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Remote I/O Data Acquisition over PROFIBUS

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***Abstract* -- Intelligent/smart transmitter protocols over Profibus ensure very reliable and self-correcting data communication. They provide control, alarm, trend and other services distributed to its devices. With their deterministic nature, field bus based system architects distribute a process over the network even for applications with hard real-time requirements. PROFIBUS-DP is recognized as a high performance bus network capable of transmitting number of I/O point information in less than a few milliseconds. There is a considerable reduction in time for installation and also the amount of cabling required to setup a Profibus based system in a power plant. Profibus based input module will read signals from the field and send them to the PROFIBUS master. In this project, complete development of PROFIBUS-DP to PROFIBUS-maser communication is proposed and will be tested with test inputs. It is proposed to use M/s Hilscher based PROFIBUS netIC (SOC) hardware solution for realization**.

Key words-- Data acquisition, Profibus, GSD.

I. INTRODUCTION

Data acquisition plays important human, civil and industrial activities. The Process field bus (PROFIBUS) is an International Organization for Standardization (ISO) defined serial, asynchronous, multi-master communications bus originally developed for the automotive industry to replace the complex wiring harness with a two-wire bus. The specification calls for high immunity to electrical interference and the ability to self-diagnose and repair data errors. PROFIBUS was designed for automotive and industrial applications needing high levels of data integrity and data rates of up to 12 Mbit/s.

PROFIBUS is an open, digital communication system with a wide range of applications, particularly in the fields of factory and process automation. PROFIBUS is suitable for both fast, time-critical applications and complex communication tasks. PROFIBUS *communication* is anchored in the international standards IEC 61158 and IEC 61784. The *application and* e*ngineering aspects* are specified in the generally available guidelines of the PROFIBUS User Organization. This fulfills user demand for manufacturer independence and openness and ensures communication between devices of various manufacturers.

II. BACK GROUND OF PROFIBUS DP

PROFIBUS goes back to a association venture project supported by the public authorities, which began in 1987 in Germany. Within the framework of this venture, 21 companies and institutes joined forces and created a strategic fieldbus project. The goal was the realization and establishment of a bit-serial fieldbus, the basic requirement of which was the standardization of the field device interface. For this purpose, the relevant member companies of the ZVEI (Central Association for the Electrical Industry) agreed to support a mutual technical concept for factory and process automation. A first step saw the specification of the complex communications protocol PROFIBUS FMS (Fieldbus Message Specification), which was tailored to demanding communication tasks. A further step in 1993 saw completion of the specification for the more simply configured and faster PROFIBUS DP protocol (Decentralized Periphery). This protocol is now available in three functionally scalable versions DPV0, DP-V1 and DP-V2. The length of transmission line should be chosen by transmit rate. PROFIBUS-DP's transmit rate ranges from 9.6kbps to 12Mkbps and its transmission distance ranges from 100m to 1,200m.

TABLE 1: TRANSMISSION RATE AND RANGE FOR CABLE

Baud Rate(bps)	Length (m)
9.6K,19.2K,93.75K	1200
187.5K	1000
500K	400
1.5M	200
12M	100

FMS (Field bus Message Specification) is designed for communication at the cell level, where programmable Controllers, such as PLCs and PCs primarily communicate with each other. It was the forerunner of PROFIBUS DP. DP (Decentralized Periphery) is the simple, fast, cyclic and deterministic process data exchange between a bus master and the assigned slave devices. The original version, designated DP-V0, has been expanded to include version DP-V1, offering acyclic data exchange between master and slave. A further version DP-V2 is also available, which provides for direct slave-to slave communication with an isochronous bus cycle. The Bus Access Protocol, layer 2 or the data-link layer, defines the master-slave procedure and the token passing procedure for coordination of several masters on the bus. The tasks of layer 2 also include functions, such as data security and the handling of data frames. The Application Layer**,** Layer 7, defines the *application layer* and forms the interface to the application program. It offers various services for cyclic and acyclic data exchange.

III. DATA ACQUISITION SYSTEM OVER PROFIBUS

In 1993, the FMS protocol was simplified and made faster and the result was a new protocol that replaced it called Decentralized Peripherals (DP). Profibus DP could transmit data at 12 megabits per second through ethernet or fiber optic cables. They are used to operate sensors, actuators, switches, valves and other production machines. Usually they stem from a central logic controller. This new protocol, however, can also be used to interconnect a core system composed of several logic controllers. This is a network arrangement called distributed intelligence.

PROFIBUS is a kind of serial multi-master communication network. PROFIBUS is not only a network but also a kind of protocol.

