MITEL SEMICONDUCTOR

AN197

Performance Measurements on the SL6609A/SL6610

Application Note

AN197 -1.9 Janaury 1995

INTRODUCTION

The objectives of this application note are to:

- Aid understanding of the receiver measurements as listed in the datasheets for SL6609A and SL6610.
- Assist users of the SL6609A/SL6610 demonstration boards when replicating the receiver measurements.

The characterisation analysis performed by Mitel was on a large scale and in order to reduce the time required for analysis a bit error rate (BER) meter under IEEE control was used. This differs from the descriptions below which suggest the use of a POCSAG encoder and decoder. A BER of 1 in 30 has been found to be equilvalent to a successful call reception rate of 80% with a POCSAG encoder and decoder.

A test set-up as shown in Fig.1 is recommended. A POCSAG Encoder generates address data that matches the address of the decoder and is at the chosen baud rate (i.e. 512, 1200 or 2400). The data is FM modulated onto an RF Carrier and applied to the demonstration board via the combiner. The detected data output from Pin 14 is passed to the decoder to acknowledge successful call detection by the SL6609A/ SL6610. Signal Generators B and C provide the interfering signals required in some measurements.

For all measurements the local oscillator frequency must be the same as the nominal RF carrier frequency used.

SENSITIVITY

Definition

The Sensitivity is the minimum power that is sufficient to produce successful call reception at the defined rate of 80%. It is a measure of the lowest signal strength the SL6609A/ SL6610 is capable of working with.

Measurement

Signal Generator A is programmed to provide an RF signal equal to the nominal frequency of the demonstration board (usually around 153MHz, 282MHz or 470MHz).

Address data from the POCSAG Encoder is DC FM modulated onto the RF signal from Signal Generator A (i.e. external modulation) with a 4.5kHz ΔF for 512 baud or 4kHz ΔF for 1200 baud.

The level of the RF Carrier from Signal Generator A is repeatedly reduced while monitoring the ability of the SL6609A/SL6610 to successfully detect the address data on the RF Carrier.

Note: Signal Generators B and C are not used for this measurement.

The Sensitivity as recorded is the minimum RF Carrier level at the input to the Low Noise Amplifier of the demonstration board which permits the 80% rate of successful data detection to be maintained. The value is used as the Reference Sensitivity Threshold for subsequent measurements.

ADJACENT CHANNEL REJECTION

Definition

The Adjacent Channel Rejection measurement establishes the capability of the SL6609A/SL6610 to operate at the 80% rate of successful call detection when there is an unwanted modulated interfering signal which differs from the wanted signal by a single channel spacing (i.e. 25kHz).

Measurement

The RF Carrier from Signal Generator A remains at the nominal frequency of the demonstration board but has the level adjusted to the Reference Sensitivity Threshold plus 3dB. This is known as the wanted signal.

Signal Generator B provides the interfering signal and is set to a frequency one channel spacing (i.e. 25kHz) below the RF Carrier and has sinusoidal FM modulation of 400Hz at 3kHz ΔF generated internally.

The level of the interfering signal is adjusted to reach the maximum at which the 80% rate of successful call detection can be maintained.

Note: Signal Generator C is not used for this measurement.

The recorded Adjacent Channel Rejection is the difference in dBs between the wanted and interfering signal levels i.e. the difference between the Reference Sensitivity Threshold plus 3dB and the interfering signal level at the RF signal input to the Low Noise Amplifier.

THIRD ORDER INTERMODULATION PRODUCT REJECTION PERFORMANCE (IP3)

Definition

The IP3 measurement establishes the capability of the SL6609A/SL6610 to operate when there are two interfering signals such that the 3rd order product is at a frequency equal to the wanted signal.

Measurement

The RF Carrier from Signal Generator A remains at the nominal frequency of the demonstration board but has the level adjusted to the Reference Sensitivity Threshold plus 3dB. This is known as the wanted signal.

Signal Generator B provides the first interfering signal and is set to a frequency one channel (i.e. 25kHz) below the RF Carrier. This signal is unmodulated.

Signal Generator C provides a second interfering signal and is set to a frequency two channels (i.e. 50kHz) below the RF Carrier. Sinusoidal FM modulation of 400Hz at 3kHz ΔF is applied to this signal.

Signal generators B and C are set to the same RF output level but are then adjusted simultaneously to reach the maximum at which the 80% rate of successful call detection can still be maintained.

The recorded IP3 is the difference in dBs between the wanted and interfering signal levels at the RF signal input to the Low Noise Amplifier (i.e. the difference between the Reference Sensitivity Threshold plus 3dB and the interfering signal levels).

SECOND ORDER INTERMODULATION PRODUCT REJECTION PERFORMANCE (IP2).

Definition

The IP2 measurement establishes the capability of the SL6609A/SL6610 to operate in the presence of two interfering RF signals, not within the wanted signal channel. The two interfering RF signals are separated in frequency by a spacing that corresponds to a frequency within the SL6609A/SL6610 baseband bandwidth (e.g. a frequency separation of 4kHz).

