BSS20043 BTS Clock Tuning Enhancement (Incl. BSS20522 & BSS20702)

CX5 Feature Training

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BSS 20043 refers to the clock tuning enhancement within the CX5 software release.

BSS 20522 refers to the fact that all BTS manager functions are available when BTS manager is used remotely from NetAct. The DAC word setting is the one function currently not available in Remote MMI that can sensibly be enabled for remote operation

BSS 20702 requests Remote change of DAC word in MetroSite

Objectives

On completion of this module the students can

- Describe the principle of the Fast Tune feature
- List two advantages of the Fast Tune feature
- State the maximum time for a BTS to be ready for traffic from initial installation

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Background

- 3GPP TS 11.21 (*was GSM 11.21)* requires that the GSM carrier is accurate to within 0.05 parts-per-million (ppm) /2/
- Specification for MetroSite and Ultra Site master clock is 0.02 ppm /4/
- The BTS uses frequency-based tuning*
- The frequency based tuning is a technique where the 26MHz OCXO is frequency-synchronized with the incoming 2.048 MHz PCM clock from the Abis.
- The purpose of frequency tuning is to achieve stability of the BTS by binding it to the PCM (2.048 MHz) frequency. The principle of frequency based tuning is to tune the oven by computing phase difference values between the OCXO and the PCM, averaged over a period of time.

  * Note that the BTS is frequency – locked, *not* phase-locked

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The BTS 26 MHz clock is not accurate enough on its own to meet the GSM Frequency accuracy requirement, so is tuned by referencing to the incoming Abis signal or to an external clock (Ext_FCk, from an LMU or another BTS) and setting a value to a DAC (Digital - Analogue Converter) that drives a tuning control input to the TCVCXO.

Need for the feature

- When referenced to the Abis the BTS can take a very long time to tune accurately to Abis, so present normal practice on initial commissioning of the BTS is to manually set the clock DAC (Digital-Analog converter) value.

- Fast Tune is specified in order to simplify and speed up the BTS commissioning process by removing any need for manual clock setting.

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Although there is no immmediately perceived 'operator' benefit, this feature reduces the time to commission a BTS the first time. It also reduces the possibility for error.

As will be seen later, the BTS's OXCO could have required up to 9.5 hours to achieve the required accuracy of 0.02 parts per million.

Using Fast Tune, the BTS is operational, and able to generate revenue faster. In addition, less equipment is needed at the site (i.e., no need for a frequency counter)

TCVCXO specification:

ppm

+2.5
+2.0
+1.5
0
-1.5
-2.0
-2.5

highest
optimum
lowest

0 1 2 3 4 5 6 7 8   Vref/V
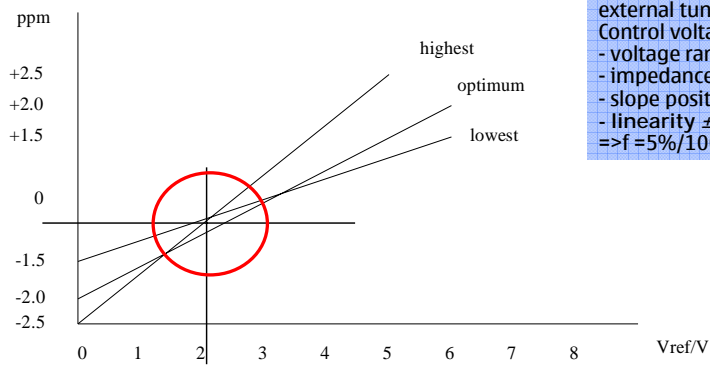
Below from /1/
Reference voltage for
external tuning (pin 4): Vref = + 4.9V ... + 6.0V
Control voltage in (pin 3)
- voltage range   0 ... Vref
- impedance > 200 k
- slope positive   + 0.50 ... +1.00 ppm/V
- linearity ± 5%
=>f =5%/100%*130.0Hz=6.5Hz)

Note 'tolerance' around the 'target area'.

