# SIM900 V2.03

# Reliability Test Report

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**Data: 2010-09-29**

# Contents

# 1. Purpose

The document provides detailed reliability test conditions and data for SIM900 under different temperature, humidity and vibration.

# 2. Reference Standards

IEC 60068-2

ETSI GSM 3GPP phase2+

SIMCOM Reliability Handbook

YD/T1215

# 3. Test Equipment

R&S CMU200 Universal Radio Communication Tester

KSON Temperature Chamber

KSON Temperature and Humidity Lab Tester

STI D-150-2

# 4. Functional Check

Functional check before reliability test and recheck after this test is obligatory in order to ensure that the changes caused by the test are under accepted tolerance.

## 4.1 Call Set Up

The module can register on an actual network and establish a call normally with a User SIM card.

## 4.2 Serial Port Communication Test

The module can communicate with a PC via AT commands through a serial port correctly.

## 4.3 GSM RF Test

On the basis of the performance requirements and the GSM Specification, measurements are to be carried out. These input measurements will be used to determine whether there have been any electromagnetic or radio-engineering changes after environmental tests.

**Measuring parameters:**

- Conducted transmitter output power
- Transmitter output power versus time
- Peak phase errors (peak), RMS phase errors and frequency errors
- Output RF spectrum due to modulation and switching
- Receiver Bit Error Ratio (BER) performance

The above parameters are measured in low, middle, high channels and at low, middle, high power levels.

***All measured results should meet the requirements of 3GPP TS51.010 Specification.***

## 4.4 Call Success Rate Test

- Establish a call with CMU200 via AT commands successfully and then disconnect.
- Repeat the above step for 2000 times.
- Calculate call success rate with the formula below:

**Call success rate = (Call Success times/ all dialed times)*100%**

# 5. Environmental and Reliability Test Result

| No. | Test Item | Test Condition | Qty. | Test Result | Standards |
|---|---|---|---|---|---|
| 1 | Cold Test | -30℃ 16h<br>(operation) | 4 | Pass | GB/T 2423.1-2001 Test Ab<br>IEC 68-2-1 Test |
| | | -40℃ 16h<br>(Restricted operation) | 4 | Pass | |
| 2 | Dry Heat | +80℃ 16h<br>(operation) | 4 | Pass | GB/T 2423.1-2001 Test Ab<br>IEC 68-2-1 Test |
| | | +85℃ 16h<br>(Restricted operation) | 4 | Pass | |
| 3 | Cold Storage | -45℃ 72h | 10 | Pass | GB/T 2423.1-2001 Test A |
| 4 | Dry Storage | +90℃ 72h | 10 | Pass | GB/T 2423.2-2001 Test Bb |
| 5 | Temperature change(shock) | Low Temp：-40℃ 30min<br>High Temp：+85℃ 30min<br>Cycles：144 | 10 | Pass | GB/T 2423.22-2002 Test Na<br>IEC 68-2-14 Na |
| 6 | Damp Heat Cyclic | High Temperature: +55℃<br>Humidity: 93%-100%<br>Cycles: 6 | 10 | Pass | IEC 68-2-30 Db Test |
| 7 | Random Vibration | 5-20Hz:0.96m2/s3<br>20-500Hz:-3dB/oct<br>3 axes , 30min per axis | 3 | Pass | GB/T 2423.13-1997 Test Fdb<br>IEC 68-2-36 Fdb Test |
| 8 | Shock Test | 100g 6ms 3*6=18shocks | 3 | Pass | ISO 16750-3<br>IEC 68-2-27 |
| 9 | Bump Test | 25g 6ms 6*1000=6000 | 3 | Pass | ISO 16750-3<br>IEC 68-2-29 |
| 10 | Micro-drop Test | 10cm ， 10000 times | 2 | Pass | SIM Internal Standard |
| 11 | MTBF | High Temperature :80℃<br>MTBF≥133690hours | 10 | Pass | SIM Internal Standard |

# 6. Test Items and Conditions

## 6.1. Cold Test (Operation)

**Temperature:** *-30℃*

**Test duration:** *16h*

**Test Unit Status:** *Power On*

**Procedure:**

*Put the modules into the temperature chamber, the modules have to be incubated for at least 12 h for temperature adjustment before measuring, and then carry out measurement of modules to be tested in the chamber.*

*a) Serial port communication test*

*b) GSM RF test (please refer to Chapter 7 table 1-3)*

*c) Call success rate test*

**Result: Pass**

## 6.2. Cold Test (Restricted operation)

**Temperature:** *-40℃*

**Test duration:** *16h*

**Test Unit Status:** *Power On*

**Procedure:**

*Put the modules into the temperature chamber, the modules have to be incubated for at least 12 h for temperature adjustment before measuring, and then carry out measurement of modules to be tested in the chamber.*

a) *RF-Test at high、Normal and Low Voltage. Set up a call connect with CMU200, during the test, RF* characteristics have to be observed. Record the abnormal parameters for RD department to reference

