CML Semiconductor Products

Application Information

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FX919B and FX929B Fade Management and 'A' Version Compatibility

Introduction

This application note is to be read in conjunction with the current FX919B and FX929B Data Sheets. This document is issued to clarify points in currently published documents and to present new information that will enable the user to easily understand and implement this 4-Level FSK product.

The FX919B and FX929B are CMOS integrated circuits that contain all of the baseband signal processing and Medium Access Control (MAC) protocol functions required for a high performance 4-level FSK Wireless Packet Data Modems. They are designed to interface with the modem host processor and the radio modulation/demodulation circuits to deliver reliable two-way transfer of the application data over the wireless link. The FX919B and FX929B are individually backwards compatible with the FX919A and FX929A but offer better performance during radio-link fading and have selectable Tx symbol shapes.

This document describes issues and strategies relating to fading applications. It also describes pertinent FX919B and FX929B features and controls which may be used in an FX919B or 929B based system.

Fade Management

Data Decoding and Receiver Training

In order to accurately decode a received data stream, a modem must properly recover its clock and signal components which are then interpreted to reconstruct the transmitted data.

Because transmit and receive modems are independent circuits (having separate and different local clock frequencies and signal levels) a receiving modem must be trained or synchronised, immediately prior to each data transfer, to establish a common and co-ordinated sense of bit timing.

In addition, the receiver must also be trained to establish a sense of nominal signal amplitude and DC offset, against which the received data signal is compared to properly interpret its data bit values. Training is generally performed by transmitting a specific data stream, the preamble, which provides evident and consistent timing (zero crossing) and amplitude (maximum peak-to-peak range) characteristics.

During the training period, a receiving modem adjusts its local clock and level circuits until the known preamble data stream is accurately reconstructed. Once this adjustment is complete, the transmit and receive modems are synchronised and user data can be reliably transferred. (Note that data transfer must immediately follow the preamble or synchronisation could be lost due to relative clock and level drift between transmit and receive modems.). However both the FX919 and FX929 have been designed to lock onto the received signal without any preamble, as is required in an application such as RD-LAP (Please refer to section 1.6.3 of the relevant data sheet).

The Fading Problem

In mobile wireless applications, dynamic changes in the radio channel alter the phase and amplitude of received signals. In order to maintain its synchronisation through these changes, a receiving FX919B and FX929B uses feedback techniques to dynamically revise its local clock and level circuits according to the changing nature of the received signal. However the receive-level measurement circuits on wireless data modems such as the FX919 and FX929 can also be disturbed by short, large-amplitude noise bursts, as can occur at the discriminator output during deep fades.

Fade Management ......

Fade Management Strategies

The FX919**B** and FX929**B** devices have a new level measuring mode (Track) which allows them to ride through most of these noise bursts, although a Data Quality monitoring algorithm has also been devised as a last resort by re-acquiring when the receiving device appeared to have completely lost track of the input signal.

This algorithm is detailed below and in the appropriate data sheet, and is recommended for both ‘A’ and ‘B’ versions of these devices to catch the occasional loss of level measurement tracking, which may be caused by exceptionally long and large noise bursts.

