MITSUBISHI ELECTRIC

LEVEL 3 SERVICE

FA9M037910

Trium

ARIA
(DUAL BAND)

REVISIONS	VERSIONS					
		A : Création X GLASSON	12/99	Rédigé par *Written by*	Verifié par *Checked by*	Approuvé par *Approuved by*
		B : Modif Setup MTS	01/00			
		C : Modif Format	05/00	X. GLASSON	B. LEGORGEU	G. LEBASTARD

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Version C
Date: 05/00

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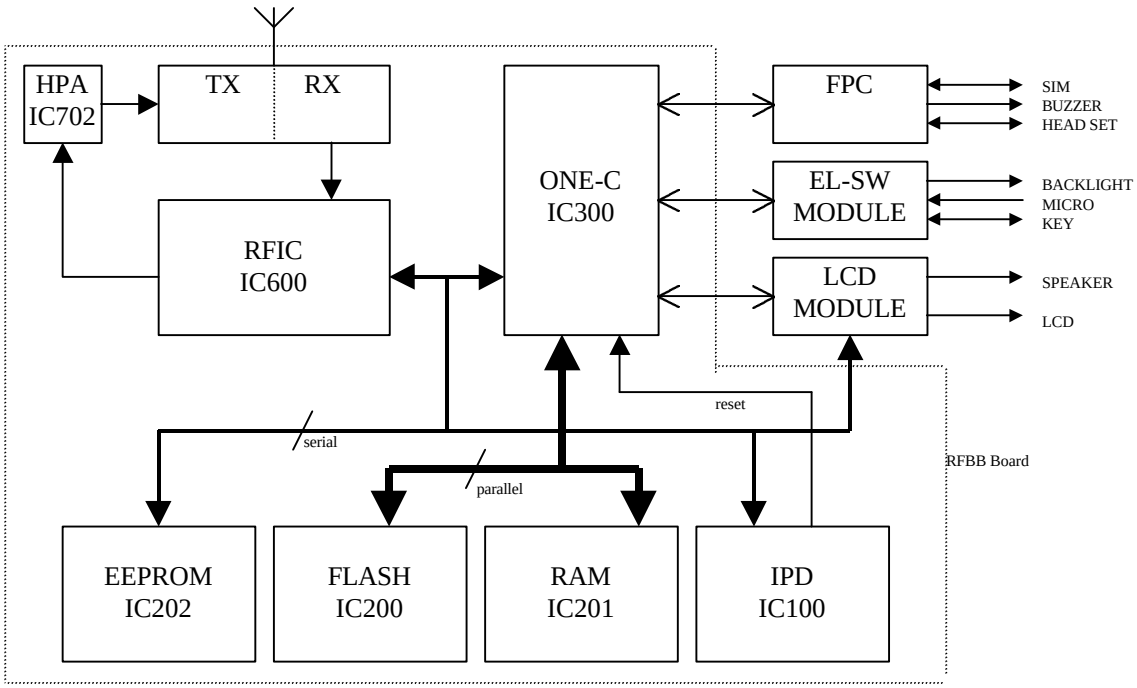
1. Functional Description

1.a General Description

The ARIA mobile have 4 different “boards”

- The PCA include the main functions : TX,RX, audio, logical circuits.
- The LCD module include the display and the speaker
- The EL-SW MODULE include the keyboard, the micro and the backlight
- The FPC (Flexible Printed Circuit) include the buzzer, the SIM reader and the head set connector

1.b Block Diagram



1.c Description of Block Diagram

1.c.1 IC 300 One-C (vWS22100).

IC300 includes in one chipset Base Band part, DSP, CPU, A/D, D/A converters, TDMA frame counters, a TX GMSK modulator, a TX power ramping circuit, RX filters. **IC300** carries out the management of the battery charging, and of the audio part. It interfaces with the radio frequency part.

1.c.2 IC100 IPD (Rohm BH6070KU).

IC100 provides the different powers supplies to RFBB board : 2.8VRTC, PSTCXO, 2.8VANA, 2.8VAUD, 2.8VD, 2.8VP, 5VSIM. The management of the battery charging is carried out by internal circuit of **IC100.**

1.c.3 IC600 RF-IC (Hitachi HD155121FEB).

Transceiver IC for E-GSM and DCS Dual Band cellular systems.

1.c.4 Memory system.

IC200 : Flash ROM (2MByte) .Stores the CPU program code
IC201 : RAM (128 kByte). Stores data for the CPU work.
IC202 : EEPROM (128K Byte) .Stores the user data and hardware adjustment data.

1.c.5 System Clock.

The system clock for the telephone is 13 MHz TCXO, generated by X600. It is processed in IC300 to provide serial clock for LCD, EEPROM, and IC100. The clock is buffered in IC300 One-C, and then fed to IC100 IPD as " CPU CLK " . It is available on pin 56 of IC100.
During Stand-By mode, the system clock is not managed from X600 TCXO but from X300 (" slow clock " at 32.768 kHz).

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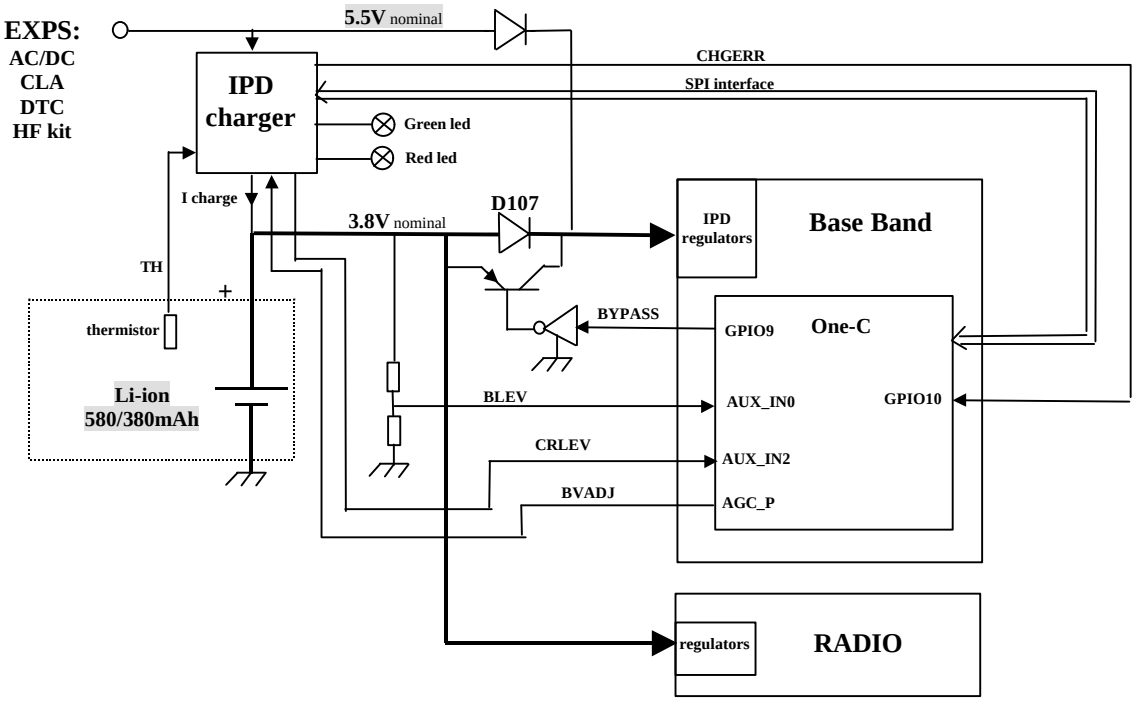
2 Battery management

2.a Block Diagram



2.b Description

The battery is Li-ion 580mAh, 3.8v nominal for Aria

External power supply for charging (EXPS) comes from the I/O connector at the bottom side of the mobile (AC/DC, CLA, DTC or H/F Kit). This power supply is 5.8 V nominal. Battery presence and battery type information are accessible in CHGM IPD register. If a Ni-MH battery is detected, the software considers that the battery is absent.

The battery temperature information (TH) is given by threshold in IPD CHGM register. This information is used only for charge control.

The battery level information is accessible in an A/D converter in One-C. It is also available in CHGM IPD register, this information is given by range only for range control.

External power supply (EXPS) presence information is accessible in CHGD IPD register. As described in the drawing above, the power supply for Base Band (IC300) comes from EXPS when it is present because EXPS level (5.8 V) is always greater than battery voltage. On the contrary, power supply for radio always comes from the battery.

The serial diode (D107) between battery and IPD (IC100) can be bypassed by software to reduce voltage headroom. Bypass is Activated when battery is less than 3.45 V.

