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Title : **Reducing EMC problem in uplink DPCCH Gated mode**

Source : **Mitsubishi Electric ITE**

Document for : **Discussion**

1 – Nature of the problem

In between transmission of data packet in uplink over a DCH, the current assumption is that DPCCH is maintained. The reason is manyfold :

- Channel estimation should be maintained for proper reception at data transmission rehearsal
- Feedback fields (TPC, FBI) of DPCCH are useful for the downlink
- Maintain track of uplink power control loop
- Avoid DTX and its potential EMC consequences

However, when the inter-packet duration becomes quite long, it may be argued that using DPCCH transmission over a such long amount of time is unecessary consuming uplink radio resource. Several solution can be put forward to solve this.

- DPCCH transmission can be stopped after time of DTX, and can be restarted some amount of time priori to data transmission rehearsal (figure 1-b). With such method, a good channel estimate can be obtained at BTS level prior to receiving data. However, there is no possibility to receive feedback information for the oppposite link in between the data, nor to maintain track of uplink power control. This solution is thus not satisfactory.

- DPCCH transmission can be gated as suggested in [1] (figure 1–c), keeping the transmission of feedback fields, uplink power control tracking, and uplink channel estimation. This solution is satisfactory in term of both uplink and downlink quality. However, because of periodic transmission of DPCCH field, this solution can potentially raise some undesirable EMC effects on hearding aids/pacemaker…

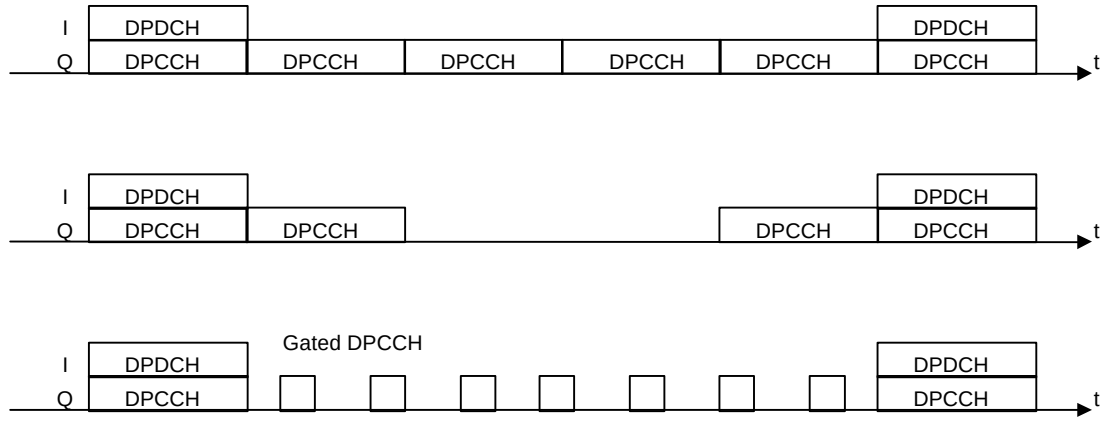

Figure 1 – (a) Current solution – (b) transmission resumption method – (c) gated transmission

2 – Proposed solution

The EMC effect is due to reception in some active devices of low frequency signal due to the enveloppe of RF high power signals. When the enveloppe is periodic, the relative spectrum of the undesirable interference produced in such devices shows some Dirac rays at harmonics corresponding to the period of the enveloppe.

In order to limit this EMC effect, we suggest to spread this Dirac in frequency domain. This can be achieved with some random hopping in time of the enveloppe pattern (figure 2). So, during DPCCH gated transmission, we suggest to vary the instant of transmission of DPCCH field, using a know-in advance time hopping rule.

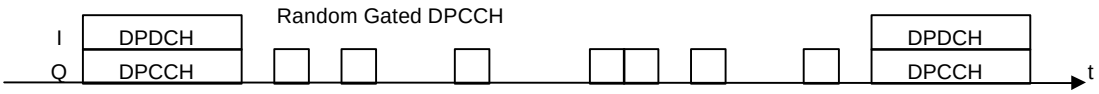

Figure 2 – Time Hopped Gated Transmission

In this scheme, the transmission start instant of the DPCCH information after the end of transmission of the previous DPCCH information is not constant T (as opposite to normal Gated mode); Instead, it is the realisation of a random variable uniformly distributed over the interval (T-x, T+x), with a precision raster of d. (see figure 3)

The value x should be kept below (T – Slot duration), so that there is no overlap possible between 2 consecutive transmitted slots. In order to best benefit from the frequency spreading effect, the time excursion x should be made as long as possible.

