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Alignment Procedure FAF1031021-BV

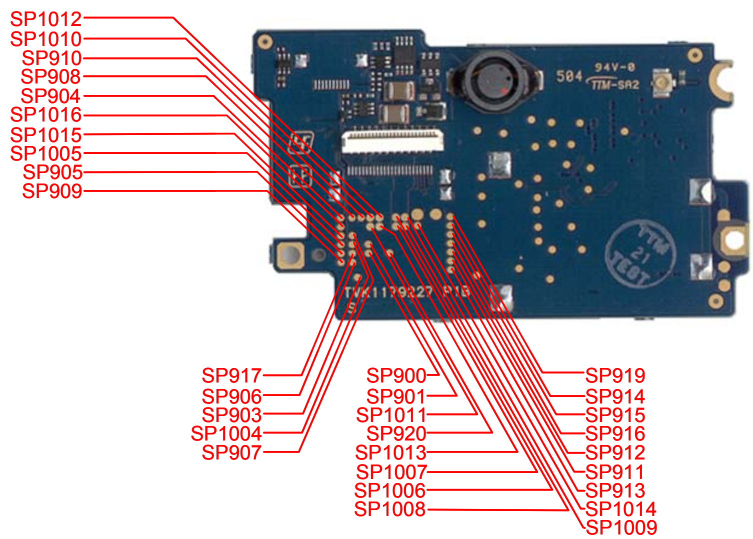
Contents

1 Reference

1.1 Service Points and Connectors

Service Point	Net name		Service Point	Net name
SP900	USBDN		SP1004	
SP901	USBDP		SP1005	
SP903	PC		SP1006	
SP904	GPIO 2 (RI)		SP1007	
SP905	EXTID0		SP1008	
SP906	EXTID1		SP1009	
SP907	SIMVCC		SP1010	
SP908	SIMCLK		SP1011	
SP909	SIMRST		SP1012	
SP910	SIMDATA		SP1013	
SP911	DTM3		SP1014	
SP912	DFM3		SP1015	
SP913	DFM1		SP1016	
SP914	DTM1			
SP915	RTS1			
SP916	CTS1			
SP917	P_ON			
SP919	SERVICE			
SP920	VREF			

The service point locations are indicated on the following diagram:



System connector pin definitions

Pin Number	Signal Name
1	USBDN
2	USBDP
3	DIG_PWR1 (VREF)
4	VBAT (OVP)
5	N/C
6	N/C
7	N/C
8	GND
9	GND
10	GND
11	GND
12	GND
13	GND
14	VIN
15	VIN
16	VIN
17	VIN
18	VIN
19	VIN
20	GPIO_2 (RI)
21	3V3
22	LED
23	UVP
24	P_EN

1.2 Test Conditions and Environment

1.2.1 Channel Definitions.

For Test and Measurement purposes described in this chapter, the following channel definitions for ***Low***, ***Mid*** and ***High*** channel ranges apply.

Band	Range	Channel Numbers
EGSM 900	ARFCN = Low	975 to 980
	ARFCN = Mid	34 to 44
	ARFCN = High	119 to 124
DCS 1800	ARFCN = Low	512 to 517
	ARFCN = Mid	692 to 702
	ARFCN = High	880 to 885
PCS 1900	ARFCN = Low	512 to 517
	ARFCN = Mid	656 to 666
	ARFCN = High	805 to 810
GSM 850	ARFCN = Low	128 to 133
	ARFCN = Mid	184 to 194
	ARFCN = High	246 to 251

1.2.2 Power Supplies

The appropriate range for the voltage applied to the VDC card is shown below:

Supply Name	Min	Nom	Max	Units
VIN	4.50	7.40	20.00	Volts
3V3	3.1	3.3	3.5	Volts
SERVICE	11.4	12.0	12.6	Volts

In addition to the voltage level, the current sourcing capability of the power supply should be considered. VIN should be powered with an external supply capable of sourcing 1A peak current. In all cases, attention should be paid to the lead lengths and parasitic resistance of the power leads and connections from the external supply to the UUT. The SERVICE signal is not required and should not be supplied for calibration and test methods.

1.2.3 Nominal Environmental Test Conditions

The following environmental conditions constitute nominal or normal Test Conditions:

Parameter	Min	Nom	Max	Units
Temperature	15	25	35	deg C
Relative Humidity	30	50	70	%
Supply Voltage	7.0	7.4	7.75	Volts

1.2.4 Extreme Environmental Test Conditions

The following environmental conditions constitute Extreme Test Conditions:

Parameter	Value	Tol.	Units
High Temperature	55	± 3	deg C
Low Temperature	-10	± 3	deg C
High Voltage	20	+0/-0.5	Volts
Low Voltage	4.5	+0.5/-0	Volts

1.2.5 Test Equipment

The recommended test equipment for GSM / GPRS and EDGE testing is either:

- Agilent E5515C – 8960 series 10
- Rohde & Schwarz CMU200

1.2.6 Terms

The following Terms are defined:

Active Mode: Denotes that the Unit Under Test has established a ***Voice Cal*** or ***Data Call*** with the Test equipment. ***Active Mode*** assumes a circuit switched connection with Full-Rate voice codec.

High Band: Either DCS 1800 or PCS 1900 Frequency Bands.

Low Band: Either GSM 900 or GSM 850 Frequency Bands.