*b) Serial Port Communication test*

*c) Call success rate Test*

**Result: Pass**

## 6.3. Dry Heat Test (Operation)

**Temperature:** *+80℃*

**Test duration:** *16h*

**Test Unit Status:** *Power On*

**Procedure:**

*Put the modules into the temperature chamber, the modules have to be incubated for at least 12 h for temperature adjustment before measuring, and then carry out measurement of modules to be tested in the chamber.*

*a) GSM RF-Test at high、Normal and Low Voltage.(please refer to Chapter 7 table 1-3)*

*b) Serial Port Communication test*

*c) Call success rate Test*

**Result: Pass**

## 6.4. Dry Heat Test (Restricted Operation)

**Temperature:** *+85℃*

**Test duration:** *16h*

**Test Unit Status:** *Power On*

**Procedure:**

*Put the modules into the temperature chamber, the modules have to be incubated for at least 12 h for temperature adjustment before measuring, and then carry out measurement of modules to be tested in the chamber.*

*a) RF-Test at high、Normal and Low Voltage. Set up a call connect with CMU200, during the test, RF* characteristics have to be observed. Record the abnormal parameters for RD department to reference

*b) Serial Port Communication test*

*c) Call success rate Test*

**Result: Pass**

## 6.5. Cold Storage Test

**Temperature:** *-45℃*

**Test duration:** *72h*

**Test Unit Status:** *Power Off*

**Procedure:**

*After 72h low-temperature storage, remove the modules from the temperature chamber to room temperature environment at least 120 min.*

*Test the actual network calls, serial port communication.*

**Result: Pass**

## 6.6. Dry Heat Storage Test

**Temperature:** *+85℃*

**Test duration:** *72h*

**Test Unit Status:** *Power Off*

**Procedure:**

*After 72h high-temperature storage, remove the modules from the temperature chamber and place it at room temperature environment at least 120 min.*

*Test the actual network calls, serial port communication.*

**Result: Pass**

## 6.7. Temperature Change (Shock)

**Low Temperature:** *-40℃*

**High Temperature:** *+85℃*

**Change Over time:** *<30 seconds (dual chamber system)*

*< 1 min (triple chamber system)*

**Test duration:** *1h*

**Number of repetitions:** *144*

**Test Unit Status:** *Power Off*

**Procedure:**

*After thermal shock, remove the modules from the temperature chamber to room temperature environment at least 120 min.*

*Test the actual network calls, serial port communication.*

**Result: Pass**

## 6.8. Damp Heat Cyclic Test

**Low Temperature:** *+25℃ ±2°C*

**High Temperature:** *+55℃ ±2°C*

**Humidity:** *93% ±3%*

**Number of repetitions:** *6*

**Test duration:** *12h+12h*

**Test Unit Status:** *Power On*

**Procedure:**

*After damp heat, remove the module from the temperature and Humidity chamber to room temperature environment at least 120 min.*

*Test the actual network calls, serial port communication functions.*

**Result: Pass**

## 6.9. Random Vibration

**Frequency range:** *10-1000 Hz*

**Acceleration:** $G_{RMS}$ **= 27.8** $m/s^2$

| Frequency Hz | PSD ($m/s^2$)$^2$/Hz |
|---|---|
| 10 | 20 |
| 55 | 6.5 |
| 180 | 0.25 |
| 300 | 0.25 |
| 360 | 0.14 |
| 1000 | 0.14 |

**Duration:** *3 x 8h*

**Test:** *all 3 axes (X, Y, Z)*

**Test Unit Status:** *Power On*

**Procedure:**

1) *Fix the module to the vibration table.*
2) *Establish a call connection with CMU200 or 8960, during the vibration, RF* characteristics have to be observed. *All RF parameters limits can not be exceeded*
3) *After random vibration, test RF characteristics at normal voltage,.(Please refer to Chapter 7 table 4)*
4) *Test serial port communication function.*

**Remark**：Modules must be fixed on the fixture tool and then not allow to be moved. The material of the fixture tool should be aluminum.

**Result: Pass**

## 6.10. Mechanical Shock Test

**Acceleration:** 100g

**Duration:** *6ms*

**Pulse Shape:** Half-Sine Waveform

**Test:** *3shocks for each of six axes (+/-X, +/-Y, +/-Z)*

*Total: 18shocks*

**Procedure:**

*Fix the module to the shock table, then shock.*

**Result: Pass**

## 6.11. Bump Test

**Acceleration:** 25g

**Duration:** *6ms*

**Pulse Shape:** Half-Sine Waveform

**Test:** *1000 shocks for each of six axes (+/-X, +/-Y, +/-Z)*

*Total: 6000shocks*

**Procedure:**

*Fix the module to the shock table, then bump*

**Result: Pass**

## 6.12. Micro-drop Test

**Height:** *10cm*

**Surface (floor):** *concrete or steel*

**Number of drops:** *10000 (front and back surface, each surface for 5000）*

**Measuring Intervals：** *1000*

**Procedure:**

*The module will be dropped from 10cm height to the concrete or steel surface floor, repeat the above step 5000 times for each surface.*