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It is apparent from the graph (from theTXVCXO manufacturers data) that simply setting the external voltage to midrange will not give the required frequency accuracy of 0.02ppm.

Products Affected:

The feature is valid for the following products:

- Ultra Site
- MetroSite

The feature requires the following software versions:

- BSC S12 (For remote control of DAC word only, >= S11 otherwise)
- CX(M)5
- BTS Manager 4.2 [Build 4.1.3] or greater

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BSS 20522 asks that all BTS manager functions are available when BTS manager is used remotely from NetAct. The DAC word setting is the one function currently not available in Remote MMI that can sensibly be enabled for remote operation. This can be used (as will be described later) to force the BTS into Fast Tune mode via NetAct, or Citrix/Remote BTS Manager

BSS 20702 requests ablity to make remote change of DAC word in MetroSite

Requirements and Provisos

On BTS Commissioning, for BTS commanded to use Abis as reference for its internal clock *if* the following conditions are met /4/:

- TCVCXO has reached its stable internal operating temperature
- OMUSIG to the BSC is working (LAPD connection established)
- Has Abis link without Wander*
- BOI/MetroSite master TRX that is either new from production or has been taken from a correctly tuned (working) BTS

Then BTS must adjust its internal 26 MHz clock so that it is within ± 0.02 parts per million accuracy within a maximum of 30 minutes. /4/

- Exception: MetroSite with EDGE Master TRX is not subject to the 30 minute time allowance.

Wander of Abis is set in GSM/ITU specification G.824 as < 8.4µSec in 15 minutes, and < 18µSec in 24H

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Stability of TCVXCO (Temperature Compensated Voltage Controlled Crystal Oscillator)

According to specifications TXVCO should reach stable operating condition within the following timescales:

If ambient temperature is between +25 and +75 degrees centigrade: 5 minutes

Between -10 an + 25 degrees centigrade: 8 minutes

Between -40 and -10 degrees centigrade: 30 minutes

Frequency control of TCVXCO (From VCXO specification /1/)

" When the control voltage is adjusted to 0.5 * Vref , the frequency must be inside nominal frequency ± 0.2 ppm during the first year in operation."

0.5 * Vref corresponds to a DAC-word of 2048.

To be resolved: Why is EDGE Master TRX exempt from this?

Principle of Operation - 1

The oven-controlled crystal oscillator (OCXO) operating at 26MHz located in the BOIA in UltraSite, or the VIFA in MetroSite is frequency-synchronised to the incoming 2.048MHz PCM clock.

(The output of the clock for testing is divided by two, giving 13 Mhz at the test point)