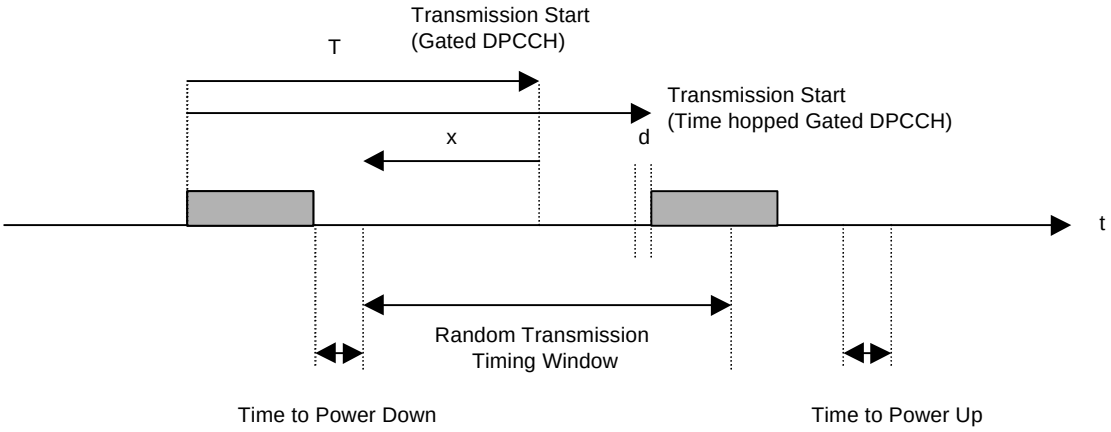

Figure 3 – Description of Random Time Hopping Concept

3 – Simulation result

Simulations (figure 4) show that using a simple uniform time hopping variable, the peak of the main Dirac in the enveloppe spectrum can be reduced by a significant amount. In our example, we assumed a 1/3 DPCCH gating ratio, with excursion of transmission time uniformly distributed between 1.1 and 4.9 slots, with a time raster of 256 chips (figure 4).

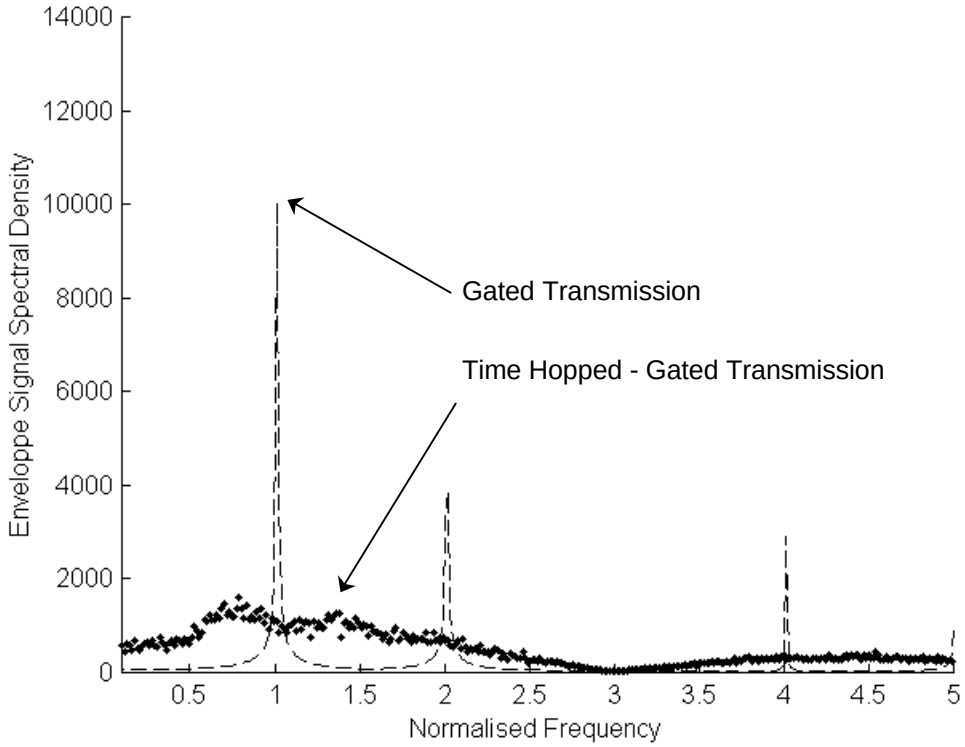

Figure 4 - Spectral Power Density of Enveloppe Signal

The observed EMC reduction reaches up to 8 dB in power for the main interference peak (at 500 Hz). The interference is spread over a much larger frequency window (between 0 and 1500 Hz). This results in a much more confortable EMC noise in devices such as hearing aids or pacemakers.

Note that the central peak is a continuous component, that is generally well handled by DC offsets components in the concerned devices.

4 – Impact on BTS receiver

In order to be able to receive such time hopped signals, the MS transmitter and BTS receiver should know in advance the timing hopping pattern. This can be done if the patterns are defined in some table in the specifications.

There may be several pattern tables, each being defined for a different DPCCH gating ratio (e.g. 1/3, 1/5).

The hopping raster may have some impact of the receiver device. If the raster is defined as an integer number of slots, we believe that the scheme has no impact on the receiver. However, having a so large raster may not be enough to significantly reduce the main peak of EMC interference. So we suggest to use a raster of 256 chips (lower figures could be used).

Using a raster size lower than a slot supposes that the RAKE receiver can handle various positions of a slot in the frame. We believe that some small internal logic can handle that, without adding significant complexity.

5 – Impact on MS transmitter

Using DTX at transmitter side is always a problem, for it raises some time constraints to power up/down the Power amplifier of the MS. So, some room should be left between transmission periods. From GSM specifications [2], we estimated the time to switch up or down RF power to 28 us (107 chips). This is why we assumed that the time excursion should be higher than one slot plus 256 chips (i.e. 1,1 slot).

6 – Conclusion

We suggest that if DPCCH gated transmission is adopted, the attached time hopping method should be added in the specifications.

7 – References

[1] Text proposal for DPCCH gating in DCH/DCH Control Only Substate Samsung

[2] An introduction to GSM S;M. Redl, M. K. Weber, M. W. Oliphant