*Test the actual network calls, serial port communication*

**Result: Pass**

## 6.13. Estimation of MTBF

1) Reliability data (acceleration life tests data)

Operating Life: Ta = 80(degree C)

Test duration time: t =10*24h=240h

Total sample quantity of series = 10 pieces

Failure = 0 pieces

Sample information:

1）Hardware Revision：SIM900 V2.03

2) Software Revision: 1137B05V03SIM900M64_ST

2）Calculation of the acceleration characteristics

First of all, the following equation is assumed as model of accelerated life test.

$$AF := \exp\left[\frac{E_A}{K}\cdot\left(\frac{1}{T_o}-\frac{1}{T_a}\right)\right]$$

AF： Temperature acceleration factor

Ea: Activation Energy by Temperature (0.8eV)

K: Boltzmann's Constant (8.6157x10-5)

To: Actual use average Temperature (To = 25+273=298˚K)

Ta: Test Temperature (Ta =80+273=353˚K)

Calculation of Temperature acceleration factor:

AF=exp [Ea/K*(1/298-1/ (273+80))]

=exp (0.8/ ($8.617*10^{-5}$)*(1/298-1/353)) =128.26

So, total device hour at 25(degree C) is calculated as follows:

Total device hour T = （10 pieces x 240hours）x128.26 =307824 hours

3）The One-sided 90% confidential intervals for MTBF （θ）

According to MIL-HDBK -338B 8.3.2.5.2 Confidence Limits - Exponential Distribution，

Calculation MTBF：

$$\theta = \left(\frac{2T}{\chi^2(\alpha, 2r+2)}, \infty\right)$$

=（ 2*307824/$x^2$(0.1,2) , ∞）= (2*307824/4.605, ∞)=(133690, ∞)

MTBF≥133690hours

(The following Appendix 7.5 is the $X^2(p, d)$ data, $X^2(0.1, 2) = 4.605$)