Mobile: Refers to the Unit Under Test – the VDC card modem.

Power Control Level: PCL. Levels defined within the GSM Specification corresponding to defined transmitter power levels.

Voice Call: Denotes a circuit switched connection with one Receive slot per Frame and one Transmit slot per frame. The Default Codec should be set to full rate (FR).

2 Calibration

This chapter describes the calibration steps, procedures and outputs that are necessary for the VDC GSM / EGPRS modem card.

For the calibration of GSM / EGPRS radio, three basic steps are performed:

1. Frequency Calibration.
2. Receive Level Calibration.
3. Transmit Power Calibration.

Each of these calibration steps is performed with the radio in an un-synchronized or “test” mode. This means that the normal GSM protocol software is not running and that the unit under calibration is not synchronized to a GSM or GPRS control channel. The “test” mode is a special mode of operation that is embedded in the standard software image, no special download is needed for this mode. “Test” mode can be entered in a variety of ways, but a common method is to reset the ASIC with mode select pins (EXTID0, EXTID1) pulled high and low respectively. Alternatively, the command AT+CFUN=6[cr] will change the operational mode from normal to test mode.

To verify USB functionality, test mode may be entered via AT commands issued through the USB connection. Once this is accomplished the test interface becomes the UART interface. It is recommended to shut down the com port program that mounted the virtual com port, then remove the USB connection to cause the PC to unload the driver.

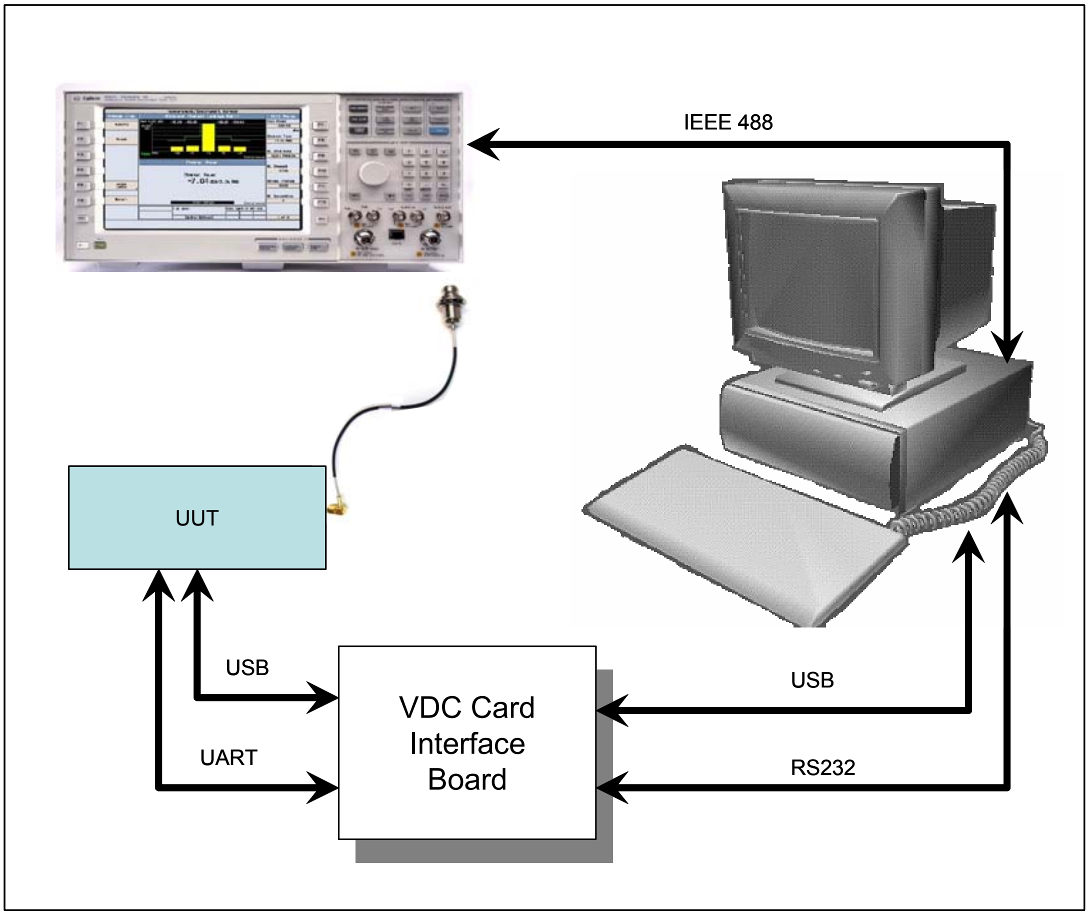
While in test mode the radio can be controlled through commands that are sent through a UART Port from a host controller. These commands allow control of basic functions such as RF Channel, TX Power Level, RX Gain, etc. The test commands and descriptions of their function can be found in reference [1].

The result, or output, of the calibration procedure is a set of parameters that are subsequently written to the Flash memory of the modem. The calibration program writes the new parameters into a text file as a series of keywords and associated numerical values. Separate download utilities included in the general software release package from the platform supplier parse the text file and convert it to a binary file for loading into the Flash.

2.1 Calibration Set-up

A calibration station consists of:

1. PC Controller with serial Port and GPIB card.
2. UART level shifter to convert PC levels to Phone Compatible levels.
3. GSM / EDGE Test equipment.