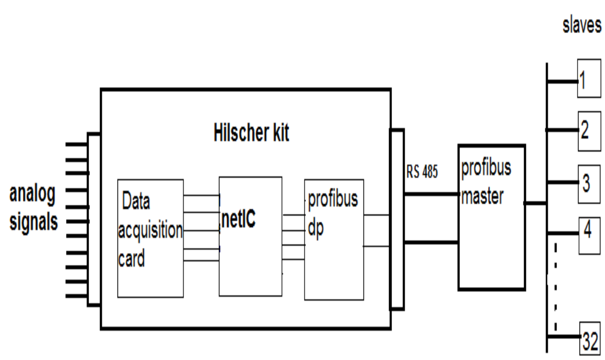

FIG.1 PROFIBUS MASTER AND SLAVE COMMMUNICATION

A. HARDWARE DESIGN OF PROFIBUS

A PROFIBUS system uses a bus *master* to poll *slave* devices distributed in multi-drop fashion on an RS485 serial bus. A PROFIBUS slave is any peripheral device (I/O transducer, valve, network drive, or other measuring device) which processes information and sends its output to the master. The slave forms a "passive station" on the network since it does not have bus access rights, and can only acknowledge received messages, or send response messages to the master upon request. It is important to note that all ProfiBus slaves have the same priority, and all network communication originates from the master.

A PROFIBUS master forms an "active station" on the network. ProfiBus DP defines two classes of masters. A class 1 master handles the normal communication or exchange of data with the slaves assigned to it. A class 2 master is a special device primarily used for commissioning slaves and for diagnostic purposes. Some masters may support both class 1 and class 2 functionality. Master-to-master communication is normally not permitted in Profibus, except in order to grant bus access rights to another master via the exchange of a token. However, master-to-master communication between two mono-master systems can be facilitated using a DP-DP gateway. Note that the exchange of bus access rights via this "token ring" only applies between masters on the bus.

A class 1 master device is normally a central programmable controller (PLC), or PC running special software. The class 1 master sets the baud rate and the slave's auto-detect this rate. The class 1 master handles the data exchange with the slaves assigned to it, and acts as the main controller for the exchange of I/O information with its distributed slaves, cyclically retrieving user I/O data according to a defined message cycle. A master can communicate actively with its assigned slaves, but only passively (upon request) with another class 2 masterdevice.

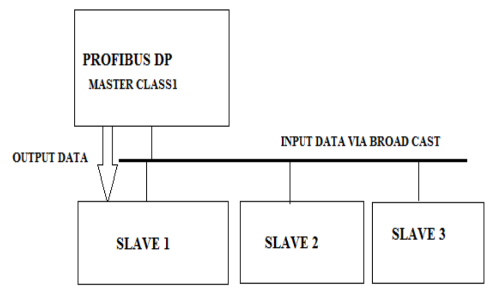

FIG.2 PROFIBUS DP CLASS1 MASTER SLAVE

The class 2 master is usually a configuration device, perhaps a laptop or programming console, and is provided for commissioning, maintenance, or diagnostic purposes. It acts like a "supervisory" master in that it can actively communicate with class 1 masters and their slaves, in addition to its own slaves, but usually only for the purpose of configuration, problem diagnosis, and data/parameter exchange. That is, class 2 masters may only briefly take over control of a slave. All exchanges between a class 2 master and class 1 master originate with the class 2 master.

Master Profiles for PROFIBUS describe classes of controller, each of which support a specific "subset"of all the possible master functionalities, such as

- Cyclic communications • Acyclic communications
- Diagnosis, alarm handling
- Clock control
- Slave-to-slave communication, isochronous mode
- Safety

B. SOFTWARE DESIGN

The General Station Description file (GSD) is an electronic device data sheet or device data base file that identifies the ProfiBus device. All ProfiBus devices (class 1 masters and slaves) have their own GSD files. The GSD file is the fundamental building block for the master parameter record. Use of the GSD file by a ProfiBus configuration tool permits plug & play interoperability among different devices from different manufacturers. This file does not reside within the device itself, but usually on a separate disk/drive. It is an ASCII text file that contains device-specific data, such as, vendor identification information, supported baud rates, supported message length, number of input/output data, meaning of diagnostic messages, timing information, plus options and features supported, data formats, and available I/O signals. For modular ProfiBus systems, a GSD file may contain several configurations (one for each I/O module), one of which will be found valid during startup.

A GSD is divided into three sections:

General Specifications This section contains information on vendor and device names, hardware and software release versions, as well as the supported transmission rates, possible time intervals for monitoring times and signal assignment on the bus connector.
Master Specifications This section contains all the master-related parameters, such as the maximum number of connectable slaves or uploads and downloads options. This section is not available in slave devices.

Slave Specifications: This section contains all slave specific information, such as the number and type of I/O channels, specification of diagnosis text and information on the available modules in the case of modular devices.

It is also possible to integrate bitmap files with the symbols of the devices. The format of the GSD is designed for maximum flexibility. It contains lists, such as the transmission rates supported by the device, as well as the option to describe the modules available in a modular device. Plain text can also be assigned to the diagnosis messages.

There are two ways to use the GSD: GSD for compact devices whose block configuration is already known on delivery. This GSD can be created completely by the device manufacturer. GSD for modular devices whose block configuration is not yet conclusively specified on delivery. In this case, the user must use the configuration tool to configure the GSD in accordance with the actual module configuration.

IV. CONCLUSION

The system, whose design is based on DATA ACQUISITION, NETX and PROFIBUS architecture, has a building-block structure and intelligent function modules. In terms of software design, it supports any combination of system's function modules. As PROFIBUS continues to be enhanced with greater performance, higher determinism, and lower cost implementations. The advantages of such a design are as follows, a higher real time of meteorological detection, high precision, and high degree of automation, cost-effective, a long-time and continuous observations, good reliability, high stability.

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