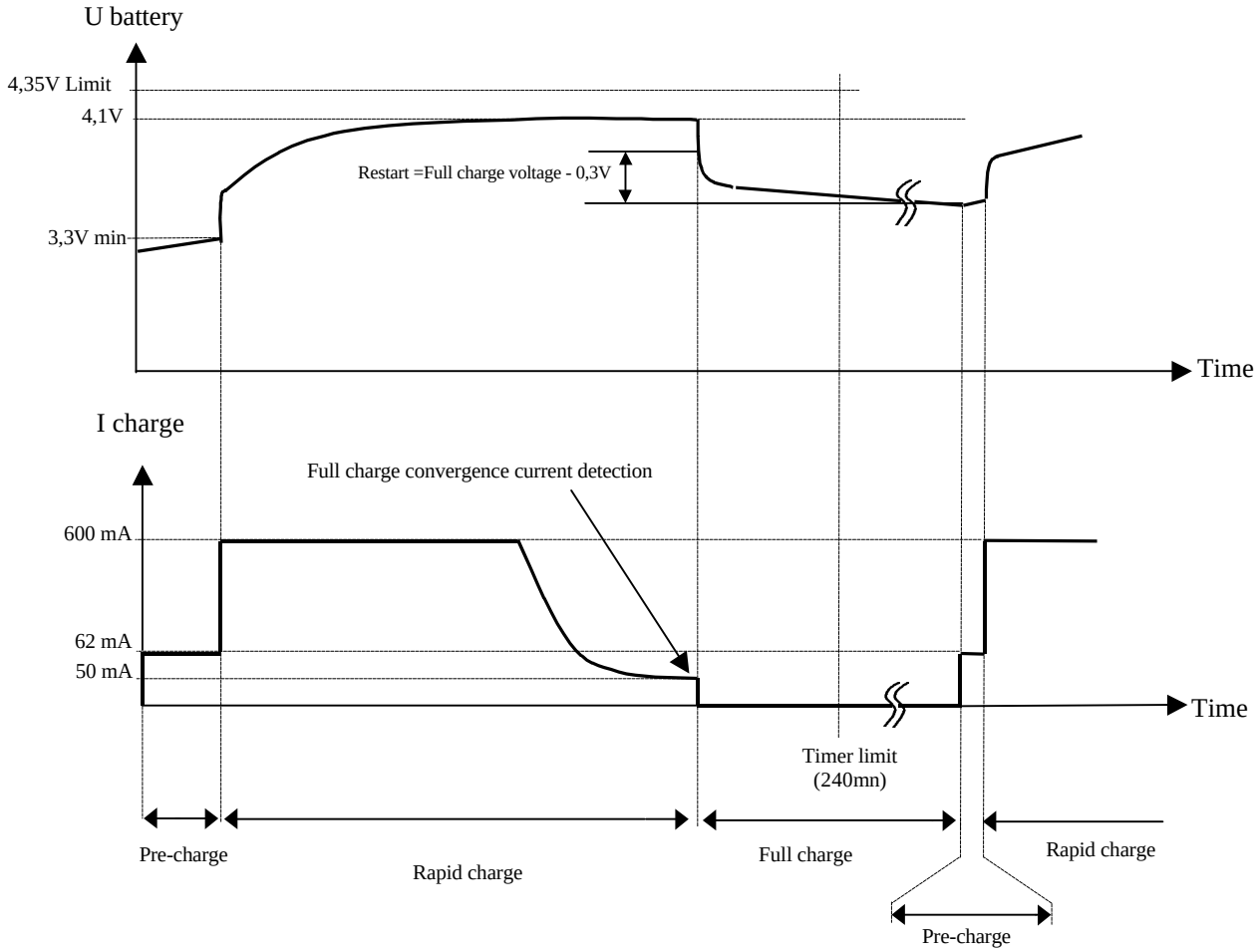
2.c Charging process

Charging process follows these successive phases :

Pre charge :
This phase is mandatory before the rapid charge to verify that battery operation is normal (normal battery voltage and temperature). Charge current during this phase is 62 mA (1/8 C). If the battery voltage is more than 3.3 V, the S/W launch rapid charge except if the temperature is not between 0°C and 55°C.

Rapid charge :
Charge current during this phase is 600 mA. If battery temperature becomes abnormal IPD charger start a low current charge (1/20 C), while temperature comes back normal (between 0°C and +55°C) during 15 mn. Full charge detection ends Rapid charge. Full charge is detected by S/W when charge current decrease less than 50mA (full charge convergence current)

Full charge :
This phase shows that the battery is fully charged by LED Green or LCD Full charge is automatically stopped after 24 hours duration.



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2.d Main characteristics

The phone transmits only if the battery is attached to it, in any configuration of power supply. When the phone is connected to H/F adapter, DTC, AC/DC, or CLA, the battery charging circuit operates.

Battery voltage (+3.8V) is applied via D107 or from TESTPS (J100 pin8) through D101 when using Hand Free.

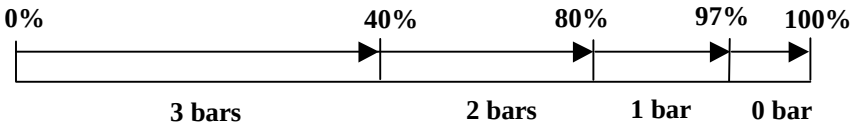
The main power supply is fed to the phone either from the attached battery via the connector J101, or from accessories :

- H/F adapter,
- Desk Top Charger DTC,
- AC/DC adapter and CLA via the external connector J100.

R107 and R108 give an internal voltage reference. If the battery voltage VBAT falls Low, then BYPASS short out the diode D107 through TR105 to reduce voltage drop.

2.e Autonomy Control

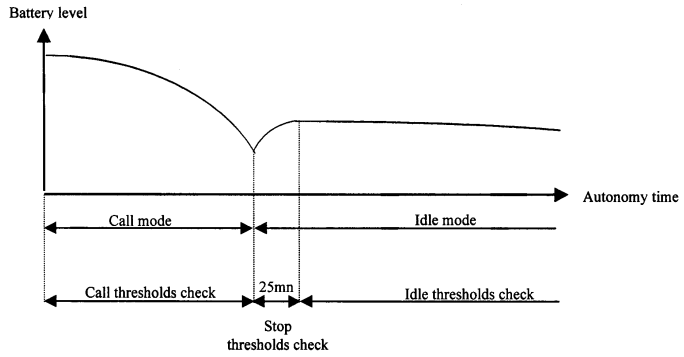
The battery energy is displayed on the LCD by a 3 bars “battery icon” . Voltage thresholds for each bars are calculated to have this autonomy time share out:



A 3 times 33% time share out is not possible because of the very stable battery voltage level between 20% to 50% autonomy time. In addition with these bars, a ” low battery alarm” is displayed between ”1 bar” and the mobile off.
All these thresholds are programmed in EEprom by the factory and given in following thresholds table.

	Idle Mode	Call Mode
Initial thresholds	**Battery level**	**Battery level**
3 bars → 2 bars	3.85 V	3.75 V
2 bars → 1 bars	3.70 V	3.60 V
1 bar → 0 bar	3.45 V	3.30 V
Power off	3.35 V	3.20 V

Thresholds are different according to the mode, Idle mode or Call mode. Idle mode threshold are checked by software 25 mn after the end of the call.



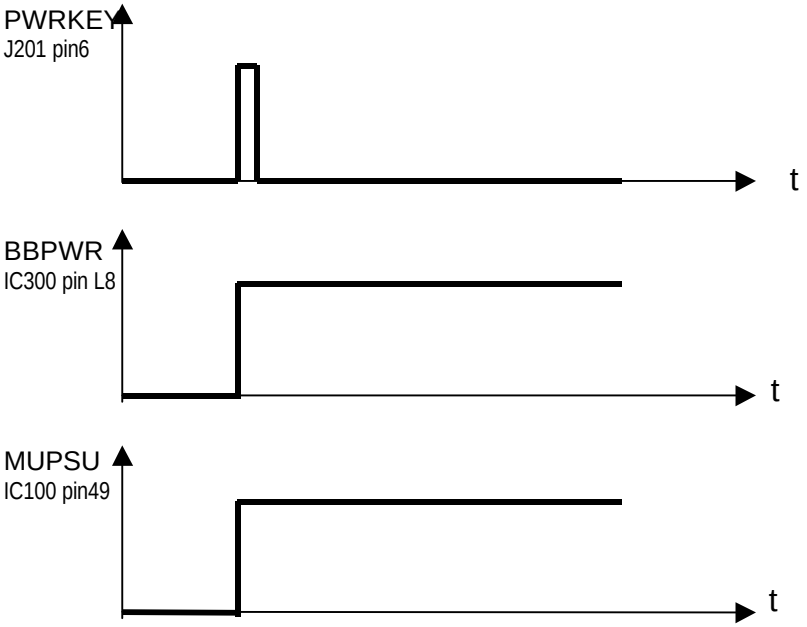
When battery voltage is less than the thresholds given in the table above, BAT_EMPTY is true.

The mobile is then powered off by Power Control.

2.f Power on

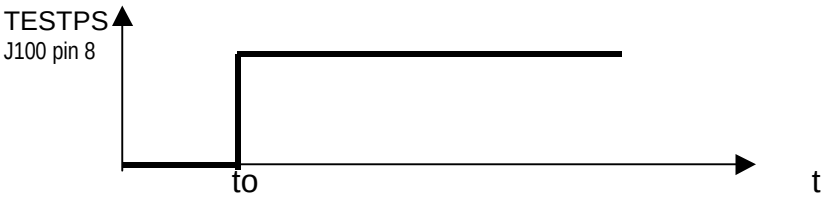
To switch on the mobile, three possibilities exist :

- With a battery :



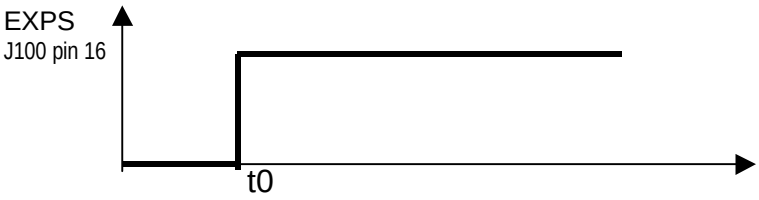
During these mode TESTPS and EXPS = low voltage level.
A high voltage level on MUPSU implies regulators REG 4, REG 5, REG 6, REG 7 are active.

- With Interface and I/O connector (Testmode M.T.S) :



t0= connexion I/O cable
When you connect I/O connector, MUPSU and BBPWR signals have the same waveform at TESTPS.
During this condition PWRKEY and EXPS = low voltage level.

