TRANSMITTER DEVIATION in SIMULCAST PMR FM 12.5KHz SYSTEMS

A discussion on the subject by Peter Rees – with help and advice from others.

It is universally recognized that, in Simultaneous Broadcast systems, the transmitter modulation characteristics of the installed equipment must be as near identical as possible. The Simulcast method introduces distortion as emergent effect of the process – a priority in the installation and commissioning of a system must be to keep this distortion to a minimum. Transmitter modulation control is a key element in this endeavour.

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1 INTRODUCTION

In a Quasi or Simulcast PMR system the setting of transmitter deviation is crucial. If the deviation is not running at its optimum level then the system will either be over deviating and hence possibly breaking a licence condition or not deviating to the optimum level and thus not using the available sideband power to the systems advantage.

The following setting up procedure has been used extensively and over a decade or more to commission and maintain Simulcast PMR systems with Tait, Philips, Simoco and Key Radio base stations. However it is not as rigorous as it could be if some finer and more obscure points are taken into account.

The example given below assumes that peak system level is -10dB into 600ohm and that the scheme is FM with 12.5KHz spacing and a limit on deviation of 2.5KHz.

2 THE PROCEDURE

2.1 When to set Deviation.

Set up the audio levels and transmitter deviation and limiting circuits before making any group delay adjustments; this is because it is likely that high frequency level adjustments will affect the audio characteristic.

2.2 The Test Equipment required.

i Telecommunications multifunction Test Set
ii Audio Characteristic Analyser (LittleGEM (a Dalman product), HP, etc)

2.3 Set Transmitter Deviation Limiting.

The first thing to do is to set the Deviation Limiting control. *It is usual that transmitters have a 'Deviation Limit' control and a separate 'Sensitivity' control. This process is performed on the Transmitter standing alone – it can be carried out in a workshop before the unit is installed in a system.* If the Transmitter documentation describes a method to set limiting then follow that process and use the following to check its action.

The objective here is to set, or check that, the Transmitter Deviation limits at 2.5KHz at an input audio frequency which would cause the greatest deviation if limiting is not applied.

a. Set Transmitter Sensitivity control to mid range.

b. Set the Test Set to output an audio signal at 1000Hz in 600ohm (low level, say -20dB) and apply to Transmitter audio input. *At this stage the operational source of traffic audio is not connected.*

c. Key the transmitter and monitor Transmitter Deviation on the Test Set. *If the Test Set has audio filter options ensure that a wide bandwidth setting is used otherwise the reading will not be accurate and will be misleading, a typical bandwidth will be 15kHz low pass*

d. Vary the Test Set audio frequency over a range of 300Hz to 3000Hz and come to rest at the frequency that causes maximum deviation. Set the deviation meter to monitor the greater of the positive or negative deviation readings. *Take care when using a deviation meter with a 'peak hold' facility.*

e. Increase the input audio level until at some input level the deviation no longer increases in sympathy. Increase the input level by a further 3dB. *The transmitter is now in deviation limiting.*

f. Adjust the Deviation Limit control for system peak deviation on the deviation meter. *This is normally 2.5kHz but refer to the CTCSS section below if CTCSS is to be used. Object achieved, now do not touch it again.*

2.4 Set Transmitter Deviation Sensitivity.

The objective here is to set, or check that, the Transmitter Deviation almost limits when an input at system peak level is applied while driving deviation to the greatest depth without limiting under standard signal conditions.

a. Set Test Set audio output to 1000Hz at –14.5dB and adjust the Transmitter Sensitivity control (note: not the Deviation Limit control) for a deviation of 1.5KHz. *Although the peak system level is -10dB, speech is normally below this level so setting the system up as described puts more energy into the side bands at normal speech levels.*

b. Increase the input level to the peak system level momentarily to confirm that the deviation approaches the peak system figure.

2.5 System commissioning.

The objective here is to adjust the audio characteristics of the system using the transmitters which are now adjusted to give optimum performance and installed in their operational position.

a. Adjust the system Line/Link Interface component to deliver –10dB at 1000Hz to the Transmitter input.

b. Adjust the system Group Delay and Bulk Delay characteristics to be as near identical as possible. This process is the subject of a separate document which relates specifically to the COSMOS 4 Integrated Line Interface product available from Dalman Technical Services Ltd (http://wwwdalmants.co.uk); however, that document (see paragraph 'Bibliography' below) may assist in the characteristic equalization process even if Cosmos 4 is not installed.

c. *When adjusting audio characteristic circuits using a LittleGEM Audio Analyser the audio sweep output level should be set to give an output to line in the range –18dB to -16dB.*

3 CTCSS?

3.1 CTCSS application before the Limiter.

Do not do it. However, if you must. When the CTCSS tone is applied such as to be mixed with the traffic audio (before the Limiter) then the test signal used to set the Transmitter Sensitivity control must be of a different level (reduced) to compensate for the increase in magnitude of the composite signal.

3.2 CTCSS application after the Limiter.

When transmitting CTCSS it is strongly recommended if not **mandatory** that the tone is inserted **after** the Transmitter Limiter circuit in order to keep to a minimum any distortion of the composite signal and ensure that the CTCSS tone level is not varied as audio limiting occurs.

The same procedure is followed for setting the Transmitter Deviation Limiting but the actual value of transmitter deviation in 2.3.f is reduced to 2.25KHz to compensate for the increase in magnitude of the composite signal.

The CTCSS deviation level should be kept to the minimum necessary to reliably operate the corresponding mobile and/or portable receivers. A deviation of 200Hz is typical.

3.3 Distortion due to CTCSS – the 'Growl'.

The CTCSS tone deviation must be set to an accuracy of within 0.5dB (that is +/-0.25dB) between transmitters, otherwise the level difference will be manifest as distortion causing harmonics of the CTCSS tone to occur in the audio band; this will be audible, when multiple transmitters are keyed, as a low 'growl' on a monitor receiver.

4 BIBLIOGRAPHY AND ACKNOWLEDGEMENTS

4.1 Bibliography

"Simulcasting Without (Too Many) Tears" – Update of a paper presented by R. Atack at the 1989 APCO Conference in Sparks, Nevada
(Available on the web: - http://quasi-sync.atackscomputers.co.uk)

4.2 Acknowledgements

Thanks to Brian Overton, David Hurst and Colin Manklow for your help and advice in the authorship of this paper.

4.3 Further Reading

"Simulcast Briefing" by D Cahill.
File SimulcastBriefing.doc* Dalman Technical Services Ltd.

"Simulcast Audio Synchronization" by D Cahill.
File SimulcastAudioSynchronization.doc * Dalman Technical Services Ltd.

"Cosmos4.3 Audio Characteristic Setting Up" by P Rees.
File Cosmos43ABDASettingUp.doc.doc * Dalman Technical Services Ltd.

* The files marked with an asterisk are available as *.pdf on the web at http://www.dalmants.co.uk.

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