# 7. Appendix

## 7.1 Table1 GSM RF Test data

| GSM RF Test Report | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **GSM900** | | **Frequency Error** | **Phase Error** | | **Power** | **P/T** | **Modulation** | **Switching** |
| | | | **Peak** | **RMS** | | | | |
| | | *<0.1ppm* | *<20 °* | *<5 °* | | | | |
| **RTNV*** | *1* | -46.4 | 5.4 | 1.5 | 32.4 | *PASS* | *PASS* | *PASS* |
| | *62* | -32 | 4.9 | 1.5 | 32.4 | *Pass* | *PASS* | *PASS* |
| | *124* | -35.4 | 5.2 | 1.3 | 32.4 | *Pass* | *PASS* | *PASS* |
| **LTHV*** | *1* | -24.6 | 3.1 | 0.9 | 33.4 | *PASS* | *PASS* | *PASS* |
| | *62* | 9.5 | 4.2 | 1 | 33.3 | *Pass* | *PASS* | *PASS* |
| | *124* | 23.1 | 4.9 | 1.1 | 33 | *Pass* | *PASS* | *PASS* |
| **LTLV*** | *1* | 11.3 | 2.8 | 0.9 | 33.2 | *PASS* | *PASS* | *PASS* |
| | *62* | -5.2 | 2.8 | 1 | 32.7 | *Pass* | *PASS* | *PASS* |
| | *124* | 24.2 | 3.5 | 0.9 | 32.4 | *Pass* | *PASS* | *PASS* |
| **HTLV*** | *1* | -16.1 | 3.4 | 1.3 | 32 | *PASS* | *PASS* | *PASS* |
| | *62* | -30.5 | 4.9 | 1.5 | 31.5 | *Pass* | *PASS* | *PASS* |
| | *124* | -21.5 | 4.6 | 1.3 | 31.1 | *Pass* | *PASS* | *PASS* |
| **HTHV*** | *1* | -49 | 5.1 | 1.4 | 32.3 | *PASS* | *PASS* | *PASS* |
| | *62* | -33.8 | 4.6 | 1.3 | 32.1 | *Pass* | *PASS* | *PASS* |
| | *124* | -30 | 4.3 | 1.3 | 31.9 | *Pass* | *PASS* | *PASS* |
| **DCS1800** | | **Frequency Error** | **Phase Error** | | **Power** | **P/T** | **Modulation** | **Switching** |
| | | | **Peak** | **RMS** | | | | |
| | | *<0.1ppm* | *<20 °* | *<5 °* | | | | |
| **RTNV*** | *512* | -88.1 | 7.3 | 1.8 | 29.5 | *PASS* | *PASS* | *PASS* |
| | *698* | -67.7 | 6.8 | 1.7 | 29.5 | *Pass* | *PASS* | *PASS* |
| | *885* | -72.9 | 7 | 1.9 | 29.5 | *Pass* | *PASS* | *PASS* |
| **LTHV*** | *512* | 10.7 | 5.8 | 2 | 30.5 | *PASS* | *PASS* | *PASS* |
| | *698* | -18.5 | 5.1 | 1.8 | 29.6 | *Pass* | *PASS* | *PASS* |
| | *885* | 18.1 | 5.8 | 2 | 29.5 | *Pass* | *PASS* | *PASS* |
| **LTLV*** | *512* | -55.8 | 5.8 | 2 | 30.1 | *PASS* | *PASS* | *PASS* |
| | *698* | -18 | 4.8 | 1.8 | 30.1 | *Pass* | *PASS* | *PASS* |
| | *885* | 24.1 | 6.4 | 2.2 | 30 | *Pass* | *PASS* | *PASS* |
| **HTLV*** | *512* | -75.4 | 5.7 | 1.7 | 29.5 | *PASS* | *PASS* | *PASS* |
| | *698* | -56.1 | 5.7 | 1.7 | 29.2 | *Pass* | *PASS* | *PASS* |
| | *885* | -63.9 | 6 | 1.7 | 29.1 | *Pass* | *PASS* | *PASS* |
| **HTHV*** | *512* | -57.7 | 5.9 | 1.6 | 29.0 | *PASS* | *PASS* | *PASS* |
| | *698* | -68.2 | 6.6 | 1.7 | 28.6 | *Pass* | *PASS* | *PASS* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *885* | -72.9 | 4.9 | 1.8 | 28.6 | *Pass* | *PASS* | *PASS* |
| **GSM850** | **PCL** | **Frequency Error** | **Phase Error** | | **Power** | **P/T** | **Modulation** | **Switching** |
| | | | **Peak** | **RMS** | | | | |
| | | *<0.1ppm* | *<20°* | *<5°* | | | | |
| **RTNV*** | *128* | -40.6 | 6.6 | 1.6 | 32.8 | *PASS* | *PASS* | *PASS* |
| | *189* | -32.8 | 4.6 | 1.5 | 32.8 | *Pass* | *PASS* | *PASS* |
| | *251* | -32.4 | 4.6 | 1.4 | 32.7 | *Pass* | *PASS* | *PASS* |
| **LTHV*** | *128* | 24.3 | 2.7 | 1 | 32.9 | *PASS* | *PASS* | *PASS* |
| | *189* | 18.5 | 2.7 | 1 | 33.1 | *Pass* | *PASS* | *PASS* |
| | *251* | 19.6 | 2.9 | 1.1 | 32.9 | *Pass* | *PASS* | *PASS* |
| **LTLV*** | *128* | 19.1 | 2.8 | 1 | 32.8 | *PASS* | *PASS* | *PASS* |
| | *189* | 20.4 | 3.3 | 1 | 32.6 | *Pass* | *PASS* | *PASS* |
| | *251* | 13.7 | 2.6 | 0.9 | 32.5 | *Pass* | *PASS* | *PASS* |
| **HTLV*** | *128* | -75.4 | 5.7 | 1.7 | 29 | *PASS* | *PASS* | *PASS* |
| | *189* | -56.1 | 5.7 | 1.7 | 29.2 | *Pass* | *PASS* | *PASS* |
| | *251* | -63.9 | 6 | 1.7 | 29.1 | *Pass* | *PASS* | *PASS* |
| **HTHV*** | *128* | -70.1 | 5.7 | 1.6 | 29.5 | *PASS* | *PASS* | *PASS* |
| | *189* | -63.7 | 5.5 | 1.8 | 29.2 | *Pass* | *PASS* | *PASS* |
| | *251* | -67.2 | 5.7 | 1.9 | 29.1 | *Pass* | *PASS* | *PASS* |
| **PCS1900** | **PCL** | **Frequency Error** | **Phase Error** | | **Power** | **P/T** | **Modulation** | **Switching** |
| | | | **Peak** | **RMS** | | | | |
| | | *<0.1ppm* | *<20°* | *<5°* | | | | |
| **RTNV*** | *512* | -88.1 | 7.3 | 1.8 | 29.5 | *PASS* | *PASS* | *PASS* |
| | *661* | -67.7 | 6.8 | 1.7 | 29.5 | *Pass* | *PASS* | *PASS* |
| | *810* | -72.9 | 7 | 1.9 | 29.5 | *Pass* | *PASS* | *PASS* |
| **LTHV*** | *512* | -75.4 | 5.7 | 1.7 | 29.7 | *PASS* | *PASS* | *PASS* |
| | *661* | -56.1 | 5.7 | 1.7 | 29.8 | *Pass* | *PASS* | *PASS* |
| | *810* | -63.9 | 6 | 1.7 | 29.4 | *Pass* | *PASS* | *PASS* |
| **LTLV*** | *512* | 28.7 | 5.4 | 2 | 29.3 | *PASS* | *PASS* | *PASS* |
| | *661* | -11.2 | 8.1 | 2.2 | 29.2 | *Pass* | *PASS* | *PASS* |
| | *810* | -25.4 | 5 | 1.8 | 29.2 | *Pass* | *PASS* | *PASS* |
| **HTLV*** | *512* | -23.1 | 5.3 | 2.1 | 29.8 | *PASS* | *PASS* | *PASS* |
| | *661* | 22.4 | 5.2 | 2 | 29.7 | *Pass* | *PASS* | *PASS* |
| | *810* | -24.1 | 5 | 1.8 | 29.7 | *Pass* | *PASS* | *PASS* |
| **HTHV*** | *512* | -41.5 | 7.8 | 2 | 28.9 | *PASS* | *PASS* | *PASS* |
| | *661* | -66.6 | 5.2 | 2 | 28.4 | *Pass* | *PASS* | *PASS* |
| | *810* | -83.2 | 6.3 | 2 | 28.3 | *Pass* | *PASS* | *PASS* |