- With AC/DC Charger, Cigar Light Adapter and DeskTop Charger.



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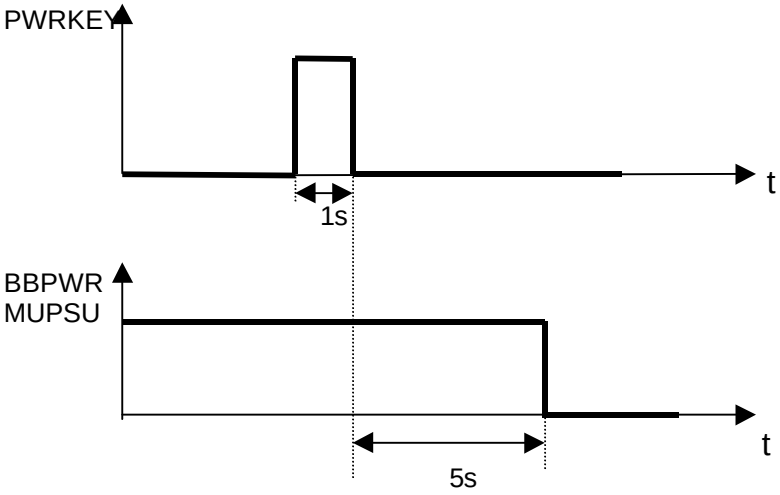
t0= connection by external power.
When you connect an accessory, MUPSU and BBPWR signals have the same waveform that TESTPS.
During this condition PWRKEY and TESTPS = low voltage level

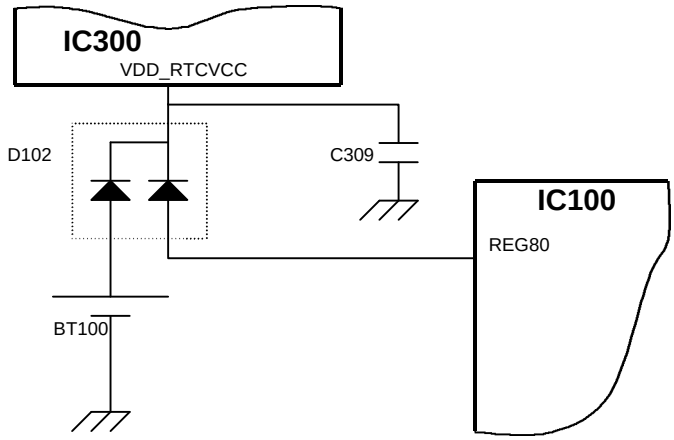
2.g Power off



2.h Real Time Clock

Real time clock is in ONE C (IC300) and energy is provided :

- By IC100 (pin 48) via D105, when the main battery is connected.
- By BT100 (back up battery) via D105, when the main battery is empty or not connected



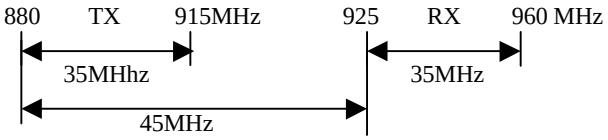
3 RF Section

3.a Frequency range

3.a.1 E-GSM Frequency :

124 Channels. 1≤ N ≤124 and 50 Channels. 975 ≤ N ≤1023 and 0
Receive frequency : 925.2~959.8 MHz
RX frequency = 935.0+0.2*N for (1≤ N ≤124) and 935.0+0.2*(N-1024) for (975 ≤ N ≤1024)
Transmit frequency : 880.2~914.8 MHz
TX frequency = 890.0+0.2*N for (1≤ N ≤124) and 890.0+0.2*N for (975≤ N ≤1024)

E-GSM BAND



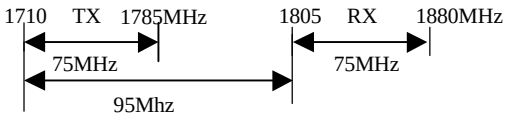
RF-PLL E-GSM BAND

RX 1st IF is 225MHz
RX 2nd IF is 45MHz

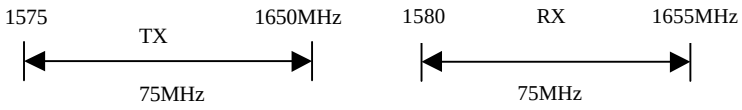
3.a.2 DCS Frequency :

374 Channels. 512≤ N ≤885
Receive frequency : 1805.2~1879.2 MHz
RX frequency = 1805.2+0.2*(N-512).
Transmit frequency 1710.2~1784.8 MHz
TX frequency = 1710.2+0.2*(N-512).

DCS BAND



RF-PLL DCS BAND



RX 1st IF is 225MHz
RX 2nd IF is 45MHz

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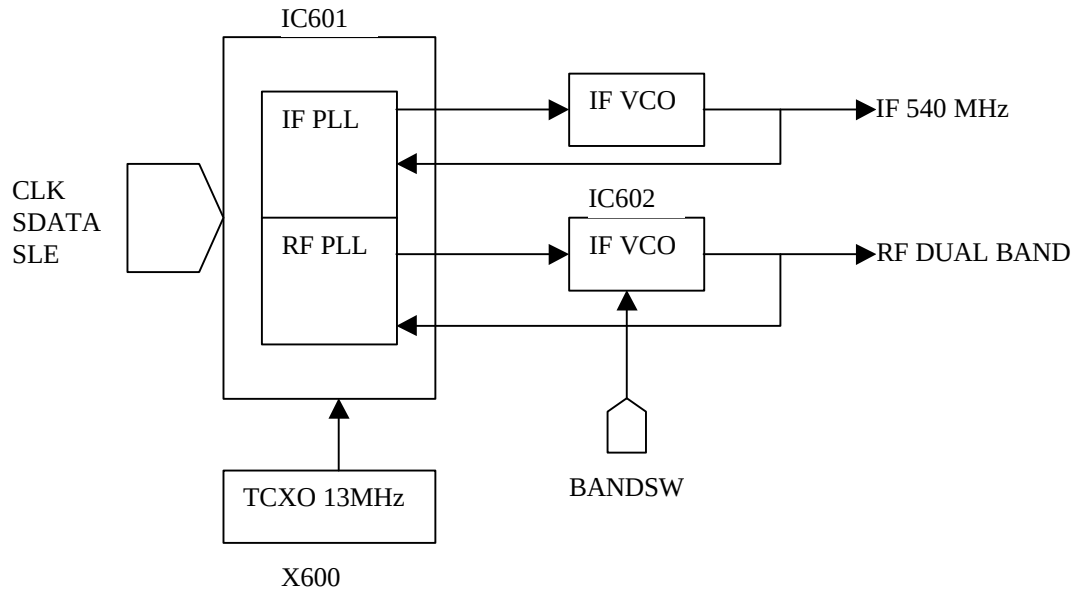
3.b Synthetiser Circuit Description.



Switching between GSM and DCS band is performed by programming the LMX2331LTM (IC601) with the serial data in BBE from CPU.
The serial data lines are connected directly to the serial input pin of the PLL IC (IC 601), and are used to program the 2 PLLs of the IC.

The LMX2331LTM has two PLLs : one is variable frequency (RF PLL), and the other is fixed frequency (IF PLL).

RF-PLL : variable frequency PLL for RX and TX for both GSM and DCS bands.
Oscillation Frequency Ranges :
- For E-GSM Band / 1150 - 1185MHz
- For DCS TX / 1575 - 1650MHz
- For DCS RX / 1580 - 1655MHz

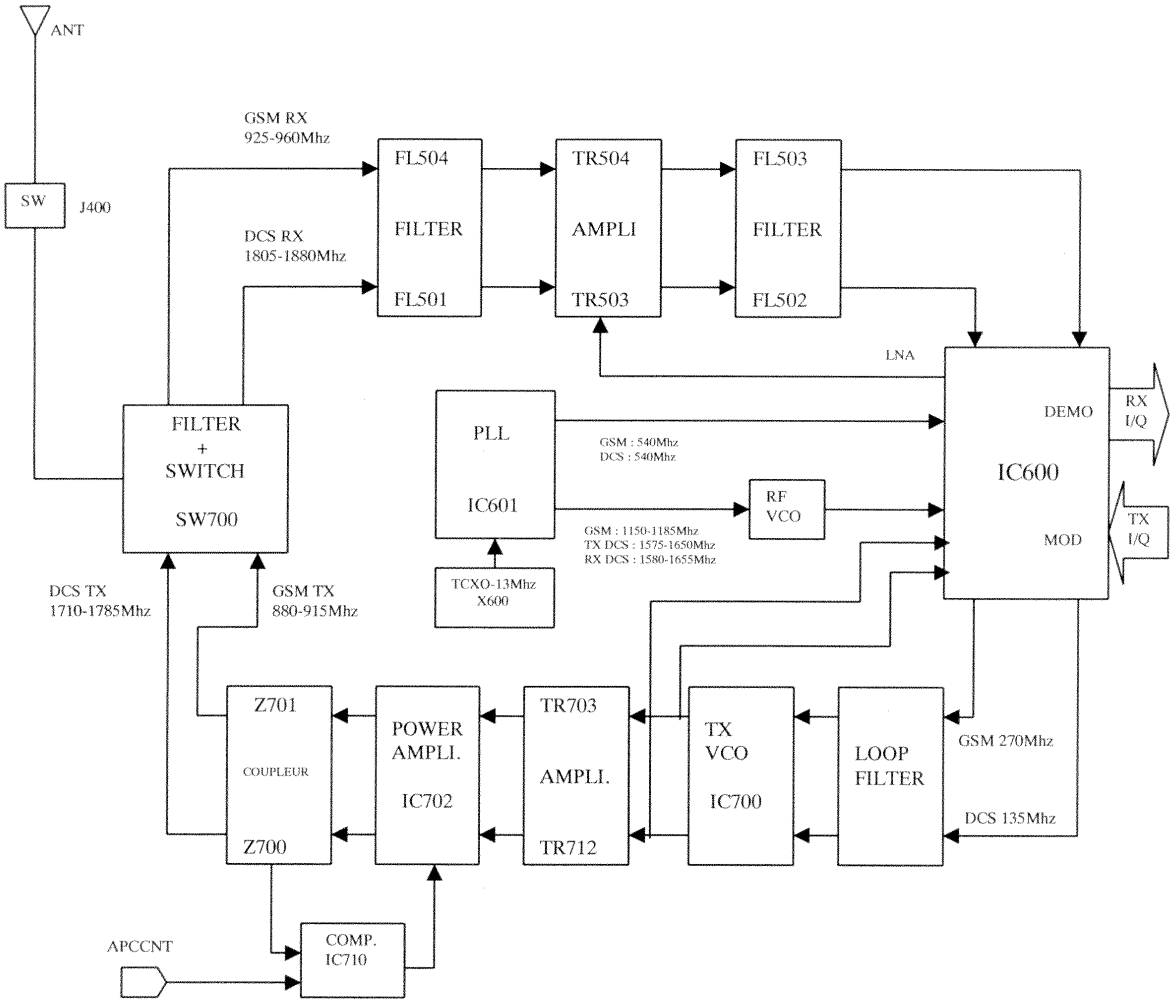
IF-PLL : Fixed frequency 540 MHz for IF of TX and RX for both E-GSM and DCS bands.

