.4125	942.4125
198	894.9375	939.9375	**248**	896.1875	941.1875	**298**	897.4375	942.4375
199	894.9625	939.9625	**249**	896.2125	941.2125	**299**	897.4625	942.4625

Channels 300 - 449

Ch.	Tx	Rx	Ch.	Tx	Rx	Ch.	Tx	Rx
300	897.4875	942.4875	**350**	898.7375	943.7375	**400**	899.9875	944.9875
301	897.5125	942.5125	**351**	898.7625	943.7625	**401**	900.0125	945.0125
302	897.5375	942.5375	**352**	898.7875	943.7875	**402**	900.0375	945.0375
303	897.5625	942.5625	**353**	898.8125	943.8125	**403**	900.0625	945.0625
304	897.5875	942.5875	**354**	898.8375	943.8375	**404**	900.0875	945.0875
305	897.6125	942.6125	**355**	898.8625	943.8625	**405**	900.1125	945.1125
306	897.6375	942.6375	**356**	898.8875	943.8875	**406**	900.1375	945.1375
307	897.6625	942.6625	**357**	898.9125	943.9125	**407**	900.1625	945.1625
308	897.6875	942.6875	**358**	898.9375	943.9375	**408**	900.1875	945.1875
309	897.7125	942.7125	**359**	898.9625	943.9625	**409**	900.2125	945.2125
310	897.7375	942.7375	**360**	898.9875	943.9875	**410**	900.2375	945.2375
311	897.7625	942.7625	**361**	899.0125	944.0125	**411**	900.2625	945.2625
312	897.7875	942.7875	**362**	899.0375	944.0375	**412**	900.2875	945.2875
313	897.8125	942.8125	**363**	899.0625	944.0625	**413**	900.3125	945.3125
314	897.8375	942.8375	**364**	899.0875	944.0875	**414**	900.3375	945.3375
315	897.8625	942.8625	**365**	899.1125	944.1125	**415**	900.3625	945.3625
316	897.8875	942.8875	**366**	899.1375	944.1375	**416**	900.3875	945.3875
317	897.9125	942.9125	**367**	899.1625	944.1625	**417**	900.4125	945.4125
318	897.9375	942.9375	**368**	899.1875	944.1875	**418**	900.4375	945.4375
319	897.9625	942.9625	**369**	899.2125	944.2125	**419**	900.4625	945.4625
320	897.9875	942.9875	**370**	899.2375	944.2375	**420**	900.4875	945.4875
321	898.0125	943.0125	**371**	899.2625	944.2625	**421**	900.5125	945.5125
322	898.0375	943.0375	**372**	899.2875	944.2875	**422**	900.5375	945.5375
323	898.0625	943.0625	**373**	899.3125	944.3125	**423**	900.5625	945.5625
324	898.0875	943.0875	**374**	899.3375	944.3375	**424**	900.5875	945.5875
325	898.1125	943.1125	**375**	899.3625	944.3625	**425**	900.6125	945.6125
326	898.1375	943.1375	**376**	899.3875	944.3875	**426**	900.6375	945.6375
327	898.1625	943.1625	**377**	899.4125	944.4125	**427**	900.6625	945.6625
328	898.1875	943.1875	**378**	899.4375	944.4375	**428**	900.6875	945.6875
329	898.2125	943.2125	**379**	899.4625	944.4625	**429**	900.7125	945.7125
330	898.2375	943.2375	**380**	899.4875	944.4875	**430**	900.7375	945.7375
331	898.2625	943.2625	**381**	899.5125	944.5125	**431**	900.7625	945.7625
332	898.2875	943.2875	**382**	899.5375	944.5375	**432**	900.7875	945.7875
333	898.3125	943.3125	**383**	899.5625	944.5625	**433**	900.8125	945.8125
334	898.3375	943.3375	**384**	899.5875	944.5875	**434**	900.8375	945.8375
335	898.3625	943.3625	**385**	899.6125	944.6125	**435**	900.8625	945.8625
336	898.3875	943.3875	**386**	899.6375	944.6375	**436**	900.8875	945.8875
337	898.4125	943.4125	**387**	899.6625	944.6625	**437**	900.9125	945.9125
338	898.4375	943.4375	**388**	899.6875	944.6875	**438**	900.9375	945.9375
339	898.4625	943.4625	**389**	899.7125	944.7125	**439**	900.9625	945.9625
340	898.4875	943.4875	**390**	899.7375	944.7375	**440**	900.9875	945.9875
341	898.5125	943.5125	**391**	899.7625	944.7625	**441**	901.0125	946.0125
342	898.5375	943.5375	**392**	899.7875	944.7875	**442**	901.0375	946.0375
343	898.5625	943.5625	**393**	899.8125	944.8125	**443**	901.0625	946.0625
344	898.5875	943.5875	**394**	899.8375	944.8375	**444**	901.0875	946.0875
345	898.6125	943.6125	**395**	899.8625	944.8625	**445**	901.1125	946.1125
346	898.6375	943.6375	**396**	899.8875	944.8875	**446**	901.1375	946.1375
347	898.6625	943.6625	**397**	899.9125	944.9125	**447**	901.1625	946.1625
348	898.6875	943.6875	**398**	899.9375	944.9375	**448**	901.1875	946.1875
349	898.7125	943.7125	**399**	899.9625	944.9625	**449**	901.2125	946.2125

Channels 450 - 600

Ch.	Tx	Rx	Ch.	Tx	Rx	Ch.	Tx	Rx
450	901.2375	946.2375	**500**	902.4875	947.4875	**550**	903.7375	948.7375
451	901.2625	946.2625	**501**	902.5125	947.5125	**551**	903.7625	948.7625
452	901.2875	946.2875	**502**	902.5375	947.5375	**552**	903.7875	948.7875
453	901.3125	946.3125	**503**	902.5625	947.5625	**553**	903.8125	948.8125
454	901.3375	946.3375	**504**	902.5875	947.5875	**554**	903.8375	948.8375
455	901.3625	946.3625	**505**	902.6125	947.6125	**555**	903.8625	948.8625
456	901.3875	946.3875	**506**	902.6375	947.6375	**556**	903.8875	948.8875
457	901.4125	946.4125	**507**	902.6625	947.6625	**557**	903.9125	948.9125
458	901.4375	946.4375	**508**	902.6875	947.6875	**558**	903.9375	948.9375
459	901.4625	946.4625	**509**	902.7125	947.7125	**559**	903.9625	948.9625
460	901.4875	946.4875	**510**	902.7375	947.7375	**560**	903.9875	948.9875
461	901.5125	946.5125	**511**	902.7625	947.7625	**561**	904.0125	949.0125
462	901.5375	946.5375	**512**	902.7875	947.7875	**562**	904.0375	949.0375
463	901.5625	946.5625	**513**	902.8125	947.8125	**563**	904.0625	949.0625
464	901.5875	946.5875	**514**	902.8375	947.8375	**564**	904.0875	949.0875
465	901.6125	946.6125	**515**	902.8625	947.8625	**565**	904.1125	949.1125
466	901.6375	946.6375	**516**	902.8875	947.8875	**566**	904.1375	949.1375
467	901.6625	946.6625	**517**	902.9125	947.9125	**567**	904.1625	949.1625
468	901.6875	946.6875	**518**	902.9375	947.9375	**568**	904.1875	949.1875
469	901.7125	946.7125	**519**	902.9625	947.9625	**569**	904.2125	949.2125
470	901.7375	946.7375	**520**	902.9875	947.9875	**570**	904.2375	949.2375
471	901.7625	946.7625	**521**	903.0125	948.0125	**571**	904.2625	949.2625
472	901.7875	946.7875	**522**	903.0375	948.0375	**572**	904.2875	949.2875
473	901.8125	946.8125	**523**	903.0625	948.0625	**573**	904.3125	949.3125
474	901.8375	946.8375	**524**	903.0875	948.0875	**574**	904.3375	949.3375
475	901.8625	946.8625	**525**	903.1125	948.1125	**575**	904.3625	949.3625
476	901.8875	946.8875	**526**	903.1375	948.1375	**576**	904.3875	949.3875
477	901.9125	946.9125	**527**	903.1625	948.1625	**577**	904.4125	949.4125
478	901.9375	946.9375	**528**	903.1875	948.1875	**578**	904.4375	949.4375
479	901.9625	946.9625	**529**	903.2125	948.2125	**579**	904.4625	949.4625
480	901.9875	946.9875	**530**	903.2375	948.2375	**580**	904.4875	949.4875
481	902.0125	947.0125	**531**	903.2625	948.2625	**581**	904.5125	949.5125
482	902.0375	947.0375	**532**	903.2875	948.2875	**582**	904.5375	949.5375
483	902.0625	947.0625	**533**	903.3125	948.3125	**583**	904.5625	949.5625
484	902.0875	947.0875	**534**	903.3375	948.3375	**584**	904.5875	949.5875
485	902.1125	947.1125	**535**	903.3625	948.3625	**585**	904.6125	949.6125
486	902.1375	947.1375	**536**	903.3875	948.3875	**586**	904.6375	949.6375
487	902.1625	947.1625	**537**	903.4125	948.4125	**587**	904.6625	949.6625
488	902.1875	947.1875	**538**	903.4375	948.4375	**588**	904.6875	949.6875
489	902.2125	947.2125	**539**	903.4625	948.4625	**589**	904.7125	949.7125
490	902.2375	947.2375	**540**	903.4875	948.4875	**590**	904.7375	949.7375
491	902.2625	947.2625	**541**	903.5125	948.5125	**591**	904.7625	949.7625
492	902.2875	947.2875	**542**	903.5375	948.5375	**592**	904.7875	949.7875
493	902.3125	947.3125	**543**	903.5625	948.5625	**593**	904.8125	949.8125
494	902.3375	947.3375	**544**	903.5875	948.5875	**594**	904.8375	949.8375
495	902.3625	947.3625	**545**	903.6125	948.6125	**595**	904.8625	949.8625
496	902.3875	947.3875	**546**	903.6375	948.6375	**596**	904.8875	949.8875
497	902.4125	947.4125	**547**	903.6625	948.6625	**597**	904.9125	949.9125
498	902.4375	947.4375	**548**	903.6875	948.6875	**598**	904.9375	949.9375
499	902.4625	947.4625	**549**	903.7125	948.7125	**599**	904.9625	949.9625
						600	904.9875	949.9875

Technical Description

Ericsson Mobile Phone EF738

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Overview

The Ericsson *EF738* Mobile Phone is a small, lightweight phone operating at 3.8V. It is a class 4 cellular telephone that is fully compatible with the ETACS system with extended frequencies.

The *EF738* includes the following three exterior parts:

- *telephone section* (incl. keypad, character display, earpiece, microphone and flip)
- removable *battery*
- removable *antenna*

Figure 1: The Ericsson Mobile Phone EF738

Basic Building Blocks

The diagram below shows the basic building blocks:

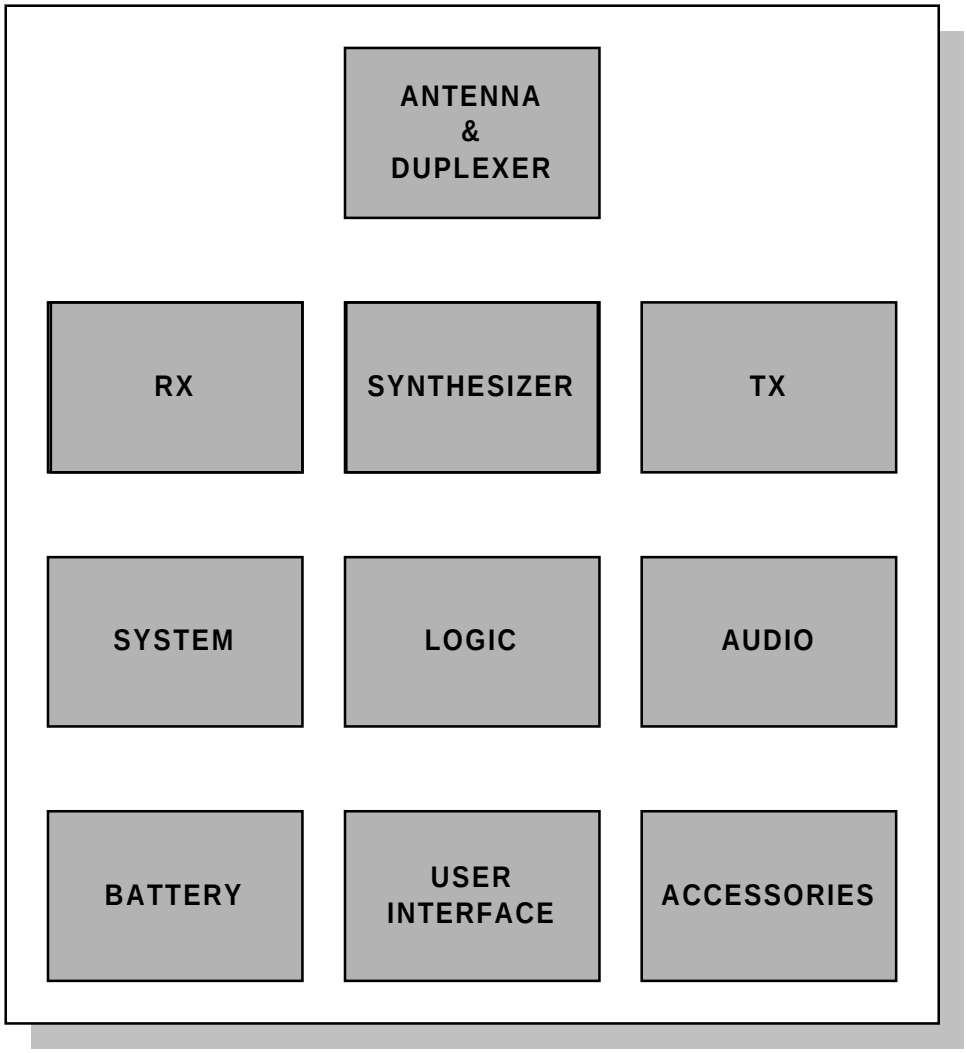

Figure 2: Basic Building Blocks

Transceiver Block Diagram

The transceiver (transmitter/receiver) consist of a digital part that controls and supervises transmission/reception on the radio channel. It also handles keyboard, display and protocol transmission to the MTX (Mobile Telephone eXchange). The audio part controls audio signals for earphone, microphone and modem.

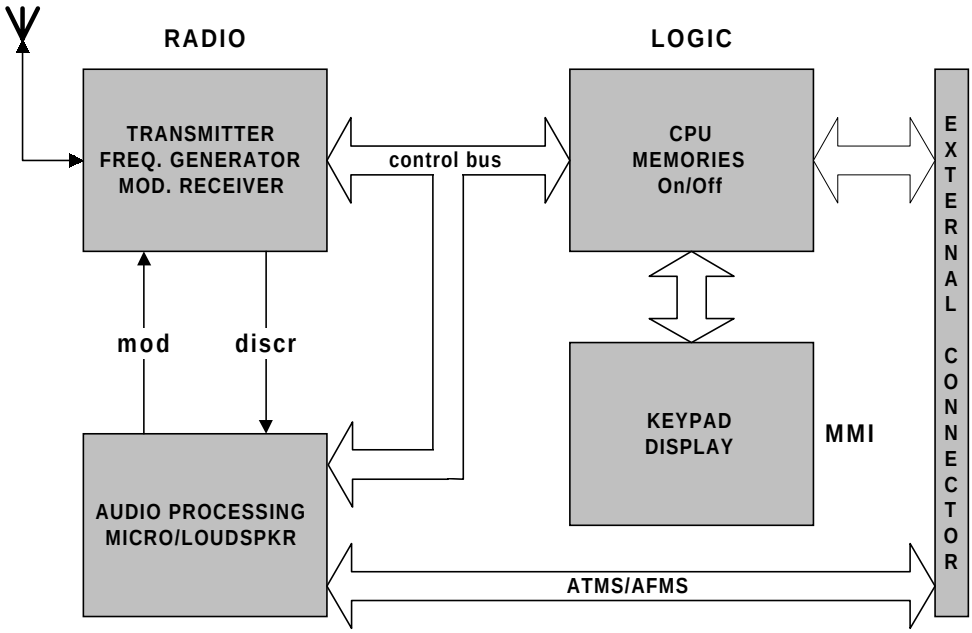

Figure 3: Transceiver Block Diagram

PCB

The printed circuit board is a 6-layer PCB where all components are located in layer 1 (primary side) and layer 6 (secondary side).
Layers 2 and 5 are ground planes and layers 3 and 4 are used for signal conducting.

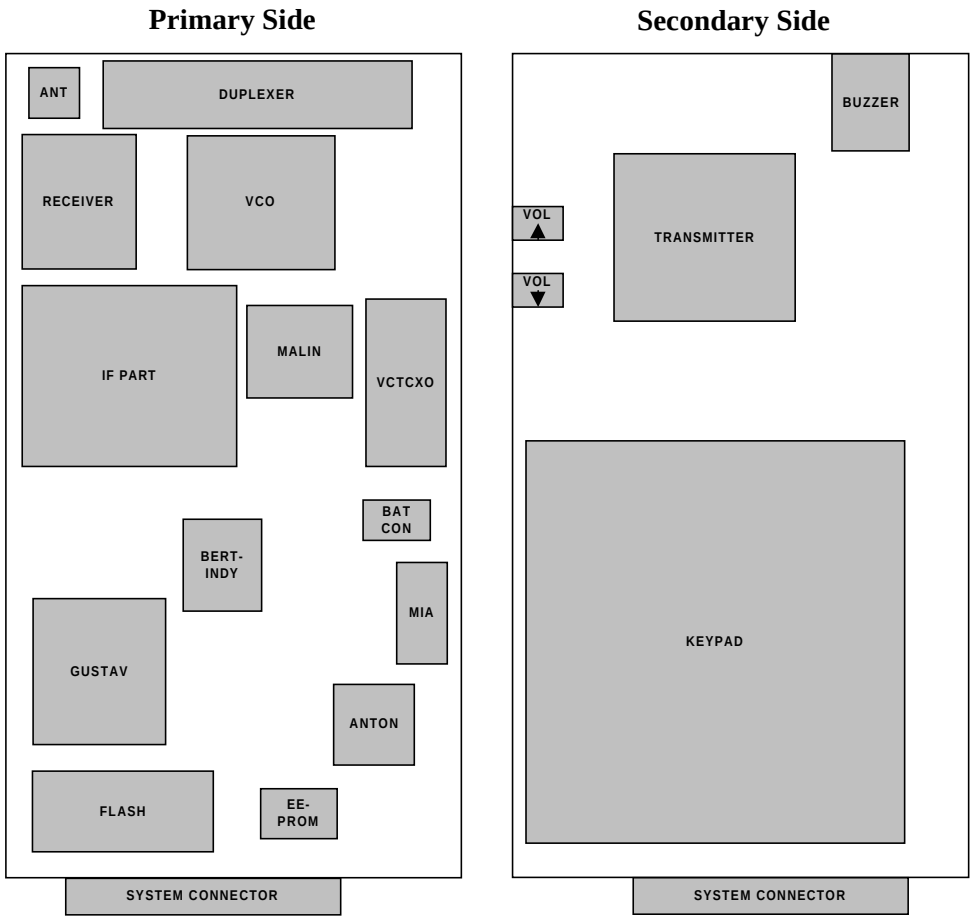

Figure 4: PCB LayOut

Mechanical Design

The phone is designed as a ‘brick’ with a mechanical assembly consisting mainly of:

- plastic front cover
- plastic rear cover
- plastic flip
- keyboard
- system connector
- LCD light guide
- metallic plastic for PCB shielding

It has been designed for easy assembly with 6 screws.
An optional clip can be mounted into the rear cover.

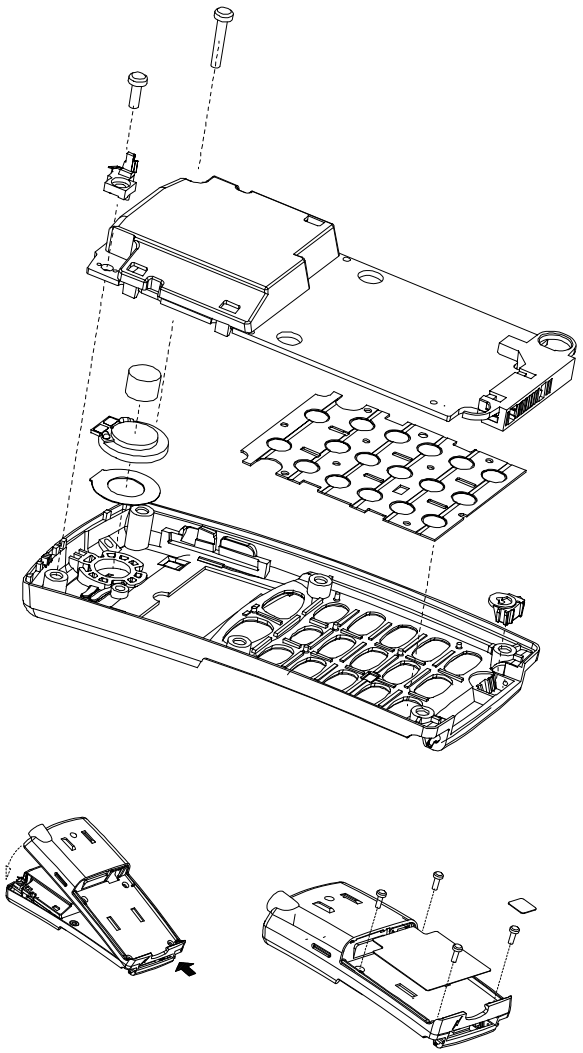

Figure 5: Mechanical Assembly

Man Machine Interface (MMI)

Keypad

The keypad has back-lighting that makes it possible to operate the station in the dark. The back lighting function (on 10sec/on 20sec/off) is selected by the user.

Note that the *END/PWR/NO* key is not part of the keyboard scanning matrix. It is connected to the 3.8V regulators enable inputs so that the power of GUSTAV is forced On when this key is held down.

The volume keys are not located on the keypad. They are push button switches mounted on the upper left hand side of the phone.

Display

The segmented LCD contains one row of 10 alpha-numeric characters and one row of icons.

The software for driving the display is contained in the Flash EPROM.
An elastomeric connector joins the PCB to the transparent conductive tracks on the LCD module.

Acoustic Signals

The acoustic signals are generated by a buzzer in the transceiver. The acoustic level as well as the frequency of the signal is variable in order to distinguish between different situations.

The different acoustic signals are:

- Ring signals
- Alarm signals
- Low battery warning
- Keypad tone or “click”

Top LED Indicator

A dual-colour LED (green & red) is positioned on the top front end.
Each LED is connected to a separate output port on GUSTAV.
Blinking rates and color of the Indicator LED are controlled by software.

Radio Design

General Overview

The radio operates on the ETACS frequency band. The transmitter operates at 872.0125 MHz to 905.9875 MHz and the receiver at 917.0125 MHz to 949.9875 MHz. The duplex spacing is 45MHz and the channel separation is 25KHz.

Together with the logic/audio part the radio fulfills the ETACS requirements.

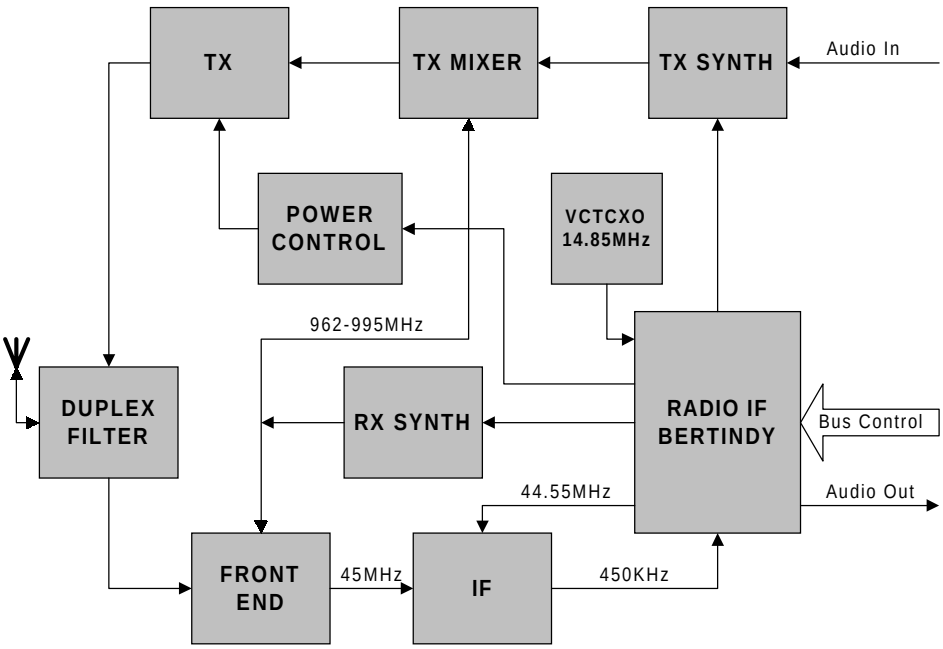

Figure 6: Radio Block Diagram

Antenna Connector

The antenna connector consists of a mechanical assembly that connects the antenna to the radio. The impedance of the antenna connector is 50Ω.

Antenna Filters

The duplex filter consists of a 4-pole TX section of band pass characteristic with a notch at the RX frequency and a 4-pole RX section filter with 50Ω impedance in each direction.

The task for the TX filter is to suppress wide band noise evolving from the VCO and the power amplifier on RX frequencies.

The task for the RX branch is to suppress the transmitter signal to a level low enough not to overdrive the receiver front end amplifier and attenuate external spurious signals.
The RX-section also suppresses leakage from the local oscillator.

