Computer Based Remote Measuring and Acquisition of Dynamic Data

Aleksandar S. Peulić[1] and Sinisa S. Randjić[2], *Member, IEEE*

Abstract – **Target of this work is realization the PC based remote measuring and acquisition dynamic data of various processes, for example, car systems, processes in medical systems. The whole system can be operated as stand-alone as well as PC controlled. The simulations of dynamic data will be various sine waves in scale of frequency from 1 Hz to 20 Hz, from signal generator. The measured data will be collected by processor MSP430 TI family and transmitted by RF wireless line. All shapes of collected data will be showed.**

Keywords – **Dynamic data, car systems, transceiver, wireless line**

I. Introduction

The network in between the measuring modules and the base station is realized as a bi-directional multi-point, single master RF-link, operating in the LPD-frequency range (868 MHz) on a single channel. The structure of the network is fully dynamic and in operation re-configurable. The TRF6900 device integrates radio frequency (RF) with digital and analog technologies to form a frequency-agile transceiver for bi-directional RF data links. The TRF6900 device operates as an integrated-transceiver circuit for both the European (868-870 MHz), and the North American (902-928 MHz) ISM bands. This device is expressly designed for low-power applications over an operating voltage range of 2.2 V to 3.6 V, and is well suited for battery-powered operation. A key feature of the TRF6900 transceiver is the use of a direct digital synthesizer (DDS) to allow agile frequency setting with fine-frequency resolution.

II. Direct Digital Sinthesizser

The receiver uses single conversion, for use with either 10.7-MHz or 21.4 MHz IF filters. The TRF6900 supports frequency-shift keying (FSK)-modulated transmission or reception with bit rates up to 115.2 Kbps. The frequency reference, f_{ref} (which determines the frequency accuracy), is divided to set the step size. This step size is in turn multiplied up to a final output frequency. Characteristics such as operating-frequency range, step size, frequency accuracy, phase noise, switching time, and spurious-signal level are parameters that are balanced to yield a final design. The DDS-based synthesizer simplifies these design issues while maintaining the various performance requirements. The basic principle of operation of the DDS is to generate a signal in the digital domain and to reconstruct the waveform in the analog domain by D/A conversion. Adders and D-type flip-flops accomplish generation of the signal in the digital domain. The D-type flip-flops act as storage devices that change their state when clocked. All arithmetic operations are done using a modulo 2^N, where the N bits determine the output-frequency resolution (f_{ad}) at the phase detector as shown in equation (1).

$$f_{pd} = \frac{f_{ref}}{2^{24}} \tag{1}$$

Where f_{pd} is the minimum phase-detector input-frequency. This is the bit weight of the 2^0 bit of the DDS for the clock frequency f_{ref} used. The power in 2^{24} represents the number of registers of the DDS accumulator, which is 24 for the TRF6900. The value of f_{pd} is multiplied by N, the prescaler value (user-selectable values of 256 or 512), which yields a minimum frequency-step size $\triangle f$ as shown in equation (2) and (3).

$$\triangle f = N \cdot f_{pd} \tag{2}$$

$$\triangle f = N \cdot \frac{f_{ref}}{2^{24}} \tag{3}$$

As previously mentioned, generation of the signal in the digital domain begins with an accumulator whose output serves as a phase generator. Control inputs to the accumulator are a user-defined frequency word, and a reference clock used to clock the accumulator and other circuits (D/A, etc.). The accumulator output is a series of pulsed digital samples, spaced at the clock rate, in the form of a linear ramp. The slope of this ramped signal represents a phase, based on the user-defined inputs.

III. Communications Methods

In time division multiple access (TDMA), time slots differentiate users. The available radio spectrum is divided into time slots. Users can either transmit or receive in their dedicated time slot. Time slots for N number of users are collected into a periodic frame, with N time slots per frame. Because TDMA data is transmitted in bursts, transmission for a given user is not continuous. Temporal synchronization between a TDMA transmitter and receiver using time gating permits reception of a specific user's time-slot data, essentially turning the receiver on and off at the appropriate times. The users essentially ”take turns” using the same radio channel. The composite signal indicates that the channel is in use

[1]Aleksandar S. Peulić is PhD student at Technical Faculty Cacak, Yugoslavia (e-mail: peulic@ptt.yu)

[2]Sinisa S. Randjić is with Technical Faculty, Cacak, 32000, Sv. Save 65, Yugoslavia (phone: +381-32-302-721, fax: +381-32-342-101, e-mail: rasin@tfc.kg.ac.yu)

for the complete length of time. TDMA is sometimes combined with time division duplex (TDD) or frequency division duplex (FDD). With TDD, half of the frame's time slots are used for transmission and half are used for reception. With FDD, different carrier frequencies are used for TDMA transmission and reception, even though similar time slots may be used for both functions.