The GPIB interface is used for communication between the PC and the test instrument.

The UART Level shifter converts the PC, RS232 levels to 3.0V signals compatible with the modem card interface.

Serial port for the PC should be set to:

Rate: 115kbps
Parity: None
Stop Bit: 1
Data Bit: 8
Flow Control: None

The USB is to be connected to the PC through the fixture interface.

For GSM /EDGE Test Equipment, it is recommended to use one of the following:

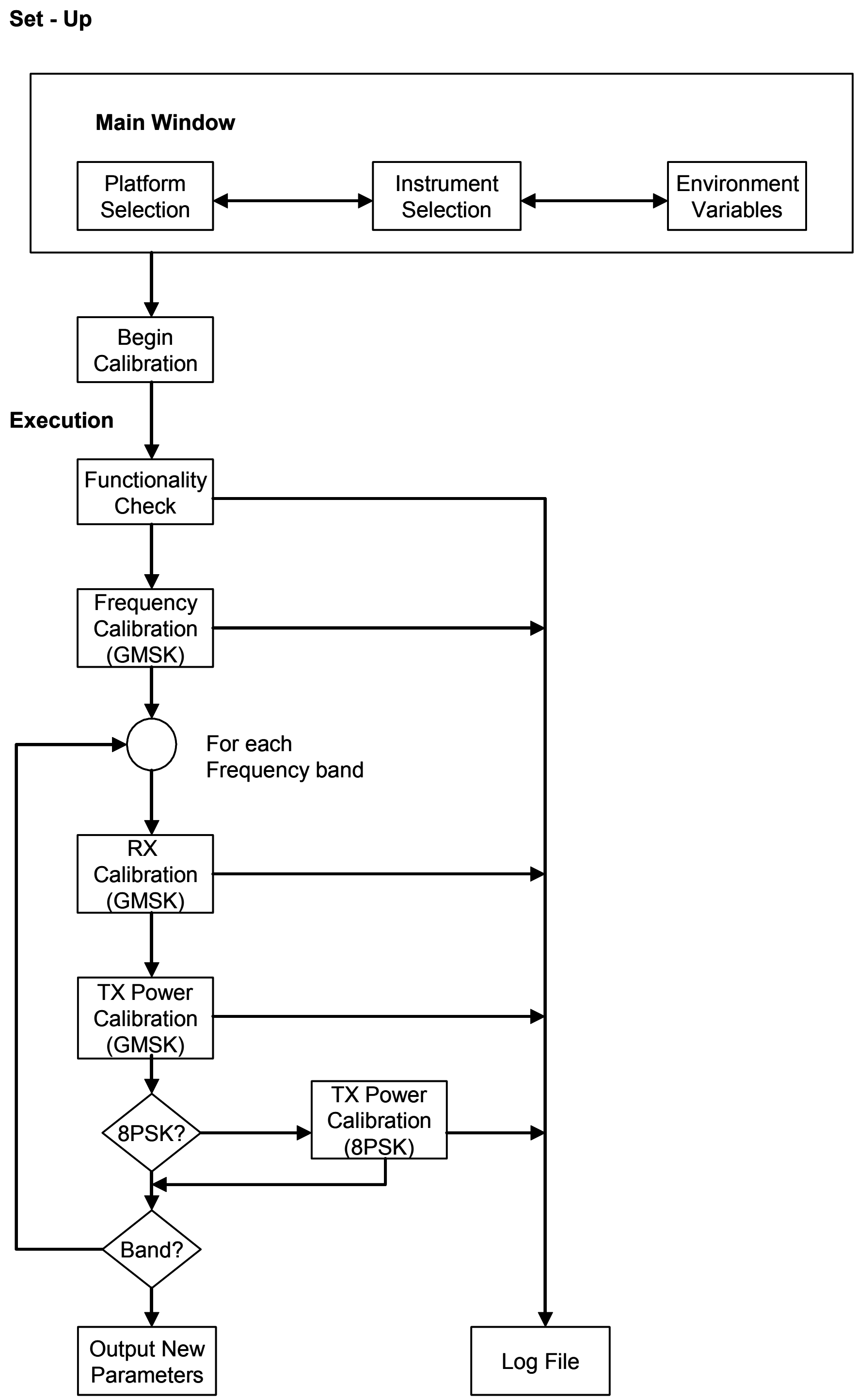
Agilent 8960:
Hardware:
a) E5515CU-K03: Service center upgrade to add EGPRS hardware on the E5515C.

Firmware:
a) E1968A - GSM/GPRS Mobile application
b) E1968A -102 GPRS functionality
c) E1968A -H03 EGPRS functionality
d) E1968A- 010- Test application installation set
e) E1968A- ABA - US English localization

CMU200:
Hardware Configuration:
a) CMU200 K21: GSM900
b) CMU200 K22: DCS 1800
c) CMU200 K23: PCS 1900
d) CMU200 K24: GSM 850
e) CMU200 K41: EDGE Capability
f) CMU200 K42: GPRS Capability
g) CMU200 K43: EGPRS Capability
h) CMU200 B11:
i) CMU200 B21
j) CMU200 B52:

Software:
Base Version V3.4.1

Calibration SW Execution Flow



2.2 Reference Oscillator and AFC Calibration

The Frequency Calibration process characterizes and centers the 26 MHz crystal reference oscillator used as the master clock in the design. The calibration routine will zero the frequency error of the free-running oscillator (relative to the reference oscillator of the test equipment used for the calibration), and will determine the slope of the tuning characteristic (Hz/LSB). At the end of the calibration routine, values for four parameters are generated for subsequent download into the phone's flash memory:

FREQ_DAC_ZERO	The DAC setting that minimizes frequency error of the free running oscillator.
FREQ_DAC_LSB	The Slope of the Tuning Characteristic in Hz-per-LSB, where "Hz" refers to the RF Frequency at the antenna. The slope is assumed to apply to the RF frequency in the 900MHz band.
FREQ_DAC_MULT	Equals 1024/FREQ_DAC_LSB.
FREQ_DAC_SHIFT	A constant value of –10, representing a right shift of 10 bits (division by 1024).

The calibration of the reference oscillator is based on a linear interpolation algorithm; that is, the assumption is made that the frequency versus control voltage characteristic is linear over a large enough range to accurately predict the frequency change for a given change in the AFC DAC.

In the calibration procedure, two values are written to the AFC DAC which generates the tuning voltage for the reference oscillator (the AFC DAC resides in the Baseband ASIC).
After each value is written, the corresponding frequency error of the transmitted RF signal is read from the test equipment. Using the linearity assumption, the characteristic equation of the line through those two points is calculated, resulting in two parameters:

FREQ_DAC_ZERO and **FREQ_DAC_LSB**.

The parameters **FREQ_DAC_SHIFT** and **FREQ_DAC_MULT** are then calculated for use by the modem's software to represent a floating point number using two integer values. The four values are generated as follows:

$$FREQ\_DAC\_ZERO = \frac{(ERR1 * DACVAL2 - ERR2 * DACVAL1)}{(ERR1 - ERR2)}$$

$$FREQ\_DAC\_LSB = \frac{(ERR2 - ERR1)}{(DACVAL2 - DACVAL1)} * \frac{900\ MHz}{Cal\_Freq}$$

$$FREQ\_DAC\_SHIFT = -10$$

$$FREQ\_DAC\_MULT = \frac{1024}{FREQ\_DAC\_LSB}$$

Where:

ERR1 = Measured Frequency Error with AFC DAC Value1
ERR2 = Measured Frequency Error with AFC DAC Value2

The AFC calibration is performed when the phone is in Calibration or Test mode, this means that the AFC correction loop is NOT running (the phone is NOT synchronized to a control channel). Some 26MHz oscillator implementations may exhibit some drift in output frequency between the initial turn-on and final, stable operation. This may need to be considered in the calibration sequence.

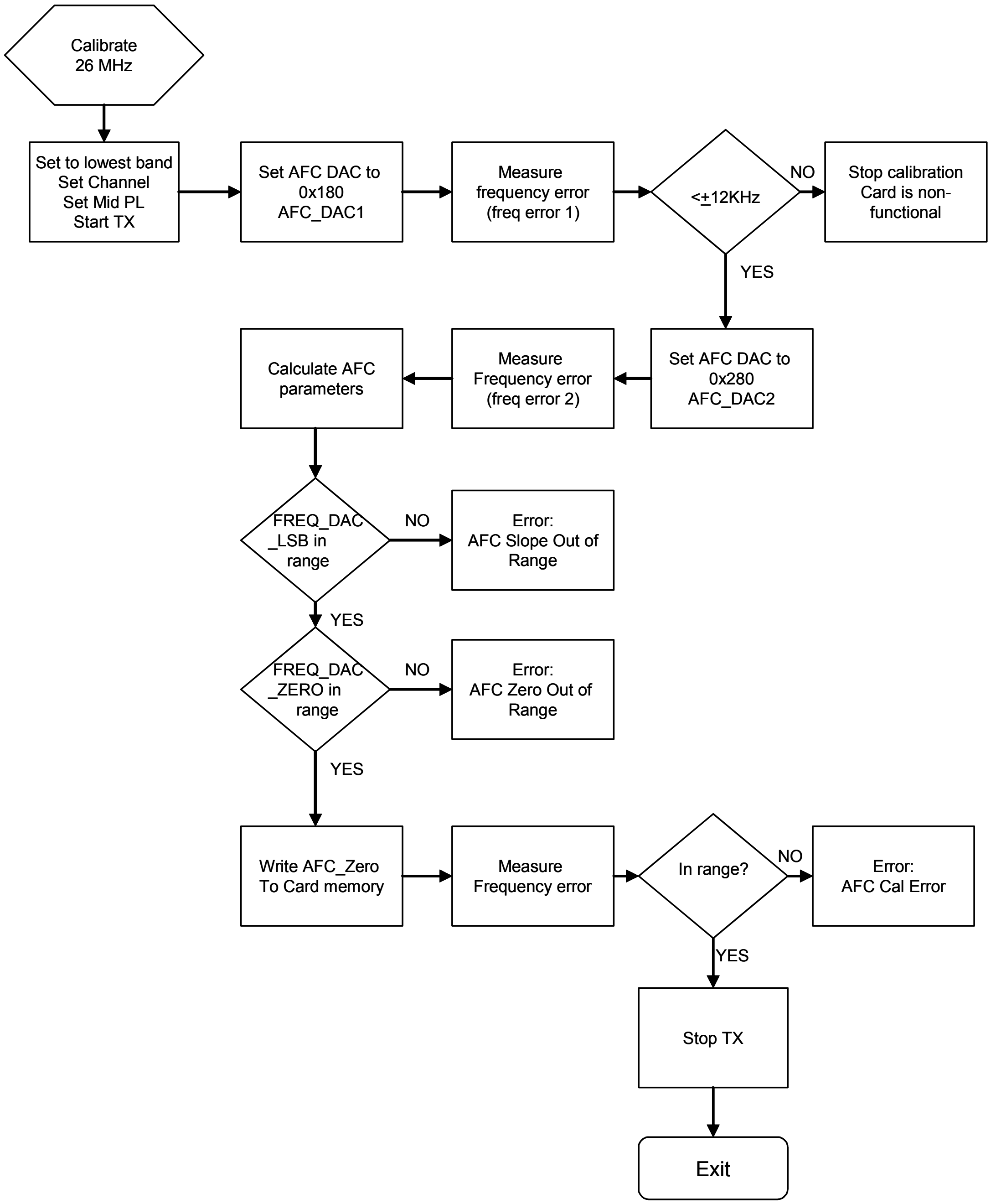
If possible the Frequency Calibration should be performed in the lower frequency band (GSM 900 or GSM 850) since the structure of the AFC algorithm assumes that **FREQ_DAC_LSB** is the slope observed in the GSM-900 band. If this is not possible then the calculated **FREQ_DAC_LSB** value will need to be scaled to reflect the larger frequency shift at the antenna for the 1800MHz and 1900MHz bands.

