6.7 Calibration procedure.

- **Frequency calibration :**.

  In order for make U401 26Mhz crystal stable within specification over the operational temperature range of –20°C ~ +55°C, IC7860 GSM main processor is controlling tuning circuitry on IC401 PMB6271 IC transceiver via a SPI.

  IC204 Flash memory hold pre-programmed temperature compensation table for the U401 26Mhz crystal and IC101 PMB7860 GSM main processor is to measure environmental temperature from a temperature sensor embedded on IC401 PMB6271 transceiver IC to control U401 26Mhz crystal frequency over desired environmental temperature range.

  Calibration done at a factory line and service facility in a means of finding a proper offset value for each U401 26Mhz crystal at a temperature of +25°C(+/-2°C) and write the offset value on to IC204 Flash memory in following step.

  a) put a device under calibration on to a test/calibration mode under room temperature of +25°C(+/-2°C).
  b) start transmits while tx frequency shall be monitored by GSM frequency measurement capable test box such as CMU-200 or Agilent 5515A/B/C.
  c) decrease or increase a frequency offset value stored on IC204 Flash memory by changing parameters DCXO_DAC which is a range of 0 ~ 8192 and center at 4096 as a default. result transmitter frequency shall be set within +-90Hz at CH40, 898.00Mhz(that makes approx. +/-0.1ppm).
  d) measure and calibrate the DCXO system sensitivity that is composed of U401 26Mhz crystal and IC401 PMB6271 transceiver IC for insure the pre-programmed temperature compensation table reliably compensate the frequency drift over operable temperature range of –20°C ~ +55°C.
     Control DCXO_DAC value from calibrated value +/- 500 and measure amount of transmit frequency shift in Hz and divide it by value of 1000 to get DCXO system sensitivity.
     The result VCXO system sensitivity shall be stored on to IC204 Flash memory parameter named DCXO_STEP.

- **Transmitter calibration :**.

  In order for the N701-AT transmitter remain it's transmit power and modulation occupied spectrum bandwidth, each module to be calibrated in proper manor at the factory line as well as at the service facility.

  Followings are name of calibration parameter that is stored on IC204 Flash memory.

  - pa_offset[a][b] : output power setting at given power level and given frequency band.
  - pa_ch_comp[a][b] : output power compensation value across low-mid-high channel of given frequency band.
  - pa_temp_comp[a][b] : output power compensation value across low-mid-high temperature.
  - pa_vcc_comp[a].offset_step : output power compensation value when VCC voltage drops below 3.6 Volts
  - pa_timing_offset[a][b].rampup : ramp up timing correction value for all band & power level.
  - pa_timing_offset[a][b].rampdown : ramp down timing correction value for all band & power level.

  note1) "[a]" value for above are array of 0 ~ 3 and designated for GSM850 = 0, EGSM900 = 1, DCS1800 = 2 and PCS1900 = 3

  note2) "[b]" value for above are array of followings;

pa_offset[a][b] : 0~19 for represent each power level from PL0 to PL19
pa_ch_comp[a][b] : 0~3 for represent low-mid-high channel of the given band as follows.

GSM850	EGSM900	GSM1800	PCS1900	EEprom name(example)
128 to 152	0 to 25	512 to 600	512 to 600	pa_ch_comp[x][0]
153 to 226	26 to 99	601 to 700	601 to 700	pa_ch_comp[x][1]
226 to 251	100 to 124	701 to 800	701 to 800	pa_ch_comp[x][2]
-	975 to 1023	801 to 885	801 to 885	pa_ch_comp[x][3]

pa_temp_comp : 0~4 for represent low-mid-high temperature as follows.
0 = below -30°C
1 = below -10°C
2 = below +10°C
3 = over +30°C
4 = over +50°C
pa_timing_offset[a][b].rampup : 0~19 for represent power level from PL0 to PL19
pa_ timing_offset[a][b].rampdown : 0~19 for represent power level from PL0 to PL19

<The transmitter calibration procedure goes as follows.>

A. Tx power calibrations for GSM850/EGSM900/DCS1800/PCS1900 PL0 ~ PL19

a1) put a device under calibration on to a test/calibration mode under room temperature of +25°C(+/-2°C).
a2) start transmits while tx power shall be monitored by GSM power measurement capable test box such as CMU-200 or Agilent 5515A/B/C.
a3) set GSM850 mid-channel(ch188), PL5 and adjust a value of pa_offset[0][5] for achieve transmit power of +32.2dBm(+/-0.05dBm) and save it on pa_offset[0][5]
a4) change PL for PL6 and adjust output power for center of specified output power within +/-0.1dBm and save the value on pa_offset[0][6].
a5) continue on PL calibration up to PL19, pa_offset[0][19]
a6) repeat a3) ~ a5) for EGSM900, DCS1800, PCS1900 with a caution of setting it's maximum power as EGSM900=+32.2dBm, DCS1800=29.2dBm, PCS1900=29.2dBm.