Receiver Part

The front-end stage is the first link in the receiver chain. It's purpose is to amplify the RF and down-convert it to the 1st IF frequency and to set the RX system noise figure. The desired input frequencies are within the range 917.0125 to 949.9875 MHz. The selected frequency is down-converted to 45 MHz and amplified. This section includes a low-voltage RX front-end chip, "Low-voltage ANNIKA", comprised of a low noise amplifier, a mixer, and the 1st image filter.

Receiver Front End

ANNIKA: RF-amplifier

The input of the integrated low-noise amplifier is matched for optimal performance regarding minimum noise level and second order intermodulation performance. It also provides a 50Ω load to the duplexer.

BP-filter

This bandpass filter is a SAW filter needed for spurious response rejection (suppression of the first image frequency). The filter also suppresses the local oscillator backwards to the antenna.

ANNIKA: Mixer

The integrated mixer in the same package as the LNA includes an internal buffer for the Local Oscillator (LO) which allows low LO input power and immunity from variations in LO input power. At the RF port, an inductor rejects the noise coming to the mixer directly at the IF band. The output of the mixer is converted to a higher impedance to match the crystal filter in the following IF circuitry.

IF Part

The IF/AF part is the second link in the receiver chain. It performs the major part of the RF amplification and all the channel filtering. The 1st IF at 45 MHz is down-converted to 450 KHz and FM demodulated in Bertindy. The IF IC generates a DC voltage (RSSI), which is logarithmically proportional to the strength of the received signal.

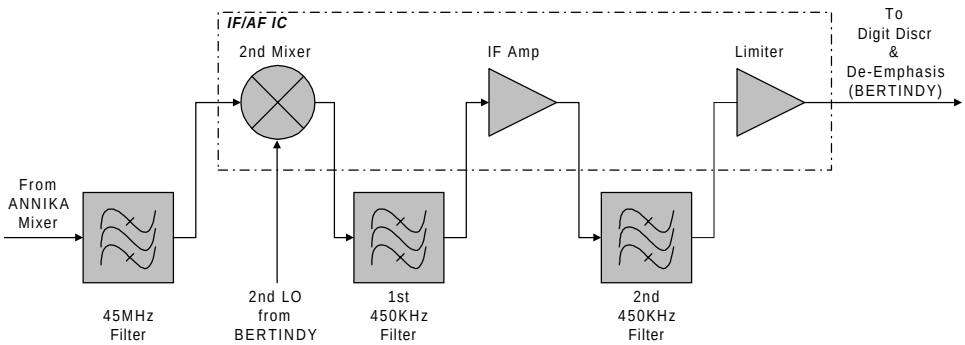

Figure 7: IF/AF Link

Receiver Back-End

The IF/AF circuit is an integrated bipolar circuit containing a mixer, IF amplifier, limiter, RSSI circuits, and FM detection circuit. The rest of the required functions are located in BERTINDY.

The 1st IF frequency of 45 MHz is fed to the 2nd mixer where it is down-converted to 450 KHz (2nd IF) in the IC. The 2nd LO signal at 44.55 MHz for the mixer comes from BERTINDY. Third harmonic of the reference oscillator frequency (14.85 MHz) is used as the 2nd LO signal.

The 450 KHz signal is filtered through a ceramic 2nd IF filter and fed to the input of the IF amplifier stage. The output signal from this stage is filtered through a second ceramic 2nd IF filter and is then applied to the limiter. The resulting 450 KHz square-wave signal is fed to the digital discriminator in BERTINDY where it is demodulated and de-emphasized before being passed to the ANTON IC for further audio processing.

Band Pass 1st IF Filter (2nd Image Filter)

This crystal filter is needed for spurious response rejection (suppression of the 2nd image frequency) and inter-modulation rejection. The crystal filter is a band pass filter with a center frequency of 45 MHz. Some channel filtering is also performed in this filter.

Channel and Noise Reduction Filters

Two bandpass 2nd IF filters are needed for broadband noise reduction and desired channel selection. Each filter is a ceramic 4-pole bandpass filter with a center frequency of 450 KHz.

450 KHz Output

From the limiter output, the 450 KHz square-wave signal is fed to the digital discriminator in BERTINDY for demodulation. This signal is also used by the AFC algorithm in determining the frequency error of the 14.85 MHz reference relative to the received signal.

RSSI Output

A voltage which is logarithmically proportional to the RF input power of the received signal is produced in the IF/AF IC.

RSSI Range

The lower end of the useable range is controlled primarily by the RF/IF gain of the receiver while the upper end of the RSSI voltage is controlled by the supply voltage of the IF/AF chip.

Synthesizer

A 900 MHz RX synthesizer is used as first LO. The TX synthesizer is modulated and working at a fixed frequency of 90 MHz. The TX frequency is obtained by mixing the frequencies from the two synthesizers.

The main synthesizer uses fractional-N to achieve lower phase noise and faster switching. In most applications the phase noise is proportional to the overall division ratio and since fractional-N uses a higher comparison frequency the phase noise will be lower.

The auxiliary synthesizer is a conventional loop without fractional-N and the comparison frequency is 75 KHz.

The RX VCO is a module which operates between 914.040 MHz and 938.970 MHz.

The MALIN chip contains the TX VCO , TX buffer stage, TX mixer, RX buffer stage and the RX prescaler.

The TX PLL, RX PLL and the lock detect logic are part of the BERTINDY chip.

Programming

The name of the PLL circuit is BERTINDY, which is a combination of the two chips Bertram and Cindy. A three line bus is used to program the synthesizer with the help of a clock frequency. The RX synthesizer is operating at 45 MHz above the required RX frequency and a 14.85 MHz reference frequency is used.

Power

The synthesizer part in BERTINDY is put in power down mode by sending a command to the chip. The auxiliary and main synthesizer can be powered down separately and the RX-VCO is controlled by BERTINDY. The prescaler and the 90 MHz VCO of MALIN is controlled by sending power up/down commands.

Lock Detect

A signal showing when the synthesizer is locked is implemented in BERTINDY. The lock detect circuit operates with both the main and the auxiliary synthesizers. If both synthesizers are enabled, the lock detect output becomes active when they are both locked. If only one synthesizer is enabled, the lock detect output becomes active when that one is locked.

VCTCXO

The task of the VCTCXO is to supply the synthesizer with a stable, accurate reference frequency. A 14.85 MHz crystal with DAC-controlled varactor diodes and a transistor stage within BERTINDY constitues the TCXO circuit. A software algorithm is used for temperature compensation as well as an AFC function.

The operating frequency of the synthesizer reference oscillator is set by the crystal element. The crystal is specified for a resonant frequency of 14.85 MHz at a specific load capacitance. Tuning of the series resonance frequency is accomplished by adjusting the total series capacitance seen by the crystal. Varactor diodes provide the method of varying the load capacitance posed to the crystal. Both varactors are controlled by DAC's within BERTINDY. DAC1 is the "fine tune" adjustment, and DAC2 is the "coarse tune" adjustment.

Initial trimming for component tolerances is done by DAC2 in the factory. In the field, the TCXO is adjusted mainly through DAC1 for temperature compensation and AFC. DAC2 is only adjusted in the field when necessary to maintain the fullest DAC1 range possible. This is where the integer ratio of tuning sensitivity is desirable.

The inherent frequency deviations of the crystal when operated over the full temperature range are corrected by a software controlled temperature compensation algorithm. A look-up table is stored in memory which is indexed by temperature readings from a signal originating from a thermistor voltage divider network. This is the only means for frequency compensation in the field when the down link signal from the base station is weak and below the AFC threshold. When the base station signal is above the threshold (roughly -110 dBm), and when the phone is in either idle or conversation mode, the AFC algorithm is enabled. The temperature compensation table ensures that the TCXO frequency will be kept close enough to lock to the base station signal and null out frequency error once the proper conditions are met.

Transmitter

The transmitter section amplifies the transmitter signal from approximately 0.25 mW to 1.25 W. This section is compound by a driver stage and a power amplifier.
Output power is regulated by a closed feedback loop incorporating a stripline coupler, Schottky rectifier diode, and a power amplifier with high and variable gain and high efficiency.

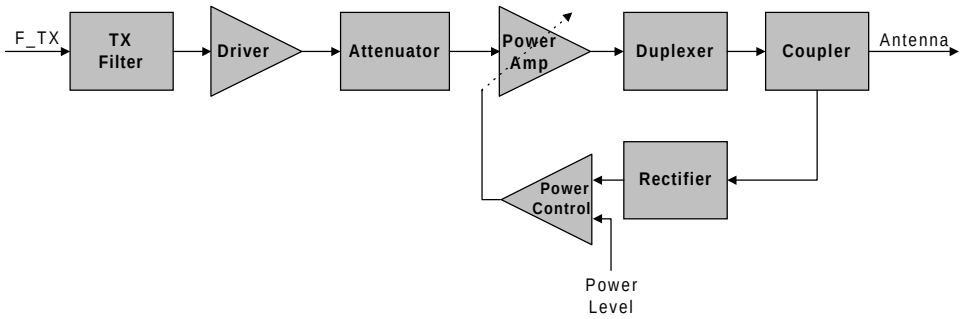

Figure 8: Transmitter Block Diagram

TX Blocks

TX Driver Amplifier

The transistor used is a bipolar type in a common emitter configuration, which offers unconditional stability and good dynamic range.
The output and inputs are matched to 50Ω, and there is an attenuation at the output to avoid damage in PA.

Power Amplifier Module

The output power of the PA-module is varied by controlling the bias point. The saturated output power of the PA is dependent upon the load presented at its output. For the required saturated output power and efficiency, a specified load must be used.

Power Detector

The power sensing is done with a coupled stripline detector. This circuit senses forward power with some directionality. A Schottky diode is used to rectify the RF and this diode is forward biased to avoid having the diode snap off when detecting low levels of RF. Direct temperature compensation is achieved by providing the detector bias voltage via a matched diode

Power Control

The output power from the power amplifier is regulated by an active feedback loop. The reference value is set via a D/A-converter in BERTINDY and is connected to the positive input of an op-amp, where the detected output power level is connected to the negative input of the same op-amp. The op-amp produces an error voltage that controls the base current of a transistor, which in turn varies the output level of the PA.

TX Filtering

The reduction of TX spurious emissions and TX noise in the RX band is achieved with two filters. The first is a bandpass SAW filter. The second filter is the TX branch of the duplexer filter. The response is predominately band-pass with a notch in the RX band to protect the receiver from TX noise power. High frequency attenuation provides reduction in the level of TX harmonics.

Protection against Electro-Static Discharge (ESD) is also provided by the high-pass element of the duplexer TX branch.

MALIN

MALIN, is an integrated RF circuit for FDMA cellular telephones. The circuit is designed for a radio architecture using one synthesizer for both RX and TX parts. The transmitter portion consists of a TX-IF VCO and a TX-mixer. The base-band signal modulates the TX-IF via an external tank circuit which is then up-converted to the TX frequency by the TX-mixer. A programmable prescaler is included for use in the main synthesizer loop, and power down control is provided for current saving.

TX-IF VCO

The TX-IF is generated by an internal oscillator of MALIN. Tuning is performed by an external tank circuit where the center frequency is controlled by the auxiliary synthesizer using a varactor diode. The TX-IF signal is also buffered and sent to the auxiliary synthesizer to maintain a constant 90 MHz TX-IF frequency.

TX Mixer

The TX mixer multiplies the TX-IF signal with the first LO signal from the main VCO to create the desired output signal. The mixer is designed to have a low noise floor in order not to affect the receiver performance. The output is differential and an LC network is used to align the signals to make them combine constructively.

TX Modulation

The modulation of the transmitter occurs in the TX-IF VCO tank circuit. The base-band signal coming from the audio IC ANTON is filtered and used to shift the resonant frequency of the external tank circuit by the varying capacitance of the varactor diode.

TX-IF Frequency Control

The center frequency of the TX-IF VCO is controlled by the auxiliary synthesizer located in BERTINDY. A portion of the TX-IF signal is buffered and sent to the TX oscillator outputs. This signal is used to lock the TX-IF in the Auxiliary PLL.

Programmable Prescaler

MALIN also includes a prescaler for use in the main synthesizer loop. The divider has separate Vcc and ground connections to provide good isolation from the TXPA outputs.

Power and Charging Design

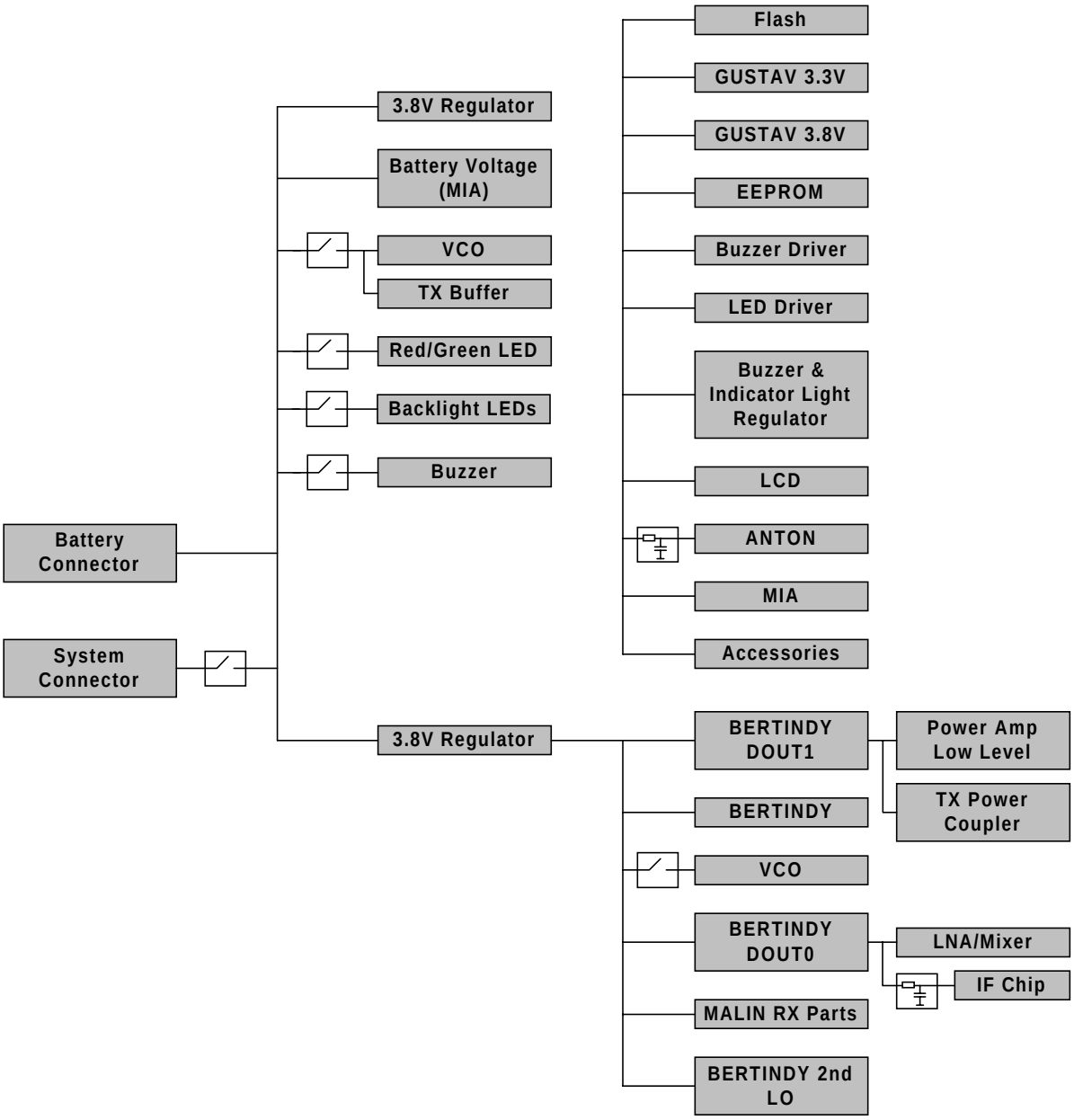

Figure 9: Power Distribution

Regulators

The phone is powered by three regulators as follows:

- VDIG powers the digital/audio/user interface circuitry
- VMALIN powers MALIN TX and buffer
- VRAD powers the remaining radio circuitry

The regulators have got an enable input, which is used to power the phone on/off. The minimum voltage for turning the regulators on is 2.0V, and the maximum for turning them off is 0.18V.

Reset

The digital voltage VDIG is monitored by a low voltage detector in ANTON. While the phone is operating, and if VDIG drops below 3.35V (typical), ANTON's LVN open-drain output will set GUSTAV's reset input (MRN) low, causing the processor to reset. Upon power-up, an RC filter holds GUSTAV's reset input low for the required 20 ms delay.

On/Off Control

The phone may be powered on by either pressing the ON/OFF/END key, or by applying 7.0V-10.0V at DCIO.

When the ON/OFF/END key is pressed for at least 200 ms, this key powers on the phone by connecting the battery voltage to the enable inputs of the regulators through a diode. The processor then comes out of reset and latches the enable inputs of the regulators.

Chargers and accessories power on the phone by applying 7.0V-10.0V at DCIO. The voltage difference between DCIO and the battery voltage turns on a transistor connected to the enable inputs of the regulators. As with the ON/OFF/END key, the DCIO voltage must be present for at least 200 ms in order to power on the phone.

If no charger is connected, the phone is powered-off by pressing and then releasing the ON/OFF/END key. Pressing the ON/OFF/END key generates an interrupt to GUSTAV via a transistor. GUSTAV then tries to disable the regulators but these will stay on until the ON/OFF/END key is released. If a charger is connected, the phone will stay on until the processor detects that the charger has been removed (no current from charger to phone). The phone cannot turn itself off as long as a charger is connected.

Charging Circuitry

The phone software controls charging by turning a FET switch on/off, based on battery voltage and charging current through a 0.1Ω resistor. Chargers are designed to have an open-circuit voltage less than 10V, and supply an average current of approximately 700mA when connected to a battery through the FET switch. A resistor allows a dead battery to become trickle charged high enough for the phone to turn on. MIA provides charge switch control and analog outputs corresponding to charger current and battery voltage. These outputs are connected to BERTINDY's A/D inputs. GUSTAV turns on the charge switch using a current control output port, which is connected to an input of MIA. If the battery voltage is less than 8.0V, the current control port controls the on/off state of the FET switch. If the battery voltage is greater than 8.0V, MIA keeps the charge switch off regardless of the state of the current control port.

Transient/ESD Protection

Diodes are used for ESD protection on the System Connector outputs. The inputs have got resistors between the System Connector and the ASIC input ports. Capacitors on DCIO prevent spikes caused by charger cable inductance when the charge switch is turned off. They also protect MIA and the FET-switch from ESD and provide de-coupling for voltage ripple. A capacitor and a varistor provide de-coupling and high-voltage / ESD protection on the battery voltage.

Off Current Draw

The current draw when the phone is off should be as low as possible in order to prevent low batteries from being too heavily discharged. The only components directly connected to the battery which may draw current when the phone is off are MIA, a low voltage detector, and the regulators.

User Interface

Illumination

The phone is illuminated with 14 SMD LED's, 4 for the display and 10 for the keyboard. The LED's are switched on and off from GUSTAV. A voltage regulating circuit is included which prevents changes in the battery voltage from affecting the backlighting intensity.

Buzzer

The buzzer, which emits the Beep-, Ring- and Alarm signals, is an electromagnetic resonance buzzer with a resonance frequency of about 3 KHz.
The sounds are generated in GUSTAV by software control and then fed to the buzzer.

LCD Display

The display is a 1- row segmented LCD which utilizes chip on glass technology for mounting of the driver chip on the LCD module. No negative voltage supply is required for this LCD and no contrast control is needed since the display in *EF738* utilizes a technology which provides a wide viewing cone.

Keypad

There is a 5 x 4 keyboard scanning connected to GUSTAV.

A detection signal is set high when the *END/PWR/NO* key is pressed and by looking at a feed-back signal GUSTAV is informed and turns the phone on.

Logic Design

GUSTAV

GUSTAV is a uP ASIC that consists of 15 blocks:

- 6303
- ROM
- RAM
- Bus Interface
- Decoder
- Serial Interface
- External Ports
- Watchdog On/Off
- IFC
- BAR
- Clock Generator
- Internal Ports
- Modem
- Baud Clock
- I2C Controller

Circuit Description

6303

The processor is an 8 bit processor with an asynchronous full duplex serial communication interface, DTMS/DFMS, for external connections.

ROM

There is an internal 512 byte ROM in GUSTAV which holds a Primitive Interface Program, used for code loading into the RAM. After a reset, the CPU will begin executing the code in IROM. If the SERV line is high, the ROM code continues to execute, otherwise the program code in the external EPROM is started.

RAM

There are 6016 bytes of RAM available in GUSTAV. The processor uses this memory as working space when the phone is turned on. When turned off, data that has to be saved will be stored in the EEPROM before turn off.

Bus Interface

The bus interface will provide the data and address lines to the external Flash EPROM and will also handle the internal busses in GUSTAV.

Decoder

The decoder in GUSTAV is an address decoder which has outputs for both internal functions and logic control signals such as chip selects (CS), write (W) and output enable (OE).

Serial Interface

The serial interface in GUSTAV has a transmitter block and a receiver block. The transmitter block consists of four write registers, a clock divider, and other logic for generating interrupts and latch signals. Data is transmitted and received via a serial interface data line.

The receiver block consists of three read registers in which the received data may be read one byte at a time by the processor.

External Ports

This block manages the keyboard along with the handling of binary input/output ports where some inputs are connected to the interrupt control block.

WatchDog On/Off

The Watchdog On/Off block in GUSTAV contains the watchdog block and the Autonomous Time Out (ATO) block. This block consists of a four second counter, which when overflown, activates a reset circuit and generates a 100ms reset.

The ATO is a supervising block that monitors the status of the received carrier detect and the transmitter power. If the transmitted power is detected without the received carrier detect for 30 seconds, the ATO initiates a hardware turn off of the phone.

IFC

The IFC counter is used to count a predetermined number of periods of the IF from the radio interface LSI.

BAR

The output from the bar generator is a continuous pulse train with program controlled ON and OFF time. This makes it possible to vary signal parameters such as:

- tone frequency
- signal period
- signal on time
- volume

Clock Generator

The processor clock is generated from an external signal or crystal.
An 8.064 MHz clock gives a system clock frequency of 1.008 MHz (or 2.016 MHz in Turbo mode). The serial interface clock will always be 1.008 MHz. The clock generator block has many divider steps to generate all clock frequencies that are required inside GUSTAV and on the logic PCB.

Internal Ports

There are three 8 bit read and three 8 bit write ports in this block that are used within GUSTAV.

Modem

The modem part supports two different cellular systems, AMPS and TACS, which consists of data receiver, data transmitter, SAT detector, and SAT transmitter.

The data receiver consists of three parts: digital discriminator, data decoder, and wordsync detector.

The data transmitter sends data bytewise where the most significant bit is transmitted first.

The SAT-detection consists of continuous measurements of 10-12 ms and the three frequencies being used are 5970, 6000 and 6030 Hz.

SAT-generation of the three frequencies is also done in GUSTAV.

Baud Clock

This block generates the baud rate for the serial interface of GUSTAV and is selectable among the following baud rates.

600 (Power on default)
1200
2400
4800
9600

I2C Controller

This part controls the communication between the EEPROM and the display.

FLASH EPROM

The system program is stored in a low voltage Flash EPROM with 128k x 8 bit area.

EEPROM

The ‘customer’ PROM is a CMOS EEPROM with 4k x 8 bit area. Data that has to be saved when the station is turned off is stored in this memory, which contains the telephone number, short numbers, talk time, area ID and other radio/audio information.

Audio Design

The baseband audio is processed by ANTON which is a mixed signal ASIC with a compander, filters, limiters and programmable gain blocks.

Receive Audio Circuit Description

Receive Audio Interface

The receive audio is demodulated by a digital discriminator in BERTINDY and then passed through a first order active bandpass filter which is comprised of an op-amp located in BERTINDY. External resistors and capacitors set the gain and bandpass of the filter and the output of this filter is then AC coupled through a capacitor to an external de-emphasis network. The interface between the radio and the baseband audio is between the discriminator's bandpass filter and the external de-emphasis network.

De-Emphasis Network

The de-emphasis network is composed of two series resistors and a shunt capacitor. The audio is routed through a resistor pair into the receive input port on ANTON. The received SAT is tapped off between the resistor pair and routed to a port on ANTON. The shunt capacitor provides the necessary de-emphasis slope to restore the low frequency components of the audio that were attenuated by the pre-emphasis in the base station transmit path.

RXSENSE Programmable Gain Stage

The receive audio enters ANTON at the receive input port. The signal first passes through an anti-aliasing filter and is then routed to the RXSENSE programmable gain stage. This gain stage is provided to trim out the tolerances between the discriminator output and the expander input. The RXSENSE gain stage has a nominal gain of 8 dB and can be adjusted +6.4/-6.0 dB in steps of +0.4 dB.
Test mode 10 'RX Sensitivity' can be used to update this gain stage.

This stage is used to adjust the AFMS level to 25 mVrms with a 1 kHz tone at 2.3 kHz deviation and nominal volume.

Receive Bandpass Filter

The output of the RXSENSE stage is fed into a 300 Hz to 3 kHz switch-capacitor bandpass filter.

Expandor Gain

The gain in the expandor is a function of the input signal level with the following relationship for the expandor:

$2(X0 - X1) = Y0 - Y1$

where: X0 = reference input (unaffected level)

Y0 = reference output

X1 = input

Y1 = output

The relationship states that a change in the input from X0 to X1 will produce a change in the output from Y0 to Y1 that equals 1:2.