The signal BANDSW controls the E-GSM/DCS Band switching.

BANDSW	RF BAND
0	E-GSM
1	DCS

In order to achieve the channel spacing, the reference frequency is set to 200kHz.

3.c RF Block Diagram



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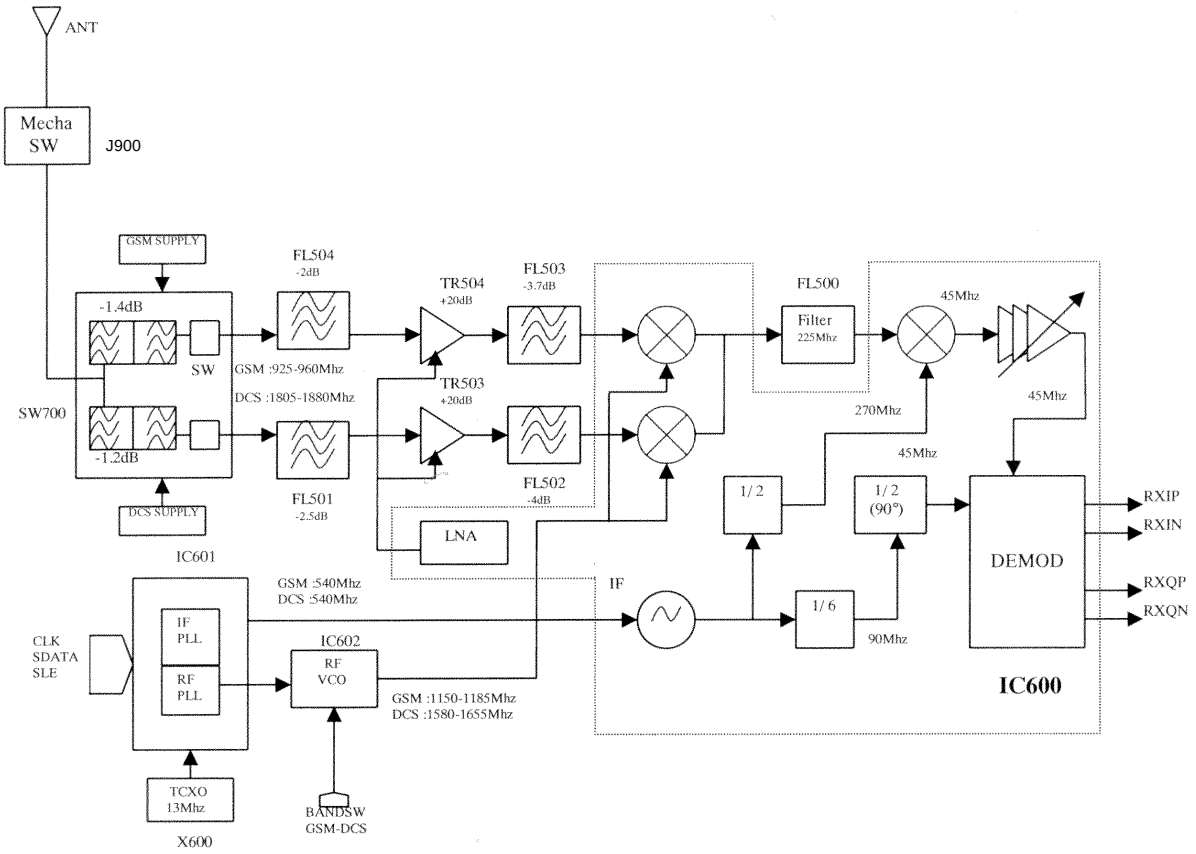
3.d Reception.

3.d.1 Reception Block Diagram.



3.d.2 Description of Reception Block Diagram.

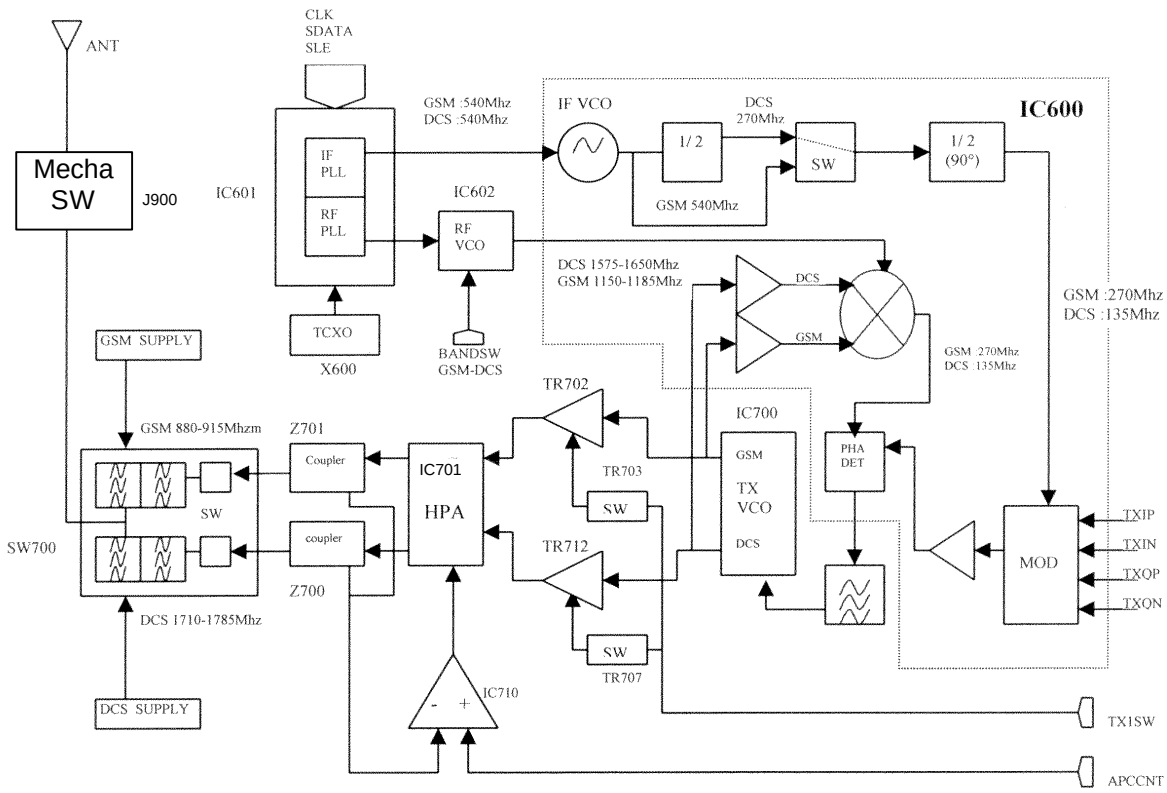
E-GSM band (925-960MHz)
Incoming RF signal from aerial is filtered and switched to the RX GSM path through SW700 . The signal is filtered by FL504, before to be amplified by TR504, and is further filtered by FL503. Then, the signal input to RF-IC (IC600) in a first mixer stage. The RF signal (925-960MHz) is mixed with the RF-PLL Frequency (1150-1185MHz) coming from IC601 (PLL) via IC602 (RF-VCO). For the channel 1, the output signal of the mixer is 225MHz (1150 - 925 =225MHz), and is filtered by FL500.

DCS band (1805-1880MHz)
Incoming RF signal from aerial is filtered and is switched to the RX DCS path through SW700 . The signal is filtered by FL501 , before to be amplified by TR503 , and is further filtered by FL502. Then, the signal input to RF-IC (IC600) in a first mixer stage. The RF signal (1805-1880MHz) is mixed with the RF-PLL Frequency (1580-1655MHz) coming from IC601 (PLL) via IC602 (RF-VCO). For the channel 1, the output signal of the mixer is 225MHz (1805 - 1575 =225MHz), and is filtered by FL500.