The channel for the calibration should be chosen from the middle range of the chosen frequency band.

Frequency Calibration Sequence:

1. Set-Up Test Equipment:
    - i. Set to “Un-Sync” or “Test” mode.
    - ii. Set the desired channel in the middle range of the frequency band.
    - iii. Set the expected power level.
    - iv. Set synchronization to midamble “0”.
2. Set-Up DUT:
    - i. Set the Operating Band and Channel.
    - ii. Set the Operating Mode (GMSK or 8PSK).
    - iii. Set transmit power.
3. Write the first value to the AFC DAC with command: DACVAL 0x160.
4. Initiate phone transmit with command: START 0.
5. Allow tester to acquire and synchronize to the transmit signal.
6. Read Frequency Error 1 from the tester.
    - i. Perform limit check to verify output is within acceptable range.
7. Write the second value to the AFC DAC with command: DACVAL 0x2A0.
8. Read Frequency Error 2 from the tester.
9. Halt Phone Transmit with command: STOP.
10. Compute Frequency Cal. Parameters.

Frequency Calibration Algorithm Flow



2.3 Receiver Calibration

Receiver Calibration corrects the receive-path loss from the antenna to the baseband A-D converter, so that the reported receive level (RXLEV) corresponds accurately to the power input at the antenna. The receive calibration is performed on one channel in each frequency band. The calibration is not intended to correct for variations across the frequency band such as may arise from ripple in the RF SAW pass-band. The output of the calibration is 64 parameters for each frequency band (**SYSGAIN *<band>* 0** through **SYSGAIN *<band>* 63**) for subsequent download to the phone's flash. Each of the **SYSGAIN** values is a decimal number which represents the correction to be added to the raw power reading from the RX ADC for each gain state of the RX line-up. The GSYS values are expressed in DB16 mode – a unit value represents 1/16 dB; therefore a difference of 16 in **SYSGAIN** would correspond to 1dB difference.

Calibration of the RX consists of applying a known RF power to the receiver, setting the receiver gain to the proper value, reading the detected RX level from the ADC, and generating a correction based on the difference between the input level and the reported level. (The reported RXLEV during calibration will depend on the default parameters stored in the **SYSGAIN** table prior to calibration.)

Depending on the linearity of the gain of the RF receiver, as few as two power points need be taken for the calibration. However, for transceivers that exhibit some gain nonlinearity, the calibration could be done at several Receive input levels, such as: -100,-80 and -48dBm, and a linear interpolation performed between successive measurement points.

The Calibration Steps are as Follows:

1. Set Up Test Instrument:
   Select band.
   Select channel. (In the middle of the band.)
2. Stop the modem by sending the string "STOP" over the RS-232 port to the modem.
3. Program the Test Equipment to the desired downlink level (Input Power, dBm).
4. Set the modem's RX Gain by sending the string "**AGC *val***" to the modem,

where ***val*** is a decimal number between 0 and 63 calculated as:

val = 110 + InputPower val

Example: For an Input Level of –85dBm:

val = 110 – 85 = 25

5. Start the modem by sending the string "START 0" to the modem.
6. Get the reported Rx level from the modem by sending the string "RXLEV?" to the modem and reading the returned value.
7. Calculate and store the delta between the reported level and expected level