*Remark:* * RTNV：Room Temp 25℃ Normal Voltage 3.8V

* LTHV：Low Temp -30℃ High Voltage 4.75V

* LTLV：Low Temp -30℃ Low Voltage 3.15V

* HTHV：High Temp 80℃ High Voltage 4.75V

* HTLV：High Temp 80℃ Low Voltage 3.15V

## 7.2 Table 2: GPRS Transmitter Characteristics Test Data

| GPRS RF Test Report | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **GSM900** | | **Frequency Error** | **Phase Error** | | **Power** | **P/T** | **Modulation** | **Switching** |
| | | | **Peak** | **RMS** | | | | |
| | | *<0.1ppm* | <±20 | <5 | | | | |
| **LTHV*** | *1* | -41.94 | 6.3 | 2.4 | 32.8 | *PASS* | *PASS* | *PASS* |
| | *62* | -36.6 | 6.5 | 2.2 | 32.9 | *Pass* | *PASS* | *PASS* |
| | *124* | -13.97 | -6.3 | 2.2 | 32.7 | *Pass* | *PASS* | *PASS* |
| **HTLV*** | *1* | -41.94 | -6.2 | 2.3 | 32.1 | *PASS* | *PASS* | *PASS* |
| | *62* | -36.6 | 6.1 | 2.3 | 31.8 | *Pass* | *PASS* | *PASS* |
| | *124* | -13.97 | 6.3 | 2.3 | 31.6 | *Pass* | *PASS* | *PASS* |
| **DCS1800** | | **Frequency Error** | **Phase Error** | | **Power** | **P/T** | **Modulation** | **Switching** |
| | | | **Peak** | **Peak** | | | | |
| | | *<0.1ppm* | *<20 °* | *<5 °* | | | | |
| **LTHV*** | *512* | -26.58 | -6.7 | 2.3 | 29.1 | *PASS* | *PASS* | *PASS* |
| | *698* | -35.55 | -6.7 | 2.2 | 29.5 | *Pass* | *PASS* | *PASS* |
| | *885* | -68.68 | 6.8 | 2.2 | 29.4 | *Pass* | *PASS* | *PASS* |
| **HTLV*** | *512* | -75.57 | -6.4 | 2.4 | 28.8 | *PASS* | *PASS* | *PASS* |
| | *698* | -69.94 | -7.3 | 2.3 | 28.7 | *Pass* | *PASS* | *PASS* |
| | *885* | -54.7 | 7.1 | 2.2 | 28.9 | *Pass* | *PASS* | *PASS* |
| **GSM850** | **PCL** | **Frequency Error** | **Phase Error** | | **Power Peak** | **P/T** | **Modulation** | **Switching** |
| | | | **Peak** | **Peak** | | | | |
| | | *<0.1ppm* | *<20 °* | *<5 °* | | | | |
| **LTHV*** | *128* | -12.97 | 6.1 | 2.2 | 32.5 | *PASS* | *PASS* | *PASS* |
| | *189* | -45.95 | 6.7 | 2.2 | 32.6 | *Pass* | *PASS* | *PASS* |
| | *251* | -42.76 | 6.4 | 2.1 | 32.5 | *Pass* | *PASS* | *PASS* |
| **HTLV*** | *128* | 6.06 | 7.0 | 2.1 | 32.0 | *PASS* | *PASS* | *PASS* |
| | *189* | -30.61 | -6.0 | 2.3 | 31.8 | *Pass* | *PASS* | *PASS* |
| | *251* | -43.96 | 6.1 | 2.1 | 31.9 | *Pass* | *PASS* | *PASS* |
| **PCS1900** | **PCL** | **Frequency Error** | **Phase Error** | | **Power Peak** | **P/T** | **Modulation** | **Switching** |
| | | | **Peak** | **Peak** | | | | |
| | | *<0.1ppm* | *<20 °* | *<20 °* | | | | |
| **LTHV*** | *512* | -69.11 | 6.4 | 2.4 | 29.5 | *PASS* | *PASS* | *PASS* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *661* | -86.94 | -6.6 | 2.4 | 29.4 | *Pass* | *PASS* | *PASS* |
| | *810* | -51.69 | 6.8 | 2.3 | 29.6 | *Pass* | *PASS* | *PASS* |
| HTLV* | *512* | -59.84 | -6.5 | 2.3 | 29.3 | *PASS* | *PASS* | *PASS* |
| | *661* | -29.45 | 6.4 | 2.4 | 29.0 | *Pass* | *PASS* | *PASS* |
| | *810* | -69.91 | 6.8 | 2.3 | 28.9 | *Pass* | *PASS* | *PASS* |