Measurement

The RF Carrier from Signal Generator A remains at the nominal frequency of the demonstration board but has the level adjusted to the Reference Sensitivity Threshold plus 3dB. This is known as the wanted signal.

Signal Generator B provides the first interfering signal and is set to a frequency one channel minus ΔF/2 below the RF Carrier. This signal is unmodulated.

Signal Generator C provides a second interfering signal and is set to a frequency one channel plus ΔF/2 below the RF Carrier. Sinusoidal FM modulation of 400Hz at 3kHz ΔF is applied to this signal.

For example, assuming a Channel spacing of 25kHz, and a ΔF of 4kHz:

- signal generator B will be set to:
  Nominal Frequency - 23kHz

- signal generator C will be set to:
  Nominal Frequency - 27kHz

Interfering Signal Generators B and C are set to the same RF output level. The level of both interfering signals is then adjusted simultaneously to reach the maximum at which the 80% rate of successful call detection can still be maintained.

The recorded IP2 is the difference in dBs between the wanted and unwanted interfering signal levels at the Low Noise Amplifier input (i.e. the difference between the Reference Sensitivity Threshold plus 3dB and the interfering signal levels).

CENTRE FREQUENCY ACCEPTANCE

Definition

The Centre Frequency Acceptance identifies the maximum tolerable frequency offset from the nominal RF Carrier frequency that can be experienced before a 3dB degradation in sensitivity is seen.

Measurement

The RF Carrier from Signal Generator A is set to the nominal frequency of the demonstration board and has the level adjusted to the Reference Sensitivity Threshold plus 3dB.

The frequency of Signal Generator A is adjusted higher and then lower to reach the limits about the nominal RF Carrier frequency at which the 80% rate of successful call detection can still be maintained.

Note: Signal generators B and C are not used for this measurement.

The centre frequency acceptance 'above' is defined as the highest frequency reached minus the nominal RF carrier frequency.

The centre frequency acceptance 'below' is defined as the nominal RF carrier frequency minus the lowest frequency reached.

The recorded centre frequency acceptance is the average of the centre frequency acceptance 'above' and 'below' measurement results.

DEVIATION ACCEPTANCE

Definition

Deviation Acceptance indicates the maximum tolerable offset from the nominal deviation frequency of the RF Carrier FM modulation that can be experienced before a 3dB degradation in sensitivity is seen.

Measurement

The RF Carrier from Signal Generator A remains at the nominal frequency of the demonstration board but has the level adjusted to the Reference Sensitivity Threshold plus 3dB.

The ΔF of Signal Generator A is modified from the nominal (i.e. 4.5kHz at 512 baud, 4kHz at 1200 baud) to reach the maximum difference at which the 80% rate of successful call detection can still be maintained.

The measurement is performed for ΔF varied both above and below the nominal deviation frequency.

Note: Signal Generators B and C are not used for this measurement.

The deviation acceptance 'up' is defined as the highest deviation frequency reached minus the nominal deviation frequency.

The deviation acceptance 'down' is defined as the nominal deviation frequency minus the lowest deviation frequency reached.

LARGE SIGNAL IP3

Definition

This is an extension to the standard IP3 test, with measurements being made starting at sensitivity and continuing to wanted signal levels well above sensitivity. The measurement assesses the large signal intermodulation performance of the device.

Measurement

Large signal IP3 is measured with the same set-up and technique as the standard IP3 test. However, as well as being measured at 3dB above sensitivity, the IP3 is assessed at 5dB steps up from this to a wanted signal level of approx -40dBm. The calculation for large signal IP3 is interferer level minus wanted level at the Low Noise Amplifier.

The results of this measurement are shown for a typical device in Fig.11 in the SL6609A/SL6610 datasheet.

The graph shows a continous roll-off of large signal IP3 verses wanted signal (refer to AGC OFF graph).

The AGC ON graph depicts the large signal IP3 performance that can be obtained by employing the AGC function. This circuit monitors the wanted signal level and effectively holds it constant at approximately -95dBm at the RF input by use of a PIN diode in the Low Noise Amplifier. This has the affect of holding up the large signal IP3 at approximately 40dB for an input range of -93 to -60dBm. Beyond that, the PIN diode runs out of attenuation range and the large signal IP3 begins to drop again.

LOCAL OSCILLATOR (LO) REJECTION

Definition

The LO Rejection indicates the maximum local oscillator level at the Low Noise Amplifier input that can be tolerated before a specified degradation in sensitivity is seen.

Note: This measurement is difficult to undertake on the Mitel Demonstration Board. It was performed during characterisation analysis and is listed in the data sheet.

