Title of the Project: Micro-Phasor Measurement Unit Development and its Applications

Abstract:

In current scenario, Phasor Measurement Units (PMUs) are positioned mainly on transmission system or in sub-stations. The novelty of PMUs can also be best utilized in the case of distribution system. But keeping the difference of transmission and distribution system in mind, a special type of PMU, called μPMU is required in latter case. The objective of the project was to design and implement a prototype of that special type of Phasor Measurement Unit called Micro-Phasor Measurement Unit compatible with measurements at distribution level (Current day Phasor Measurement Units are used only for transmission system measurements). The design started with Literature Survey of constraints of distribution system that don't allow the same instrument to be used for transmission and distribution system synchrophasor measurements. Above study led to the overlaying of specifications of a Micro-Phasor Measurement Unit that can be implemented for distribution system measurements exploiting synchrophasor technology. The design of Micro-Phasor Measurement Unit needed a block for GPS time signal reception and another for phasor estimation and time stamping.

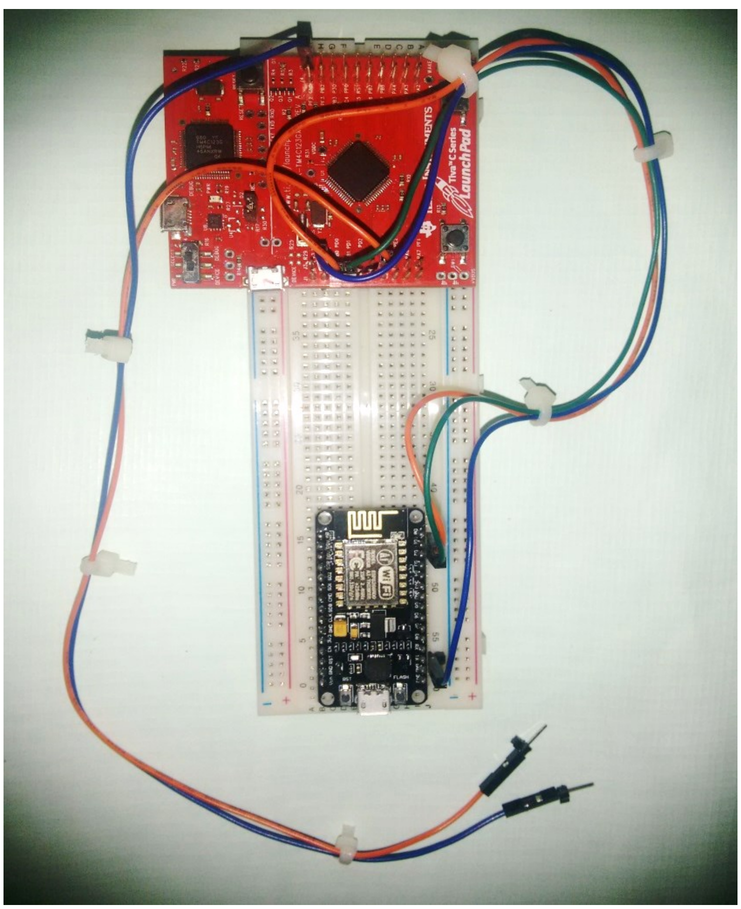

Fig.1 Circuit of the prototype of Micro-Phasor Measurement Unit

Knowledge of microcontrollers led to the selection of Tiva™ C Series TM4C123G (EK- TM4C123GXL) from Texas Instruments as the microcontroller (for Phasor Estimation and time stamping) and ESP 8266 Wifi Development Module (for time signal reception). ESP 8266 has the capability to connect to an internet source and retrieve any information from it. The microcontroller was programmed using IAR Embedded Systems Workbench and the wifi module was programmed using Arduino Software Platform. The circuit was connected as shown in figure 1. The Wifi module was used to retrieve GPS time from a central GPS server located usually at distribution sub-stations.

GPS time from Wifi module was conveyed to the microcontroller via UART mode of communication. The delays can be compensated using Network Time Protocol (NTP). The microcontroller was used for voltage/current signal acquisition, signal processing, phasor estimation and time stamping of input signals. Parallel processing was used in the microcontroller for updating its reference time against the time sent periodically by the wifi module. In this project UART communication was used for communication between the microcontroller and the wifi module, but, other modes of communications such as SPI or I2C communications can equally be implemented. For communication of phasor data to further levels such as Phasor Data Concentrator (PDC) or Super PDCs, LAN communication can be used as the phasor data from microcontroller was available on monitoring screen. Typical results are shown in figure 2. The optimization involved is significant, from using low cost high power microcontrollers to cheaper and versatile wifi modules. Hence the product holds huge commercial potential as it has been designed taking into account the economic constraint of large scale installation in distribution system. So, the project presents a prototype of a Micro-Phasor Measurement Unit that is efficient for distribution system synchronized measurements and at the same time has potential to provide a sound business case for installations in actual distribution systems.

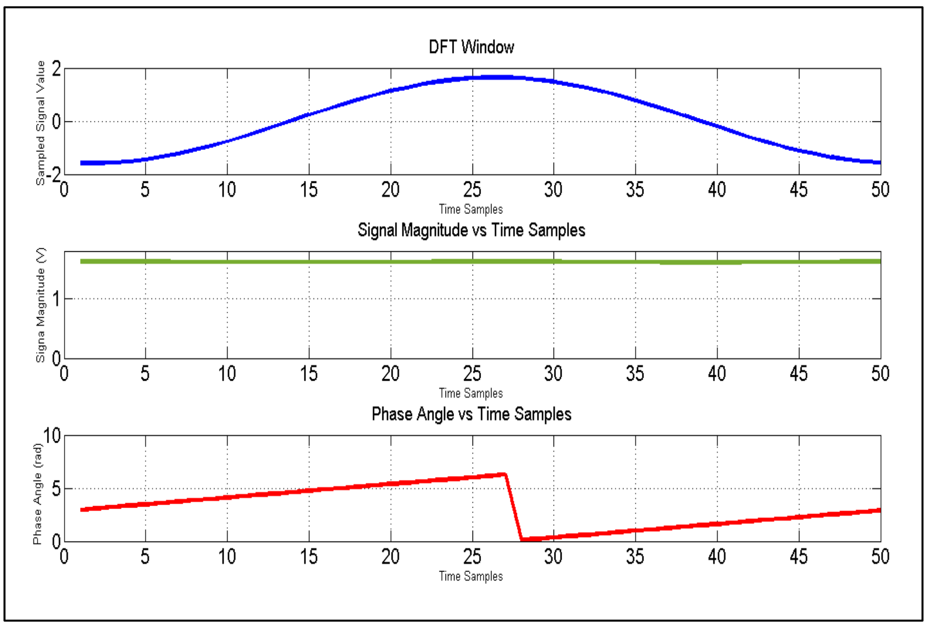

Fig.2 Typical Results with Micro-Phasor Measurement Unit Prototype