TDMA systems using FDD usually add several time slots of delay to separate a particular user's transmission and reception time slots and to synchronize transmitters and receivers. The guard time between transmissions can be designed as small as the system's synchronization permits. (Guard times of 30 to 50 ms between time slots are common in practical TDMA systems). All mobile units must be synchronized to the base station to within a fraction of the guard time. Users of FDMA systems divide the frequency spectrum into narrow bandwidth channels where each user is assigned a specific frequency or frequencies for transmission and reception. The receiver demodulates information from the desired channel and rejects other signals nearby. Code-division multiple access (CDMA) systems are either direct-sequence spread spectrum (DSSS), which use orthogonal or un-correlated pseudorandom-noise (PN) codes to differentiate signals that overlap in both frequency and time, or frequency-hopping spread spectrum (FHSS), in which signals are randomly hopped about different portions of an available spectrum. In DSSS CDMA, a narrowband message signal is multiplied by a very large-bandwidth PN spreading signal with a chip rate that is orders of magnitude larger than the data rate of the message signal. (The chip period is the inverse of the spreading rate.) A large spreading rate can minimize the effects of multi path distortion, such as channel signal fading. Each user has a unique pseudorandom code. Due to the orthogonal of the codes, all other codes appear as noise to a given user. A matched filter extracts a specific user's signal, with little or no output signals resulting from other users. Armed with the proper code for that user, a CDMA receiver can effectively extract a user's signals from a channel with multiple signals at the same relative amplitude level. For CDMA systems to work effectively, the power levels of mobile units seen by the base-station receiver must be approximately equal. CDMA achieves this balance using dynamic power control techniques. The total power of multiple users at a receiver determines a CDMA system's noise floor after decorrelation. Unless the power of each user within a cell is controlled so that they are approximately equal at the base station receiver, the strongest received mobile signal can dominate the base-station's demodulator. Signals rising above the level of the other signals increase the noise level at the base station receiver. Higher-level signals decrease the probability that a desired signal will be received and decorrelated. As a result, CDMA systems employ power control at each base station to control the signal level received from each mobile unit, making them all approximately equal. In this way, a mobile unit close to the base station will not overpower the base station for a user much further away. Power control is implemented by rapidly sampling the received signal strength indicator (RSSI) level from each mobile unit and then sending a power change command over the forward radio link to each unit. Unfortunately, out-of-cell mobile units can still provide interference for the base station

IV. Experimental Results

The RF measuring network consists of two measuring modules and of one master module. Each measuring module has a TF6900 and microcontroller capable to make analog to digital conversions. The master acts in direct conjunction with PC by RS232, collecting information from RF link and sending to database by PC application. User action by PC application master translates to slaves by RF link. At the next pictures are showed simple application and transmitted sine wave from sine generator. Frequency band is form 1 Hz to 20 Hz and it mean that it is possible to transmit wide spectrum of measured signal, a temperature, a pressure, a EKG etc. The application is designed in Visual Basic environment and using demo version of graph module for graph representing of sine waves. The slave modules making digital scanning, for example two switches and sending information by RF link to master if switch is on or off.