Measurement (Mitel Characterisation Analysis Only)

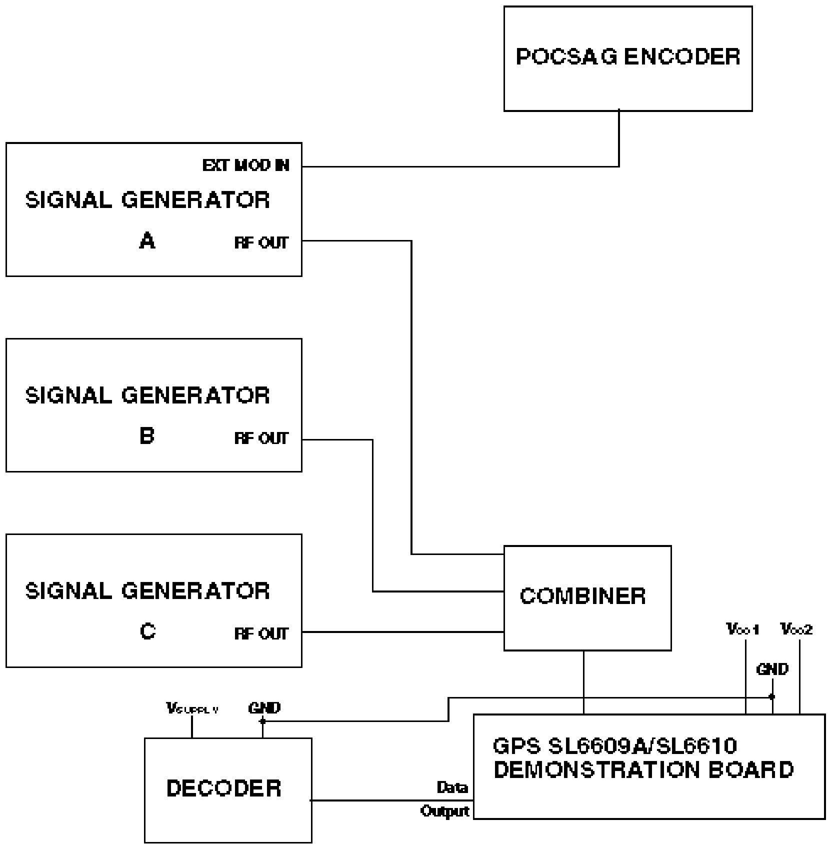
The Local Oscillator signal was split to provide the original Local Oscillator signal and a signal to be combined with the wanted RF Carrier via a variable phase shift network and variable attenuator.

The RF Carrier from Signal Generator A remained at the nominal frequency of the demonstration board but the level was adjusted to the Reference Sensitivity Threshold plus a specified level; either 0.5dB or 3dB (the shifts as listed in the data sheet).

The variable phase shift network was adjusted to cause maximum receiver degradation and then the level of the Local Oscillator combined with the wanted RF Carrier was adjusted, using the variable attenuator, to reach the maximum at which the 80% rate of successful call detection could still be maintained.

Note: The Local Oscillator signal applied to the device local oscillator input pins (LOX and LOY) was kept at a constant level. Signal generators B and C were not used for this measurement.

The measurement as recorded is the level of the Local Oscillator signal at the RF Input to the Low Noise Amplifier and is recorded against the degradation from the Reference Sensitivity Threshold (i.e. 0.5dB or 3dB).



NOTE: Generator B and C have internal modulation set for relevant measurements.

Fig. 1 Suggested Test Set-up

HEADQUARTERS OPERATIONS
MITEL SEMICONDUCTOR
Cheney Manor, Swindon,
Wiltshire SN2 2QW, United Kingdom.
Tel: (01793) 518000
Fax: (01793) 518411

MITEL SEMICONDUCTOR
1500 Green Hills Road,
Scotts Valley, California 95066-4922
United States of America.
Tel (408) 438 2900
Fax: (408) 438 5576/6231

Internet: http://www.gpsemi.com
CUSTOMER SERVICE CENTRES
- **FRANCE & BENELUX** Les Ulis Cedex Tel: (1) 69 18 90 00 Fax : (1) 64 46 06 07
- **GERMANY** Munich Tel: (089) 419508-20 Fax : (089) 419508-55
- **ITALY** Milan Tel: (02) 6607151 Fax: (02) 66040993
- **JAPAN** Tokyo Tel: (03) 5276-5501 Fax: (03) 5276-5510
- **KOREA** Seoul Tel: (2) 5668141 Fax: (2) 5697933
- **NORTH AMERICA** Scotts Valley, USA Tel: (408) 438 2900 Fax: (408) 438 5576/6231
- **SOUTH EAST ASIA** Singapore Tel:(65) 3827708 Fax: (65) 3828872
- **SWEDEN** Stockholm Tel: 46 8 702 97 70 Fax: 46 8 640 47 36
- **TAIWAN, ROC** Taipei Tel: 886 2 25461260 Fax: 886 2 27190260
- **UK, EIRE, DENMARK, FINLAND & NORWAY**
  Swindon Tel: (01793) 726666 Fax : (01793) 518582

These are supported by Agents and Distributors in major countries world-wide.