The gain, A, is then:

$A = Y1 - X1 = Y0 - 2X0 + X1$

RX HF Attenuation

Following the expander is a 0 to -49 dB attenuator for full duplex handsfree operation. This stage is programmable in steps of 7 dB. When the external audio signal on the system connector is low, the software implements a handsfree algorithm that attenuates the unused audio path to prevent feedback from external speakers to the microphone.

Under normal modes of operation this stage is set to 0 dB. However, during the generation of DTMF tones to the earpiece, this stage is used to attenuate the signal to prevent clipping.

RX Volume Control

The RX audio level is controlled by a 0 to -24 dB gain stage in steps of 3 dB.

EARSENS Programmable Gain Stage

A programmable gain stage is provided to trim the level to the Earpiece to provide 84 dBspl with a 1 kHz tone at 2.3 kHz deviation and max. volume setting (0 dB). This stage is programmable in 0.4 dB steps from -2.8 to 3.2 dBs.

Test Mode 28 ‘Earpiece’ is used to trim this stage.

Externally Programmable Gain Stage

An inverting amplifier follows the EARSENSE stage. The input and feedback elements are external to allow for external programming of gain and filtering.

This stage is bypassed when the earpiece drivers are put in external mode.

Earpiece Driver

The earpiece driver is composed of a differential pair, a non-inverting amplifier and an inverting amplifier.

The drivers can be software configured in four modes:

- single-ended
- differential
- external
- muted

A resistor is added in series with the earpiece as a pad to limit the maximum acoustic level to 103 dBspl. The gains in the ASIC are set to force the signal into clipping at maximum deviation and maximum volume and the excess amplitude is divided down between the resistor and the earpiece.

AFMS

The inverting earpiece amp is used to generate the AFMS signal. The signal is AC coupled to reduce popping when connecting a portable handsfree unit.

Transmit Audio Circuit Description

ATMS

The ATMS signal is AC coupled to the transmit audio path via a capacitor and is then reduced by 2 dB and biased to a voltage. A switch to this voltage is also connected to the output of the ATMS port to provide a bias for the portable handsfree microphone. This switch is controlled by the microprocessor, but can be controlled directly by the PORTHF port of the system connector.

Microphone Input

The ASIC has a switchable +22/+32 dB gain stage for amplifying low level microphone signals. The ASIC also provides a low noise bias voltage for microphone biasing.

ANTON is designed to provide gain to the portable handsfree microphone by the use of software controlled switches which are located before and after the Mic gain stage, to allow routing of the signal from the ATMS port through the Mic amplifier. The switches can be configured to route the mic audio through the mic amp, to route ATMS through the mic amp or to bypass ATMS around the mic amp. In all three cases, the output of this block is routed to the soft limiter.

Soft Limit

A 0 to -30 dB attenuator follows the audio input block where this soft limit is enabled through software and is used to limit clipping before the compressor. The soft limit is controlled by two threshold comparators. When the signal exceeds the threshold, a clock will step a tap on a resistor ladder to increase the attenuation. When the level drops below the threshold, a slower clock steps the tap back up the resistor ladder to reduce the attenuation.

INPSENSE Programmable Gain Stage

The soft limit output is AC coupled into the INPSENSE programmable stage and this stage is used to adjust the audio level into the compressor. The gain is programmed through software in a range from +2 to +14.4 dB in steps of 0.8 dB where the nominal setting is +8 dB.

This stage has calibration settings for three modes of operation:

- external audio
- internal audio
- DTMF tones

The three calibration values are stored in the EEPROM.

Transmit Bandpass Filter

The next block in the transmit audio chain is a switched capacitor bandpass filter which is designed to allow frequencies from 300 to 3000 Hz to pass through.

TX HF Attenuator

Following the bandpass filter is a 0 to -49 dB attenuator for full duplex handsfree operation, which is programmable in steps of 7 dB. When the external audio signal on the system connector is low, the software implements a handsfree algorithm that attenuates the unused audio path to prevent feedback from external speakers to microphone.

Compressor

The audio is AC coupled from the transmit handsfree attenuator block into a 2:1 switch capacitor compressor. This stage is enabled during the conversation modes of the phone and can be bypassed for testing.

Test mode 29 has two options for control of the compressor.

An integrator using an amplifier in the ASIC is configured to provide feedback from the output to the input of the compressor.

Pre-emphasis

A 3 dB/Octave high pass filter follows the compressor. This filter is used to equalize the audio spectrum by attenuating the low frequency components of the signal.

Hard Limit

A +13.5 dB gain hard limit follows the pre-emphasis block in the transmit audio path in order to limit the maximum audio level out of the ASIC and into the modulator block.

Transmit Lowpass Filter

A 3 kHz lowpass filter follows the hard limit to filter out the harmonic components caused by clipping in the hard limit.

AUDIODEV Programmable Gain Stage

The AUDIODEV programmable gain stage follows the TX lowpass filter to allow adjustment of the maximum transmit deviation. This stage is provided to trim out tolerances in the following summing stage.

The nominal gain in the AUDIODEV stage is 0 dB with an adjustment range from +3.2 to -2.8 dB in steps of 0.4 dB.

Test mode 14 can be used to adjust the AUDIODEV stage for TX audio.

The transmitted DTMF tone has a separate setting for AUDIODEV in EEPROM. It needs to be adjusted to provide enough gain after the compressor so that the signal does not clip in the compressor.

Summing Amplifier

The summing amplifier is provided to combine the TX audio / DTMF tone, SAT tone and Manchester data into the modulator. The input resistors and feedback resistor for this circuit are external to the ASIC to allow for gain adjustments.

TXSENSE Programmable Gain Stage

The TXSENSE programmable gain stage is an amplifier which is provided to trim out tolerances in the modulator but is currently not used, however set to a default value of 0 dB. This stage has an adjustment range from +3.2 to -2.8 dB with steps of 0.4 dB.

Low Voltage Detect Circuit

A comparator is included in ANTON to provide a reset signal to GUSTAV when the regulated voltage drops below approximately 3.3 V. This circuit is enabled at power up and can be disabled by software to save a small portion of current in standby mode.

RX and TX Sat Circuits

RX SAT Filter

A 6 kHz bandpass filter is included to capture the received SAT tone from the composite received audio signal

RX SAT Schmit Trigger

The filtered SAT signal is then amplified and routed to a schmit trigger circuit in ANTON where it is squared up and driven to GUSTAV as a digital signal.

TX SAT Filter

The TX SAT signal originates in GUSTAV as a digital signal. The TX SAT filter is a 6 kHz bandpass filter for removal of high order harmonics from the signal.

TX SATDEV Programmable Gain Stage

A programmable gain stage SATDEV is provided to adjust tolerances in the summing circuit to maintain the proper signal level to transmit a 6 kHz SAT tone at 1.7 kHz FM deviation. This gain stage is nominally 0 dB with an adjustment range of +4.8 to -4.5 dB in steps of 0.3 dB.

Test mode 22 can be used to adjust SATDEV.

8Kbit/s Manchester Data Circuit

Data Filter

A 20 kHz lowpass filter is provided to limit the frequency components of the digitally generated Manchester data.

Data is transmitted as an 8 kHz signal at 6.2 kHz FM deviation.

DATADEV Programmable Gain Stage

The filtered data signal is routed to a programmable gain stage, DATADEV, for trimming out tolerances in the summing amplifier. The DATADEV gain stage is nominally 0 dB with an adjustment range of +3.2 to -2.8 dB with steps of 0.4 dB.

HandsFree Circuit

ANTON includes rectifier circuits for audio detection in the RX and TX paths.
A single port is provided for the monitoring of the rectified signal.
A switch is software controlled to select the RX or TX path for sampling.
An external capacitor is provided to set the time constant for each path.

Software Design

Power Down Control

All voltage regulators are on all the time when in SLEEP, STAND BY and TRANSMIT mode. The operation modes of ANTON and BERTINDY are software controlled directly from GUSTAV through the serial interface.

Timing and Operation

In the ETACS system it is most important that a well working sleep function can be implemented as this will increase the standby time by several hours.

Main Modes of Operation

The transceiver hardware operation can be split into four main modes: OFF, SLEEP, STAND BY and TRANSMIT.

- OFF is when all regulated power are switched off by the on/off logic. The hardware is powered up when the voltage regulators are enabled. At power-up the 8 MHz clock frequency synthesizer has to be loaded with the correct division ratios and the RAM has to loaded as well. All software controlled circuits have to be initiated and loaded with their default settings, and then powered down by software until needed again.
- SLEEP mode is the lowest operation mode the transceiver can be put in (excl. OFF mode). All receiver, transmitter and audio circuits are put in power down mode or switched off.
- STAND BY mode is the normal data receive mode, where the transceiver can listen to the data signalling from the base station.
- TRANSMIT mode is the normal conversation/data mode.

Power Saving Sleep Function

When in STAND BY mode the transceiver doesn’t have to be awake listening all the time as there are time slots where the transceiver can be put into SLEEP mode.

Software Assignments

Software is loaded via the serial channel through GUSTAV into the Flash EPROM and the main assignments are:

- controller of the hardware circuitry
- communicator with the cellular system via the RF link
- provider and handler of the operating interface to the user
- provider of test and tune commands for factory and field service
- co-ordinator of the overall system (e.g. operating system)
- controller of the battery charging

Technical Specifications

General

Phone Model:	EF738
Type Number:	1030601-BV
System:	ETACS
Frequency Range:	TX: 872 - 905 MHz RX: 917 - 950 MHz
Channel Spacing:	25kHz
Number of Channels:	1320
Modulation:	FM
Frequency Stability:	±2.5ppm
Duplex Spacing:	45MHz
LCD:	One 10 chrs. alphanumeric line One status indicator line (icons)
Keypad:	17 front keys, 2 side keys
Antenna:	quarter-wave
External Antenna Jack:	No
Voltage Operation:	4.8V
Power Consumption:	<590mA at level 2 (full power) <45mA (standby) <30mA (standby with DRX)
Standard Battery Durability:	≈ 80 min. conversation ≈ 22 hours standby
Dimensions:	106 x 50 x 24 mm; 4.17 x 1.97 x 0.94 in
Weight:	70g; 2.5oz (excl. battery) 137g; 4.8oz (incl. standard battery)
Temperature Range:	-10° to +55°C; +14° to +131°F (operating) -40° to +70°C; -40° to +185°F (storage)
Humidity:	0 - 95% relative humidity

Transmitter

RF Power Output:	26.5dBm (level 2)
Output Impedance	50Ω
Spurious Emission (TX):	<-26dBm below 1GHz; <-30dBm above 1GHz

Receiver

RF Level:	≥ -113dBm (20dB SINAB)

Test/Service Programs
Ericsson Mobile Phone EF738

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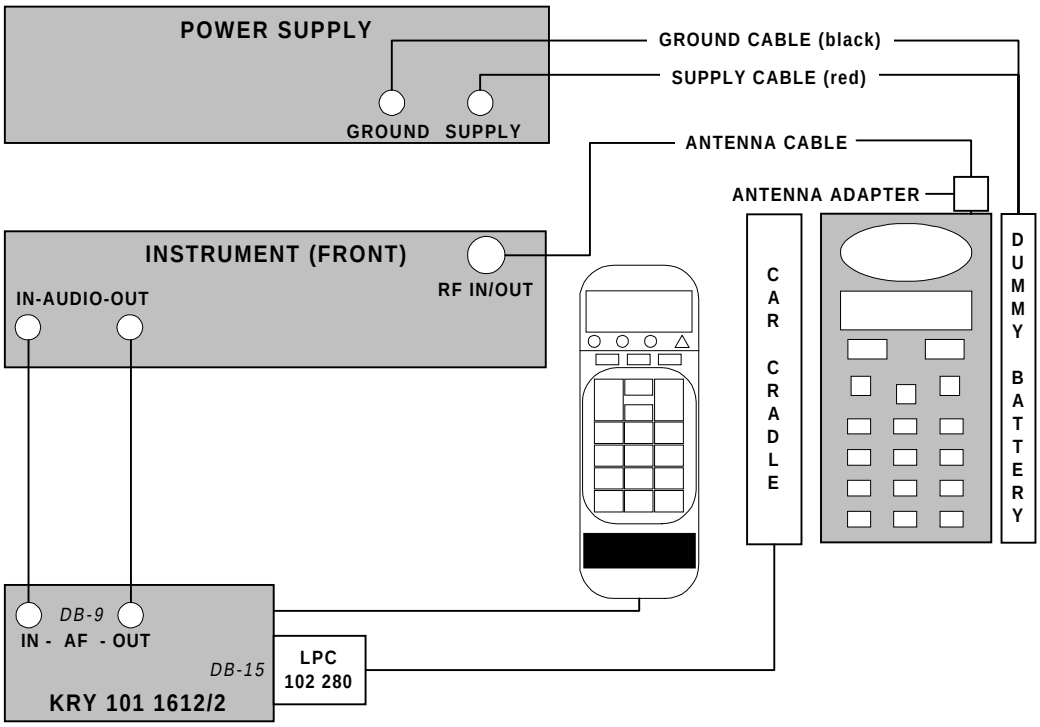
Test Equipment

The type of equipment required for service on the *Ericsson Mobile Phone EF738* is listed below and includes instruments, tools, and other hardware.
Descriptions of the programs for test, service, NAM programming, ESN transfer, and software upgrading are also included in the following subsections.

Recommended Instruments

Instrument	***Recommended Unit***
Alternative 1:	
Radio Test System	Marconi 2960
lternative 2:	
Communication Test Set	Schlumberger 4031
Alternative 3:	
Communications Test Set	Schlumberger 4015
Alternative 4:	
Radio Test Set	Rohde & Schwarz CMS 52
Signalling Unit	Rohde & Schwarz CMS-B13
Other alternatives:	
Oscilloscope	Tektronix 2235
Multimeter	Hewlett-Packard 3468A
Digital Voltmeter	Fluke 8060A
Power Supply Unit	Power Box EK030-10



Other Equipment

Equipment	Ordering Number
ETACS Service Program	
Programming Interface	NTZ 112 311
Connection Cable	KRY 101 1135/10
Adapter	LPC 102 280
Car Cradle	KRY 109 1001/72
Test Handset	NTZ 112 210
Antenna Cable	NTZ 112 294
Antenna Cable Adapter	RNT 403 012/003
Dummy Battery	NTZ 112 310
Service Adapter Kit	
- Test Interface Box	LPC 102 280
- Audio Box	KRY 101 1612/51
- Power Supply 110V	KRY 101 1612/54
- Power Supply 220V	KRY 101 1612/55

Standard tools and soldering equipment must also available

Note: *When servicing mobile telephones, it is most important that a bench earthing network is used to protect sensitive components against electrostatic discharge (ESD).*

Test Program

How to Use

This document will describe the use of the built-in test program for the *EF738*.
After the more extensive descriptions found in *Individual Test Options*, an overview follows in the form of a table with data referring to the different options.
This table will become a handy alternative after having some experience of the test program.

Initiating the Test Program

The test program is initiated from the special test handset;
by holding down the **M** button and pressing **90 40 59** or
by pressing **90 40 59** followed by **M M**

However, if the *Test Program Enter* function is enabled in the telephone, the program can be initiated and run directly from the keypad by pressing the same sequence (**M = MENU**).

When the phone enters the test mode, the hardware becomes initialized and the text *TEST INPUT* appears in the display.

To step forward and backwards in the test program; press SEND and RCL.
To choose a specific test; press its number followed by the **#** button.

Return to TEST INPUT

Press the **C** or **M** button to return to the input mode where the TEST INPUT prompt is displayed.

Exit

To exit from the test program; select **test option 99** and press the **#** button.

Individual Test Options

A list describing the use of the test program options follows below.
A summary of the test options and possible parameter values is given as well.

1 CH NUMBER Setting of channel number
Choose any chanel in the ETACS system (0-600, 1329-2047).
Default setting is channel 1.
To change channel number; enter a 4-digit decimal number followed by **#**.
Use ***** and **#** to step backwards/forwards.
Channel number and signal strength are displayed.

2 TX POWER Sets the transmitter on and offF and determines the output power level.

- **8** off
- **7** power level 7; minimum output power
- **6** power level 6
- **5** power level 5
- **4** power level 4
- **3** power level 3
- **2** power level 2; maximum output power

When the power reduction function is activated in menu 76, power level 2 will be displayed as ‘S’.
When the extra power option in menu 76 is activated, power level 2 will be displayed as ‘X’.

4 FLASHER Used only when loading the program into a terminal.

5 PWR CAL Calibration of power levels.
Transmitter is turned on and tuned to the calibration channel.
Modify the power levels with the following keys:

- **# / *** increases/decreases the power level
- **M+S** stores the value and steps to next power level; transmitter is turned on
- **M+#** starts calibration and displays power level; steps forward to next power level (2->3->...->7->2).
- **C** turns off TX, restores channel no., returns to menu 0.

6 TX DETECT Performs two simple transmitter tests: a general Go/NoGo transmitter test and a transmitter leakage test.
To start the test, press any key except **C**.
The result is displayed when the test is finished:

- **FF** both tests passed
- **01** general transmitter test failed
- **02** leakage test failed

7 TX SENS Factory and level 5 repair only

9 RF CAL Calibrates the RSSI levels based on the level of the signal currently being received.
The value determined for each level is the minimum strength signal for that level, averaged over 16 readings to provide a more reliable value.
The value for level 0 is used to update the Receiver Carrier Detect (RXCD) such that signals below this level are ignored. This value (plus a fixed offset) also determines the minimum signal threshold for the AFC.
When the received signal is below this threshold, the AFC provides TCXO compensation based on a default temperature compensation table.
The values for level 1 and 5 are used to determine the RSSI graph to display.
The values for level 2, 3 and 4 are interpolated from these two reference levels.
M+**#** displays the next RSSI level number and its current value
M+**S** reads an averaged RSSI value and stores it

10 RX SENS Adjustment of the receiver audio output
M+**#** enables calibration and echoes the initial value
/ ***** increases/decreases the value by 1; new value is echoed
M+**S** stores the current value

11 KEYPAD Factory and level 5 repair only

13 BANDGAP Factory and level 5 repair only

14 AUDIO DEV Adjustment of the audio deviation
M+**#** enables calibration and echoes the initial value
/ ***** increases/decreases the value by 1; new value is echoed
M+**S** stores the current value

15 AFC Sets the AFC operating mode and displays AFC information
0 only temperatue compensation
1 temp. + age compensation
2 temp. + age + freq. compensation, smoothed (default)
3 temp. + age + freq. compensation, no smooth
4 no compensation
Any other code entered in handset mode will display:
ABCCDDEEFF where
A = AFC operating mode
0 only temperatue compensation
1 temp. + age compensation
2 temp. + age + freq. compensation, smoothed (default)
3 temp. + age + freq. compensation, no smooth
4 no compensation

B = AFC state
- **1** waiting for signal;
  (no valid RSSI, compensate for temp. or temp. + age)
- **2** acquiring lock;
  (RSSI good, use whole freq. error for 1.5 sec for fast lock)
- **3** locked (RSSI good, use smoothed freq. compensation)
- **4** freeze lock (RSSI temporarily lost, compensate for temp + age + (frozen) freq. error for up to 30 sec.)
- **5** locked using short count;
  (RSSI good, use smoothed freqcompensation);
  only entered when current savings is active;
  short freq. measurements is used to find freq. error compensation
- **6** entered when DRX has started;
  compensate for temp. + age + (frozen) freq. error.

CC total compensation
DD temperature table component
EE age component
FF frequency error component

18 DAC2CAL Calibration of the VCTCXO.
M+**#** enables calibration and echoes the initial value
/ ***** increases/decreases the value by 1; new value is echoed
M+**S** stores the current value
During the calibration the AFC is in 'Temperature only compensation mode' (Tp-15:0)
Upon exiting the calibration the AFC returns to its previously selected operating mode.

19 RX SAT Factory and level 5 repair only

20 AUDIO Sets the audio paths in the audio circuit

Key	*TX-audio*	*RX-audio*
0	muted	muted
1	unmuted	muted
2	muted	unmuted
3	unmuted	unmuted

21 HANDSET Sets the audio paths in the handset.
- **0** microphone off, earphone off, loudspeaker off (default)
- **1** microphone on, earphone on, loudspeaker off
- **2** microphone off, earphone off, loudspeaker on

22 TX SAT Controls the SAT tone switch and TX SAT deviation.
- **0** generate 5970 Hz SAT
- **1** generate 6000 Hz SAT
- **2** generate 6030 Hz SAT
- **3** no SAT generated
- **4** SAT tone switch setting = ON
- **5** SAT tone switch setting = OFF

M+**#** enables calibration and echoes the initial value
/ ***** increases/decreases the value by 1; new value is echoed
M+**S** stores the value

23 MANCH OUT Controls the wideband data and deviation
To transmit these data the transmitter must be switched on.
0 off - no data output)
1 8kHz output; ones
2 8kHz output; zeros
3 hardcoded idle frame; 0101010101
M+**#** enables calibration and echoes the initial value
/ ***** increases/decreases the value by 1; new value is echoed
M+**S** stores the value

24 MANCH IN Displays the latest received data from the base station.
The value is displayed each time a key is pressed.

25 VOLUME Sets the earpiece and loudspeaker volume.
Possible values: 0 - 7 (default: 3)

26 DTMF DTMF tones consist of a lower frequency in combination with a higher frequency.
The test enables listening to either or both as follows:
0 low frequency
1 high frequency
2 both frequencies.
/ ***** scroll forwards/backwards to next/previous DTMF tone
M+**#** enables calibration and echoes the initial value
/ ***** increase/decrease the value by 1; new value is echoed
M+**S** stores the value

27 TX SOURCE Sets the TX audio paths in the audio circuit.
Also possible to adjust the levels of the different audio paths.
0 external line input, ATMS (default)
1 internal MIC
2 internal MIC with MicAmp gain
M+**#** enables calibration and echoes the initial value
/ ***** increases/decreases the value by 1; new value is echoed
M+**S** stores the value

28 EARPIECE Sets the earpiece mute switch in the audio circuit to allow for adjustment of the earpiece sensitivity values.

0 internal earpiece disconnected
1 internal earpiece connected
2 audio sent out AFMS on system connector (default)
internal earpiece and AFMS can both be adjusted
M+**#** enables calibration and echoes the initial value
/ ***** increases/decreases the value by 1; new value is echoed
M+**S** stores the value

29 COMP Selects compander or linear mode
M+**#** displays the current compander settings
M+**0** linear mode (default)
M+**1** companding mode

30 HF Controls the handsfree attenuation level for RX and TX audio

- **M+0** selects RX handsfree audio gain settings and echoes initial gain settings
- **M+1** selects TX handsfree audio gain settings and echoes initial gain settings
- **0-7** sets the gain for the selected path: 0=0dB, 1=-7dB, 2= -14dB, ... 7=-49dB

32 SOFTLIMIT Sets the use of the softlimiter in the audio circuit. Changes made are temporary and will not update the EEPROM.

35 COUNTRY Factory and level 5 repair only

36 BER Factory and level 5 repair only

37 OMC Factory and level 5 repair only

38 ADC Displays the different hex values from the ADC

- **M+1** RSSI
- **M+2** battery voltage
- **M+3** unused
- **M+4** temperature sense
- **M+5** bandgap reference
- **M+6** current sense
- **M+7** handsfree level

39 DAC Changes temporarily the output voltage from the DAC.

- **M+1** normally controlled by AFC
- **M+2** normally trimmed using ‘MENU 18’
- **M+3** power level
- **xxx M+#** decimal value followed by ‘MENU + #’ sent directly to the active DAC (valid values: 000 - 255)
- **# / *** increases/decreases value by 1; new value is echoed

40 INPORT Shows the status of the different inports (updated every second)

- **M+1** external audio connection detected
  0 = input high
  1 = input low
- **M+2** state of CPU port 2
- **M+3** flip status
  0 = flip closed
  1 = flip open
- **M+4** transmitter status
  0 = transmitter off
  1 = transmitter on
- **M+6** external handsfree detected
  0 = input low
  1 = input high
- **M+7** receiver carrier detect
  0 = RSSI < sensitivity limit
  1 = RSSI > sensitivity limit
- **#** immediately reads the selected port

41 OUTPORTS Shows the status of the selected outport
First select a digital outport:
M+1+0 VRX
M+1+1 VTX, **Note!** VRX must be on!
M+1+2 power down VCO
M+1+3 unused
M+1+4 SWDC
M+1+5 MPD2
M+1+6 FMPD1
M+1+7 unused
M+1+8 temperature
M+2 ICTRL
M+3 MUTE
M+4 green LED
M+5 red LED
M+6 back light
Then select the state:
0 set output low
1 set output high

42 DSCR Turns the discriminator and multiplier on and off
0 discriminator off
1 discriminator on (default)

43 BAR Tests the different tones of the phone
0 continous ringing signal at maximum volume
1 continuos alarm signal
2 click signal single pulse
3 error signal single pulse
4 continuous 3kHz ringing tone

45 LCD Tests the different segment and icons of the display as five different patterns
M+digit (1-5) shows the selected pattern no. (1-5)
shows all patterns continuously starting with pattern no. 1
C or **S** terminates the test

46 PWR DOWN Factory and level 5 repair only

47 SW REV Displays the software, revision and ESN inside the terminal.
Press any key to show software name and revision.
Additional pressure of any key will show the ESN.