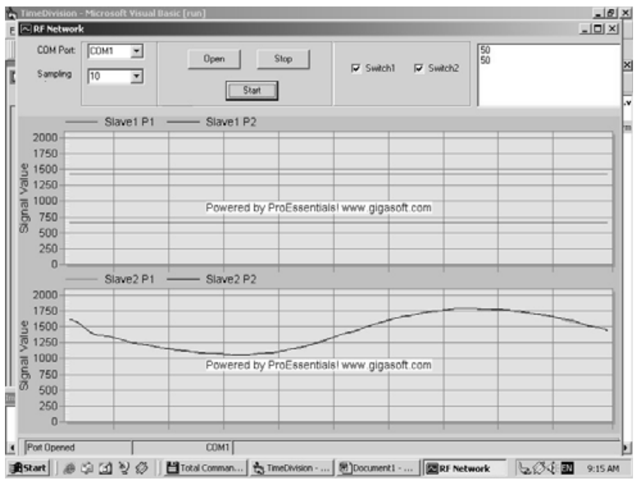

Fig. 1. The sine wave of 1 Hz

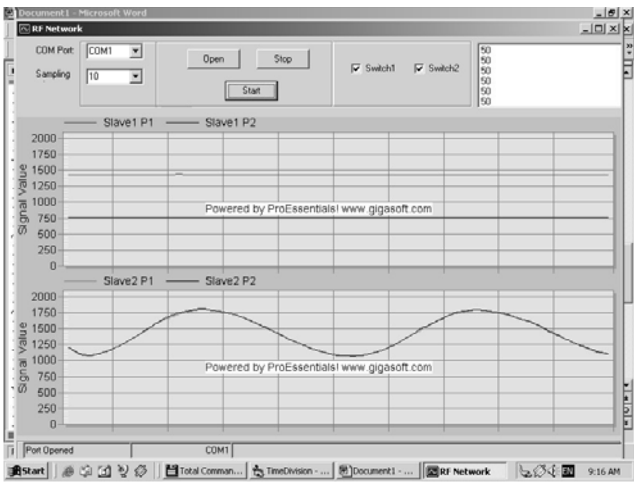

Fig. 2. The sine wave of 2 Hz

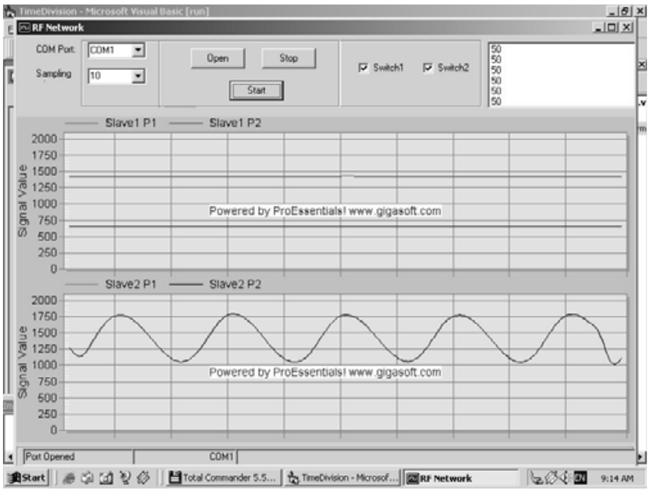

Fig. 3. The sine wave of 5 Hz

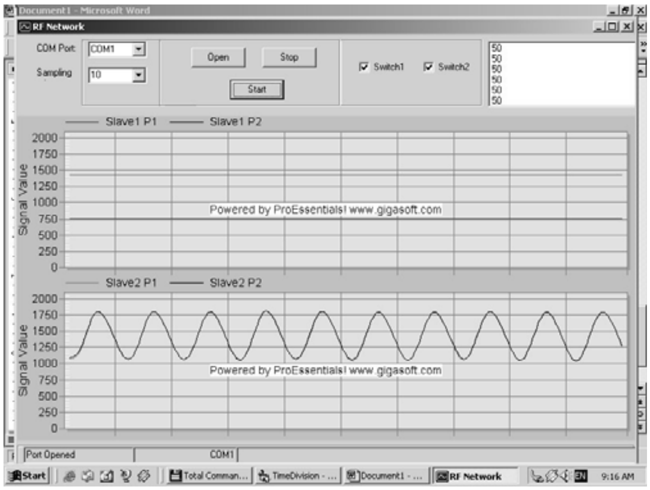

Fig. 4. The sine wave of 10 Hz

V. Conclusion

This application using new frequency band from 868 MHZ to 870 MHz and this band is getting flooded with applications of all kinds. The Rf link and communication between a computer and RF modules are realized. In praxis exist many kind of processes, which should be measuring. The final target is realization a stand alone base station with local data storage will be connected by internet to one big Internet based control, monitoring and operation system.

References

[1] Mr A.Peulić, Dr S.Randjić, *Radio Frequency Measured Data Transmit*, ICEST 01.-04. October 2002, Nis, Yugoslavia, CD zbornik, Measurement Technique

[2] P.J.Gawthrop, *Symbolic Algebra and Phisicakl Model Based Controll*, Report CCSC 96-00,june 1996

[3] P.Spevak, *Impelmenting a bi-directional FSK link*,july 2000

[4] H.J.Vaughan-Nichols, *Web Services: Beyind the Hype*,Computer, february 2002

[5] Hai Lin, *Internet Based Monitoring and Controls for HVAC*, Jan/Feb 2002.