Expected[i] = 110 + Input_Power

Delta = Expected – measured

8. Calculate and store the index in the System Gain table that was used

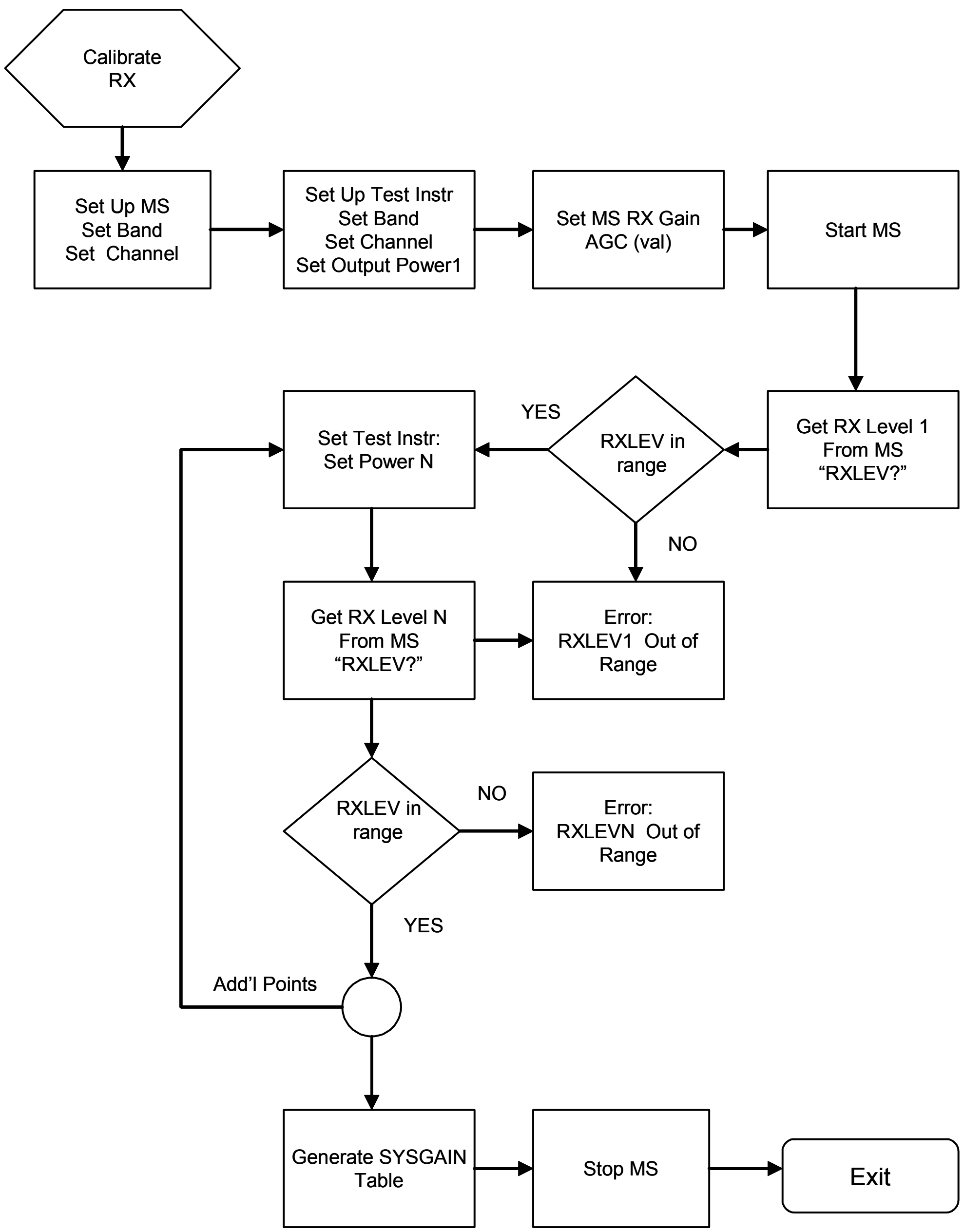
$$Index[i] = 34 - \frac{16 * (110\ Input\_power) - GSYS\_34 - 1168}{32}$$

GSYS_34 = the system gain table entry at index 34

Example **SYSGAIN** table for GSM band:

```
GSM Rx Level calibration results:
// Band Index Offset
// ==== ===== ======
SYSGAIN GSM 0 1152
SYSGAIN GSM 1 1120
. . .
SYSGAIN GSM 62 -832
SYSGAIN GSM 63 -864
```

Receive Calibration Algorithm Flow



2.4 Transmit Power and Ramping Calibration

Basic Transmitter calibration for GSM/GPRS consists of determining new values for the **TX_DB_CONVERT** tables in the parameter file. In theory, values in the **TX_POWER_PARM** table could also be adjusted in the calibration procedure, this would be necessary in cases where the Power vs. Time ramping profile for each phone required adjustment in the factory calibration step; generally it is not anticipated that this will be necessary and the procedure described here assumes that only the **TX_DB_CONVERT** table is calibrated.

The **TX_DB_CONVERT** table is a table of 128 hexadecimal values that can be output to the APC DAC, there is one table for each frequency band. **TX_DB_CONVERT** defines a look-up table of output power vs. DAC input, and is defined such that each step in the table index corresponds to a fixed increment in the transmit output power, typically 0.5dB per index. In a calibrated system, the hexadecimal word stored at each table location should produce the output power that corresponds to that table index. See the table below for a typical correspondence between table index, DSP index and calibrated output power.

While the **TX_DB_CONVERT** table consists of 128 stored values in the parameter file, the DSP interpolates between these stored values to generate a table internally consisting of 2033 values, software accesses to the **TX_DB_CONVERT** table will use indices in the range 0 – 2032.