For the E-GSM and DCS bands
The first intermediate frequency is 225MHz. Then, this frequency is filtered by FL 500 before input to the second mixer stage. The first IF (225MHz) is mixed with the 270MHz (Fixed Frequency PLL 540/2=270MHz), to a second IF at 45MHz. The 2nd IF is demodulated to Base Band (IC300) I/Q phase demodulated signals. RF-IC (IC600) provides automatic gain control.
IC600 includes a quadrature demodulator using a divide by four technical 90° phase splitter. The 2nd IF signal (45MHz) is demodulated to I, Q balanced signals for ONE C.

3.e Transmission

3.e.1 Transmission Block Diagram.



3.e.2 Description of Transmission Block Diagram

The direct and phase shifted signals are then fed to I and Q modulators inside the IC600. I and Q data components are fed into the IC600. The output from the two modulators is summed and fed out of pin 11. The GMSK signal leaves the modulator of IC 600, and is amplified also inside IC600.

E-GSM Band (880-915MHz)
A phase locked loop is created around the TXVCO IC700. The output is fed into IC600 and converted to 270 MHz (135 MHz on DCS) by mixing with RFVCO at 1150-1185 MHz (1575 – 1650 MHz DCS). This 270 MHz signal is compared with the 270MHz signal from the modulators, and the error signal is used to control the TXVCO. Note that the error signal on TP700 will have a DC component to control frequency, and an AC component at approx 270 kHz to control phase changes. Then the signal is filtered, amplified by TR702, and further filtered before to input to the power amplifier (IC701).From the PA, the output goes through coupler Z701, is switched to the TX path and is filtered by SW700. The signal then goes up to the antenna.

DCS Band (1710-1785MHz)
A phase locked loop is created around the TXVCO IC700. The output is fed into IC600 and converted to 135 MHz (270 MHz on GSM) by mixing with RFVCO at 1575 – 1650 MHz. This 135 MHz signal is compared with the 135 MHz signal from the modulators, and the error signal is used to control the TXVCO. Note that the error signal on TP700 will have a DC component to control frequency, and an AC component at approx 270 kHz to control phase changes. Then the signal is filtered, amplified by TR712, and further filtered before to input to the power amplifier (IC701).From the PA, the output

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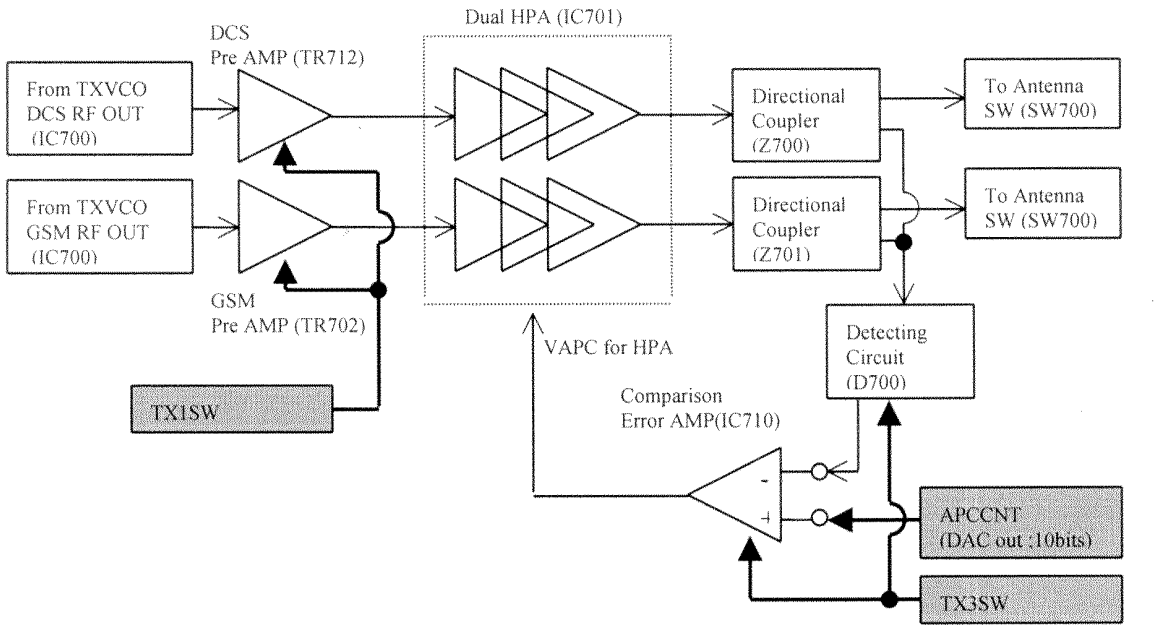
goes through coupler Z700, is switched to the TX path and is filtered by SW700. The signal then goes up to the antenna.

3.e.3 Output power control.



APCCNT is the reference waveform voltage for a TX burst (provided by IC300).

TX1SW: This control signal is used to switch on/off the preamplifiers. (TR702 and TR712)
H. Level : Pre Amp is active.
L. Level : Pre Amp is not active.

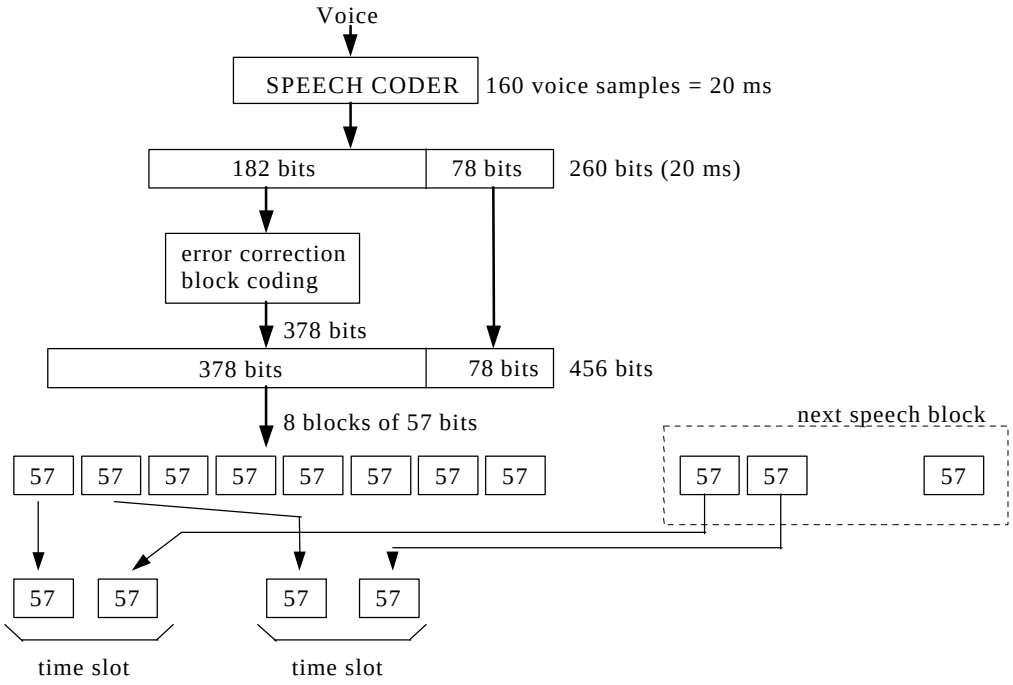
TX3SW:This control signal is used to switch on/off the operational amplifier of the APC Loop (IC710).
H. Level : Detecting Circuit and comparison Error AMP is active.
L. Level : Detecting Circuit and comparison Error AMP is not active.

RF signal is rectified by voltage doubler Schottky barrier diodes D700. This level is compared with APCCNT. The result of the comparison is used to vary the gain of the HPA IC701.
The APCCNT signal input from the base band circuit (IC300) contains the burst shaping information and the power level to be set among the 15 power levels defined by the GSM, or the 16 power levels defined by the DCS specifications. It controls the output power level by a feed-back loop (Automatic Power Control).

E-GSM	DCS
PCL 5 → +33 dBm	PCL 0 → +30 dBm
PCL 19 → +5 dBm	PCL15 → +0 dBm

4 Speech coder

Audio is sampled at 8 kHz rate, and divided into 20 ms blocks of 160 samples per block. Each 20 ms block is characterised by 260 bits i.e. 13 Kbits/s. The resulting signal is processed by a regular pulse excitation - long term predictor (RPE - LTP) codec. This yield a digital representation of vocal chord vibrations, together with the filter characteristics which must be applied to them to make voice sounds.
The most significant 182 bits will go through error correction and become 378 bits. The less critical group of 78 bits will not go through error correction and will just be summed with the 378 bits which will yield 456 bits.



These 456 bits are then separated in 8 blocks of 57 data bits.
These blocks are interleaved with adjacent blocks to guard against burst errors and broken up into blocks of 114 bits for transmission. This block of 114 bits are the data bits of the timeslot.

Timing data is added, and the resulting bit stream is fed to the Gaussian Minimum Shift Keying (GMSK) modulator, where the bits are taken two at a time and used to smoothly change the phase of an RF carrier according to bit combination.

4.a Full rate / Half rate / Enhanced full rate

The data rate of 13kbit/s (**full rate**) is considerably lower than for direct speech digitising as in PCM. Now more advanced voice coders cut this to 5.6 kbit/s (**half rate coding**).
The **enhanced full rate**, is just a full rate with a different speech coder which improves the transmission quality.