The frequency tuning is achieved by altering the value of the control word of a Digital to Analog Converter – known as the DAC-word, which adjusts the frequency of the OCXO
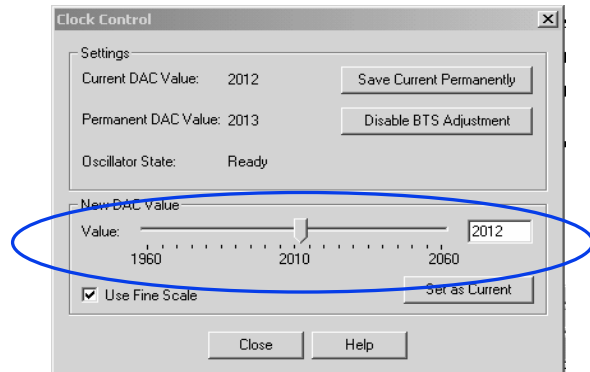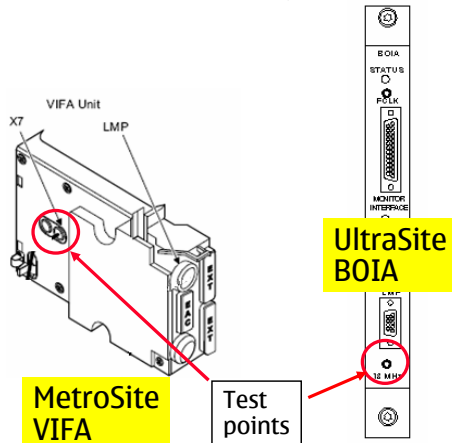
```
  DAC
  word

BOIA/   12        Vout (0-5V)      OCXO
VIFA         DAC                (Nominal 26MHz)
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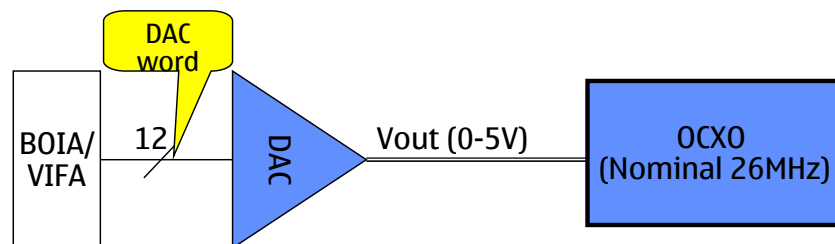
See next slide for the procedure to manually adjust the DAC-word

Principle of operation - 2

Prior to Fast Tune, the DAC word was required to be manually adjusted using BTS Manager, monitored with a frequency counter.

1. Connect frequency counter to the 13 MHz test connector on BOIA/VIFA
2. Set Measurement Period to one second
3. Adjust current DAC Value
4. Save current DAC value
5. Adjust maximum measuring period
6. Repeat Step 3-4 if necessary, using "fine scale" if applicable

VIFA Unit
X7
LMP

MetroSite VIFA
Test points

UltraSite BOIA

BOIA
STATUS
P-CLK
MONITOR INTERFACE
LMP
13 MHz

Clock Control

Settings

Current DAC Value: 2012   Save Current Permanently

Permanent DAC Value: 2013   Disable BTS Adjustment

Oscillator State: Ready

New DAC Value

Value: [slider] 2012

1960   2010   2060

☑ Use Fine Scale   Set as Current

Close   Help

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Procedure that was followed before "Fast Tune" feature:-

Step 1 above:

In MetroSite, the test point is located behind a rubber dust cover on the VIFA. In Ultra Site, the test point (labelled 13MHz) is located on the front of the BOIA

In step 5, the Frequency counter is adjusted as the tuning gets closer to have a gate period of at least 10 seconds

In step 6, click the "Use Fine Scale" option to assist more accurate adjustment.

Now, with CX5, if the DAC-word is set manually, the BTS enters Fast Tune mode automatically.

Flowchart of Fast tune
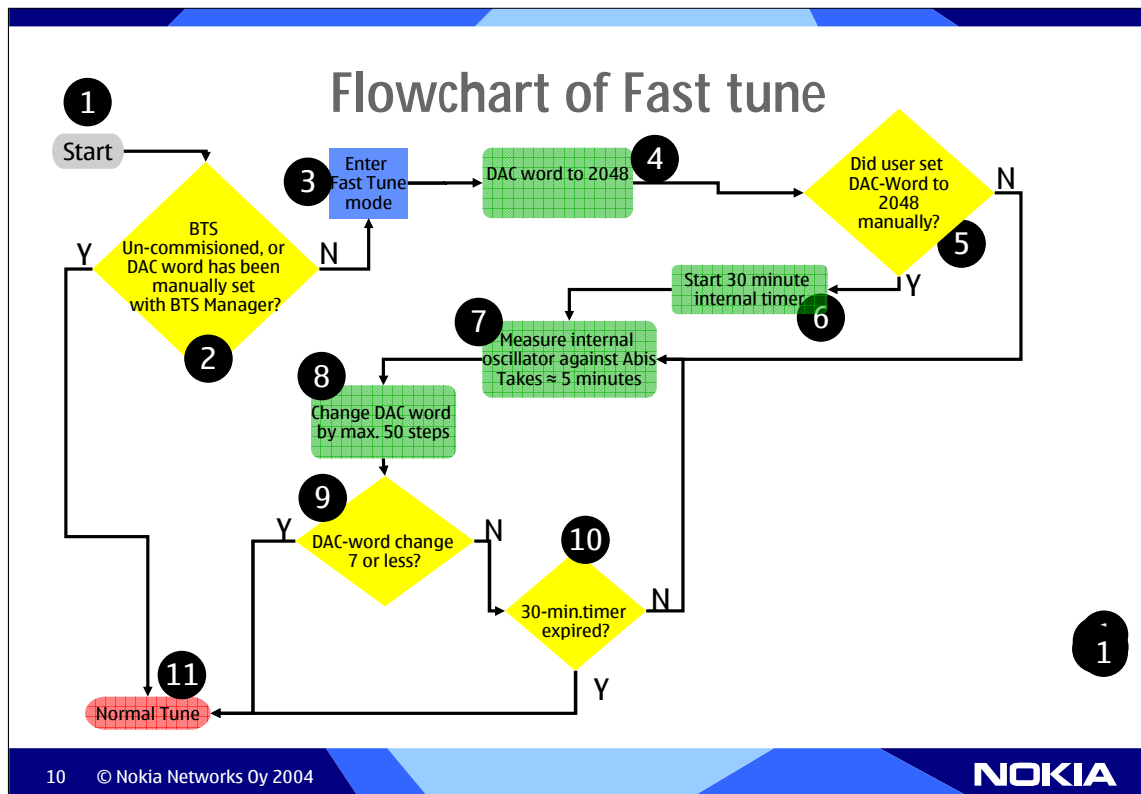
The process follows this procedure: (Numbers correspond to the numbers on the flowchart)

1) The BTS has been powered up.

   Connection to Abis is available, and the Abis is 'good' (see slide 6).

   The Oven compensated 26MHz oscillator has reached its operating temperature /