B. Tx power calibrations for channel offset.

b1) set Tx PL=5 and a channel on the low end of channel of the GSM850 band and adjust pa_ch_comp[0][0] to get 32dBm of output power.
b2) change the channel to the high end of channel of the GSM850 band and adjust pa_ch_comp[0][3] to get +32dBm of output power.
b3) repeat b1) ~ b2) for EGSM900, DCS1800, PCS1900 with a caution of setting it's maximum power as EGSM900-+32dBm, DCS1800=29dBm, PCS1900=29dBm.

C. Tx power calibrations for low voltage offset.

c1) set GSM850 mid-channel(ch188), PL5 and and bring the power supply voltage from 4.0 Volts to 3.4Volts.
c2) adjust pa_vcc_comp[0].offset_step to get +32dBm of output power.
c3) repeat c1) ~ c2) for EGSM900, DCS1800, PCS1900 with a caution of setting it's maximum power as EGSM900-+32dBm, DCS1800=29dBm, PCS1900=29dBm.

D. Tx power calibrations for High temperature offset.

d1) write following table of to pa_temp_comp.
pa_temp_comp[0][3] = 8 →GSM850 / above +30°C(+0.06dB)
pa_temp_comp[0][4] = 20 →GSM850 / above +50°C(+0.22dB)
pa_temp_comp[1][3] = 8 →GSM900 / above +30°C(+0.06dB)
pa_temp_comp[1][4] = 20 →GSM900 / above +50°C(+0.22dB)

pa_temp_comp[2][3] = 15 →DCS1800 / above +30°C(+0.2dB)
pa_temp_comp[2][4] = 50 →DCS1800 / above +50°C(+0.65dB)
pa_temp_comp[3][3] = 15 →PCS1900 / above +30°C(+0.2dB)
pa_temp_comp[3][4] = 42 →PCS1900 / above +50°C(+0.42dB)

E. Tx switching spetrum(occupied bandwidth) and phase error calibration.

e1) set GSM850 mid-channel(ch188), PL5 and monitor Tx switching spectrum and phase error and adjust ***pa_timing_offset[0][5].rampup*** and ***pa_timing_offset[0][5].rampdown*** value to get minimum Tx switching spectrum while the phase error remains within the specification. If the Tx switching spectrum is more than 3dB lower than the specification limit, it is not necessary to perform the calibration.

e2) continue on PL6 ~ PL19. If the Tx switching spectrum is more than 5dB lower than the specification limit, it is not necessary to perform the calibration at given power level.

e3) repeat e1) ~ e2) for EGSM900, DCS1800, PCS1900 with a caution of applicable power level.

F. GPRS Tx performance verification.

e1) at the end of Tx calibration, check GPRS power levels on all four bands and all power level as well as under low supply voltage of 3.4 Volts.

note) since it is GPRS Class 8 and Class B mobile station, GSM output power and GPRS output power shall be identical and there are no designated calibration parameter(s) for GPRS output power.

<Output power vs GSM/GPRS Tx Power Level>

Tx output power level for normal condition shall be as follows.

Power control level	GSM850	EGSM900	DCS1800	PCS1900
PL	(dBm)	(dBm)	(dBm)	(dBm)
0	33 ±2dB	33 ±2dB	30 ±2dB	30 ±2dB
1	33 ±2dB	33 ±2dB	28 ±3dB	28 ±3dB
2	33 ±2dB	33 ±2dB	26 ±3dB	26 ±3dB
3	33 ±2dB	33 ±2dB	24 ±3dB	24 ±3dB
4	33 ±2dB	33 ±2dB	22 ±3dB	22 ±3dB
5	33 ±2dB	33 ±2dB	20 ±3dB	20 ±3dB
6	31 ±3dB	31 ±3dB	18 ±3dB	18 ±3dB
7	29 ±3dB	29 ±3dB	16 ±3dB	16 ±3dB
8	27 ±3dB	27 ±3dB	14 ±3dB	14 ±3dB
9	25 ±3dB	25 ±3dB	12 ±4dB	12 ±4dB
10	23 ±3dB	23 ±3dB	10 ±4dB	10 ±4dB
11	21 ±3dB	21 ±3dB	8 ±4dB	8 ±4dB
12	19 ±3dB	19 ±3dB	6 ±4dB	6 ±4dB
13	17 ±3dB	17 ±3dB	4 ±4dB	5 ±4dB
14	15 ±3dB	15 ±3dB	2 ±5dB	3 ±5dB
15	13 ±3dB	13 ±3dB	0 ±5dB	0 ±5dB
16	11 ±5dB	11 ±5dB	--	--
17	9 ±5dB	9 ±5dB	--	--
18	7 ±5dB	7 ±5dB	--	--
19	5 ±5dB	5 ±5dB	--	--

note1) under an extreme condition, allowable tolerance range will be widen by 1dB except power level specified on note2.