## 7.3 Table 3 GPRS RF Rx sensitivity Test Record

| LTHV* | Class10 | 4D1Up | 3D2Up | 2D2Up | 1D2Up |
|---|---|---|---|---|---|
| GSM900 CH62 | CS-2(-103dB) | 0 | 0 | 0 | 0 |
| | CS-4(-100dB) | 0 | 0 | 0 | 0 |
| | Result | PASS | PASS | PASS | PASS |
| DCS1800 CH698 | CS-2(-101dB) | 0 | 0 | 0 | 0 |
| | CS-4(-98dB) | 0 | 0 | 0 | 0 |
| | Result | PASS | PASS | PASS | PASS |
| GSM850 CH189 | CS-2(-103dB) | 0 | 0 | 0 | 0 |
| | CS-4(-100dB) | 0 | 0 | 0 | 0 |
| | Result | PASS | PASS | PASS | PASS |
| PCS1900 CH661 | CS-2(-101dB) | 0 | 0 | 0 | 0 |
| | CS-4(-98dB) | 0 | 0 | 0 | 0 |
| | Result | PASS | PASS | PASS | PASS |
| **HTLV*** | **Class10** | **4D1Up** | **3D2Up** | **2D2Up** | **1D2Up** |
| GSM900 CH62 | CS-2(-103dB) | 0 | 0 | 0 | 0 |
| | CS-4(-100dB) | 0 | 0 | 0 | 0 |
| | Result | PASS | PASS | PASS | PASS |
| DCS1800 CH698 | CS-2(-101dB) | 0 | 0 | 0 | 0 |
| | CS-4(-98dB) | 0 | 0 | 0 | 0 |
| | Result | PASS | PASS | PASS | PASS |
| GSM850 CH189 | CS-2(-103dB) | 0 | 0 | 0 | 0 |
| | CS-4(-100dB) | 0 | 0 | 0 | 0 |
| | Result | PASS | PASS | PASS | PASS |
| PCS1900 CH661 | CS-2(-101dB) | 0 | 0 | 0 | 0 |
| | CS-4(-98dB) | 0 | 0 | 0 | 0 |
| | Result | PASS | PASS | PASS | PASS |