48 SYNTH Factory and level 5 repair only

49 RX PWR MODE Factory and level 5 repair only

50 GUARANTEE Press any key to display year and month when warranty/guarantee was activated and the length (months)of the warranty period

53 SYNT I SET Factory and level 5 repair only

54 EEPROM INIT Factory and level 5 repair only

60 SYNTH	Factory and level 5 repair only
61 AUDIO CIRCUIT	Factory and level 5 repair only
62 RADIO CTRL	Factory and level 5 repair only
74 TCA TEST	Checks the ETACS combining algorithm
76 BATT SAVE	Controls the reduced and extra power functions **0** off **1** power reduction invoice channel (power level 2 only) **2** extra power (power level 2 only)
77 EEDATA	Factory and level 5 repair only
79 PIN	Factory and level 5 repair only
91 EEPROM DUMP	Factory and level 5 repair only
92 EEPROM LOAD	Factory and level 5 repair only
96 COLD START	Clears the RAM, exits service & test mode, and powers up in 'terminal charge only mode' **#** exit service & test mode; power up in normal mode **M**+**#** exit service & test mode; power up in charge only mode
97 FLASH CHSUM	Calculates the checksum of the flash memory **#** 2 bytes checksum will be displayed
98 ERROR	Factory and level 5 repair only
99 EXIT	Press # to exit the service program

Overview of the Test Program

Menu	*Possible Values*
1 CH NUMBER	0-600, 1329-2047
2 TX POWER	8 (off) - 2 (maximum power)
4 FLASHER	only used when loading program into terminal
5 PWR CAL	calibration of power levels
6 TX DETECT	simple test of transmitter
7 TX SENS	factory and level 5 repair only
9 RF CAL	RSSI calibration
10 RX SENSE	adjustment of receiver audio output
11 KEYPAD	factory and level 5 repair only
13 BANDGAP	factory and level 5 repair only
14 AUDIO DEV	adjustment of maximum audio deviation
15 AFC	sets AFC operating mode and displays AFC information
18 DAC2CAL	calibration of VCTCXO
19 RX SAT	factory and level 5 repair only
20 AUDIO	sets audio paths in audio circuits
21 HANDSET	sets audio paths in handset
22 TX SAT	controls SAT tone switch and TX SAT deviation
23 MANCH OUT	controls wideband data and deviation
24 MANCH IN	displays latest received data from base station
25 VOLUME	sets earpiece and loudspeaker volume
26 DTMF	DTMF tones
27 TX SOURCE	sets TX audio paths in audio circuit
28 EARPIECE	sets earpiece mute switch in audio circuit
29 COMPAND	selects compander/linear mode
30 HF	controls handsfree attenuation level for RX and TX audio
32 SOFTLIMIT	sets use of softlimiter in audio circuit
35 COUNTRY	factory and level 5 repair only
36 BER	factory and level 5 repair only
37 OMC	factory and level 5 repair only
38 ADC	displays different hex values from ADC
39 DAC	changes temporarily output voltage from DAC
40 INPORTS	shows status of different inports

Menu	*Possible Values*
41 OUTPORTS	selects status of selected outport
42 DISCR	turns discriminator/multiplier on/off
43 BAR	tests different tones of phone
45 LCD	tests different segments and icons of display
46 PWR DOWN	factory and level 5 repair only
47 SW REV	displays software, revision and ESN inside terminal
48 SYNTH	factory and level 5 repair only
49 RX PWR MODE	factory and level 5 repair only
50 GUARANTEE	warranty information
53 SYNT I SET	factory and level 5 repair only
54 EEPROM INIT	factory and level 5 repair only
60 SYNTH	factory and level 5 repair only
61 AUDIO CIRCUIT	factory and level 5 repair only
62 RADIO CTRL	factory and level 5 repair only
74 TCA TEST	checks ETACS combining algorithm
76 BATT SAVE	controls reduced and extra power functions
77 EEDATA	factory and level 5 repair only
79 PIN	factory and level 5 repair only
91 EEPROM DUMP	factory and level 5 repair only
92 EEPROM LOAD	factory and level 5 repair only
96 COLD START	powers up in ‘terminal charge only mode’
97 FLASH CHSUM	calculates checksum of flash memory
98 ERROR	factory and level 5 repair only
99 EXIT	press # to exit service program

ETACS Service Program

The *ETACS Service Program* is a tool used for entering the initializing customer parameters into the EEPROM of the Ericsson mobile phone *EF738*.

This description of the *ETACS Service Program* includes information on:

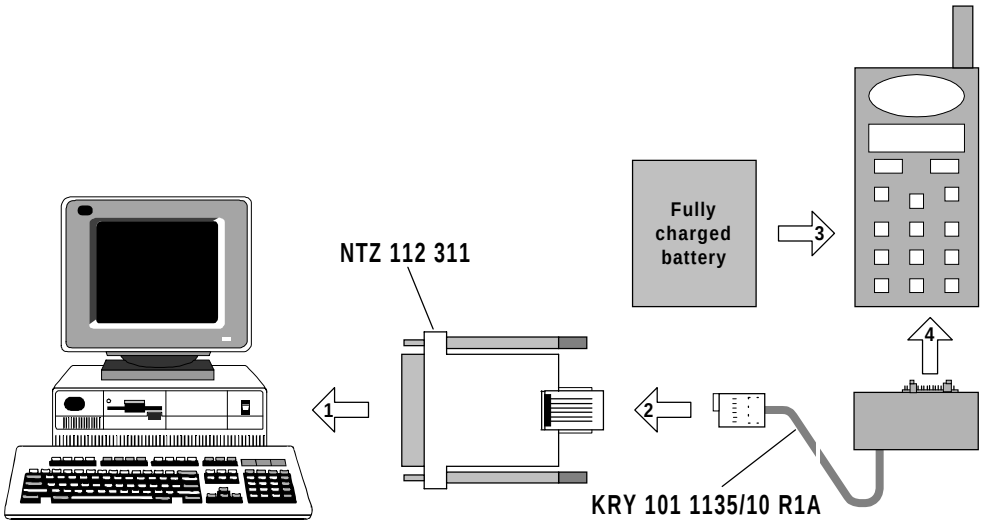
- hardware requirements
- software setup
- programming instructions

Hardware Requirements

The following equipment is required when using the *ETACS Service program* for the *EF738* Ericsson mobile phone:

- PC with Windows 3.1 or Windows 95 operating system
- COM port (COM1 - COM2) available on the PC
- Programming cable, KRY 101 1135/10 R1A
- Programming interface, NTZ 112 311
- Adapter, 25- to 9-pin; for PC equipped with a 9-pin COM-connector (not supplied by Ericsson)

.



Software Installation

The *ETACS Service Program* consists of four files:

- SPEP1361.EXE
- TYPE1361.CFG
- TYPE1361.EDT
- TYPE1361.MNU

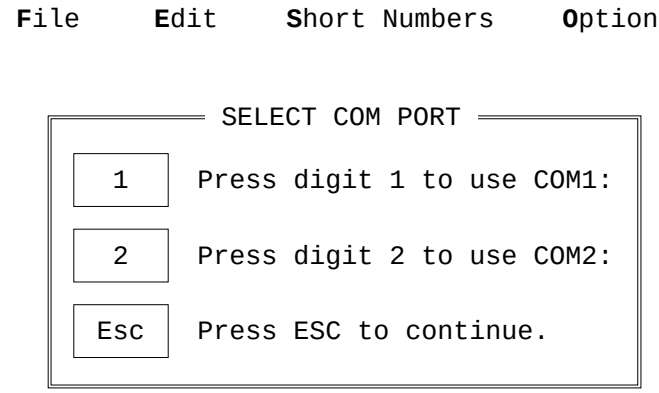
The program can be run directly from a diskette, but it is adviseable to have it run from the hard disk.
Simply install the software on the hard disk by copying the contents of the diskette to a suitable directory on the hard disk.

The copying of files mentioned above describes how to install the *ETACS Service Program* from a standard floppy disk, but the program may become distributed in other media formats.

CAUTION!
Use a fully charged phone battery, since the interface is powered by the phone. Using an even slightly discharged battery may result in misreadings, even if the Low Battery warning has not yet appeared.

Starting the Program

Turn the phone On.
Start the program by double-clicking the file **SPEP1361.EXE** in the File Manager / Explorer, and the following picture appears on the screen:

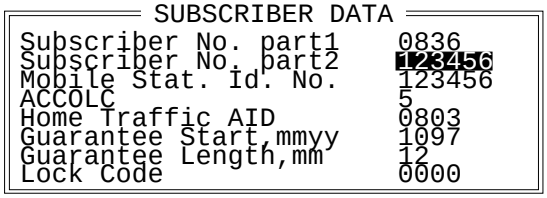


Select the serial port (COM1 or COM2) where the programming interface is connected, as instructed on the screen.

The Programming Cycle

Details of the different entries are given in ‘Using the Menus’.
Below is a brief description of the main events.

After selection of the COM port the *Subscriber Data* editing window is automatically displayed. Most customers will require data to be entered in this window only. Move the cursor by the arrow keys of the PC, or click the mouse on the respective field of the window.
Press the **Esc** key to return to the main menu on the top row of the screen.



The service program will fetch ‘today’s date’ from the system clock of the PC. Check and (if necessary) correct the date before starting the programming.

When ready to program the telephone, i.e. transfer data into the EEPROM:

- Press **F2** while keeping the **ALT**-key depressed (**ALT+F2**)
- Confirm by pressing the **Y**-key

After the programming the result can be verified by pressing **ALT+F3**.

To exit the program, press **ALT**+**X**.

Using the Menus

How to Select

Press **Esc** to reach the menu.
From a 'Data edit window' it is also possible to go directly to a sub-menu by holding down the **ALT** key and pressing the highlighted letter in the main menu, e.g. **ALT+F** to go to *File* functions.

Move the selection bar (reverse video) to the left or right by the keypad arrow keys to select a sub-menu and press **Enter** to open it. The functions in the sub-menu are selected by moving the selection bar up or down using the arrow keys.
Press **Enter** to activate the selected function, or **Esc** to return to the main menu.

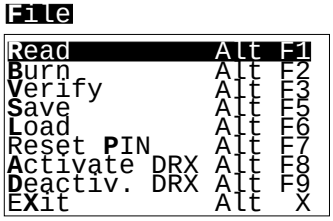
Sub-menus and functions can also be reached by clicking with the mouse.

The Functions

NOTE! Defaults are printed in *italic*.

File

The ‘File’ sub-menu includes the functions listed below:



Read Transfers the contents of the EEPROM to the computer memory. **CAUTION!** When using this function, make sure to reload the configuration file before programming other phones, as incorrect data inadvertently might be programmed.

Burn Programs the phone with the Subscriber, Country and System data that has been entered into the PC memory.

Verify Comparison between the PC memory and the phone.

Save This command has two different functions:

1. Creates a configuration file which is automatically loaded at each program start.
   The file name must be manually changed to **TYPE1361.CNF**.
   All data from the edit windows are saved**.**
   Guarantee Start is set to ‘today's date’ by the system clock.
2. Saves the data in the phone before service.
   Data in the edit windows is saved if the file name is other than TYPE1361.CNF.
   Default name is STATION1.SAV.

Load Reloads a configuration file.

Reset PIN Resets the PIN to 0000.

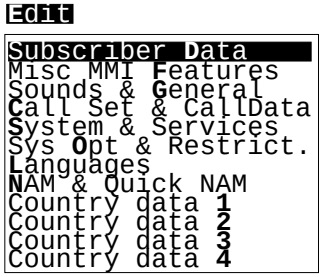
Activate DRX Activates the Discontinuous Reception feature.
CAUTION! May deteriorate the performance of the phone, if DRX is not supported by the system

Deactivate DRX Deactivates the Discontinuous Reception feature.

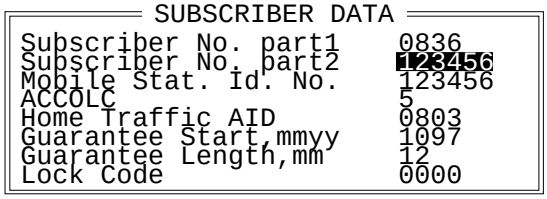
Exit Quit the program.

Edit

When leaving the ‘File’ menu the ‘Subscriber Data’ edit window is displayed. After pressing **Esc** the ‘Edit’ sub-menu is reached and the editing windows listed below can be accessed*:*



SUBSCRIBER DATA



Subscriber No. Part 1/Part 2
The Subscriber No. (shown in certain menues and at power on) is information intended for the user and is not used by the system.

Mobile Station Identification No.
The 6 least significant digits of the international mobile station number, usually identical to the 6 least significant digits of the subscriber number.

ACCOLC
The Access Overload Class is normally the second last digit of the Mobile Station Identification No.

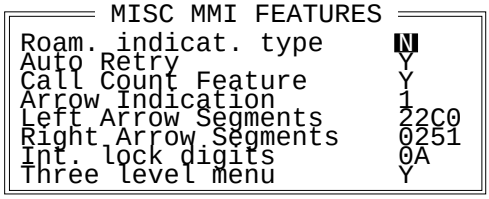
Home Traffic AID
The Home Traffic Area Identification is entered as a hexadecimal code.

Guarantee Start, mmyy
Is read from the PC's system clock at program start, but can be manually altered.

Guarantee Length, mm
To be used in conjunction with the Guarantee Start.

Lock Code
The subscriber's four-digit lock code which must initially be set to *0000* to comply with the information of the User's Manual.

MISCELLANEOUS MMI FEATURES



Roaming Indicator Type
Y = Icon flashing
N = Icon steady on

Auto Retry
Y = Enables Automatic Retry when network is busy
N = Disables Automatic Retry when network is busy

Call Count Feature
Y = Enables registration of unanswered incoming calls
N = Disables registration of unanswered incoming calls

Arrow Indication
0: no arrow is displayed
1: one arrow is displayed
2: one arrow followed by hyphen is displayed

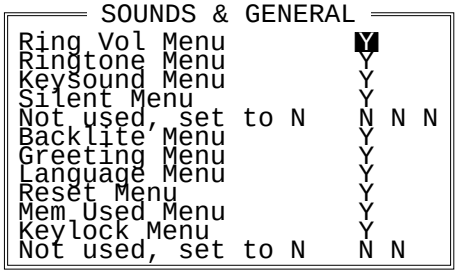
Left Arrow Segments
Layout of Left Arrow Segments: $22C0_{HEX}$, (not to be changed)

Right Arrow Segments
Layout of Right Arrow Segments: 0251_{HEX}, (not to be changed)

International Lock Digits
No. of digits as hex. code to define the minimum length of an international phone number

Three Level Menu
Y = 3-level user menu structure is set to comply with the User's Manual
N = 2-level user menu structure

SOUNDS & GENERAL



Ring Volume Menu
Y = Ringing volume selection 'Low/Med/High/Step/Silent' enabled
N = Ringing volume selection disabled.

RingTone Menu
Y = Ringing tone selection 'Low/Med/High/Mixed/Scale/Fast/Melodies' enabled
N = Ringing tone selection disabled.

KeySound Menu
Y = Key sound selection 'Burst/Continuous/Click/Silent' enabled
N = Key sound selection disabled

Silent Menu
Y = Silent Mode selection 'Off/On' enabled
N = Silent Mode selection disabled

BackLite Menu
Y = Backlight selection 'Off/On 10sec/On 20sec' enabled
N = Backlight selection disabled

Greeting Menu
Y = Greeting String (at power on) choice enabled
N = Greeting String disabled

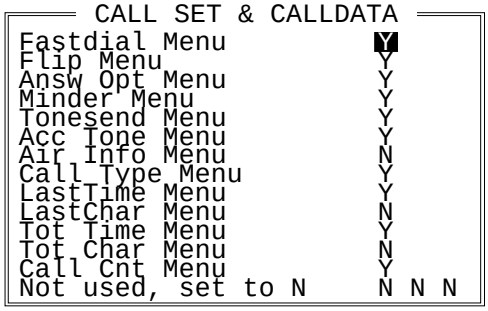
Language Menu
Y = Language selection 'English/Espanol/Italiano/Deutsch/Melayu' enabled
N = Language selection disabled

Reset Menu
Y = Reset option 'Reset All' enabled
N = Reset option disabled

Memory Used Menu
Y = Memory Used Menu is accessable
N = Memory Used Menu not accessible

KeyLock Menu
Y = Key lock selection 'Unlock/Lock' enabled
N = Key lock selection disabled

CALL SET & CALL DATA



FastDial Menu
Y = Fast Dial (one-key-dial) *selection 'Off/On' enabled*
N = Fast Dial selection disabled

Flip Menu
Y = Flip (answer/end-call) *selection 'Off/On' enabled*
N = Flip answer/end-call disabled

Answering Option Menu
Y = Answering method selection 'Any Key/Send Only' enabled
N = Answering method selection disabled

Minder Menu
Y = Minder (minute beep) *selection 'Off/On' enabled*
N = Minder selection disabled

Tone Send Menu
Y = Tone Send (DTMF when key pressed during call) *selection 'Off/On' enabled*
N = Tone Send selection disabled

Access Tone Menu
Y = Access Tone (outgoing call established) *selection 'Off/On' enabled*
N = Access Tone selection disabled

Air Info Menu
Y= Air Info (duration or charge) display selection 'Air Time/Call Charge' enabled
N = Air Info disabled

Call Type Menu
Y = Call Type charge (out or out/in) *display selection 'Only Out/Out and In'enabled*
N = Call Type charge display selection disabled

Last Time Menu
Y = Last Time (duration of last call) *display selection enabled*
N = Last Time display selection disabled

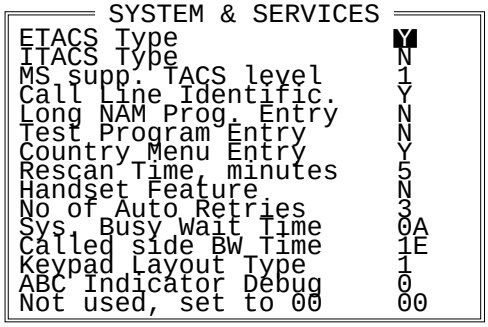
Last Charge Menu
Y = Last Charge (no. of charge units for last call) display selection enabled
N = Last Charge display selection disabled

Total Time Menu
Y = Total Time (since counter reset) *display selection enabled*
N = Total Time display selection disabled

Total Charge Menu
Y = Total Charge (since counter reset) display selection enabled
N = Total Charge display selection disabled

Call Count Menu
Y = Call Count (no. of in/out-going calls since reset) *display selection enabled*
N = Call Count display selection disabled

SYSTEM & SERVICES



ETACS Type
Y = Phone is an ETACS type
N = Phone is a TACS only type

ITACS Type
Y = Phone is an ITACS type
N = Used in combination with ETACS type

Mobile Station supported TACS level
0: if TACS
1: if TACS-2

Calling Line Identification
Y = Calling Line Identification functions enabled
N = Calling Line Identification functions disabled

Long NAM Programming Entry
Y = User access to the NAM menu is enabled
N = User access to the NAM menu is disabled

Test Program Entry
Y = The test program is accessed by entering a code on the keypad
N = The test program cannot be accessed from the keypad

Country Menu Entry
Y = User access to the Country Menu is enabled
N = User access to the Country Menu is disabled

Rescan Time, minutes
No. of minutes until a Rescan is started (default: *5 minutes*) after signalling

Handset Feature
Y = Handset Feature enabled
N = Handset Feature disabled

No. of Auto Retries
Max. number of Automatic Retries (default: *3*)

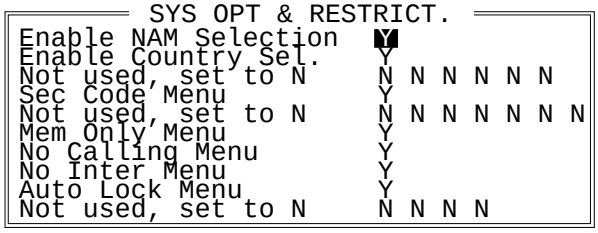
System Busy Wait Time
Time between attempts in Auto Retry when system is busy (default: $0A_{HEX}$)

Called Side Busy Wait Time
Time between attempts in Auto Retry when called number is busy (default: $1E_{HEX}$)

Keypad Layout Type
0: Not applicable
1: New international alpha keypad layout

ABC Indicator Debug
Enables the use of special indicators, ‘ABC’, for internal tests:
0: not used
1: NAM system indication
2: Accessory indication
3: Data/Voice mode
4: TX power indication
5: Power save indication

SYSTEM OPTIMIZATION & RESTRICTIONS



Enable NAM Selection
Y = NAM selection enabled
N = NAM selection disabled

Enable Country Selection
Y = Country selection enabled
N = Country selection disabled

Security Code Menu
Y = Security Code (4-digit personal code) *Menu is accessible*
N = Security Code Menu not accessible

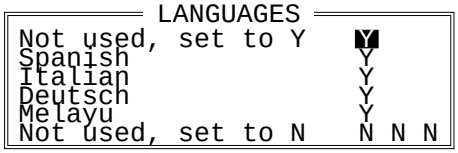
Memory Only Menu
Y = Memory Only (calls from mem. pos. 1-10 only) *Menu is accessible*
N = Memory Only Menu not accessible

No Calling Menu
Y = No Calling (receive only) *Menu is accessible*
N = No Calling Menu not accessible

No Inter Menu
Y = No Inter (no international calls) *Menu is accessible*
N = No Inter Menu not accessible

Auto Lock Menu
Y = Auto Lock (phone locked at power-up) *Menu is accessible*
N = Auto Lock Menu not accessible

LANGUAGES



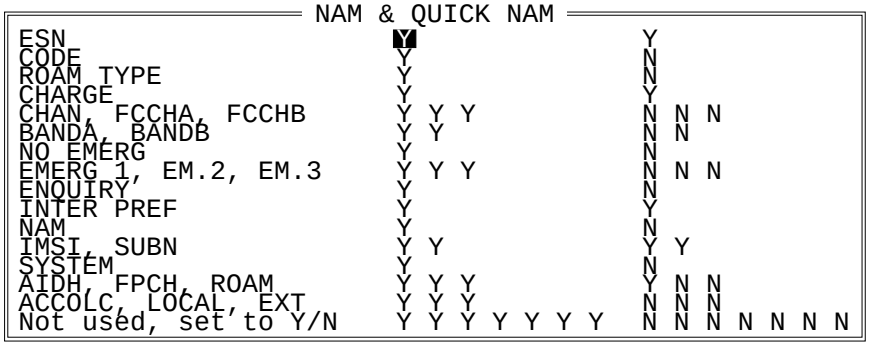
Spanish
Y = Spanish language selectable
N = Spanish language not selectable

Italian
Y = Italian language selectable
N = Italian language not selectable

Deutsch
Y = German language selectable
N = German language not selectable

Melayu
Y = Malayan language selectable
N = Malayan language not selectable

NAM & QUICK NAM



The table above displays the various programmable parameters for:

- NAM programming (center column)
- Quick NAM programming (right column)

By entering a Y, the parameter becomes accessible for programming.
By entering a N, the parameter becomes not accessible for programming.

The default settings for the accessibility of the NAM and Quick NAM parameters are as listed in the table above.

For more detailed information, refer to ‘Keypad NAM Programming’ which is found further on in this section.

COUNTRY DATA

The example below shows one out of four country dependent data tables.
The parameters are identical for all countries, but the settings will vary.

COUNTRY DATA 1

Country Name	UK	
CC Data, System A B	0023 21	0323 21
Station Class Mark	13	
Enquiry Number	3 192	
No of Emergency No.s	2	
Emergency no. 1	3 999	
Emergency no. 2	3 112	
Emergency no. 3	0	
Intern. Prefix Info	2 00	
NAM User Selectable	Y	N
Subscriber No.	0836123456	0836123456
Mobile Stat. Id. No.	123456	123456
ACCOLC, AID	5 0803	5 0803
Inter System Roaming	N	N
System	A	A
First Paging Channel	0023	0023
Country & Netw. Code	234 A	234 A
Send Ext. MS Number	N	N
Resp. to Local Mess.	N	N

Country Name
If the Country Name contains less than ten letters, remaining positions can be blank.

CC Data, System A B
First control channels and the number of control channels for system A and B.
Values are to be entered in decimal form.

Station Class Mark
The Station Class Mark is always set tot 13_{HEX}.

Enquiry Number
The number of digits of the Enquiry Number and the actual Enquiry Number.

No. of Emergency Numbers
The total number of available Emergency Numbers.

Emergency No. 1
The number of digits of the Emergency Number and the actual Emergency Number.

Emergency No. 2
As Emergency No.1, if available, otherwise set to 0.

Emergency No. 3
As Emergency No.1, if available, otherwise set to 0.

International Prefix Information
The number of digits of the International Prefix and the actual International Prefix.

NAM User Selectable
Y = NAM can be selected by the user
N = NAM cannot be selected
Note! First NAM must always be enabled

Subscriber No.
The Subscriber Number is a max. 10-digit number from which the user may want only part of it to be displayed.
Enter **A** for 10-digit display, or
enter **0** to **9** for the reduced number of digits, counted from the end digit.
The Subscriber No. is information aimed for the user and is not used by the system.

Mobile Station Identification No.
The 6 least significant digits of the international mobile station number, in most countries equal to the 6 least significant digits of the subscriber number.

ACCOLC, AID
The Access Overload Class, normally the last digit of the Mobile Station Id. No., followed by the Home Traffic Area Identification entered as hex. code.

Inter System Roaming
Y = Inter System Roaming enabled
N = Inter System Roaming disabled

System
A = System A is the home system in the NAM
B = System B is the home system in the NAM

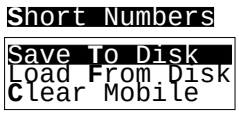
First Paging Channel
First paging channel in the present NAM to be entered in decimal form.

Country & Network Code
Mobile Country Code (3 digits), followed by Mobile Network Code (1 digit), for the present NAM.

Send External Mobile Station Number
Y = Phone must send the extended address word when accessing the system
N = Extended address word not required when accessing the system

Response to Local Message
Y = Phone must respond to local control messages sent on the FOCC
N = Response not required to local control messages sent on the FOCC

Short Numbers



Save To Disk Reads the short numbers from the telephone and transfers them to a file, see below.