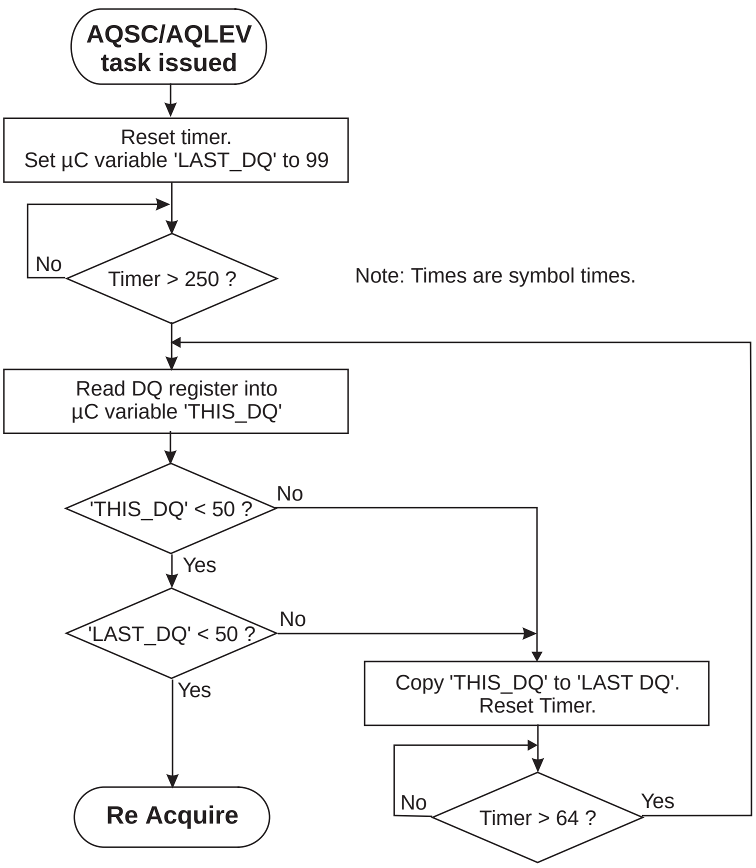
Received Signal Quality Monitor

In applications where the modem has to monitor a long transmission containing a number of concatenated frames, it is recommended that the controlling software includes a function which regularly checks that the modem is still receiving a good data signal, and triggers a re-acquisition and possibly changes to another channel if a problem is encountered. This strategy has been shown to improve the system’s overall performance in situations where fading, large noise bursts, severe co-channel interference or loss of the received signal for long periods are likely to occur.

Such a function can be simply implemented by regularly reading the Data Quality Register, which gives a measure of the overall quality of the received signal, as well as the current effectiveness of the modem’s clock extraction and level measurement systems. Experience has shown that if two consecutive DQ readings are both less than 50 then it is worth instructing the FX919 or 929B to re-acquire the received signal levels and timing once it has been established that the received carrier level is satisfactory. This re-acquisition should follow the normal procedure given in section 1.6.3. of the current relevant data sheet.

The intervals between Data Quality readings is not critical, but should be a minimum of 64 symbol times except for the first reading made after triggering the AQSC and AQLEV automatic acquisition sequences, which should be delayed for about 250 symbol times.

A suitable algorithm is illustrated below:



Performance Monitoring During Fading

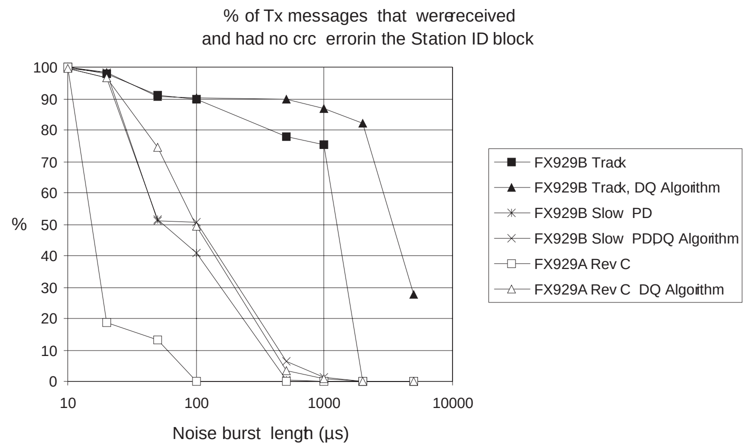
Users of the EV9000 Evaluation Kit will be able to compare the immunity to noise bursts of the FX919B and FX929B devices operating in both ‘Track’ and ‘Slow Peak Detect’ modes.
Test 9 of version 4.0 Ev Kit software sends a stream of concentrated short messages (Frame Sync., Station ID Block (FX929B specific) and a Header Block) without interleaving Symbol Sync. Patterns.

The receiving device is started with a single AQSC/AQLEV acquisition sequence, then reads the messages using SFS, RSID and RHB tasks without any further AQSC/AQLEV unless the Data Quality monitoring algorithm decides that re-acquisition is needed.

Noise bursts may be added to the signal to simulate a discriminator output during deep fading conditions, i.e. the noise bursts may be generated by gating the output of a white noise generator set to 5kHz bandwidth and with and RMS voltage set to 4 times the data signal rms voltage (this give noise peaks of about $\underline{+}V_{DD}/2$). The length of each noise burst should be varied from 10µs to 5ms, for comparison with the graphs below.