The Calibration procedure will consists of three basic steps:

1. Load a known set of values into the **TX_DB_CONVERT** table for the band to be calibrated. (A linear table simplifies the relationship between the table index and the stored DAC value).

2. Using the loaded **TX_DB_CONVERT** table, determine the index/DAC necessary to produce a given output power. Repeat this step for as many calibration points as desired.

3. Using the data from Step 2, interpolate / extrapolate to completely fill the 128 values of the **TX_DB_CONVERT** table.

TX_DB_CONVERT		LINEAR DAC (Loaded for Cal)		Lowband Calibration Results		Highband Calibration Results	
Table Index	DSP Index	Hex	Dec	Target Power (dBm)	Calibrated DAC Values	Target Power (dBm)	Calibrated DAC Values
0	0	0x000	0	-31.0		-34.0	
1	16	0x000	0	-30.5		-33.5	
2	32	0x000	0	-30.0		-33.0	
3	48	0x000	0	-29.5		-32.5	
…	…	…	…	…		…	
…	…	…	…	…		…	
…	…	…	…	…		…	
63	1008	0x000	0	0.5		-2.5	
64	1024	0x00F	15	1.0		-2.0	
65	1040	0x01F	31	1.5		-1.5	
66	1056	0x02F	47	2.0		-1.0	
67	1072	0x03F	63	2.5		-0.5	
68	1088	0x04F	79	3.0		0.0	
69	1104	0x05F	95	3.5		0.5	
70	1120	0x06F	111	4.0		1.0	
71	1136	0x07F	127	4.5		1.5	
72	1152	0x08F	143	5.0		2.0	
…	…	…	…	…		…	
…	…	…	…	…		…	
…	…	…	…	…		…	
125	2000	0x3DF	991	31.5		28.5	
126	2016	0x3EF	1007	32.0		29.0	
127	2032	0x3FF	1023	32.5		29.5	

Table 1

The TX_DB_CONVERT table consists of 128 values stored in the Parameter file. The DSP interpolates between these to generate a table of 2033 values to be used by the software. The Linear DAC table is loaded into the phone at calibration to provide a known correspondence between the DSP index and the hexadecimal DAC value. By definition, Table indices should also correspond to given output powers in a calibrated phone (GSM Pwr, DCS Pwr). Calibration will determine, through direct measurement or through interpolation / extrapolation, the “Calibrated DAC Values” for the final calibrated Table.

(1) Load a known set of values into the TX_DB_CONVERT table.

In calibration mode, access and control of the transmit power is accomplished using indices referencing the **TX_DB_CONVERT** table. To insure that a known relationship exists between the indices and the hexadecimal values output to the APC DAC, a known table must be loaded into the phone during calibration. The procedure is simplified if the known table assumes a linear form … that is, each increment of one in DSP index corresponds to an increment of one in APC DAC. The maximum DAC value of 0x3FF should be stored at Table index 127; index 126 should be 16 less or 0x3EF. If continued in this fashion, table index 64 would correspond to DAC: 0x00F and index 63 to 0x000.
All remaining table entries should be 0. The linear DAC table is shown below.

(0)	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000
(1)	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000
(2)	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000
(3)	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000	0x000
(4)	0x00F	0x01F	0x02F	0x03F	0x04F	0x05F	0x06F	0x07f	0x08F	0x09F	0x0AF	0x0BF	0x0CF	0x0DF	0x0EF	0x0FF
(5)	0x10F	0x11F	0x12F	0x13F	0x14F	0x15F	0x16F	0x17F	0x18F	0x19F	0x1AF	0x1BF	0x1CF	0x1DF	0x1EF	0x1FF
(6)	0x20F	0x21F	0x22F	0x23F	0x24F	0x25F	0x26F	0x27F	0x28F	0x29F	0x2AF	0x2BF	0x2CF	0x2DF	0x2FE	0x2FF
(7)	0x30F	0x31F	0x32F	0x33F	0x34F	0x35F	0x36F	0x37F	0x38F	0x39F	0x3AF	0x3BF	0x3CF	0x3DF	0x3EF	0x3FF

Linear Progression TX_DB_CONVERT Table.

The Linear DAC table is loaded into the phone using the test command:

TXDB_WRITE *<Row 0-7> <v0 v1 v2 ….. v15>*

to write 16 values at a time into each of the 8 rows of the table. This procedure will be performed for each frequency band that is calibrated.

(2) Calibrate selected Output Power points.

Once the known **TX_DB_CONVERT** table has been loaded into the phone, individual power points may be calibrated. A simple search algorithm adjusts the APC DAC (via the **TX_DB_CONVERT** index) to reach a target output power. The following test mode commands are used to adjust the TX output power:

RAMP_SELECT *<PCL>*

Selects the default settings corresponding to the given Power Control Level (PCL) and enters the power control sub-menu. With the Linear table loaded, the default PCL should be 10 for 850 / GSM and 5 for PCS/DCS. In the sub-menu, command:

PEAK *<index>*

allows the output power level to be adjusted through the *index* value; this command is utilized by the search algorithm *Index* is the DSP index to the TX_DB_CONVERT table (range: 0 – 2032). With the linear table the relation between the index and the output to the APC DAC is :

DAC = 1023 – (2032 - *index)*

where DAC is the decimal value output to the APC DAC, 1023 is the maximum possible DAC value and 2032 is the highest possible DSP index. From this is can be seen that for the Linear table, *index* values below 1009 are undefined as they would produce a negative DAC value. *Index* values below 1009 should be trapped by the routine.