Load From Disk Reads short numbers from a file and stores (burns) them in the phone.

Clear Mobile Clear all short numbers in the phone.

Options

COM Port Possible to change the COM-port whithout leaving the program, for example, when having programming interfaces connected to both COM-ports.

Re-Programming a Telephone

When making changes to a telephone that has already been programmed, first read the EEPROM by pressing **ALT+F1**.
Then perform the desired changes and program the EEPROM by pressing **ALT+F2**.
Verify by pressing **ALT+F3**.

Note: Make sure that the configuration file has been reloaded before programming other phones. Otherwise incorrect data may inadvertently be programmed.

Contents of Saved Short Number Files

The ‘Save’ file is a normal text file which may be edited by any word processor or text editor as an ASCII text file. It is possible to create a file independently from the program, and then use the program for transfer to the telephone. The file does not have to list the short numbers in any particular order, and it is not necessary to supply all 99 numbers.

For example, it is possible to create a file with only three short numbers at pos. 21, 22, and 23, and add these to a phone that already has some numbers programmed.

Each line of the file should have the following form:

1. Two digits representing the Short Number positions from 01 through 99.
2. Name of the subscriber, maximum 10 characters, letters and digits.
3. Telephone number of no more than 16 or 32 characters (system dependent). Digits 0 - 9, *** ,** and **#** are allowed.

Example:

01 ERICSSON 0094646193000
02 JOHN DOE 12345678
03 TRANSFER *21*9171234567#

Lines containing the positions only will erase the shortcodes, for example:
04
05
06

A line containing text only ‘NO NUMBERS’ is a comment and will not cause any programming of the telephone.

Keypad NAM Programming

The *Keypad NAM (Number Assignment Modules) Programming* includes not only the NAM parameters but also some functionally related parameters as well as country dependent parameters.

Two different *Keypad NAM Programming* modes are available:

- Long NAM (non-user selectable by default)
- Quick NAM (always selectable)

A list of the available programmable parameters, programming instructions, and country-related default values for Long resp. Quick NAM follows.

Long NAM Programming

Programmable Parameters

Electrical Serial Number (ESN)
The ESN, which is a unique binary number that identifies the MS to the cellular system, is set by the factory and can not be modified.

Security Code
This code gives the user access to protected memory locations, resetting of menus, and setting of call restrictions.

Roam Type
The roaming indicator can be set in three different modes: off, flashing, steady-on.

Subscription with Charge Rate
This parameter determines whether AirTime/CallCharge is selectable by the user.

Number of Channels
Defines the allowed number of channels according to the frequency band.

First Dedicated Control Channel in System A
This control channel number can be programmed in service mode for internal tests.

First Dedicated Control Channel in System B
This control channel number can be programmed in service mode for internal tests.

Total Number of Dedicated Control Channels in System A
Maximum number of dedicated control channels in System A.

Total Number of Dedicated Control Channels in System B
Maximum number of dedicated control channels in System B.

Number of Emergency Numbers
Determines the number (≤3) of available emergency numbers for the country.

Emergency Number 1
States the first emergency number.

Emergency Number 2
States the second emergency number (if exists).

Emergency Number 3
States the third emergency number (if exists).

Enquiry Number
States the enquiry number

Country International Prefix
Prefix required when dialing an international call.
This parameter detects an international call at call restrictions.

NAM
Each country area is subdivided into NAM-areas NAM1 and NAM2, which are programmed with System A and System B parameters when shipped from factory.
A configuration of system and subscriber data (preferred system, subscriber number, etc.) can be programmed into each NAM.

International Mobile Station Identity (IMSI)
This IMSI identity is a 10-digit number composed of three parts:
- MNC (Mobile Network Code), 3 digits
- MCC (Mobile Country Code), 1 digit
- MSIN (Mobile Station Identification Number), 6 digits

Subscriber Number
The subscriber number may include from 0 up to 10 digits.

Pref Sys
Both NAMs associated with each country are programmable to become operable in both systems. If both systems are programmed as System A, the automatic NAM switch function will search the A system channels for both NAMs.

Home System Identity Number (AID)
This identity number states the subscriber home system and is provided by the subscription operator.

First Paging Channel
The first paging channel is programmed in service mode and the appropriate value for this parameter is provided by the home system operator at subscription.

Roam
This parameter defines whether inter system roaming is allowed on the complementing network or not. If set, it will enable the use of both systems (A and B) in the present NAM.

Access Overload Class
Overload class field that controls access attempts made by the MS (identical to the second last digit of the IMSI).

Response to Local Control Message Enabled
Determines whether the MS will respond to Local Control Messages sent on the Forward Control Channel.

Sending of Extended MS Number
Determines whether the MS must send the extended address word when accessing the system.

Programming Instructions

To enter the Long NAM Programming mode:

- press **9 2 3 8 8 5**, **MENU**, **MENU** or
- keep the **MENU** key depressed while pressing **9 2 3 8 8 5**

After entering the Long NAM Programming mode, the phone exits the Standby mode, turns off the radio, and becomes non-operational.

Key Functions

Key	Function
MENU	Saves value and steps forward
↑	Saves value and steps forward
↓	Saves value and steps backwards
MEM	Moves to beginning of present menu
*	Moves to beginning of NAM submenu (when in NAM menu)
#	Moves to beginning of Long NAM Programming menu
CLR	Returns to previous value
0-9	Entry of numbers and toggling of values
End/Pwr/No	Exit from Long NAM Programming mode

NOTE! Due to the limited amount of display characters, some parameters will be displayed as two parts, an intro text shown for 1 second followed by the numeric data (indicated as two text rows in the *Display*-column below).

Menu Type	Display	Menu	Action
ESN (Electrical Serial No.)	ESN 1 2 3 1 2 3 4 5 6 7 8	1	3 most significant digits shown 1 sec; Remaining digits shown thereafter
Security code	CODE 0 0 0 0	2	Code shown (set in menu mode)
Roam type	ROAMTYPE 0	4	Press '0-9' to switch 'ROAMTYPE1'
Subscription with charge rate	CHARGE OFF	5	Press '0-9' to switch 'CHARGE ON'
Number of channels	CHAN 1 3 2 0	6	Press '0-9' to switch 'CHAN 600'
1st dedicated control channel in System A	FCCHA 0 0 2 3	7	Enter number (0000-0600,1329-2047) incl. leading zeroes
1st dedicated control channel in System B	FCCHB 0 3 2 3	8	Enter number (0000-0600,1329-2047) incl. leading zeroes
Total no. of dedicated control channels in System A	BANDA 0 0 2 1	9	Enter 4-digit number incl. leading zeroes
Total no. of dedicated control channels in System B	BANDB 0 0 2 1	10	Enter 4-digit number incl. leading zeroes
No. of emergency numbers	NO EMERG 1	11	Enter digit 0-3
Emergency number 1	EMERGENCY1 9 1 1	12	Enter max. 10 digits, press 'MENU' or '↑' to go to next emerg. no, if any
Enquiry number	ENQUIRY 9 1 2	13	Enter a number with max. 10 digits
Country international prefix	INTER PREF 0 7	14	Enter a number with max. 4 digits
NAM	NAM 1	15	Press '0-9' to switch 'NAM2'
International Mobile Station Identity Number (IMSI)	IMSI 1 1 1 1 1 1 1 0 1 1 1	16	Enter a 10-digit number
Subscriber number	SUBNUMBER1 1 1 1 1 1 1 0 1 1 1	17	Enter a max. 10-digit number
Pref Sys	SYSTEM1 A	18	Press '0-9' to switch 'SYSTEM1 B'
Home system identity number (AID)	AID1 0 0 0 0 0	19	Enter a number (00000-32767) incl. leading zeroes
1st paging channel	FPCH1 0 0 2 3	20	Enter a number (000-600,1329-2047) incl. leading zeroes
Roam	ROAM1 ON	21	Press '0-9' to switch 'ROAM1 OFF'
Access overload class	ACCOLC1 0 1	22	Enter two digits (00-15). Default = 0 + second last IMSI digit
Response to local control message enabled	LOCAL 1 ON	23	Press '0-9' to switch 'LOCAL1 OFF'
Sending of extended MS number	EXT1 ON	24	Press '0-9' to switch 'EXT1 OFF'

Default Values

Parameter	Austria	China	Hong Kong	Ireland	Italy	Malay-sia
ESN (Electrical Serial No.)						
Security code	0000	0000	0000	0000	0000	0000
Roam type	0	0	0	0	0	0
Subscription with charge rate	off	off	off	off	off	off
Number of channels	1320	1320	1320	1320	1320	1320
1st dedicated control chan-nel in System A	0023	0023	1996	0023	0023	0023
1st dedicated control chan-nel in System B	0323	0323	0323	0323	0323	0323
Total no. of dedicated control channels in System A	0021	0021	0021	0021	0021	0021
Total no. of dedicated control channels in System B	0021	0021	0021	0021	0021	0021
No. of emergency numbers	3	2	3	2	3	2
Emergency number 1	122	110	112	999	116	999
Emergency number 2	133	119	110	112	113	112
Emergency number 3	144		119		112	
Enquiry number	11611		108	192		103
Country international prefix	00	00	00	00	00	00
NAM						
International Mobile Station Identity Number (IMSI)	232 0 123456	460 0 123456	454 2 123456	234 0 123456	222 2 123456	502 0 123456
Subscriber number	0000 123456	0836 123456	90 123456	0836 123456	0337 123456	0000 123456
Pref Sys	A	A	A	A	A	A
Home system identity number (AID)	26625	02051	11083	02051	24641	18435
1st paging channel	0023	0023	1996	0023	0023	0023
Roam	off	off	off	off	off	off
Access overload class	05	05	05	05	05	05
Response to local control message enabled	off	off	off	off	off	off
Sending of extended MS number	off	off	off	off	off	off

Parameter	Philip-pines	Singa-pore	Spain	UK	Kuwait
ESN (Electrical Serial No.)					
Security code	0000	0000	0000	0000	0000
Roam type	0	0	0	0	0
Subscription with charge rate	off	off	off	off	off
Number of channels	1320	1320	1320	1320	1320
1st dedicated control channel in System A	0023	0023	0023	0023	0023
1st dedicated control channel in System B	0323	0323	0323	0323	0323
Total no. of dedicated control channels in System A	0021	0021	0021	0021	0021
Total no. of dedicated control channels in System B	0021	0021	0021	0021	0021
No. of emergency numbers	2	2	0	2	2
Emergency number 1	110	995		999	999
Emergency number 2	119	112		112	112
Emergency number 3					
Enquiry number		5319828	908	192	192
Country international prefix	00	00	07	00	00
NAM					
International Mobile Station Identity Number (IMSI)	460 0 123456	525 7 123456	214 8 123456	234 0 123456	234 0 123456
Subscriber number	0836 123456	7 123456	908 123456	0836 123456	0836 123456
Pref Sys	A	B	B	A	A
Home system identity number (AID)	02051	20480	23552	02051	02051
1st paging channel	0023	0323	0323	0023	0023
Roam	off	off	off	off	off
Access overload class	05	05	05	05	05
Response to local control message enabled	off	off	off	off	off
Sending of extended MS number	off	off	off	off	off

Quick NAM Programming

The number of programmable parameters available in Quick NAM Programming is defined, as earlier described, in *ETACS Service Program (NAM & Quick NAM).* The parameters below are the available Quick NAM Programmable Parameters as set by default.

Programmable Parameters

Electrical Serial Number (ESN)
The ESN, which is a unique binary number that identifies the MS to the cellular system, is set by the factory and can not be modified.

Subscription with Charge Rate
This parameter determines whether AirTime/CallCharge is selectable by the user.

Country International Prefix
Prefix required when dialing an international call.
This parameter detects an international call at call restrictions.

International Mobile Station Identity (IMSI)
This IMSI identity is a 10-digit number composed of three parts:
- MNC (Mobile Network Code), 3 digits
- MCC (Mobile Country Code), 1 digit
- MSIN (Mobile Station Identification Number), 6 digits

Subscriber Number
The subscriber number may include from 0 up to 10 digits.

Home System Identity Number (AID)
This identity number states the subscriber home system and is provided by the subscription operator.

Programming Instructions

To enter the Quick NAM Programming mode:

- press **9 8 7**, **MENU**, **MENU** or
- keep the **MENU** key depressed while pressing **9 8 7**

By scrolling forward '↑' or backwards '↓', all NAMs will be reached.

NOTE! Due to the limited amount of display characters, some parameters will be displayed as two parts, an intro text shown for 1 second followed by the numeric data (indicated as two text lines in the *Display*-column below).

Menu Type	**Display**	**Menu**	**Action**
ESN (Electrical Serial No.)	ESN 1 2 3 1 2 3 4 5 6 7 8	1	3 most significant digits shown 1 sec; Remaining digits shown thereafter
Subscription with charge rate	CHARGE OFF	2	Press '0-9' to switch 'CHARGE ON'
Country international prefix	INTER PREF 0 7	3	Enter a number with max. 4 digits
International Mobile Station Identity Number (IMSI)	IMSI 1 1 1 1 1 1 1 0 1 1 1	4	Enter a 10-digit number
Subscriber number	SUBNUMBER1 1 1 1 1 1 1 0 1 1 1	5	Enter a max. 10-digit number
Home system identity number (AID)	AID1 0 0 0 0 0	6	Enter a number (00000-32767) incl. leading zeroes

Default Values

Parameter	Austria	China	Hong Kong	Ireland	Italy	Malay-sia
ESN (Electrical Serial No.)						
Subscription with charge rate	off	off	off	off	off	off
Country international prefix	00	00	00	00	00	00
International Mobile Station Identity Number (IMSI)	232 0 123456	460 0 123456	454 2 123456	234 0 123456	222 2 123456	502 0 123456
Subscriber number	0000 123456	0836 123456	90 123456	0836 123456	0337 123456	0000 123456
Home system identity number (AID)	26625	02051	11083	02051	24641	18435

Parameter	Philip-pines	Singa-pore	Spain	UK	Kuwait
ESN (Electrical Serial No.)					
Subscription with charge rate	off	off	off	off	off
Country international prefix	00	00	07	00	00
International Mobile Station Identity Number (IMSI)	460 0 123456	525 7 123456	214 8 123456	234 0 123456	234 0 123456
Subscriber number	0836 123456	7 123456	908 123456	0836 123456	0836 123456
Home system identity number (AID)	02051	20480	23552	02051	02051

Flash Programming

Introduction

The *Ericsson Mobile Maintenance Applications (EMMA)* flash program is a tool used for upgrading and recovery of the software for the new generation of Ericsson mobile phones.

This description of the EMMA flash program includes information on:

- hardware requirements
- software setup
- hardware setup
- flashing instructions

Hardware Requirements

The following equipment is required when using the EMMA flash program for the Ericsson mobile phones:

- PC with Windows 3.1 (or later) operating system
- COM port (COM1 - COM4) available on the PC
- Programming cable, KRY 101 1135/10 R1A
- Programming interface, NTZ 112 311
- Adaptor, 25- to 9-pin; for PC equipped with a 9-pin COM-connector (not supplied by Ericsson)

Software Setup

The EMMA program consists of two separate programs,

- the *SHELL*, one program common for all phone models based on this platform
- the *FLASHER*, one program for each phone model

which are installed in the above sequence.

Note! The installation procedure below describes how to install the EMMA flash program by using standard floppy disks, but the program may become distributed in other media formats.

Installing the Shell Program

It is not possible to install a Flasher program unless the Shell program first has been installed on the local hard disk or a network server.

To install the Shell program, proceed as follows:

4. Close all active windows and insert the Shell disk.
5. In the Program Manager window, click on *File* and *Run*, type **a:setup** in the Command Line box, and click *OK*.
6. After a while, some important information is displayed. Read the information and click *Next >*.
7. The shell program suggests a Destination Location in the directory C:\emma\ If convenient, click *Next >*. If not convenient, click *Browse*, select a suitable directory, and click *Next >*.
8. The copying of files is begun and also displayed by several graphs.
9. After completion of the file copying, the installation of the Shell program is ended, but additional information can be retrieved by clicking *Yes* to the question *Do you want to view the README file now?*
10. Confirm the completion by clicking *OK* in the Information window and remove the disk.

Note! The path and name of the Shell location directory must not be altered after completed installation.

Installing a Flasher Program

After having the Shell program installed, the Flasher programs of various phones based on the same platform are easily added:

1. Close all active windows and insert a Flasher disk.
2. In the Program Manager window, click on *File* and *Run*, type **a:setup** in the Command Line box, and click OK.
3. After a while, some important information is displayed. Read the information and click *Next >*.
4. The Flasher program suggests a path and subdirectory where the flasher program is placed. If convenient, click *Next >*. If not, click *Browse*, select a directory path that corresponds with the Shell location register, and click *Next >*.
5. The copying of files is begun and also displayed by several graphs.
6. After completion of the file copying, the installation of the Flasher program is ended. Confirm the completion by clicking *OK* in the Information window and remove the disk.
7. In the Program Manager a new window, EMMA, has been created, from which the Flasher program now can be opened and started by clicking on the group icon *ETACS Flash*.

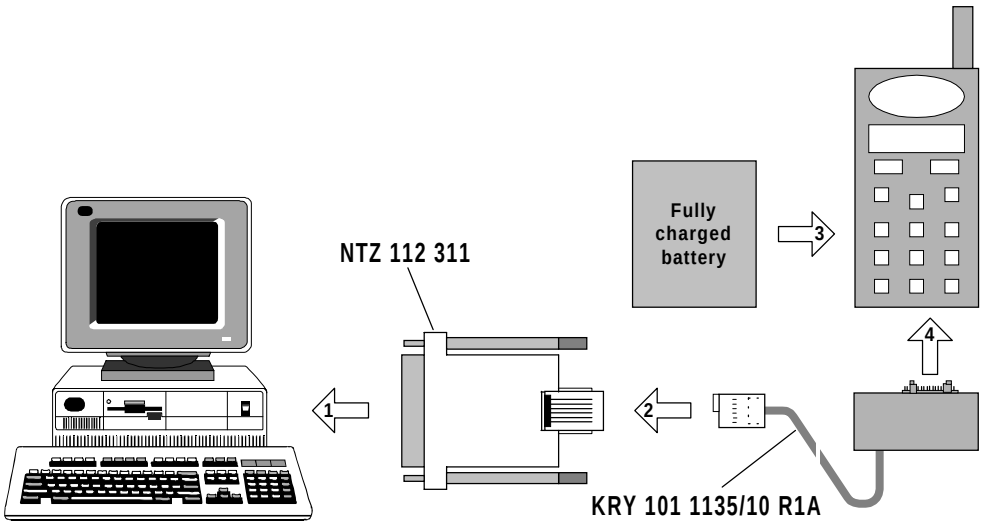
Flash Operation

Hardware Setup

To make the setup for the upgrading of the mobile phones, follow the instructions below and refer to *Figure 1*.

1. Connect the programming interface NTZ 112 311 to an available COM port.
2. Connect the programming cable KRY 101 1135/10 R1A to the interface.
3. Connect a fully charged battery to the phone.
4. Connect the programming cable to the phone.

Keep the phone turned OFF until further notice.



Note!
Use a fully charged phone battery, since the interface is powered by the phone. The use of an even slightly discharged battery may result in erroneous flashing.

Flashing Instructions

1. In the EMMA window of the Program Manager, first double-click the subdirectory *etacsflash* and then double-click the wanted flasher program.
2. If the default Com Port has not previously been set:
   Click *Settings* and *Com Port*, select the default Com Port (Com1 - Com4), and click *OK*.
3. To check that the appropriate input file will be used:
   Click *Settings* and *Input File*, click *Default* to select the default file, or *New* to select a different input file.

4. Check that the phone is connected to the PC with a fully charged battery as described on previous page.
5. Click *Start* to enter the flashing dialogue.
   If required, a Com Port different to the default port can be temporarily selected. The baud rate, 9600, is controlled by the program and can not be manu-ally altered.
6. Press the On/Off-key on the phone and click immediately *Start* to start flashing. *Transfering hex load file* is displayed.
   The flash memory is erased after which the actual flash programming process is begun and also displayed by a graph.
7. After completion, click *OK* to confirm *SUCCESSFUL FLASHING!*, disconnect the phone and, if required, connect an identical phone, and repeat the procedure as from step 5.
8. Exit the EMMA flash program.

Note! If the flash programming is not succesful or has become interrupted during the flashing process, the flash connector and phone battery have to be disconnected and reconnected before the flashing can be resumed.

Service Instructions

Ericsson Mobile Phone EF738

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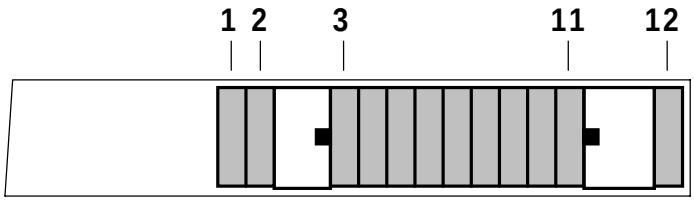
System Connector Signals

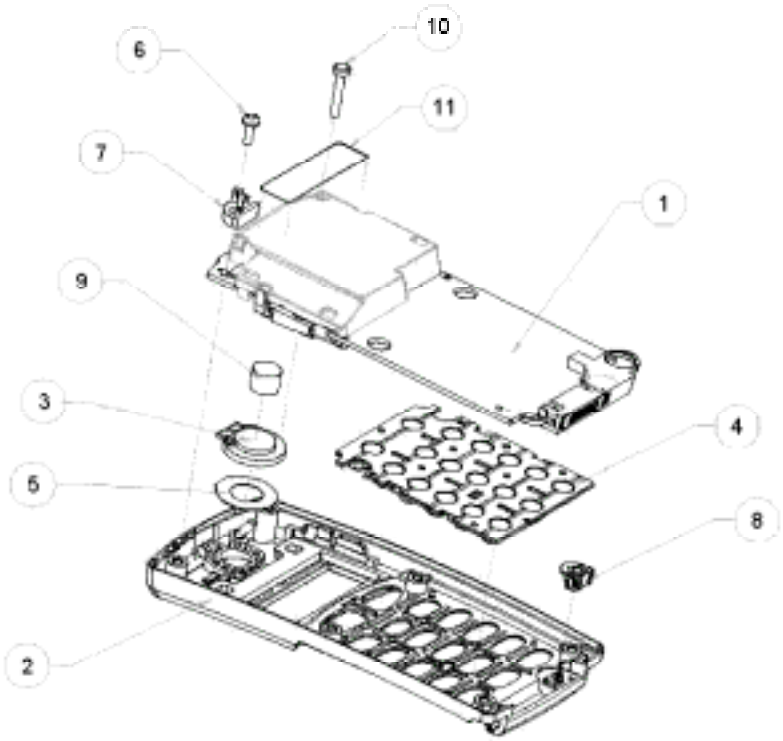
External units are connected to the Transceiver Board via the 12-pin System Connector.



Pin	Signal	In/Out	Function
1	AFMS	Out	Audio From Mobile Station
2	ATMS	In	Audio To Mobile Station
3	EXTAUD	In	External Analog Audio Accessory Sense
4	AGND		Audio Signal Ground, 0V reference
5	PORTHF	In	Portable Handsfree
6	MUTE	Out	Music Mute
7	VPPFLASH	In	Flash Memory Voltage and Service Voltage
8	VDD	Out	Logic Reference, Status ON
9	DFMS	Out	Data From Mobile Station
10	GND		Digital Ground and DC Return
11	DTMS	In	Data To Mobile Station
12	DCIO	In/Out	DC positive pole for phone battery charging and external accessory powering

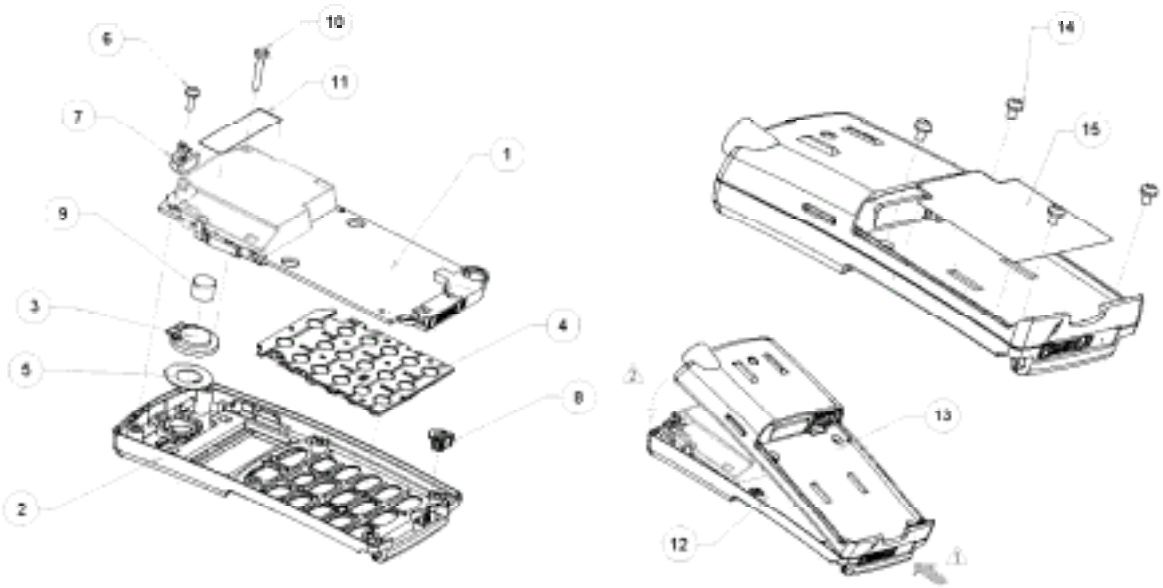
Disassembly

1. Remove the battery and the antenna
   Before opening the unit for further disassembly, make sure that the parts can be placed on a *dust-free ESD-protected surface*.
   NOTE! Do not touch the display with your fingers!
2. Place the phone on its front and remove four screws with the appropriate torx screwdrivers.
3. Remove the back cover carefully from underneath.
4. Loosen the remaining screws (6, 10).
   Be careful not to damage the antenna connector (7).
5. Carefully remove the board (1) from the front cover (2) by lifting it upwards.
6. Remove the keypad (4).