2) The BTS is un-commissioned, *or* the DAC Word has been set using BTS Manager by the user. If neither of these are true, the BTS uses Normal Tuning, as the previously calculated DAC Word in Flash before the last reset or power-up will provide sufficient accuracy.

3) The BTS will now enter Fast Tune

4) First, the DAC word is set to 2048 by the O&M part of the BTS SW (ref. /3/ , 3.1.1 (CAB Task))

5) If the user set the DAC word manually to 2048, a 30-second timer is started (6) However, if the

7) Over an approximately 5 minute period (104*16 samples) the internal oscillator is compared to the incoming Abis.

8) The value received in step 7) is used to calculate a new DAC-word. This new DAC word cannot be more than 50 steps away from the previous measurement. This corresponds to approximately 0.05 ppm change in frequency. The new DAC word is now taken into use.

9) In this step, a test is made to determine if the oscillator frequency is now close to 26MHz. If the DAC word change in step 8 was 7 or less then Normal Tuning (measurements taken every 20 minutes, with a maximum DAC-word change of 7) is now used. A step of 7 corresponds to approximately 0.007 parts-per-million,
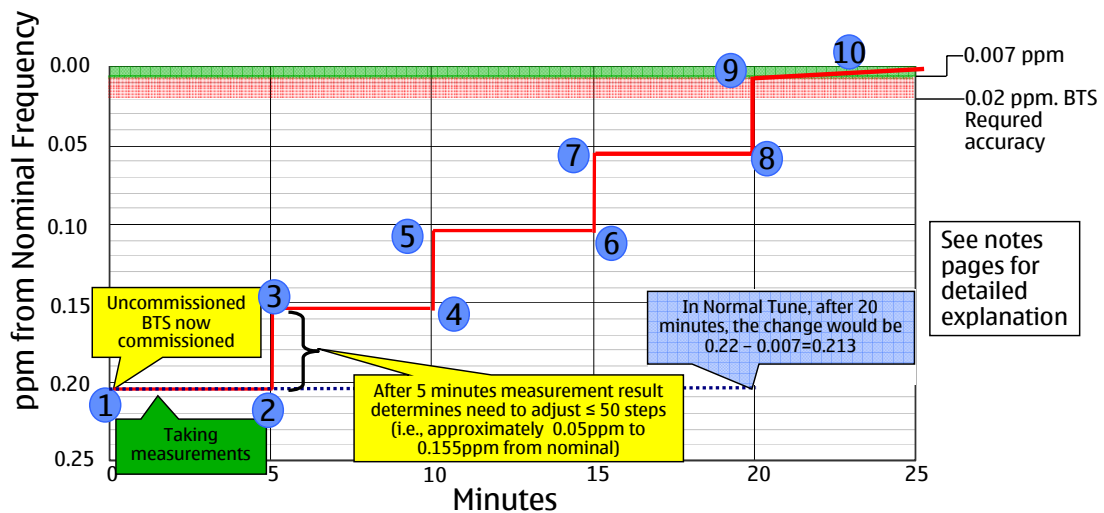
In the scenario depicted and described, it is assumed that the VXCO within the BOIA or WIFA is near its (nominally) worst case situation of 0.25ppm error. . I.e., for this illustration, assume that setting a DAC word of 2048 (midrange) to the BOIA/WIFA DAC-word will result in a frequency error of the 26MHz oscillator of **0.205** ppm.

The specification for the BTS is that the oscillator shall be within 0.02 parts-per-million of 26MHz

(1) The previously uncommissioned BTS is powered on, and commissioning has been completed. The conditions in slide 6 have been met (i.e, connection to LAPD, the Crystal oscillator has warmed up, etc.)

(2) At the end of a five minute peiod, sufficient samples of both the incoming ABIS and the internal clock have been made. If the difference between the two is more than 0.007ppm, the DAC-word is adjusted by up to 50 steps (effecting a change of up to approximately 0.05ppm) (3)

A comparison between the new calculated DAC word, and the current DAC word is made. If the difference is more than 7 steps, Fast Tune is continuedand this procedure is repeated as required (4) → (5) , (6) → (7), and (8) →(9). At point (9) the oscillator is only 0.005ppm away from the nominal. This is within both the BTS requirement, and also within 7 steps (0.007ppm) of the DAC-word. Fast tuning stops, and "Normal Tune" is used (10).