The search algorithm will try to adjust the output power to the target power within certain error bars. Default error bars of +/- 0.5dB are set. When the target has been met, the actual measured power and the corresponding DAC value are stored for later use.

The initial guess for the search algorithm can substantially reduce the search time and thus the calibration time. Provision is made for passing initial guess values to the search algorithm.

A trade-off exists between the number of power points that are directly calibrated and the time that the calibration procedure takes. The number of power points that will be calibrated are passed as a parameter to the routine. For any band the minimum number of points is 2, and the maximum is the number of defined Power Control Levels (15 for 850 / 900 and 16 for DCS / PCS). The following default settings are supported:

GMSK

Number of Cal Points	Calibrated PCL's lowband	Calibrated PCL's highband
2	5, 19	0, 15
3	5, 12, 19	0, 7, 15
4	5, 9, 14, 19	0, 5, 10, 15
6	5, 8, 11, 14, 17, 19	0, 3, 6, 9, 12, 15
All	5 – 19	0 -15

8-PSK

Number of Cal Points	Calibrated PCL's lowband	Calibrated PCL's highband
2	8, 19	2, 15
3	8, 12, 19	2, 7, 15
4	8, 9, 14, 19	2, 5, 10, 15
6	8, 9, 11, 14, 17, 19	2, 3, 6, 9, 12, 15
All	8 – 19	2 -15

The allowed tolerance provided in the table below will aid in determining the number of calibration points selected.

Default Target powers are set as below:

GMSK

PCL	850 Target Power (dBm)	~~900 Target Power (dBm)~~	Allowed tolerance		PCL	DCS Target Power (dBm)	PCS Target Power (dBm)	Allowed tolerance
5	33	~~33~~	+/-0.25		0	30	30	+/-0.25
6	31	~~31~~	+/-0.5		1	28	28	+/-0.5
7	29	~~29~~	+/-0.5		2	26	26	+/-0.5
8	27	~~27~~	+/-0.5		3	24	24	+/-0.5
9	25	~~25~~	+/-0.5		4	22	22	+/-0.5
10	23	~~23~~	+/-0.5		5	20	20	+/-0.5
11	21	~~21~~	+/-0.5		6	18	18	+/-0.5
12	19	~~19~~	+/-0.5		7	16	16	+/-0.5
13	17	~~17~~	+/-0.5		8	14	14	+/-0.5
14	15	~~15~~	+/-0.5		9	12	12	+/-0.5
15	13	~~13~~	+/-0.5		10	10	10	+/-0.5
16	11	~~11~~	+/-0.5		11	8	8	+/-0.5
17	9	~~9~~	+/-0.5		12	6	6	+/-0.5
18	7	~~7~~	+/-0.5		13	4	4	+/-0.5
19	5	~~5~~	+/-0.5		14	2	2	+/-0.5
					15	0	0	+/-0.5

8-PSK

PCL	850 Target Power (dBm)	~~900 Target Power (dBm)~~	Allowed tolerance		PCL	DCS Target Power (dBm)	PCS Target Power (dBm)	Allowed tolerance
8	27	~~27~~	+/-0.5		2	26	26	+/-0.5
9	25	~~25~~	+/-0.5		3	24	24	+/-0.5
10	23	~~23~~	+/-0.5		4	22	22	+/-0.5
11	21	~~21~~	+/-0.5		5	20	20	+/-0.5
12	19	~~19~~	+/-0.5		6	18	18	+/-0.5
13	17	~~17~~	+/-0.5		7	16	16	+/-0.5
14	15	~~15~~	+/-0.5		8	14	14	+/-0.5
15	13	~~13~~	+/-0.5		9	12	12	+/-0.5
16	11	~~11~~	+/-0.5		10	10	10	+/-0.5
17	9	~~9~~	+/-0.5		11	8	8	+/-0.5
18	7	~~7~~	+/-0.5		12	6	6	+/-0.5
19	5	~~5~~	+/-0.5		13	4	4	+/-0.5
					14	2	2	+/-0.5
					15	0	0	+/-0.5

(3) Generate Values to fill the TX_DB_CONVERT Table.

After the search / measurement algorithms are completed, the data pairs: “Actual measured power” and “DAC Value” are used to compute values to fill the calibrated **TX_DB_CONVERT** Table.

A linear fit between successive measured points is used to fill the calibrated DAC values based on the 128 Target powers as defined in Table 1. A linear fit does not work well when the measured power is in dBm, this is especially true when only a few output power points are actually measured. A better linear approximation can be achieved when the power in dBm is converted to volts (this conversion should be used for both measured and target powers):

$$V_{out} = \sqrt{10^\wedge(P_{dBm}/10)}$$

Below the lowest Power Control Level, an extrapolation based on the lowest pair of measured points is used to fill the table down to a defined “Lowest Power Level.” This value is passed to the calibration routine. Usually this “Lowest Power Level” will still leave some values in the **TX_DB_CONVERT** Table unfilled, so a procedure to fill the remaining table values is needed. A “Fill” value is passed to the routine which is either a given DAC value to be placed in any remaining unfilled table positions or an indication to repeat the final extrapolated DAC value for “Lowest Power Level” in the remaining table positions.