Reassembly

1. Place a front cover (2) on the workbench
   Assemble the keypad (4).
2. Carefully place the board (1) into the front cover with the shield can upwards.
   NOTE! Do not touch the display with your fingers
3. Drop a screw (10) into the upper right corner hole in the board.
   Tighten the screw with a screwdriver (0.15Nm).
4. Drop an antenna connector (7) into the placement cavity of the antenna connector placement guide.
   Ensure that the locating posts of the antenna connector are positioned in the mating holes of the board.
5. Drop a screw (6) into the screw hole in the antenna connector.
   Tighten the screw with a scredriver (0.15Nm).
6. Mount the back cover (13) on the front cover (12).
   Hold down the lower part of the back cover against the front cover and press the upper part of the phone together.
7. Drop the four screws (14) into the holes on the back cover.
   Tighten the screws with a screwdriver (0.15Nm).
8. Mount the antenna by screwing it clockwise into the thread.
9. Insert the battery pack into the phone and push until a click is heard.



Flip Mount Inspection

After mounting the flip;
Hold the telephone upside down and check that the flip is not open.
The flip must be closed as shown in *fig. 1*; not open as shown in *fig. 2*.

Fig. 1: Flip Closed

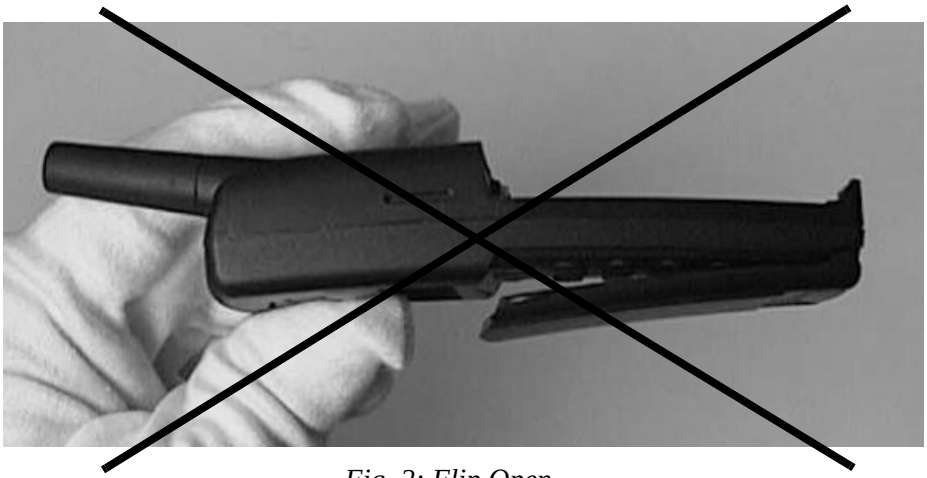


Fig. 2: Flip Open

Warranty Seal

Place the warranty seal over the right hand torx screw at the bottom.

Exchanging the Circuit Board

1. Transfer the EEPROM contents of the phone to the PC as described in section 3, *Test/Service Programs*.
2. Disassemble as previously described in this section.
3. Exchange the board.
4. Reload the EEPROM customer data into the phone.
5. Check the function of the phone and, if necessary, align as described next in *Fault Finding and Alignment*.

Fault Finding and Alignment

The table below shows information about test points and test data of the radio and logic/audio parts of the board. This information will become an aid in testing as well as fault finding. In general, the following procedure can be used:

1. Align the boards in the sequence stated below.
2. If a specific value cannot be obtained, use the tools mentioned in step 3 below to trace the reason.
3. The built-in *Test Program* will provide access to the function or signal to become investigated, and any signal data that may be required is found in the section *Connectors and Signals*, where the distribution of signals at the respective connector pins is found.

The telephone is tested, unless otherwise explicitly stated, with DC-power 6.2V supplied via a dummy battery.

Channel 1	TP-1:1 (RX = 935.0125MHz, TX = 890.0125MHz)
RF Power Off	TP-2:8
AFC Active	TP-15:2
Audio Switches On	TP-20:3 (TX & RX audio paths unmuted)
SAT Tone Off	TP-22:3
Manchester Out Off	TP-23:0
Volume 4	TP-25:4 (mid range)
TX Source ATMS	TP-27:0
Earpiece External	TP-28:2
Compandor Disabled	TP-29:0 (disabled)
Softlimiter Off	TP-32:0
Green LED Off	TP-41:MENU+4:0
Red LED Off	TP-41:MENU+5:0
ICTRL Off	TP-41:MENU+2:0
Illumination Off	TP-41:MENU+6:0

TP = Test Program

The above settings are automatically executed when entering the test program.

For detailed information regarding the adjustments, refer to subsection *Test Program* in this section.

Sequence of Adjustments

Item 1: VCTCXO

Purpose:
Checking and, if necessary, calibrating the reference frequency generator for the synthesizers

Test method:
Radio test set in TX mode, measured with a frequency counter

Input signal:
None

Measurement point:
Transmitter frequency at antenna connector

Limit:
890.0125MHz ±200Hz

Procedure:
1. Turn on the transmitter (**TP-2:2**)
2. Disable the AFC (**TP-15:0**)
3. Check the frequency error
4. If the transmitter frequency is not within 890.0125MHz ±200Hz;
   enter VCTCXO calibration (**TP-18**:)
5. Press **M** + **#** to enable the calibration
6. Use **#** and ***** buttons to change value and press **M** + **S** to store the new value

Item 2: RSSI Calibration

Purpose:
Calibration of the RSSI (received signal strength indicator)

Test method:
Radio test set in RX mode

Input signal:
Apply 935.0125MHz RF signal modulated with a 1kHz tone at 5.7kHz deviation at a level of -115dBm to the antenna connector

Measurement point:
None

Limit:

-115dBm	20 < value < 150
-107dBm	30 < value < 218
-87dBm	50 < value < 279

Procedure:

1. Apply 935.0125MHz RF signal modulated with a 1kHz tone at 5.7kHz deviation at a level of -115dBm to the antenna connector
2. Turn the transmitter on (**TP-2:2**)
3. Disable the AFC (**TP-15:0**)
4. Enter RF sensitivity test (**TP-9**)
5. Press **M** + **S**
6. Press **M** + **#** to move to next adjustment
7. Set the signal generator to -107dBm
8. Press **M** + **S** to store the value
9. Press **M** + **#** to move to next adjustment
10. Set the signal generator to -87dBm
11. Press **M** + **S** to store the value

Item 3: RF Output Power

Purpose:
Checking and, if necessary, calibrating the RF output power

Test method:
Radio test set in TX mode

Input signal:
None

Measurement point:
Output power at the antenna connector measured with an RF power meter

Limit:

Power level	Output power
2	+26.5dBm ±0.1dB
3	+22.5dBm ±0.5dB
4	+18.5dBm ±0.5dB
5	+14.5dBm ±0.5dB
6	+10.5dBm ±0.5dB
7	+6.5dBm ±1.0dB

Procedure:

1. Turn the transmitter on (**TP-2:2-7**)
   Check if the output power is within the above stated limits
   Check the output power at low (1329), mid (1), and high channels (600)
2. If the output power is not within the above stated limits;
   use **TP-5** to calibrate the output power
3. Press **M** + **#** to start the calibration and display power level and calibrated value
4. Use **#** and ***** to increase/decrease the output power
   Press **M** + **S** to store the value and step to next power level
5. Press **C** to turn off TX, restore channel number, and jump to menu 0 (test input)

Item 4: Maximum Deviation

Purpose:
Checking and, if necessary, calibrating the maximum deviation of the transmitter

Test method:
Radio test set in TX mode

Input signal:
1kHz sine wave signal at $320mV_{RMS}$ to ATMS (system connector)

Measurement point:
At the antenna connector measured with a deviation meter

Tolerance:
±7.2kHz -1dB (6.462 - 7.200 kHz)

Procedure:
1. Set TXSENS programmable gain stage to nominal value (**TP-7**, value 7)
2. Enable the compandor (**TP-29:1**)
3. Connect a 1kHz sine wave signal at $320mV_{RMS}$ to ATMS (system connector)
4. Turn the transmitter on (**TP-2:2**)
5. Monitor RF peak deviation
6. If the deviation is outside the limits; adjust the deviation
7. Enter **TP-14**
8. Start the trimming by pressing **M** + **#**
9. Trim audio deviation to 6.462 - 7.200 kHz by pressing # and * to increase/ decrease the deviation
   Allowed trim values are 2 to 13
   Trim step size is 0.4dB per step
10. Press **M** + **S** to store the value

Item 5: Nominal Deviation

Purpose:
Checking and, if necessary, calibrating the nominal deviation of the transmitter

Test method:
Radio test set in TX mode

Input signal:
1kHz sine wave signal at 190mV_{RMS} to ATMS (system connector)

Measurement point:
At the antenna connector measured with a deviation meter

Limit:
±5.7kHz ±0.5dB (5.38 - 6.02 kHz)

Procedure:
1. Enable the compandor (**TP-29:1**)
2. Connect a 1kHz sine wave signal at 190mVRMS to ATMS (system connector)
3. Turn the transmitter on (**TP-2:2**)
4. Monitor RF peak deviation
5. If the deviation is outside the limits; adjust the deviation
6. Enter **TP-27**
7. Start the trimming by pressing **M** + **#**
8. Trim audio deviation to 5.38 - 6.02 kHz by pressing **#** and ***** to increase/decrease the deviation
   Allowed trim values are 2 to 29
   Trim step size is 0.4dB per step
9. Press **M** + **S** to store the value

Item 6: SAT Deviation

Purpose:
Checking and, if necessary, calibrating the SAT (Supervisor Audio Tone) deviation of the transmitter

Test method:
Radio test set in TX mode

Input signal:
None

Measurement point:
At the antenna connector measured with a deviation meter

Limit:
±1.7kHz ±0.5dB (1.60 - 1.80 kHz)

Procedure:
1. Mute the TX audio path (**TP-20:0**)
2. Activate the SAT-tone (**TP-22:1**)
3. Unmute the TX SAT path (**TP-22:4**)
4. Turn the transmitter on (**TP-2:2**)
5. Monitor the SAT deviation
6. If the deviation is outside the limits; adjust the deviation
7. Enter **TP-22**
8. Start the trimming by pressing M + #
9. Trim SAT deviation to 1.60 - 1.80 kHz by pressing # and * to increase/decrease the deviation
   Allowed trim values are 2 to 29
   Trim step size is 0.3dB per step
10. Press **M** + **S** to store the value

Item 7: TX Data Deviation

Purpose:
Checking and, if necessary, calibrating the TX data deviation of the transmitter

Test method:
Radio test set in TX mode

Input signal:
None

Measurement point:
At the antenna connector measured with a deviation meter

Limit:
±6.4kHz ±0.5dB (6.021 - 6.780 kHz)

Procedure:
1. Mute the TX audio path (**TP-20:0**)
2. Activate the TX Data (**TP-23:1**)
3. Turn the transmitter on (**TP-2:2**)
4. Monitor the TX data deviation
5. If the deviation is outside the limits; adjust the deviation
6. Enter **TP-23**
7. Start the trimming by pressing **M** + **#**
8. Trim TX Data Deviation to 6.021 - 6.780 kHz by pressing **#** and ***** to increase/ decrease the deviation
   Allowed trim values are 2 to 13
   Trim step size is 0.4dB per step
9. Press **M** + **S** to store the value

Item 8: AFMS and Harmonic Distortion

Purpose:
Checking and, if necessary, calibrating the deviation of the receiver

Test method:
Radio test set in RX mode

Input signal:
Apply a -50dBm 935.0125MHz RF signal modulated with a 1kHz tone, ±2.3kHz deviation to the antenna input

Measurement point:
At the AFMS output from the system connector measured with an AC volt meter

Limit:
25mV ±1.5dB (21.035 - 29.710 mV)

Procedure:
1. Enable the compandor (**TP-29:1**)
2. Apply a -50dBm 935.0125MHz RF signal modulated with a 1kHz tone, ±2.3kHz deviation to the antenna input
3. Monitor the AFMS output with a 100kΩ load
4. If AFMS is outside the limits; adjust the AFMS level
5. Enter **TP-10**
6. Start the trimming by pressing **M** + **#**
7. Trim the AFMS level by pressing **#** and ***** to increase/decrease
8. Press **M** + **S** to store the value
9. Measure the receiver harmonic distortion
10. Should be less than 4.5% at AFMS using a CCITT filter

Item 9: Receiver Sensitivity

Purpose:
Checking the receiver sensitivity

Test method:
Radio test set in RX mode

Input signal:
Apply an RF signal at low, mid, and high channel modulated with a 1kHz tone at 5.7kHz deviation at a level of -113dBm to the antenna input

Measurement point:
At the AFMS output from the system connector measured with an AC volt meter

Limit:
Better than 20dB SINAD at low, mid, and high channel

Procedure:
1. Select channel (**TP-1:1329, 1, or 600**)
2. Disable AFC (**TP-15:0**)
3. Turn the transmitter on **(TP-2:2**)
4. Apply an RF signal at low, mid, and high channel modulated with a 1kHz tone at 5.7kHz deviation at a level of -113dBm to the antenna input
5. Measure better than 20dB SINAD on AFMS using a CCITT filter

Accessories

Ericsson Mobile Phone EF738

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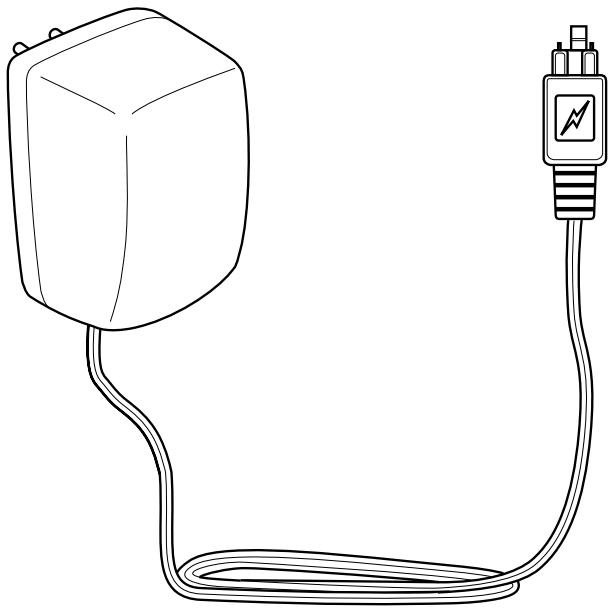
Rapid Charger

Introduction

The *Rapid Charger* is a basic charger which converts AC to DC by using a conventional transformer followed by a rectifying circuitry. This charger can consequently not be used worldwide, as opposed to a primary switched charger, and will therefor be available in several different versions as listed on next page.

The *Rapid Charger* consists of:

- AC/DC converter incl. wall plug
- secondary cord with power connector



The AC/DC converter is plugged directly into the mains power outlet and the rectified DC voltage/current is distributed via the secondary cord to the power connector, which is plugged into the system connector of the phone.

Main Features

The *Rapid Charger* can be used as power source in two different ways, for:

- the *7X8*-family phones
- the DeskTop Charger MC7000

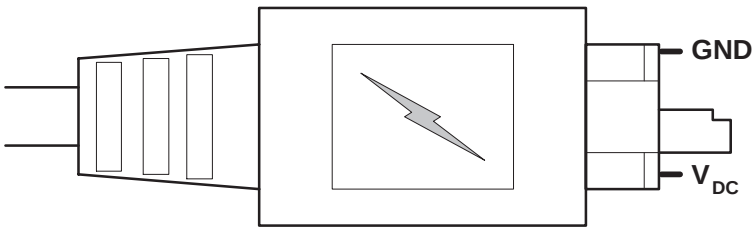
Versions

The *Rapid Charger* is designed in several versions for different mains voltages, frequencies, and power outlets as specified below:

Mains voltage	Frequency	Mains plug
115V ±10%	60Hz ±5%	US standard
230V -10% to +6%	50Hz ±5%	EU standard US (Thailand) UK (Hong Kong)
240V -10% to +6%	50Hz ±5%	UK standard
240V ±10%	50Hz ±5%	AUS standard

Connectors

Secondary DC-cord



Specifications

Type No:	402 0034-UK
Dimensions:	
- AC/DC-Converter	78 x 42 x 45 mm; 3.1 x 1.7 x 1.8 in (excl. wall plug)
- Power Plug	24 x 11 x 11 mm; 0.9 x 0.4 x 0.4 in
Input Voltage	Refer to *Versions* above
Input Frequency:	Refer to *Versions* above
Output Voltage/Current:	$6V_{DC}$/700mA

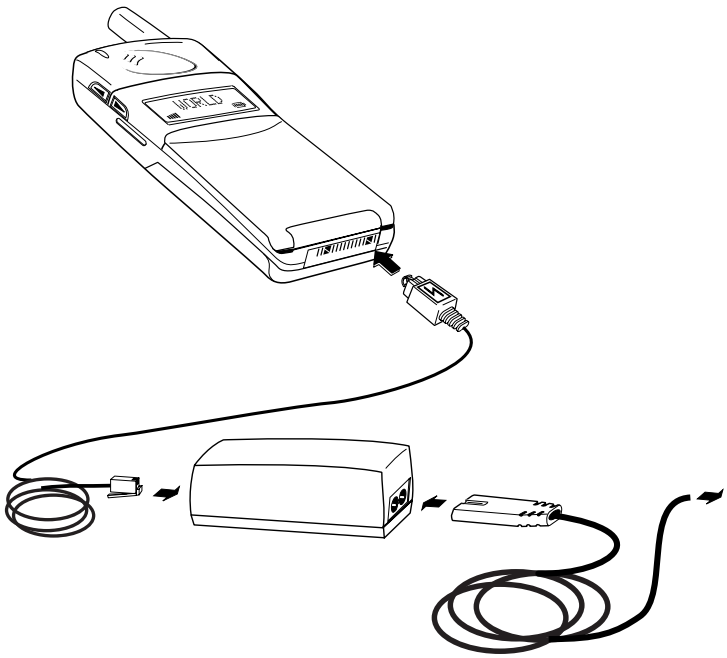
Travel Charger

Introduction

The *Travel Charger* is a primary switched AC/DC-converter to be used as charger and power supply world wide without the need of an AC/AC-converter.

The *Travel Charger* consists of three parts:

- mains primary AC-cord
- AC/DC-converter
- secondary DC-cord



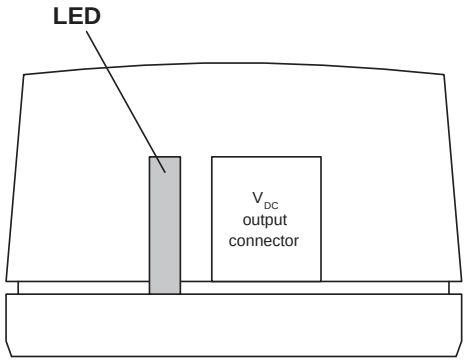
Main Features

The *Travel Charger* can be used as power source in two different ways, for:

- the *7X8*-family phones
- the DeskTop Charger MC7000

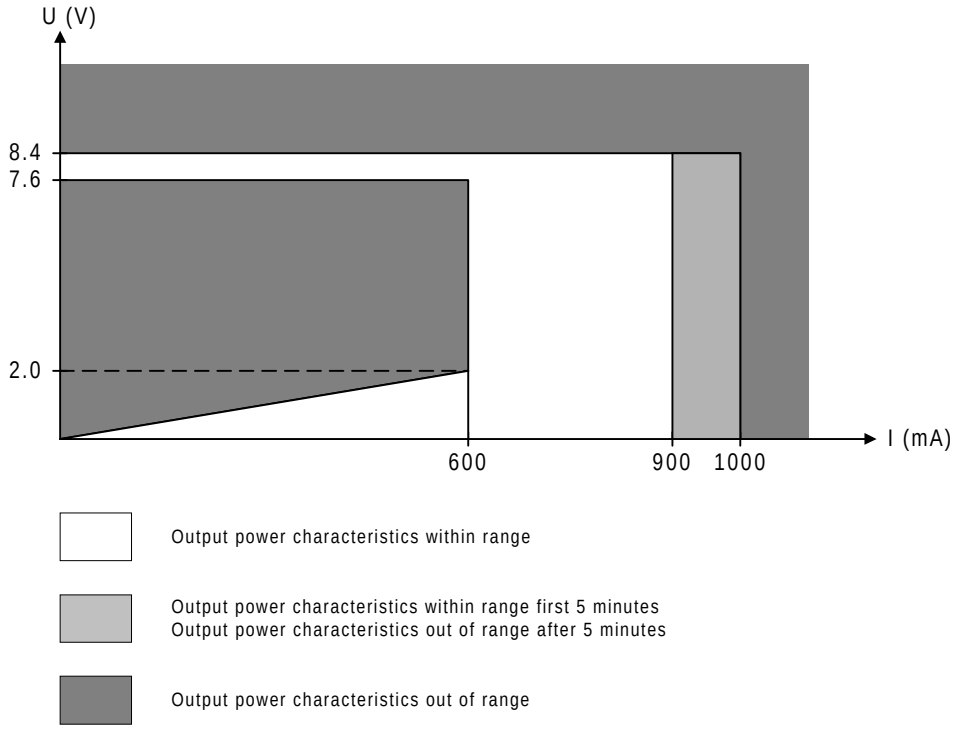
Indicators

A green LED located next to the secondary DC output is turned on whenever the mains voltage is available on the primary side



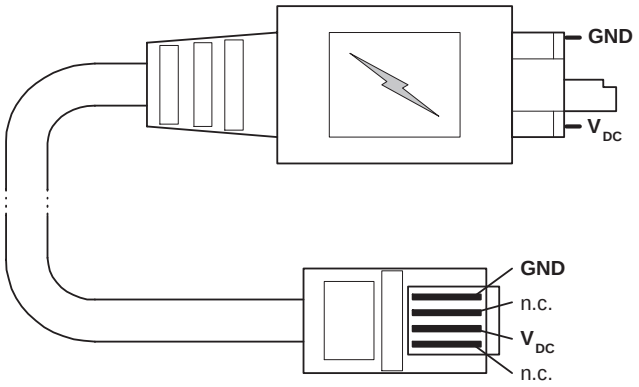
Output Characteristics

The output voltage and current of the *Travel Charger* should after 5 minutes stay within the values indicated as “white” area in the picture below.



Connector

Secondary DC-cord



Specifications

Type No:	402 0036-BV
Dimensions:	
- AC/DC-Converter	95 x 38 x 27 mm; 3.7 x 1.5 x 1.1 in
- Power Plug	24 x 11 x 11 mm; 0.9 x 0.4 x 0.4 in
Input Voltage	100 - 240 V_{AC} (±10%)
Input Current:	150mA (typical)
Input Frequency:	50 - 60 Hz (±5%)
Output Voltage/Current:	7.6 V_{DC}/600mA

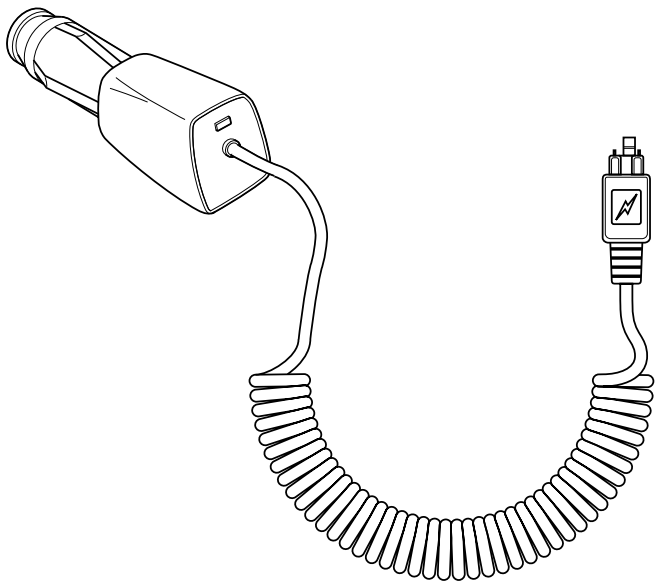
Vehicle Power/Charger

Introduction

The *Vehicle Power/Charger* is a step-down DC/DC-converter to be used as charger and power supply for the phone when plugged into the +12V or + 24V (negative ground) cigarette lighter outlet.