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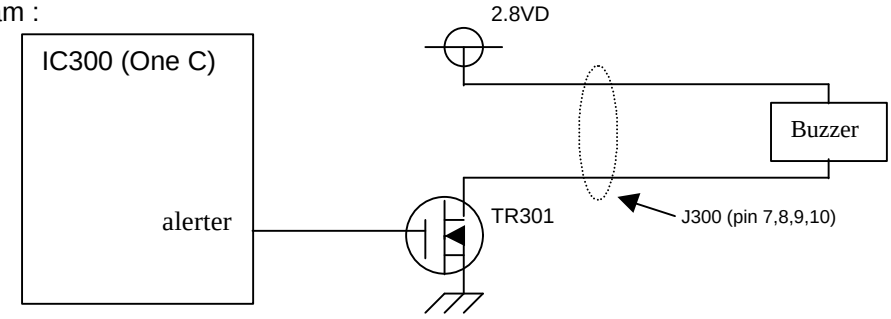
5 Analogue Audio

The audio part is managed by the One-C circuit (IC300).

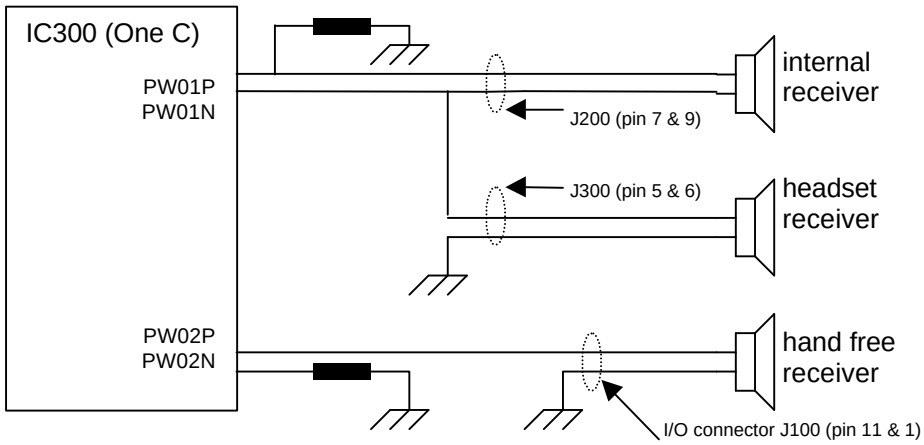
5.a Buzzer.

Diagram :



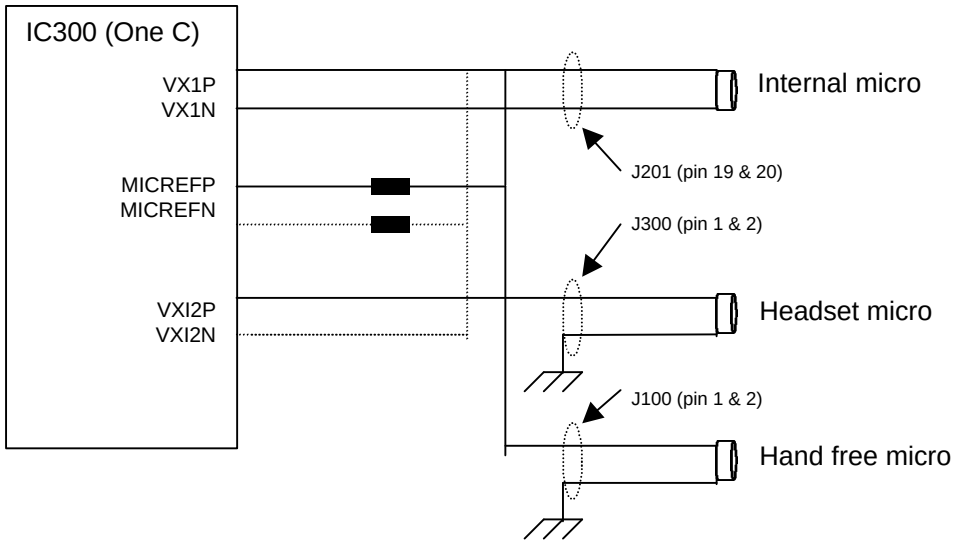
5.b Speaker (RX audio)

Diagram :



5.c Micro (TX audio)

Diagram :



When Handfree Kit is used there is a high level on HFDETL J100 pin 5 .

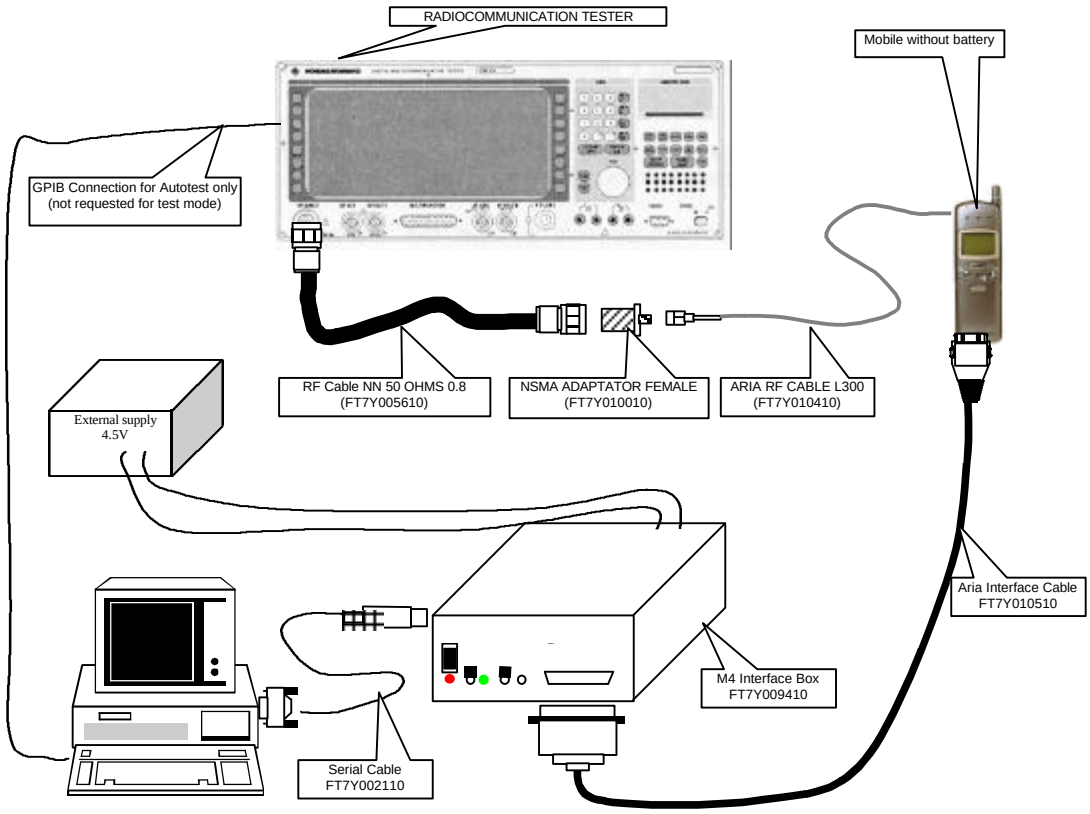
6 Testmode Software

For M4 family test mode is not directly possible from the mobile indeed relevant software is available on PC only.

- Basic test mode functions (delete data user, print labels, download of settings) are available in MSTools software (see level 2 service manual),
- download of mobile software is available with IPLTrium software (see level 2 service manual).
- More advanced testmode functions to test the mobile are available in MTS software. This software can be used only with a runtime engine TEST STAND.

When making measurement on the board itself, it is possible to power the board from the M4 interface box

6.a Equipment installation



The test mode is used to control or adjust mobile parameters.
You must have the following requirements :

- Radio-communication tester
- Aria RF cable L300
- Aria Interface cable
- M4 Interface Box
- Serial Cable
- Computer under Windows 95 (PII 350 MHz 64 Mb recommended)

If you want to use autotest function which is included in MTS, then your Radio-communication tester must be a CMD55 (with firmware 3.6 and GPIB interface) and your computer must have GPIB interface. The result of autotest (measurement values) is displayed as HTML file.

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6.b Software (MTS) installation

This part describes how to install the different components of MTS depending of the functions of MTS you want to use.

6.b.1 Simple Setup:

If you want to have only the test mode functions (control and adjust RF parameters), follow : this procedure:

- Launch Setup.exe on MTS CD ROM root.
- Select the **Custom** Setup Type in Setup Type selection window and click on Next >
- Select the component as follow :

  ☑ MTS Application

  ☑ TestStand Engine

  ☐ GPIB Software

  ☐ NI-VISA Software

  ☐ Internet Explorer

- Then continue the setup program until Reboot information window and reboot.