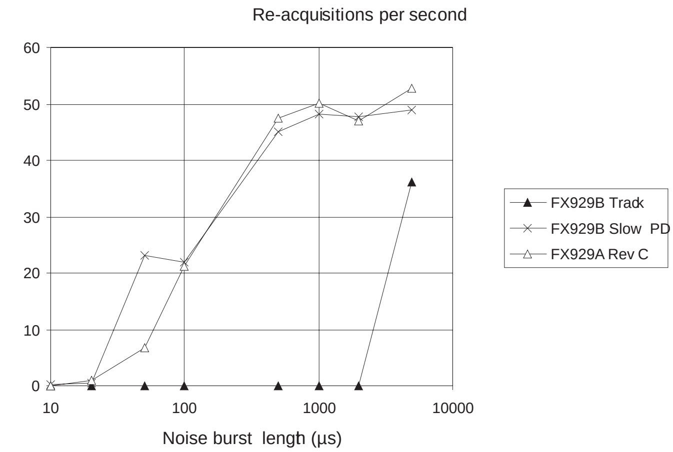
The fading performance characterisation shown below was performed using the at 3.0V, 9600s/s, PLLBW = Medium, FSTOL = 4, with and without the Data Quality monitoring algorithm enabled, and with 1250 messages transmitted for each test.

The following chart shows the marked improvements gained by use of the FX919B and FX929B ‘Track’ mode and the use of the Data Quality monitoring algorithm:



The Data Quality monitoring algorithm used by TEST9 is as described in this application note and in section 1.6.6 of the FX919 and 929B Data Sheets.

A second measure of performance is the number of times that the Data Quality monitoring algorithm has to force a re-acquisition, the following chart again shows the superiority of the FX919B and FX929B in ‘Track’ mode.



Changes to the Level Measurement Modes

These are controlled by the Control Register LEVRES field (bits 2 and 3) as below:

Control Register Bits	B3	B2	FX919A and FX929A	FX919B and FX929B
	0	0	Hold	Hold
	0	1	Slow Peak Detect	Level Track
	1	0	Lossy Peak Detect	Lossy Peak Detect
	1	1	Clamp	Slow Peak Detect

The normal recommended setting will still be ‘0 1’, which will select ‘Level Track’ on the FX919and FX929B devices in place of the previous ‘Slow Peak Detect’ mode, thus giving improved performance without any software changes.

The old ‘Slow Peak Detect’ mode may be useful in some particular circumstances, particularly for some FX919B applications, so it has been retained as a user-selectable option, replacing the old ‘CLAMP’ option.

Note that the CLAMP mode will no longer be program selectable, although it will remain as an internal mode used at the start of a AQLEV acquisition sequence.

Thus the automatic AQLEV acquisition sequence has also changed:

FX919A and FX929A AQLEV Sequence	FX919B and FX929B AQLEV Sequence
Clamp for 1 Symbol.	Clamp for 1 symbol.
Lossy Peak Detect for 15 symbols.	Lossy Peak Detect for 15 symbols.
Slow Peak Detect.**	Slow Peak Detect until Frame Sync. Detected.
	Level Track.**

** Assuming that the LEVRES bits of the control register are set to ‘0 1’ (Slow Peak Detect for FX919A and FX929A devices), which in practice they would be on existing software. Otherwise the level measurement circuits will revert to whatever other mode has been set in the Control Register.

Transmit Symbol Shapes

The FX919B and FX929B include the additional feature of selectable Tx symbol shapes (Please refer to section 1.5.7 of the current data sheets), this feature allows these devices to communicate effectively with various OEM’s base station equipment (e.g. in RD-LAP applications).

Summary

The FX919B and FX929B will give better immunity to fading than the FX919 and FX929A and are software compatible as long as the ‘Clamp’ mode is not currently being used. Please note however for FX919B applications where isolated messages are being sent with indeterminate length gaps of unmodulated carrier, it is recommended that the LEVRES mode is set to ‘Slow Peak Detect’ mode when searching for a Frame Sync., reverting to ‘Track’ mode when Frame Sync. has been detected and while the message is being received.

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