The *Vehicle Power/Charger* is an integrated unit consisting of three parts:

- cigarette lighter adaptor
- coiled cord
- power plug



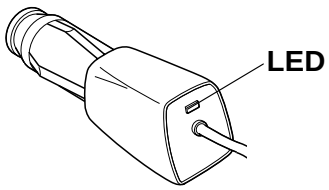
Main Features

The *Vehicle Power/Charger* can be used as power source in two different ways, for:

- the *7X8*-family phones
- the DeskTop Charger MC7000

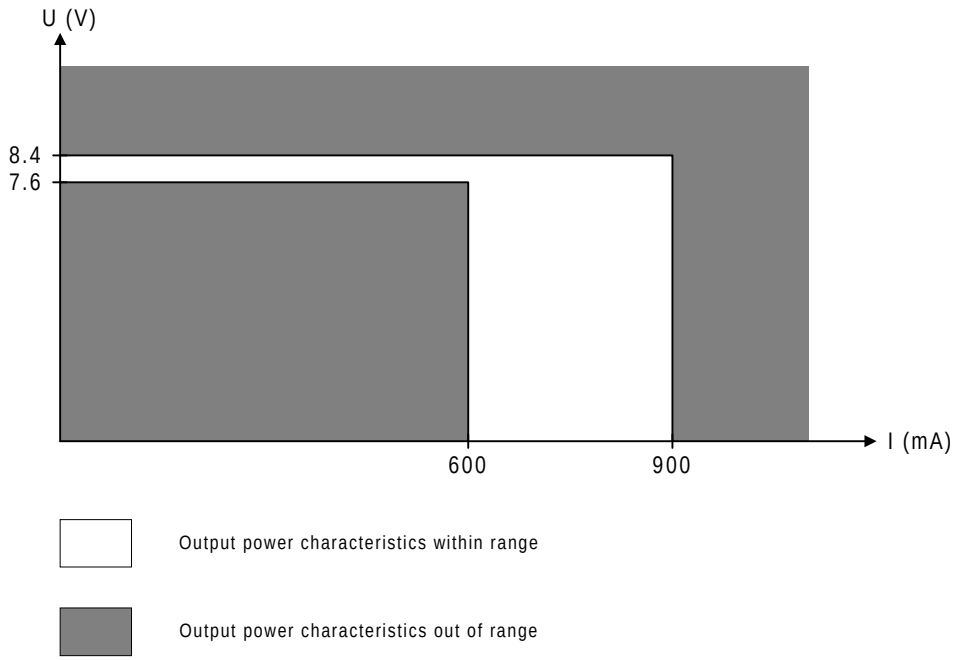
Indicators

A green LED located next to the coiled cord outlet of the cigarette lighter adaptor is turned on whenever the appropriate vehicle voltage is available.



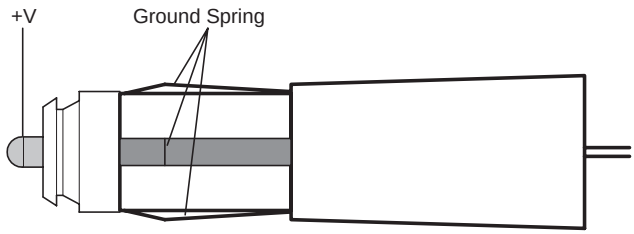
Output Characteristics

The output voltage and current of the *Vehicle Power and Charger* should stay within the values indicated as “white” area in the picture below.

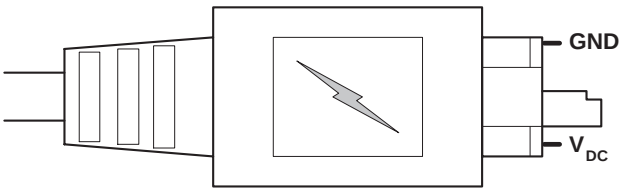


Connectors

Cigarette Lighter Adaptor



Power Plug



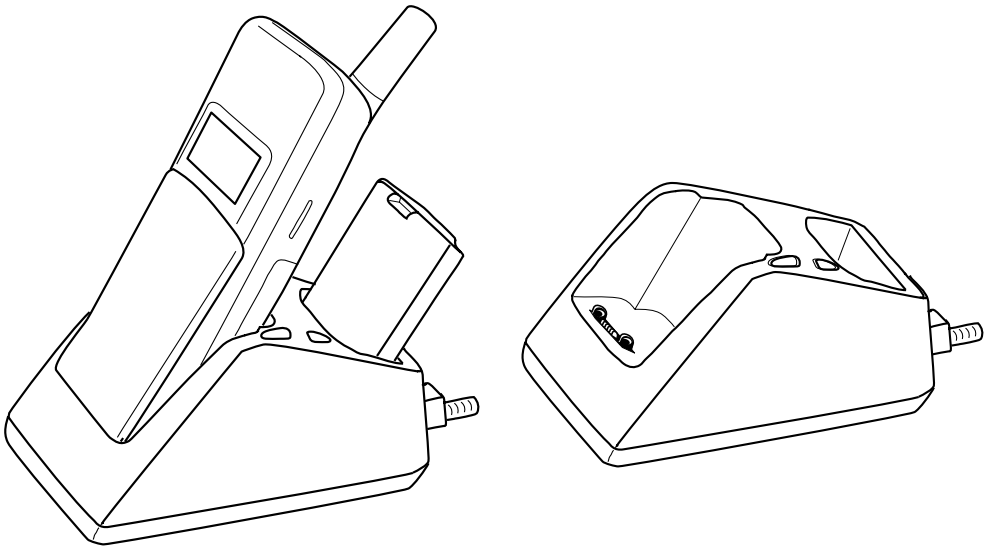
Specifications

Type No:	402 0035
Dimensions:	
- Cigarette Lighter Adaptor	96 x 28 x 25 mm; 3.8 x 1.1 x 1.0 in
- Power Plug	24 x 11 x 11 mm; 0.9 x 0.4 x 0.4 in
Input Voltage	10.8 - 31.2 V_{DC}
Output Voltage/Current:	7.6V_{DC}/600mA

DeskTop Charger MC7000

Introduction

The *DeskTop Charger MC7000* is a dual desk charger specially designed for the *7X8*-family telephones. The phone is placed in the front slot for simultaneous powering and battery charging, while the spare battery to be charged is placed in the rear slot, which also features a manual discharge/reconditioning facility.



As the *MC7000* does not include an internal power supply, an external power source has to be connected to the system bus connector at the rear of the unit.

The external power source should be one of the following Ericsson product:

- Rapid Charger
- Travel Charger
- Vehicle Power/Charger

Furthermore, the Portable HandsFree as well as Mobile Office equipment can be connected to the *DeskTop Charger MC7000*.

Electronics

The electronics of the *MC7000* is designed around the Central Processing Unit.

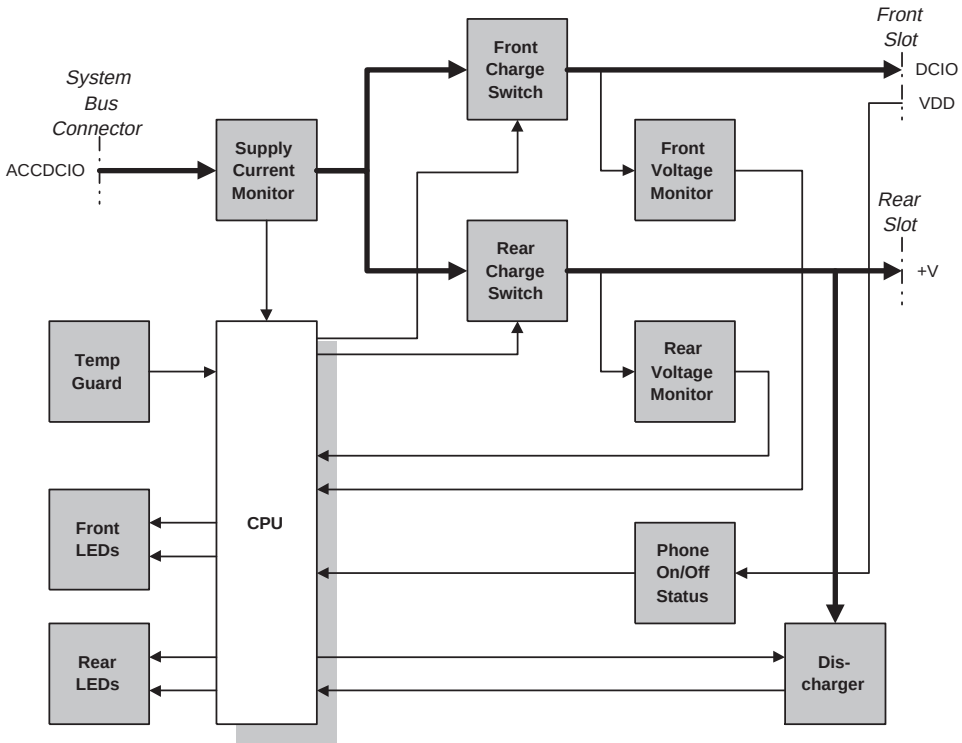
Central Processing Unit

The Central Processing Unit (CPU) is equipped with 4kbyte ROM, thus making it possible to control the entire *MC7000* charger.

The supply voltage to the CPU is +3.8V which is being derived from a linear voltage regulator and a crystal generates a 5MHz clock frequency to the oscillator input of the CPU.

The Central Processing Unit interacts with the following major peripheral blocks:

- Supply Current Monitor
- Charge Switches; front & rear
- Voltage Monitors; front & rear
- Phone On/Off Status
- Discharger
- LED Indicators; front & rear
- Temperature Guard



Supply Current Monitor

The current distributed from the external power source to the front or rear slot passes through the Supply Current Monitor. The CPU reads the output from the Supply Current Monitor is order to establish whether *charging* or *charging completed* is in effect as follows:

>200mA: Charging
<200mA: Charging completed

Charge Switches

The current from the external power source to the two slots can independently be switched On/Off by two separate CPU outputs.

Front Slot Switch

This CPU controlled switch is normally On except when the spare battery is being charged.

Rear Slot Switch

The rear slot charging switch is controlled by the second CPU output, which will allow charging of the spare battery only if the phone battery is fully charged or if no phone is inserted in the front slot. This switch goes Off for a short while once every other second for voltage reading purposes.

Voltage Monitors

The CPU controls the Voltage Monitors to enable reading of the battery voltages.

Front Slot Monitor

If the CPU input of the Front Slot Voltage Monitor suddenly detects a voltage at DCIO when the corresponding charge switch is Off, this means that the voltage is coming from the battery, i.e. a phone has been inserted into the slot. This will be detected regardless of whether the phone is turned On or Off. If Off when inserted, the auto-turn-on mode will turn it On.
However, if the phone is removed during charging, e.g. when a call is received, this will not be detected as this input still will read a voltage, now coming from the external power source. (See Phone On/Off Status on next page)

Rear Slot Monitor

The Rear Slot Voltage Monitor detects whether the spare battery requires charging. During the charging the current is switched off for a short while every other second in order to read the battery voltage and in this way establish whether the battery is fully charged or not. The CPU is in this way also informed if the battery is removed during the charging process.

Phone On/Off Status

The VDD input indicates whether the phone is Off or On and will inform the CPU if the phone has been removed during charging.

Discharger

To prolong the battery life the rear slot is equipped with a reconditioning feature. By pressing the discharge switch (same as the rear LED indicator), the CPU becomes notified that it will have to carry out a discharge operation on the battery in the rear slot.
The CPU then activates the discharge operation by draining the battery at a suitable resistive load.

LED Indicators

The LEDs are used for indication of the various charging phases.

Front LEDs

The two front LEDs (green and red) can be On and Off in any combination except both On.

Rear LEDs

The two rear LEDs (green and red) can be On and Off in any combination.

Temperature Guard

A temperature related voltage is generated due to an onboard NTC resistor and fed to an input of the CPU for detection and measures to prevent overheating. The threshold is set to +55°C onboard corresponding to an ambient temperature of +35°C.

Power Distribution for Phone Operation

The power to the front slot for phone operation is entirely controlled by the phone. The various current values needed in different situations, like stand-by or transmission, are programmed and stored in the telephone.
The *MC7000* is able to deliver 500 - 700 mA to the phone depending on the power source is being connected.

Battery Charging

The charging of both batteries is turned on and off by a switch circuitry which is controlled by the Central Processing Unit. Charging is only possible for one slot at a time where the front slot has got highest priority, i.e. charging of the spare battery will not begin until the phone battery is fully charged or removed.

The batteries being used are four 1.2V cell NiMH (Nickel-Metal-Hydride) or NiCd (Nickel-Cadmium) chargeable batteries, without internal thermistor.

Front Slot Charger

Main Charging

The charging is entirely controlled by the phone, which after being inserted into the charger slot starts being charged by the *MC7000*. Any possible charging of a spare battery in the rear slot is interrupted, and 500 - 700 mA is delivered to the phone battery.

Note! The phone does not have to be turned On when inserted into the charger slot due to its auto-turn-on feature.

Trickle Charging

After the main charging the phone automatically returns to normal power distribution and trickle charging unless a spare battery then is going to be charged. The power distribution and trickle charging to the phone is in that case inhibited until the spare battery charging is terminated.

Rear Slot Charger

Main Charging

The 500 - 700 mA charging current to the spare battery is entirely controlled by the Central Processing Unit. Several algorithms are used to establish when the battery is fully charged:

- -dv/dt
  The battery voltage is sampled once a second for approximately one minute and the mean value is calculated. The max. mean value is stored and compared with consecutive values. When a specific divergence is obtained, the charging is terminated.
- peak detect
  The charging is terminated when the above mentioned values are less or identical to the max. mean value for a specific time.
- safety time elapsed (4 hours)
  The safety timer is used as a last resort when the above methods fail.

Trickle Charging

When the main charging is completed an 8mA trickle charging generated by short pulses is automatically initiated, but only in case the front slot is empty.

Discharging

After pressing the discharge button the spare battery is discharged by a 200mA current. Charging will commence when the battery voltage has dropped to 4.0V.

Error Detection

An error is indicated and charging is halted for 20 minutes when the ambient temperature is higher than +35°C.

LED Indicators

Front Indicator - Phone Slot

Status	Significance	Detection
Off	No phone	Front Voltage Monitor or Phone On/Off Status
Red	Charging	Supply Current Monitor >200mA
Green	Charging complete	Supply Current Monitor <200mA

Rear Indicator - Spare Battery Slot

Status	Significanse	Detection
Off	No battery	Rear Voltage Monitor
Red	Charging	Rear Voltage Monitor
Green	Charging complete	Rear Voltage Monitor
Yellow	Discharging	Discharge Switch
Red flash	Temperature error	Temperature Guard

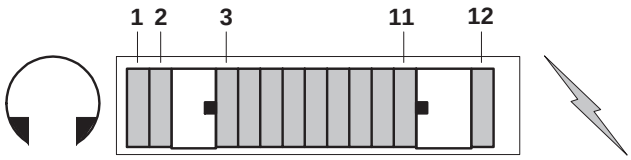
Specifications

Battery type	Charging time - Front	Charging time - Rear
NiMH 650mAh:	≈1h50min	≈ 1h25min

Type No.:	402 0040-BV 402 0040-UK
Dimensions:	73 x 90 x 47 mm 2.9 x 3.5 x 1.9 in
Input voltage:	7 - 10 V_{DC}
Ambient temp:	+5°C to +35°C +41°F to +95°F

Connectors and Signals

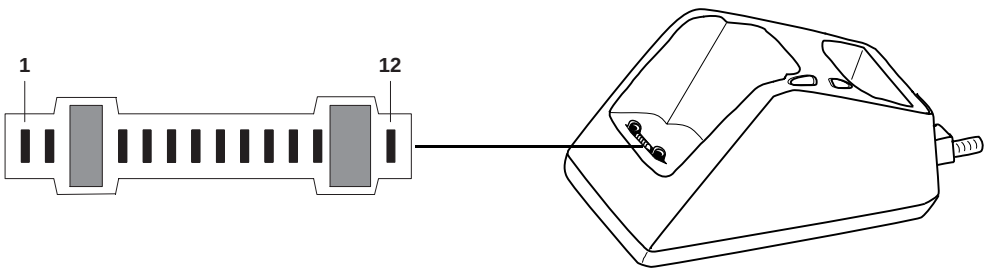
System Bus Connector



Pin	Signal	Specification
1	AFMS	Audio-from-mobile-station
2	ATMS	Audio-to-mobile-station
3	EXTAUD	External analog audio accessory sense
4	AGND	Audio signal ground, 0V refernce
5	PORTHF	Portable handsfree
6	MUTE	Music mute
7	VPPFLASH	Flash memory voltage and service voltage
8	VDD	Logic reference, status On
9	DFMS	Data from mobile station
10	DGND	Digital ground and DC return
11	DTMS	Data to mobile station
12	ACCDCIO[1)] DCIO[2)]	DC positive pole for phone battery charging and external accessory powering

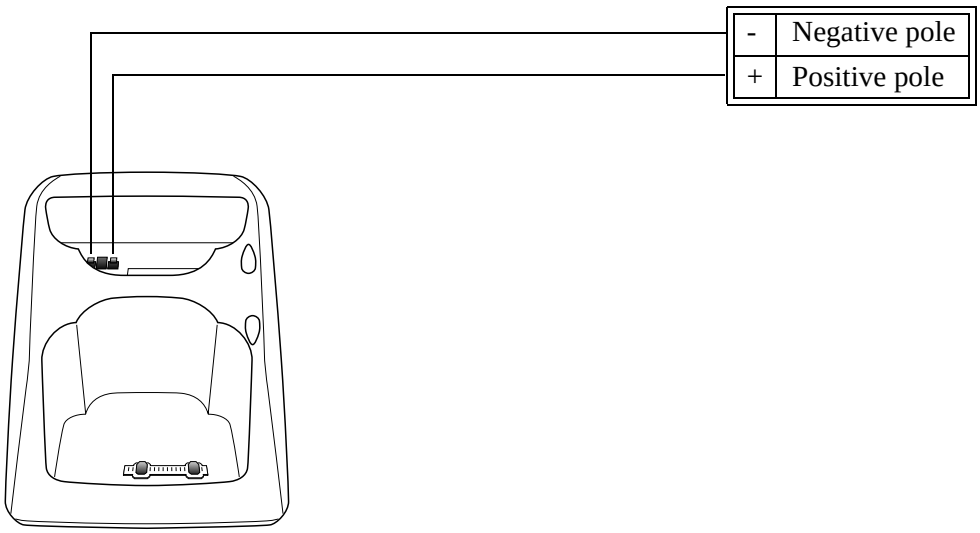
1) System Bus Connector
2) Front Slot Connector

Front Slot



Note: For pin assignments, refer to *System Bus Connector* above

Rear Slot



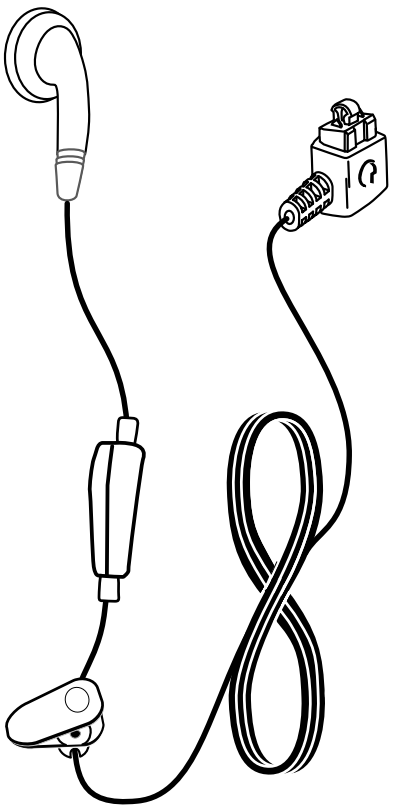
Portable HandsFree

Introduction

The *Portable HandsFree* is a light-weight unit which allows the user to combine the mobility of a handheld phone with the advantages of being handsfree.The following three main components are included:

- microphone
- earphone
- connector

The connector is plugged into the system connector of the phone. After fitting the earphone and attaching the microphone clip to a suitable part of the clothing, the portable handsfree facility is ready to be used.



Portable HandsFree Features

The *Portable HandsFree* is designed to be used with all phones in the Ericsson *7X8*-family.

The portable handsfree communication is full duplex, i.e. both parties will be able to talk simultaneously.

Specifications

Type No.:	502 0013-BV

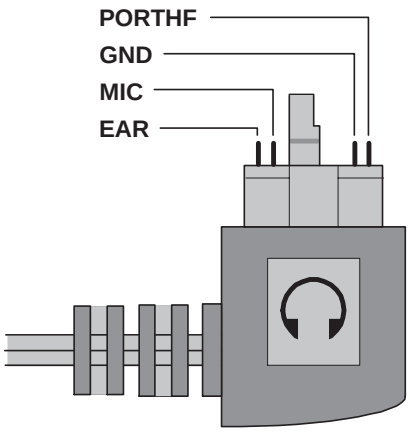
Microphone

Characteristics:	Omnidirectional
Sensitivity:	-43.5dB ±3dB rel. 1V/Pa at 1kHz
Impedance:	≤ 2kΩ
S/N ratio:	≥ 35dB

Earphone

Sensitivity:	106dB/250mV at 1kHz
Impedance:	16Ω

Connector and Signals



Portable HF connector	Signal direction	System connector
MIC	→	ATMS
EAR	←	AFMS
GND	—	GND
PORTHF (actice LO)	→	PORTHF (detect)

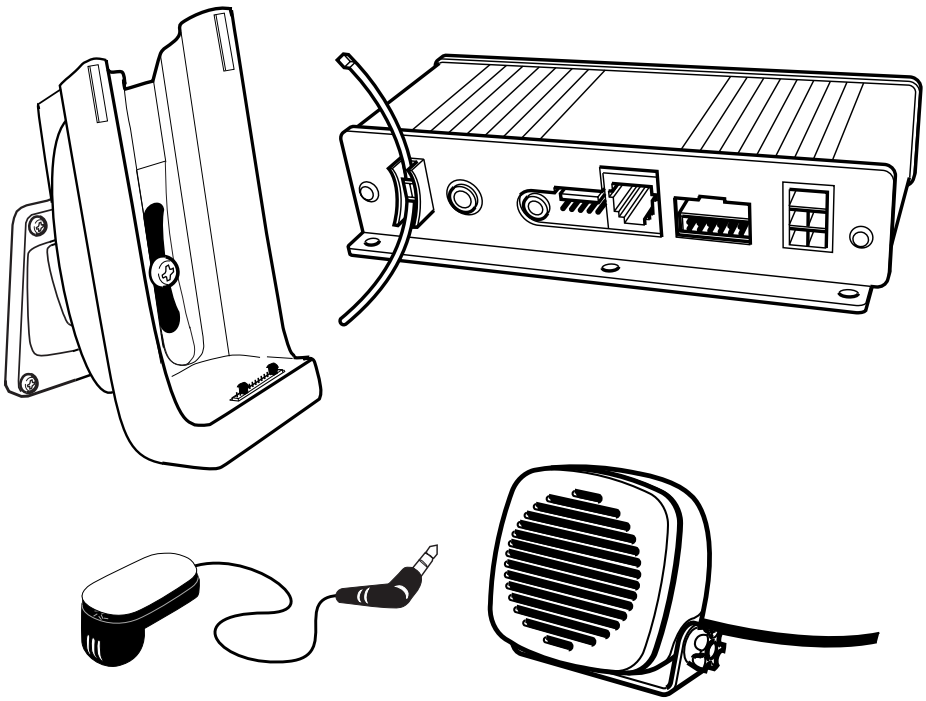
Vehicle HandsFree Solution HF7300

Introduction

The *Vehicle Handsfree Solution HF7300* is specially designed for the Ericsson *7X8*-family telephones and includes apart from the handsfree facilities also a power supply for battery charging and phone operation.

The four main components are:

- Cradle
- Stick-On Microphone
- External Speaker
- Handsfree Unit



HandsFree Features

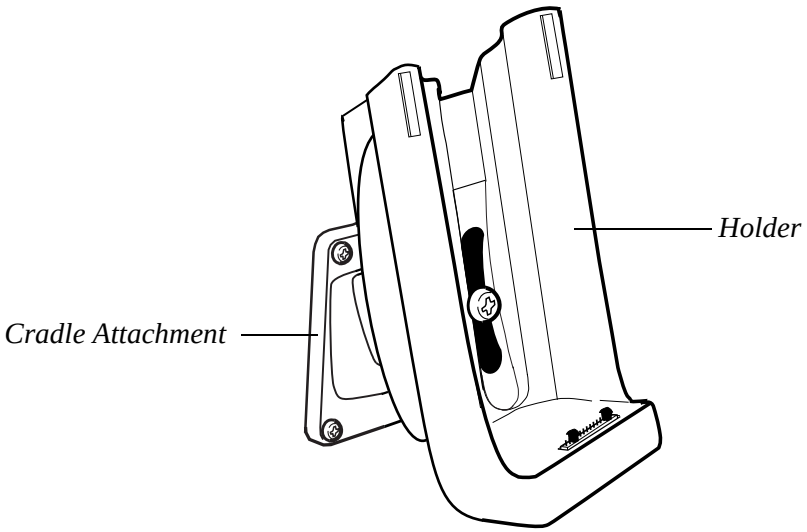
The HandsFree Unit does not include a DSP (digital signal processor) as the CPU (Central Processing Unit) of the telephone handles the handsfree switching.

The handsfree function is semi-duplex, which only permits one party to talk at a time while the other party is switched off to avoid feedback. When the land side party is talking, a "comfort noise" is added to simulate the background noise heard from the mobile.

HandsFree Components

Cradle

The cradle consists of two sub-units, the *Cradle Attachment* and the *Holder.*



The Cradle is equipped with a slide joint which is adjusted during the installation to a suitable vertical and horizontal angle for easy reach of the phone. The snap/click-in Holder connects the phone to the HandsFree Unit.

Stick-On Microphone

The Stick-On Microphone included in the kit is a unidirectional microphone to be mounted in a fixed position in the vehicle and connected to the HandsFree Unit.

External Speaker

Unless an optional Music Mute unit is utilised, the 4Ω External Speaker has to be connected to the speaker amplifier output of the HandsFree Unit.

HandsFree Unit

The HandsFree Unit includes the following electronic blocks:

- Microphone Amplifier
- Speaker Amplifier
- Modem/Handset Option
- Audio Switch Control
- External Audio Control
- Music Mute Control
- Power Supply

Microphone Amplifier

The Microphone Amplifier has got two individual inputs for the two types of microphones being available:

- Stick-On microphone (standard)
- Goose-Neck microphone (optional)

The microphone signal passes through two amplifier stages which results in a total gain of 31dB and 21dB for the Stick-On and Goose-Neck microphone resp.