MTS after sale service is now available in Start, Program, MTS After Sale Service

6.b.2 Complete Setup:

If you want to have all the function of MTS (control and adjust the RF parameters, execute and parameter the autotests), follow this procedure :

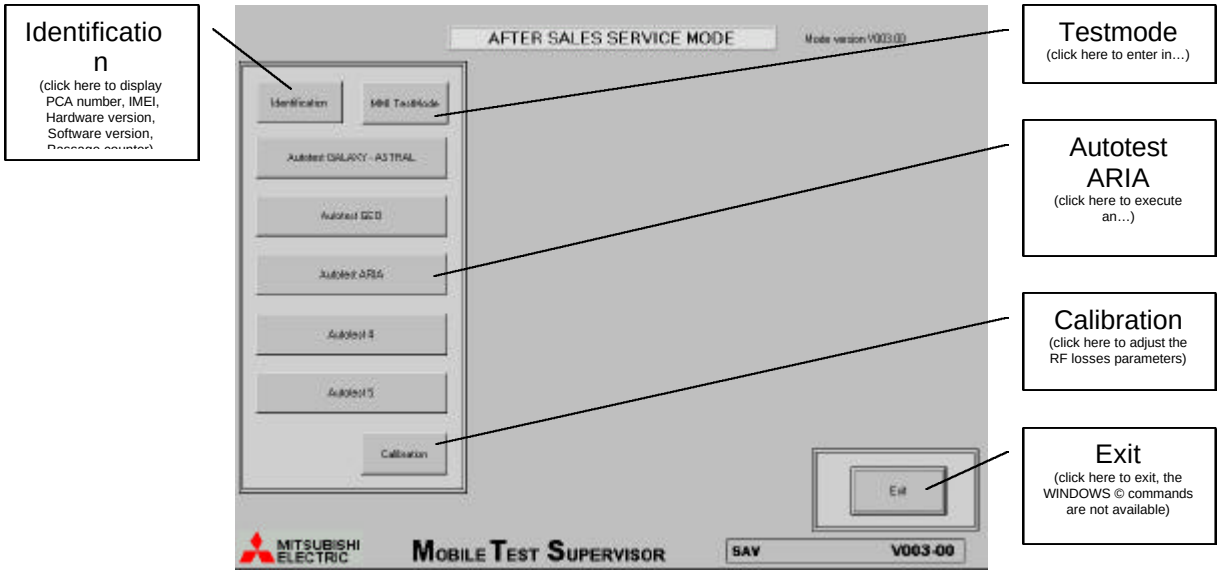
- Launch Setup.exe on MTS CD ROM root.
- Select the **Typical** Setup Type in Setup Type selection window and click on Next >
- Then continue the setup program until Reboot information window and reboot.

MTS after sale service is now available in Start, Program, MTS After Sale Service

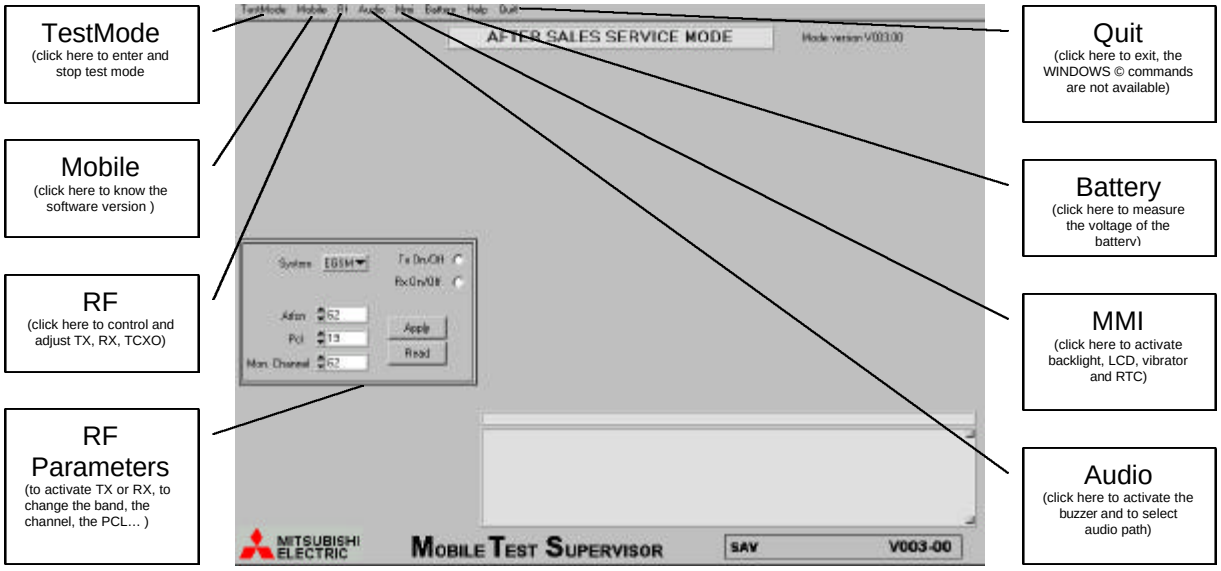
Before you launch an autotest, you must unvalid the step : **4301 DIO initialisation**
For that you have to turn the **Execution mode** switch on **run selected step** in the autotest page.

6.c Software (MTS) description

When you launch MTS from start menu you the main screen is displayed :



6.c.1 MMI Testmode interface : description of functions



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Enter in test mode :

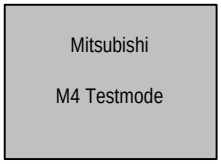
The mobile can be turned in test mode from two different ways :

- Using test mode code (hold the * and enter 5472) and PC cable S4 (FK8L011010)

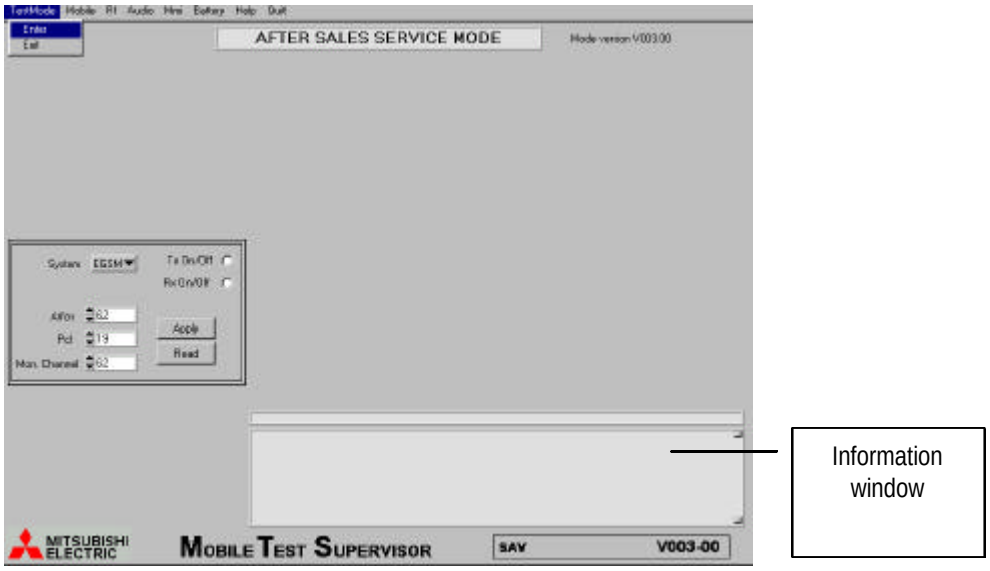
or

- Using the M4 interface box (FT7Y009410) and Aria interface cable (FT7Y010510)

When the mobile displays :

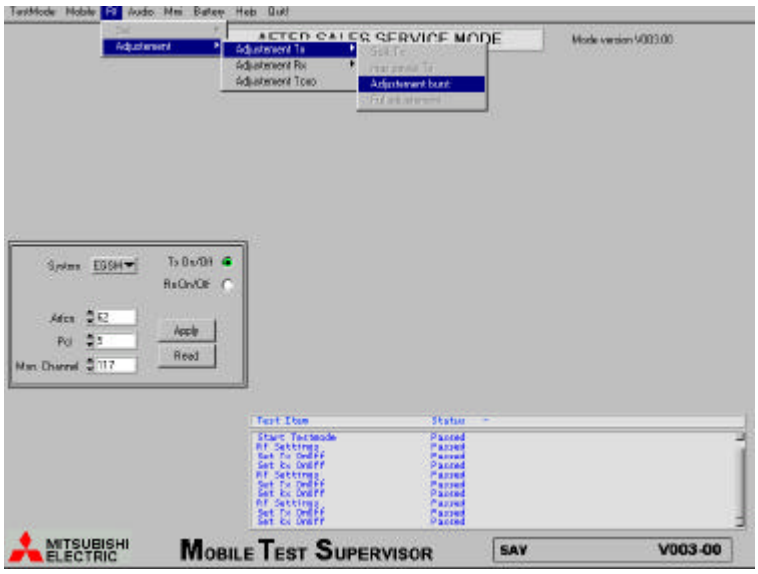


You can enter in Testmode, for that, choose **Enter** in **Testmode** menu as follow.

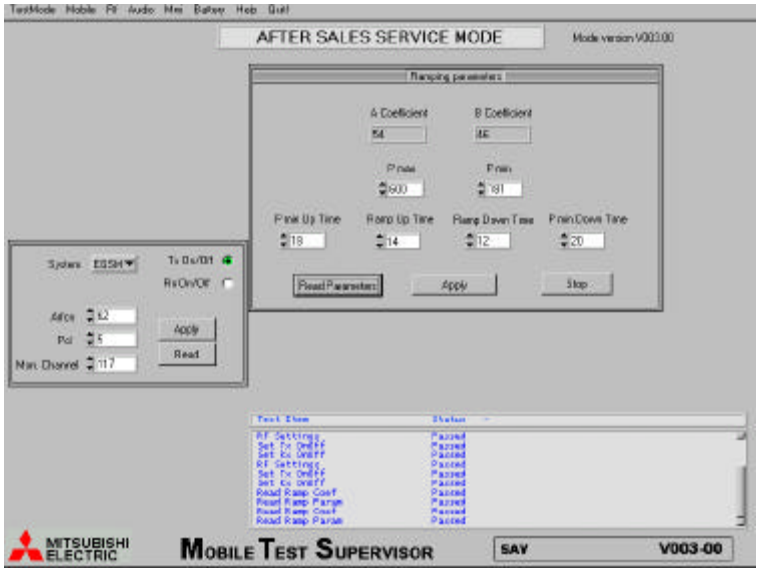


When the communication is established between mobile and computer the information window displays :

Power adjustment :
To enter in Power adjustments, choose **RF** menu, **Adjustmen**t, **Adjustment TX**, **Adjustment burst** as follow :