## 7.4 Table 4 RF Test Record of Vibration Test

| 900MHz | PCL | Frequency Error | Phase Error | | Power | P/T | Modulation | Switching |
|---|---|---|---|---|---|---|---|---|
| | | | Peak | RMS | | | | |
| | | *<0.1ppm* | *<20°* | *<5°* | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | -46.4 | 5.4 | 1.5 | 32.4 | *Pass* | *Pass* | *Pass* |
| 1 | 12 | -36.5 | 3.4 | 1.3 | 18.8 | *Pass* | *Pass* | *Pass* |
| | 19 | -32.4 | 3.6 | 1.5 | 4.9 | *Pass* | *Pass* | *Pass* |
| | 5 | -32 | 4.9 | 1.5 | 32.4 | *Pass* | *Pass* | *Pass* |
| 62 | 12 | -35.6 | 3.8 | 1.4 | 18.7 | *Pass* | *Pass* | *Pass* |
| | 19 | -35.3 | 3.6 | 1.4 | 4.9 | *Pass* | *Pass* | *Pass* |
| | 5 | -35.4 | 5.2 | 1.3 | 32.4 | *Pass* | *Pass* | *Pass* |
| 124 | 12 | -31.7 | 3.6 | 1.4 | 18.7 | *Pass* | *Pass* | *Pass* |
| | 19 | -28.5 | 3.6 | 1.4 | 4.8 | *Pass* | *Pass* | *Pass* |
| **1800MHz** | **PCL** | **Frequency Error** | **Phase Error Peak** | **Phase Error RMS** | **Power** | **P/T** | **Modulation** | **Switching** |
| | | *<0.1ppm* | *<20 °* | *<5 °* | | | | |
| | 0 | -88.1 | 7.3 | 1.8 | 29.5 | *Pass* | *Pass* | *Pass* |
| 512 | 7 | -82.8 | 4.7 | 1.5 | 16.1 | *Pass* | *Pass* | *Pass* |
| | 15 | -73.5 | 5.9 | 1.7 | 0.3 | *Pass* | *Pass* | *Pass* |
| | 0 | -67.7 | 6.8 | 1.7 | 29.5 | *Pass* | *Pass* | *Pass* |
| 698 | 7 | -70.9 | 4.5 | 1.5 | 16.2 | *Pass* | *Pass* | *Pass* |
| | 15 | -65.9 | 5.4 | 1.6 | 0.3 | *Pass* | *Pass* | *Pass* |
| | 0 | -72.9 | 7 | 1.9 | 29.5 | *Pass* | *Pass* | *Pass* |
| 885 | 7 | -89 | 5.2 | 1.6 | 16.1 | *Pass* | *Pass* | *Pass* |
| | 15 | -86.4 | 6.1 | 1.8 | 0.3 | *Pass* | *Pass* | *Pass* |
| **850MHz** | **PCL** | **Frequency Error** | **Phase Error Peak** | **Phase Error RMS** | **Power** | **P/T** | **Modulation** | **Switching** |
| | | *<0.1ppm* | *<20 °* | *<5 °* | | | | |
| | 5 | -40.6 | 6.6 | 1.6 | 32.8 | *Pass* | *Pass* | *Pass* |
| 128 | 12 | -37.4 | 4 | 1.5 | 19 | *Pass* | *Pass* | *Pass* |
| | 19 | -34.3 | 4.4 | 1.5 | 5 | *Pass* | *Pass* | *Pass* |
| | 5 | -32.8 | 4.6 | 1.5 | 32.8 | *Pass* | *Pass* | *Pass* |
| 189 | 12 | -30.7 | 4.1 | 1.4 | 19 | *Pass* | *Pass* | *Pass* |
| | 19 | -32.5 | 3.8 | 1.5 | 5 | *Pass* | *Pass* | *Pass* |
| | 5 | -32.4 | 4.6 | 1.4 | 32.7 | *Pass* | *Pass* | *Pass* |
| 251 | 12 | -32.7 | 3.7 | 1.4 | 19 | *Pass* | *Pass* | *Pass* |
| | 19 | -26.6 | 4.1 | 1.4 | 5 | *Pass* | *Pass* | *Pass* |
| **1900MHz** | **PCL** | **Frequency Error** | **Phase Error Peak** | **Phase Error RMS** | **Power** | **P/T** | **Modulation** | **Switching** |
| | | *<0.1ppm* | *<20 °* | *<5 °* | | | | |
| | 0 | -70.4 | 8.1 | 1.9 | 29.9 | *Pass* | *Pass* | *Pass* |
| 512 | 7 | -69.1 | 5.2 | 1.7 | 16.3 | *Pass* | *Pass* | *Pass* |
| | 15 | -65.4 | 5.2 | 1.6 | 0.4 | *Pass* | *Pass* | *Pass* |
| | 0 | -59.5 | 6.9 | 1.7 | 29.9 | *Pass* | *Pass* | *Pass* |
| 661 | 7 | -73 | 5.2 | 1.6 | 16.3 | *Pass* | *Pass* | *Pass* |
| | 15 | -66.4 | 4.6 | 1.6 | 0.5 | *Pass* | *Pass* | *Pass* |
| 810 | 0 | -75.5 | 7.2 | 1.8 | 29.8 | *Pass* | *Pass* | *Pass* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 7 | -58.9 | 5.6 | 1.8 | 16.3 | *Pass* | *Pass* | *Pass* |
| | 15 | -57.5 | 5.6 | 1.6 | 0.4 | *Pass* | *Pass* | *Pass* |