Speaker Amplifier

The AFMS (audio-from-mobile-station) signal received from the phone is amplified by a programmable gain amplifier and fed to a differential amplifier consisting of four power transistors resulting in a total gain of 21dB. To protect the power transistors and the speaker against high current, a feed back signal from the power transistors to the programmable amp will allow only short peaks of high current to get through but reduce continuous high current to approximately 1.2A corresponding to just about 5W output power.

Modem/Handset Option

The Data Communication connector can be utilised for connection of two different options:

- analog PCMCIA modem
- external handset

When any of these devices is connected the audio signal ATMS (Audio-To-Mobile-Station) is switched to this connector, while AFMS (audio-from-mobile-station) always is available.

Note: A Data Extension Unit is required for the connection between the optional unit and the Data Communication connector.

Audio Switch Control

The Audio Multiplexer Control is used to switch the audio paths between the external microphone and the modem/handset connector.

Control signals such as EXTAUD (external audio control) and MUTEINV (inverted mute) are derived from logical gates controlled by the signals PORTHF (portable handsfree), DV (data/voice), and HOOKSNS (hook sense).

External Audio Control

The EXTAUD (external audio control) signal informs the phone when an accessory which is using the two external audio signals AFMS and ATMS has been connected to the HandsFree Unit

Music Mute Control

An optional Music Mute unit can be supplied with +12V from the vehicle battery. The Music Mute function is controlled from the phone by the MUTE signal which is

inverted by an open collector transistor before becoming available at two of the connectors.

Power Supply

The Handsfree Unit is able to deliver power to the phone for operation and battery charging by regulating the +12V of the vehicle battery to a constant current supply of max. 850mA and less than 1mA during stand-by.

Phone Operation:

The power consumption of the phone in different situations, e.g. in stand-by or in transmission, is entirely controlled by the phone itself, as these power levels are programmed and stored in the phone.

Battery Charger:

As the phone battery at all times is provided with current from the HandsFree Unit, the charging of the battery, incl. trickle charging, is controlled by the phone itself.

For more information regarding the battery charging algorithms of the telephone, refer to section 2, *Technical Description*, subsection *Battery Charging*.

Optional Accessories

Music Mute

An optional Music Mute unit can be connected to the HandsFree Unit and will direct the amplified received audio signal to the car stereo speakers during the handsfree conversation.

If the car stereo is equipped with a specific “mute” input, the optional Music Mute Cable connected directly between this input and the HandsFree Unit will mute the car stereo during the handsfree conversation.

Note: Max. current load at Music Mute output is 200mA.

Goose-Neck Microphone

A Goose-Neck Microphone allows a more flexible microphone position for improved sound quality incl. reduction of transmitted noise.

Data Extension

Data communication using handsfree mode is made possible by connecting a Data Extension Unit between a modem and the Data Communication Connector.

External Handset

An External Handset will give the user the possibility to switch from handsfree to handheld operation without disconnecting the power source. A Data Extension Unit is required for the connection between the External Handset and the Data Communication Connector.

Specifications

HandsFree Unit

Type No:	502 0019-BV
Dimensions:	135 x 100 x 28 mm; 5.3 x 3.9 x 1.1 in
Input Voltage:	10.8 to 15.6 VDC
Ambient Temperature - Operating:	-25^{o}C to +60^{o}C; -13^{o}F to +140^{o}F
Ambient Temperature - Charging:	+10^{o}C to +35^{o}C; +50^{o}F to +95^{o}F

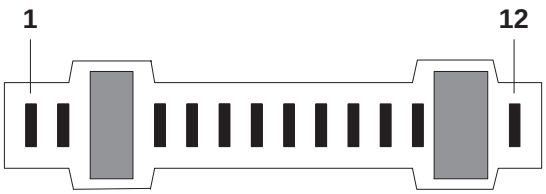
Cradle

Weight:	105g; 3.7 oz
Height:	95mm; 3.7 in
Depth (incl. cradle attachment):	54mm; 2.1 in
Width:	60mm; 2.4 in

Connectors and Signals

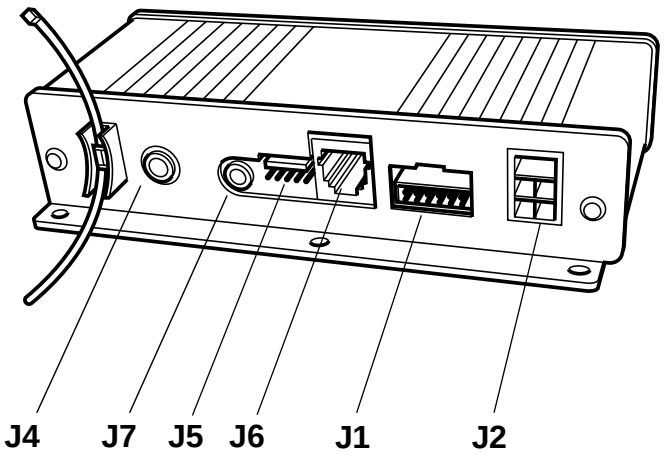
Holder

System Connector

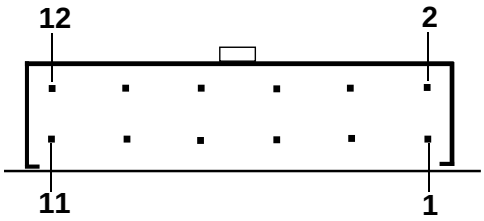


Note: For pin assignments, refer to column **H-pin** of System Connector J1 table on next page.

HandsFree Unit



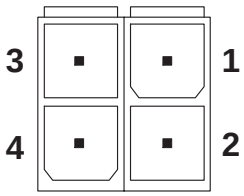
System Connector J1



J1-pin	H-pin	Signal	Specification
1	10	DGND	Digital ground & DC return
2	12	DCIO	DC voltage supply to phone power
3	4	AGND	Audio signal ground & 0V reference
4	2	ATMS	Audio to mobile station
5	-	HOOKSNS	Hook sense (connected to cradle, not phone)
6	1	AFMS	Audio from mobile station
7	6	MUTE	Music Mute
8	3	EXTAUD	External analog audio accessory sense
9	5	PORTHF	Portable handsfree sense
10	8	VDD	Logic reference, status ON
11	9	DFMS	Data from mobile station
12	11	DTMS	Data to mobile station

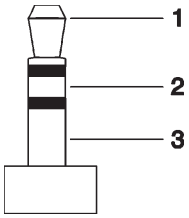
J1-pin = HandsFree Unit System Connector J1 pin
H-pin = Holder System Connector pin

Power Connector J2



1	GND
2	+12VDC
3	MUTEINV
4	n.c.

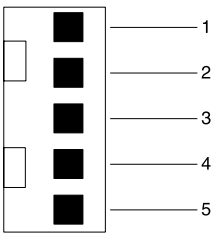
Microphone Connector J4



1	+10dB	Stick-On microphone
2	0dB	Goose-Neck microphone
3	AGND	Signal ground

Microphone connector J4 is female
Picture shows corresponding male

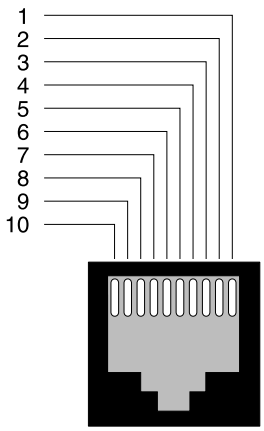
Music Mute Connector J5



1	LSP-	Loudspeaker common
2	DGND	Digital ground & DC return
3	LSP+	Loudspeaker signal
4	MUTE	Music mute
5	DC12OUT	+12VDC output

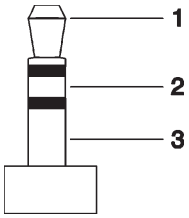
Music Mute connector J5 is male
Picture shows corresponding female

Data Communication Connector J6



1	MUTEINV	Music Mute (inverted)
2	VDD	Logic reference, status ON
3	DC12OUT	+12VDC output
4	AFMS (RX)	Audio from mobile station
5	D/V	Data/voice signal
6	ATMS (TX)	Audio to mobile station
7	PORTHF	Portable handsfree sense
8	DTMS	Data to mobile station
9	DFMS	Data from mobile station
10	DGND	Digital ground & DC return

Speaker Connector J7



1	LSP+	Loudspeaker signal
2	LSP-	Loudspeaker common
3		n.c.

Speaker connector J7 is female
Picture shows corresponding male

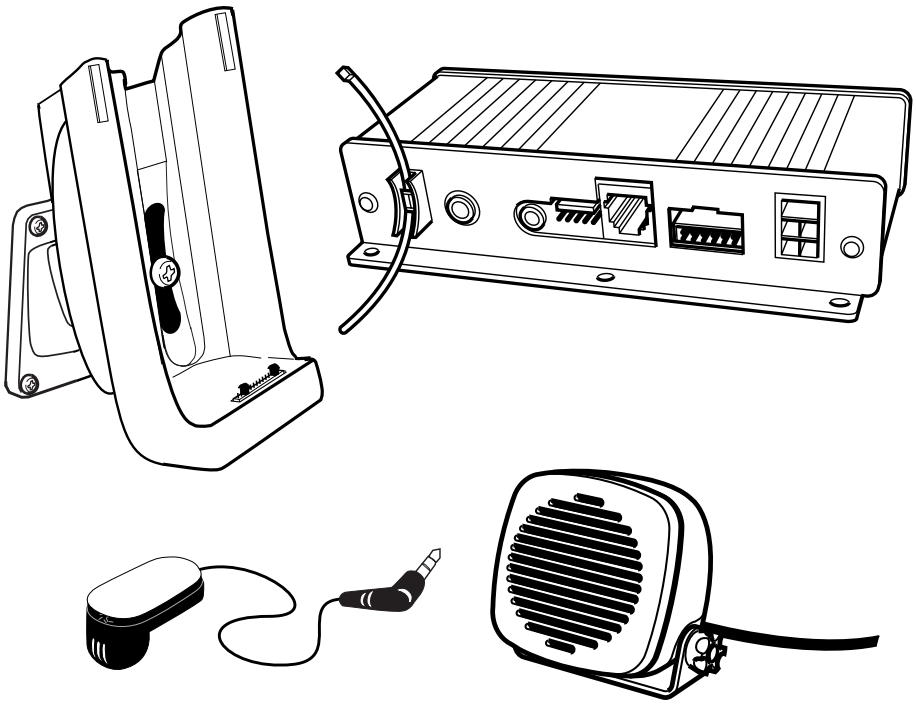
Vehicle HandsFree Solution HF7600

Introduction

The *Vehicle Handsfree Solution HF7600* is specially designed for the Ericsson *7X8*-family telephones and includes apart from the handsfree facilities also a power supply and battery charger for the phone.

The four main components are:

- Cradle
- Stick-on Microphone
- External Speaker
- HandsFree Unit



HandsFree Features

After placing the telephone in the *HF7600* holder, all handsfree functions are controlled by the DSP (Digital Signal Processor) and its peripherals located in the HandsFree Unit.

The handsfree communication is full duplex, i.e. both parties will be able to talk simultaneously. Some attentuation can however be noticed on the land side during simultaneous talking, while both speech channels will be open on the mobile side all the time.

Echo Cancellation

To avoid acoustic feedback in a full duplex handsfree system, i.e. prevent the speaker sound being picked up by the microphone from becoming amplified, the DSP has to suppress these signals by Echo Cancellation. The DSP will be able to distinguish transmitted speech from received echoed speech, if it is informed about the acoustic environment of that particular vehicle where the handsfree kit is installed. This is automatically done by an *adaptive training sequence* which is being continuously updated.

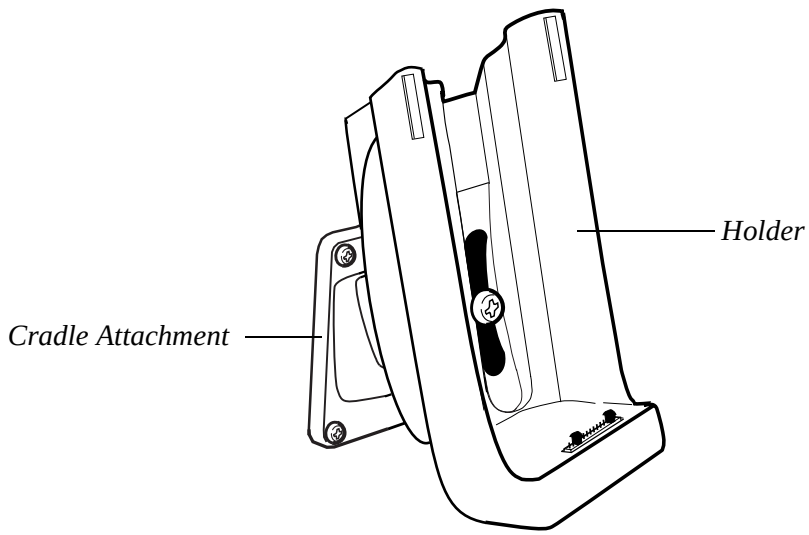
Noise Reduction

The ambient noise of a driven vehicle is often too loud to allow an acceptable speech quality when using handsfree. The DSP is however able to separate this noise from the speech and reduce it to an acceptable level.

HandsFree Components

Cradle

The Cradle consists of two sub-units, the *Cradle Attachment* and the *Holder*



The Cradle is equipped with a slide joint which is adjusted during the installation to a suitable vertical and horizontal angle for easy reach of the phone. The snap/click-in Holder connects the phone to the HandsFree Unit.

Stick-On Microphone

The Stick-On Microphone included in the kit is a unidirectional microphone to be mounted in a fixed position in the vehicle and connected to the HandsFree Unit.

External Speaker

Unless an optional Music Mute unit is utilised the 4Ω External Speaker has to be connected to the speaker amplifier output of the HandsFree Unit.

Handsfree Unit

The Handsfree Unit includes the following electronic blocks:

- Digital Signal Processor (DSP)
- Audio-To-Mobile-Station
- Audio-From-Mobile-Station
- Microphone Amplifier
- Speaker Amplifier
- Music Mute Control
- Power Supply

Digital Signal Processor (DSP)

The main functions of the Digital Signal Processor are to reduce the ambient audible noise and to suppress the speaker sound after being picked up by the microphone, so called echo cancellation. The circuitry around the DSP includes memories like ROM, EEPROM, and SRAMs.

Audio-To-Mobile-Station

The digital output from the DSP is D/A-converted and amplified by the Audio-To-Mobile-Station block. The audio signal passes through an analog multiplexer and a latch when enabled, which occurs when the signal MUTE from the phone goes high, i.e. when a conversation is initiated by the phone. The audio signal is supplied from the latch to the phone via the ATMS pin of the System Connector.

Audio-From-Mobile-Station

The analogue audio signal from the phone is received via the AFMS pin of the System Connector and supplied to the Audio-From-Mobile-Station block, where the level of the signal is reduced by an amplifier and then A/D-converted.

Microphone Amplifier

The low level signal from the microphone is amplified and filtered by the Microphone Amplifier which also includes an A/D-converter. The signal level is reduced prior to being digitised in order not to exceed the max. allowed peak voltage at the input of the A/D-converter.

Speaker Amplifier

The digital speaker signal from the DSP is D/A-converted, fed through an analogue multiplexer, and a latch. The final stage of the Speaker Amplifier includes the power amplifier which is able to supply approximately 7W into a 4Ω speaker. The +12V power supplied to the Speaker Amplifier is switched on and off by the phone via the DCIO pin of System Connector.

Music Mute Control

An optional Music Mute unit is supplied with +12V via the DC12OUT pin of the Music Mute Connector. The Music Mute function is controlled from the phone by the MUTE signal of the System Connector via the DSP, a latch, and finally a switching transistor in the Music Mute Control block.

Power Supply

The HandsFree Unit is able to deliver up to 950mA to the phone for operation and battery charging.

Phone Operation:

The power consumption of the phone in different situations, e.g. in stand-by or in transmission, is entirely controlled by the phone itself, as these power levels are programmed and stored in the phone.

Battery Charger:

As the phone battery at all times is provided with current from the HandsFree Unit, the charging of the battery, incl. trickle charging, is controlled by the phone itself.

For more information regarding regarding the battery charging algorithms of the telephone, refer to section 2, *Technical Description*, subsection *Battery Charging*.

Optional Accessories

Music Mute

An optional Music unit can be connected to the Handsfree Unit and will direct the amplified received audio signal to the car stereo speakers during the handsfree conversation.

If the car stereo is equipped with a specific “mute” input, the optional Music Mute Cable connected directly between this input and the Handsfree Unit will mute the car stereo during the handsfree conversation.

Note: Max. current load at Music Mute output is 200mA.

Goose-Neck Microphone

A Goose-Neck Microphone allows a more flexible microphone position for improved sound quality incl. reduction of transmitted noise.

Data Extension

Data communication using handsfree mode is made possible by connecting a Data Extension Unit between a modem and the Data Communication Connector.

External Handset

An External Handset will give the user the possibility to switch from handsfree to handheld operation without disconnecting the power source. A Data Extension Unit is required for the connection between the External Handset and the Data Communication Connector.

Specifications

Handsfree Unit

Type No:	502 0020-BV
Dimensions:	135 x 100 x 28 mm; 5.3 x 3.9 x 1.1 in
Input Voltage:	10.8 to 15.6 VDC
Ambient Temperature - Operating:	-25^{o}C to +60^{o}C; -13^{o}F to +140^{o}F
Ambient Temperature - Charging:	+10^{o}C to +35^{o}C; +50^{o}F to +95^{o}F

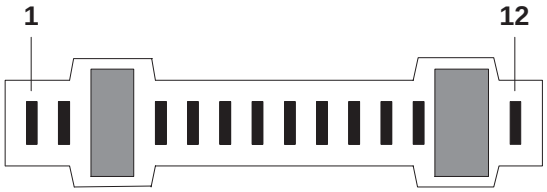
Cradle

Weight:	105g; 3.7 oz
Height:	95mm; 3.7 in
Depth (incl. cradle attachment):	54mm; 2.1 in
Width:	60mm; 2.4 in

Connectors and Signals

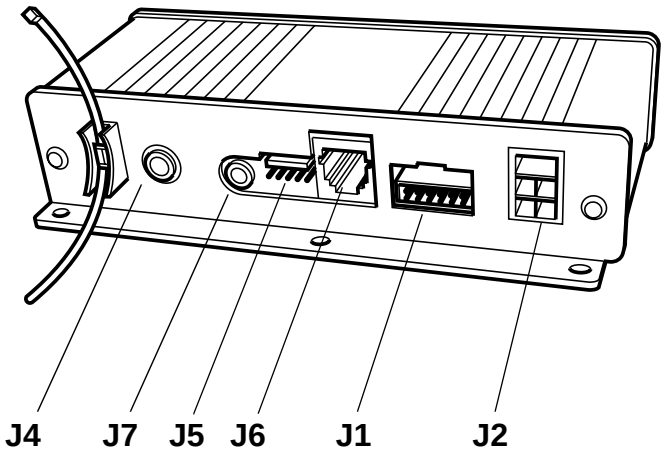
Holder

System Connector

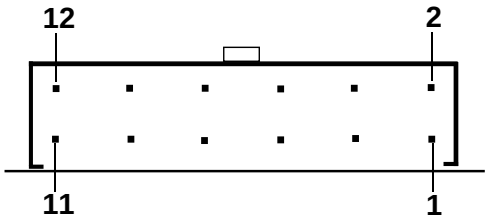


Note: For pin assignments, refer to column **H-pin** of System Connector J1 table on next page.

HandsFree Unit



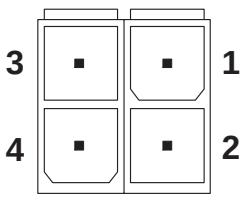
System Connector J1



J1-pin	H-pin	Signal	Specification
1	10	DGND	Digital ground & DC return
2	12	DCIO	DC voltage supply to phone power
3	4	AGND	Audio signal ground & 0V reference
4	2	ATMS	Audio to mobile station
5	-	HOOKSNS	Hook sense (connected to cradle, not phone)
6	1	AFMS	Audio from mobile station
7	6	MUTE	Music Mute
8	3	EXTAUD	External analog audio accessory sense
9	5	PORTHF	Portable handsfree sense
10	8	VDD	Logic reference, status ON
11	9	DFMS	Data from mobile station
12	11	DTMS	Data to mobile station

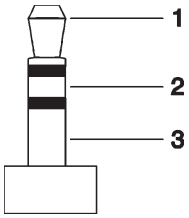
J1-pin = HandsFree Unit System Connector J1 pin
H-pin = Holder System Connector pin

Power Connector J2



1	GND
2	+12VDC
3	MUTEINV
4	n.c.

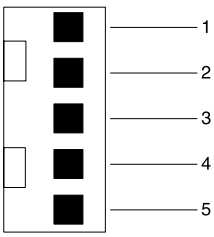
Microphone Connector J4



1	+10dB	Stick-On microphone
2	0dB	Goose-Neck microphone
3	AGND	Signal ground

Microphone connector J4 is female
Picture shows corresponding male

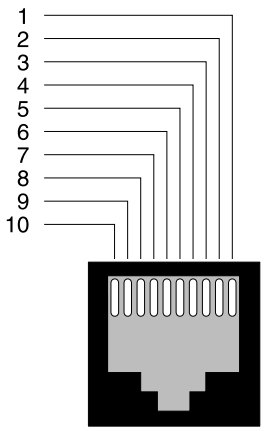
Music Mute Connector J5



1	LSP-	Loudspeaker common
2	DGND	Digital ground & DC return
3	LSP+	Loudspeaker signal
4	MUTE	Music mute
5	DC12OUT	+12VDC output

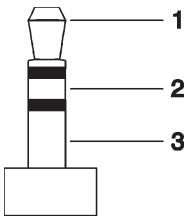
Music Mute connector J5 is male
Picture shows corresponding female

Data Communication Connector J6



1	MUTEINV	Music Mute (inverted)
2	VDD	Logic reference, status ON
3	DC12OUT	+12VDC output
4	AFMS (RX)	Audio from mobile station
5	D/V	Data/voice signal
6	ATMS (TX)	Audio to mobile station
7	PORTHF	Portable handsfree sense
8	DTMS	Data to mobile station
9	DFMS	Data from mobile station
10	DGND	Digital ground & DC return

Speaker Connector J7



1	LSP+	Loudspeaker signal
2	LSP-	Loudspeaker common
3		n.c.

Speaker connector J7 is female
Picture shows corresponding male

HandsFree Installation

Ericsson Mobile Phone EF738

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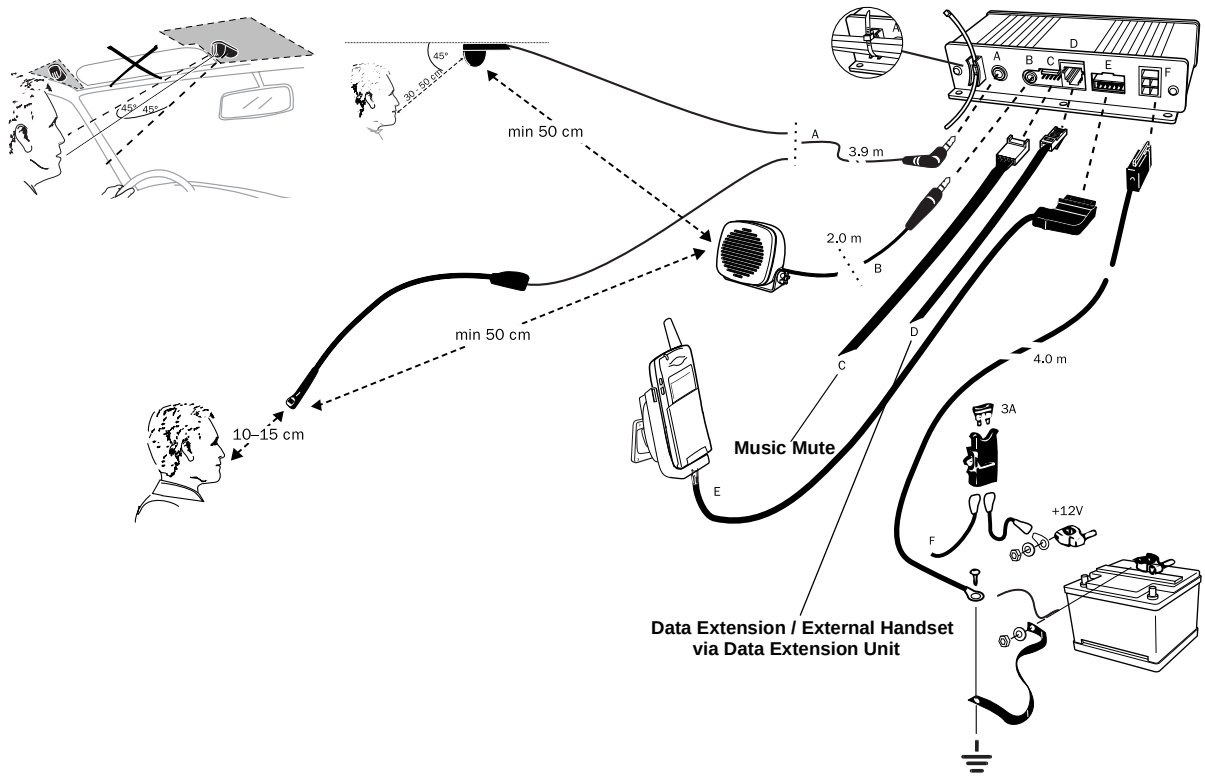

Spare Parts
Ericsson Mobile Phone EF738

To be distributed by the After Sales organization within the Region

Service Messages
Ericsson Mobile Phone EF738

To be distributed by the After Sales organization within the Region

EF738 **Ericsson Mobile Phone** Service Manual

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