Note the blue dotted line. This shows the progression if only Normal Tune was used

Exceptional circumstance

In MetroSite, the EMUCA ASIC in Edge TRX has a bug which causes the normal TCVCXO to Abis frequency comparison to fail immediately (that is, within the first (5 minute) fast tune measurement period) or after a 10 - 20 hour period.

Once the fault is seen the SW changes to a backup method of frequency comparison, and the normal Fast Tune limit of 50 DAC steps is not usable with this backup frequency comparison.

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[REMOVE] Explanation of ASIC problem in earlier MetroSites

Exercise

- 1) Give the two main advantages of the Fast Tune feature

- 2) In what circumstances will Fast Tune be invoked?

- 3) What condition will cause Fast Tune to revert to Normal Tune

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Answers

- 1) Give the two main advantages of the Fast Tune feature

  a) The BTS will reach specified frequency accuracy within 20 minutes as opposed to (possibly) many hours, thus giving service faster
  b) A frequency counter is not required, if the Abis connection is good.

- 2) In what circumstances will Fast Tune be invoked?

  a) If the BTS is not yet commissioned
  b) If the DAC-word has been manually set by the user

- 3) What condition will cause Fast Tune to revert to Normal Tune

  If the calculation for frequency correction results in a DAC-word change of 7 or less

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References

- /1/ 26 MHZ SMD OCXO specification B7S 467171AE.doc
  - gives the requirement specification for the oven controlled crystal oscillator.

- /2/ 3GPP specification 3GPP TS 11.21

- /3/ CX5.0 O&M SW Fast Tune Functional Specification PI 13-299189 Version 4.0

- /4/ Clock tuning updates CX5 PI 13-292516 V2.2

- /5/ R50.CTE.BTS.008

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Further information

Further information to be added to this material when
available:

1. Why is EDGE MetroSite master exempt from the 30-minute
   timer?

2. To add screenshots of the trace logs showing Fast Tune →
   Normal Tune transition

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