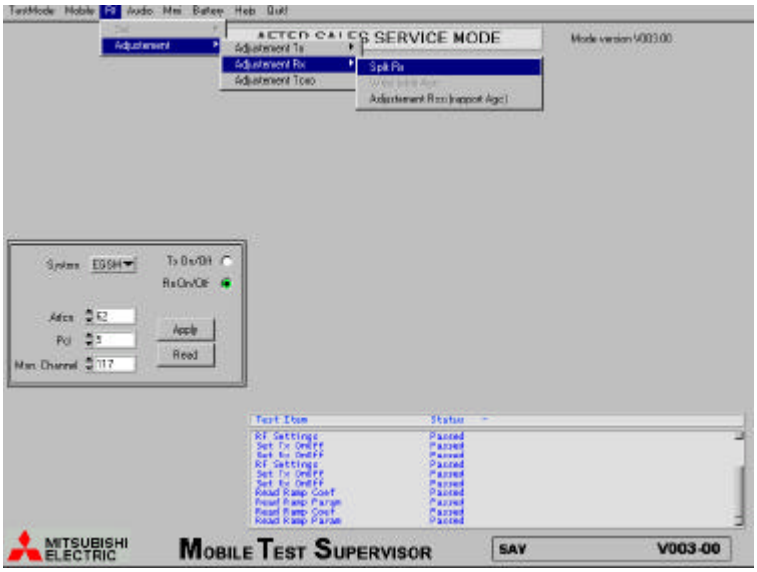


Then, the Ramping parameters Window is displayed as follow :



To adjust RSSI (if RX level is not good, for example), you have to process to different steps :
RX SPLIT and **RSSI ADJUSTMENT**

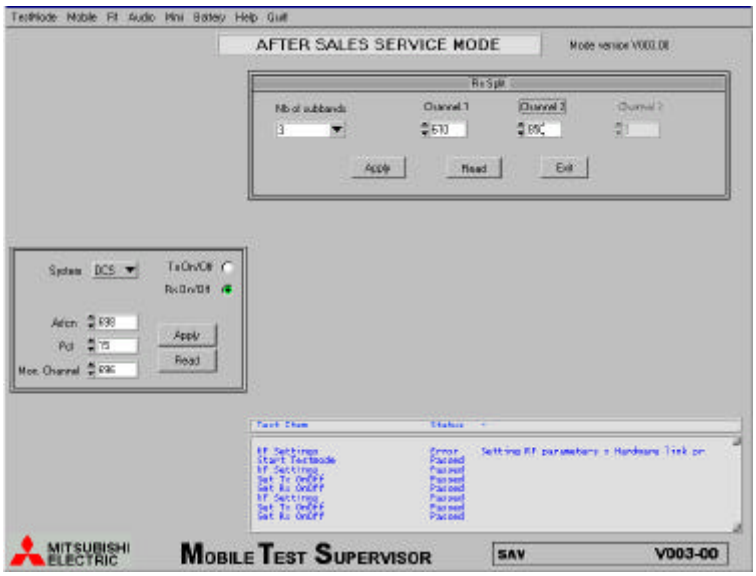
- For RX Split we choose :
  RF menu, **Adjustmen**t, **Adjustment RX**, **Split RX** as follow :



Then we fix RX split at the right value :
For the E-GSM band the number of sub-bands is 1(no split)
For the DCS band the number of sub-bands is 3

We split the DCS band as follow :	L range :	512 to 610
	M range :	611 to 850
	H range :	851 to 885

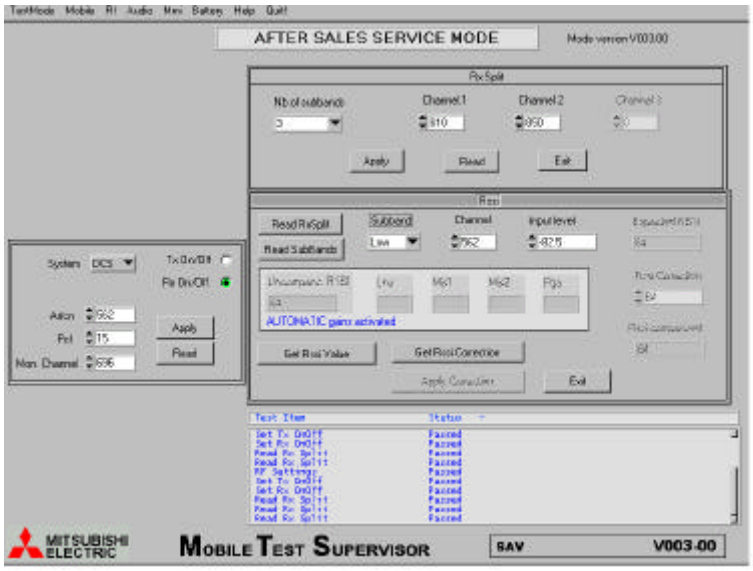
The RX split window should be as follow :



Now we can adjust RSSI for each sub-band,

- For RSSI ADJUSTMENT, we choose :
  RF menu, **Adjustment**, **Adjustment RX**, **Adjustment RSSI (rapport AGC).**

Then we get the RSSI window :



To adjust RSSI, we input a GMSK modulated signal (67.7 kHz shifted) at level and channel as follow :

Step	Channel	Level
1	37	-82.5
2	37	-31.5
3	562	-82.5
4	562	-31.5
5	730	-82.5
6	730	-31.5
7	868	-82.5
8	868	-31.5

If the RX level measurement is not good in E-GSM we adjust only the E-GSM band (step 1 and 2).
If the RX level measurement is not good in DCS we adjust only the DCS band (step 3 to 8).

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7 Basic Adjustment

7.a Power Adjustment

For the ARIA, Mitsubishi uses only MELCO HPA (IC701). Each mobile is adjusted in the factory and the TX parameters (Power Control Level values and ramping values) are stored in the EEPROM (IC202)

About the adjustment value of TX Power, see the following table.

E-GSM				DCS		
Ch-62 PCL	**Power Level (dBm)**	**tolerance**		**Ch-698 PCL**	**Power Level (dBm)**	**tolerance**
5	33	+/-2dB		**0**	30	+/-2dB
6	31	+/-3dB		**1**	28	+/-3dB
7	29	+/-3dB		**2**	26	+/-3dB
8	27	+/-3dB		**3**	24	+/-3dB
9	25	+/-3dB		**4**	22	+/-3dB
B	23	+/-3dB		**5**	20	+/-3dB
11	21	+/-3dB		**6**	18	+/-3dB
12	19	+/-3dB		**7**	16	+/-3dB
13	17	+/-3dB		**8**	14	+/-3dB
14	15	+/-3dB		**9**	12	+/-4dB
15	13	+/-3dB		**10**	10	+/-4dB
16	11	+/-5dB		**11**	8	+/-4dB
17	9	+/-5dB		**12**	6	+/-4dB
18	7	+/-5dB		**13**	4	+/-4dB
19	5	+/-5dB		**14**	2	+/-5dB
				15	0	+/-5dB

Example of adjustment :

E-GSM Table:

E-GSM							
Ch-62 PCL	**Power Level (dBm)**	**Pmax (DEC)**	**Pmin (DEC)**	**Pmin UP Time**	**Ramp UP Time**	**Ramp DN Time**	**Pmin DN Time**
5	32.1	649	176	18	14	12	20
6	30.7	555	176	18	14	12	20
7	28.7	474	176	18	14	12	20
8	26.7	411	176	18	14	12	19
9	24.7	360	176	18	14	12	19
10	22.8	320	171	18	14	12	19
11	20.3	288	171	18	14	12	19
12	18.5	262	171	18	14	12	19
13	16.6	242	171	18	14	12	19
14	14.4	226	166	16	14	12	19
15	12.4	213	166	16	14	12	19
16	10.1	203	156	15	14	12	19
17	8	196	146	15	12	12	19
18	6.1	191	146	13	11	12	19
19	3.8	186	136	11	8	12	19

DCS Table:

DCS							
Ch-698 PCL	**Power Level (dBm)**	**Pmax (DEC)**	**Pmin (DEC)**	**Pmin UP Time**	**Ramp UP Time**	**Ramp DN Time**	**Pmin DN Time**
0	29	734	188	18	14	12	20
1	27.6	634	188	18	14	12	20
2	25.7	536	183	18	14	12	20
3	23.8	458	183	18	14	12	19
4	21.7	396	178	18	14	12	19
5	19.9	347	178	18	14	12	19
6	17.9	308	173	18	14	12	19
7	15.9	277	173	18	14	12	19
8	13.9	252	168	18	14	12	19
9	12	235	163	17	14	12	19
10	10.6	221	163	16	14	12	19
11	9.3	209	103	15	6	12	19
12	7.8	203	103	13	6	12	17
13	5.8	198	103	13	1	12	17
14	3.6	194	103	10	1	12	17
15	1.2	192	103	2	1	12	17

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7.b RSSI control

To control RSSI go back to page 19 of the manual.
Set your radiocommunication tester at a given reference and check RSSI :

REF Gene	RSSI
-83.5 dBm	27 +/- 4
-60.5 dBm	50 +/- 4

8 Software Version

The software version is coded with 8 digits, evolving in the following order : 0, 1, 2, ...,9, A, B, ...,Z, a, b,...,z.

F	H	S	V	E	Vf	Ef	Vc

F : Family ex : 1 M3, 2 M4, ….
H : Hardware ex : 1 GALAXY, 5 GEO, 3 ARIA….
S : Software ex :
V : Version ex :
E, Vf, Ef, Vc are Mitsubishi Code.

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