## 7.5 Table $X^2(p, d)$

| | p | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | 0.99 | 0.975 | 0.95 | 0.9 | 0.8 | 0.75 | 0.5 | 0.25 | 0.2 | 0.1 | 0.05 | 0.03 | 0.01 | 0.001 |
| 1 | 0.0002 | 0.00098 | 0.0039 | 0.016 | 0.064 | 0.1 | 0.455 | 1.32 | 1.64 | 2.71 | 3.841 | 5.02 | 6.635 | 10.83 |
| 2 | 0.0201 | 0.05064 | 0.1026 | 0.211 | 0.446 | 0.58 | 1.386 | 2.77 | 3.22 | 4.61 | 5.991 | 7.38 | 9.21 | 13.82 |
| 3 | 0.1148 | 0.2158 | 0.3518 | 0.584 | 1.005 | 1.21 | 2.366 | 4.11 | 4.64 | 6.25 | 7.815 | 9.35 | 11.34 | 16.27 |
| 4 | 0.2971 | 0.48442 | 0.7107 | 1.064 | 1.649 | 1.92 | 3.357 | 5.39 | 5.99 | 7.78 | 9.488 | 11.1 | 13.28 | 18.47 |
| 5 | 0.5543 | 0.83121 | 1.1455 | 1.61 | 2.343 | 2.67 | 4.351 | 6.63 | 7.29 | 9.24 | 11.07 | 12.8 | 15.09 | 20.52 |
| 6 | 0.8721 | 1.23734 | 1.6354 | 2.204 | 3.07 | 3.45 | 5.348 | 7.84 | 8.56 | 10.6 | 12.59 | 14.4 | 16.81 | 22.46 |
| 7 | 1.239 | 1.68987 | 2.1673 | 2.833 | 3.822 | 4.25 | 6.346 | 9.04 | 9.8 | 12 | 14.07 | 16 | 18.48 | 24.32 |
| 8 | 1.6465 | 2.17973 | 2.7326 | 3.49 | 4.594 | 5.07 | 7.344 | 10.2 | 11 | 13.4 | 15.51 | 17.5 | 20.09 | 26.12 |
| 9 | 2.0879 | 2.70039 | 3.3251 | 4.168 | 5.38 | 5.9 | 8.343 | 11.4 | 12.2 | 14.7 | 16.92 | 19 | 21.67 | 27.88 |
| 10 | 2.5582 | 3.24697 | 3.9403 | 4.865 | 6.179 | 6.74 | 9.342 | 12.5 | 13.4 | 16 | 18.31 | 20.5 | 23.21 | 29.59 |
| 11 | 3.0535 | 3.81575 | 4.5748 | 5.578 | 6.989 | 7.58 | 10.34 | 13.7 | 14.6 | 17.3 | 19.68 | 21.9 | 24.72 | 31.26 |
| 12 | 3.5706 | 4.40379 | 5.226 | 6.304 | 7.807 | 8.44 | 11.34 | 14.8 | 15.8 | 18.5 | 21.03 | 23.3 | 26.22 | 32.91 |
| 13 | 4.1069 | 5.00875 | 5.8919 | 7.042 | 8.634 | 9.3 | 12.34 | 16 | 17 | 19.8 | 22.36 | 24.7 | 27.69 | 34.53 |
| 14 | 4.6604 | 5.62873 | 6.5706 | 7.79 | 9.467 | 10.2 | 13.34 | 17.1 | 18.2 | 21.1 | 23.68 | 26.1 | 29.14 | 36.12 |
| 15 | 5.2293 | 6.26214 | 7.2609 | 8.547 | 10.31 | 11 | 14.34 | 18.2 | 19.3 | 22.3 | 25 | 27.5 | 30.58 | 37.7 |
| 16 | 5.8122 | 6.90766 | 7.9616 | 9.312 | 11.15 | 11.9 | 15.34 | 19.4 | 20.5 | 23.5 | 26.3 | 28.8 | 32 | 39.25 |
| 17 | 6.4078 | 7.56419 | 8.6718 | 10.09 | 12 | 12.8 | 16.34 | 20.5 | 21.6 | 24.8 | 27.59 | 30.2 | 33.41 | 40.79 |
| 18 | 7.0149 | 8.23075 | 9.3905 | 10.86 | 12.86 | 13.7 | 17.34 | 21.6 | 22.8 | 26 | 28.87 | 31.5 | 34.81 | 42.31 |
| 19 | 7.6327 | 8.90652 | 10.117 | 11.65 | 13.72 | 14.6 | 18.34 | 22.7 | 23.9 | 27.2 | 30.14 | 32.9 | 36.19 | 43.82 |
| 20 | 8.2604 | 9.59078 | 10.851 | 12.44 | 14.58 | 15.5 | 19.34 | 23.8 | 25 | 28.4 | 31.41 | 34.2 | 37.57 | 45.31 |
| 21 | 8.8972 | 10.2829 | 11.591 | 13.24 | 15.44 | 16.3 | 20.34 | 24.9 | 26.2 | 29.6 | 32.67 | 35.5 | 38.93 | 46.8 |
| 22 | 9.5425 | 10.9823 | 12.338 | 14.04 | 16.31 | 17.2 | 21.34 | 26 | 27.3 | 30.8 | 33.92 | 36.8 | 40.29 | 48.27 |
| 23 | 10.196 | 11.6886 | 13.091 | 14.85 | 17.19 | 18.1 | 22.34 | 27.1 | 28.4 | 32 | 35.17 | 38.1 | 41.64 | 49.73 |
| 24 | 10.856 | 12.4012 | 13.848 | 15.66 | 18.06 | 19 | 23.34 | 28.2 | 29.6 | 33.2 | 36.42 | 39.4 | 42.98 | 51.18 |
| 25 | 11.524 | 13.1197 | 14.611 | 16.47 | 18.94 | 19.9 | 24.34 | 29.3 | 30.7 | 34.4 | 37.65 | 40.6 | 44.31 | 52.62 |
| 26 | 12.198 | 13.8439 | 15.379 | 17.29 | 19.82 | 20.8 | 25.34 | 30.4 | 31.8 | 35.6 | 38.89 | 41.9 | 45.64 | 54.05 |
| 27 | 12.879 | 14.5734 | 16.151 | 18.11 | 20.7 | 21.7 | 26.34 | 31.5 | 32.9 | 36.7 | 40.11 | 43.2 | 46.96 | 55.48 |
| 28 | 13.565 | 15.3079 | 16.928 | 18.94 | 21.59 | 22.7 | 27.34 | 32.6 | 34 | 37.9 | 41.34 | 44.5 | 48.28 | 56.89 |
| 29 | 14.256 | 16.0471 | 17.708 | 19.77 | 22.48 | 23.6 | 28.34 | 33.7 | 35.1 | 39.1 | 42.56 | 45.7 | 49.59 | 58.3 |
| 30 | 14.953 | 16.7908 | 18.493 | 20.6 | 23.36 | 24.5 | 29.34 | 34.8 | 36.3 | 40.3 | 43.77 | 47 | 50.89 | 59.7 |