Measurement Bus
A Simple Way of Fieldbus Technology
Applied to European Petrol Station Interface (EPSI)

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Abstract

This paper describes the benefits of Measurement Bus in a short overview and mainly deals with **EPSI** (European Petrol Station Interface), which is the de facto standard for petrol station forecourt devices in Germany. About 100 petrol stations are running on EPSI at present and it is expected that it will be more than 150 at the end of this year.

Investigations on wiring methods have shown that up to 100 kBit/s free topologies may be used. This paper also deals with an actual application inside a big building in Berlin (Treptower) based on the results of this research.

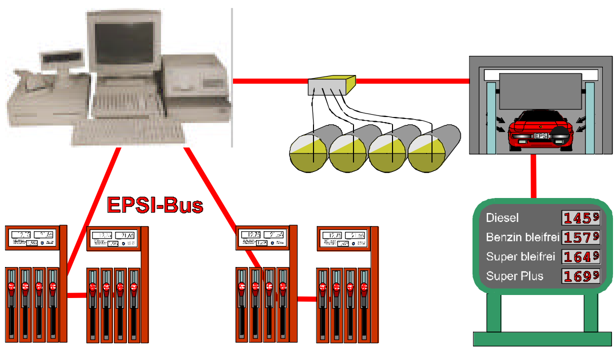
Introduction

Measurement Bus was the first fieldbus standard worldwide, not promoted by manufacturers (compare Bitbus, which is the only elder system). Layers 1 and 2 were published in Germany as DIN 66348 part 2 in 1989. It is a simple master/slave system, derived from proven international standards like **ISO 8482** (Physical Layer) and **ISO 1745** (Data Link Layer). Layer 7 has been published this year as DIN 66348 part 3, the draft was published in 1996. This Application Layer is based on **ISO 9506** (MMS, Manufacturing Message Specification).

The spreading of Measurement Bus in Germany is not first of all based on special features for special applications, the main advantages are, among other things,

- very simple system, may be programmed on any microcontroller (of course with personal computers too),
- very easy handling of "wiring", free topologies with data transmission speed up to 100 kBit/s,
- very powerful because of a very efficient polling procedure
- very flexible because of the versatile application layer (MMS).

So Measurement Bus can be found in any application area, starting with manufacturing automation and not ending with chemistry industries, even simple building automation is done with Measurement Bus. In most cases **small and middle-sized factories** produce equipment for Measurement Bus. Because it is easy to develop, there is no chance of making a business with the system itself. Measurement Bus is always expected to be cheaper than the others.



Cash Desk/Controller and Forecourt Devices

This paper will concentrate on EPSI (European Petrol Station Interface), which is the most developed application for Measurement Bus in Germany. More than 100 petrol stations will be automated with Measurement Bus this year and it is a very much increasing market. DEA, one of the biggest oil suppliers in Germany, will equip all their petrol stations with EPSI in the next years. Especially the **small and middle-sized holders** of petrol stations are very much intended for EPSI, because they will have the greatest advantages from being independent of equipment manufacturers. All petrol station equipment manufacturers in Germany offer their devices with the EPSI-interface, also the international operating factories like Schlumberger, Wayne-Dresser, Tokheim, etc. It is not only that users may buy the petrol dispensers from any manufacturer and have them running with any site controller, it is also possible to combine equipment of different manufacturers. With EPSI, not only the communication itself is standardized, there are also rules for the runtime behaviour of the devices, so it is possible to exchange devices of the same kind without any correction at the controlling application (= **Plug and Play**).

This paper will also mention another application of Measurement Bus in order to show the handling of the bus wiring. In a very big building in Berlin, the so-called Treptower, all drink delivering machines are controlled via Measurement Bus, about 120 devices in more than 10 floors. But the wiring was done with the erection of the building, so Measurement Bus had to use the wiring as it existed. A splendid example for free topology.

Basis for other standards

Measurement Bus is used as a basis for other standardization procedures. EPSI is the most advanced project at the moment with a lot of devices running. The **Plug and Play** is proved. Next the standardization of EPSI as an official standard (DIN 26050) will be finished, describing the behaviour of petrol station devices controlled via Measurement Bus.

There is another de facto standard in Germany based on **Measurement Bus**. This is the Digital Interface for Gas Measuring Devices (DSfG, **D**igitale **S**chnittstelle **f**ür **G**asmeßgeräte). There is no official standardization for this interface so far, but it has proven its **Plug and Play** suitability in several installations.

Profiles for Laboratory Devices are defined in DECHEMA, a federation of the chemical industries in Germany. These profiles will be officially standardized in DIN 12900 and mapped onto PROFIBUS and **Measurement Bus**. And in this year a task force for defining the use of fieldbus systems in sewage works has started, dealing with INTERBUS S, PROFIBUS and **Measurement Bus**. This is initiated and controlled by the Society of German Engineers.

European Petrol Station Interface

As mentioned above, Measurement Bus is not fixed to special application areas. Many users have their own ideas how a fieldbus should be and Measurement Bus fits in a lot of application areas. But in this paper we concentrate mainly on EPSI and the users view to the fieldbus.

Current situation

Nearly 100 petrol stations are running on EPSI at this time in Germany. But that is only the initiation, many renovations are ordered, most of the stations have to be controlled with EPSI-devices.

The power to drive EPSI into the market comes mainly from users like DEA (a major oil supplier in Germany) and BFT (society of free petrol stations), supported by many small, not organized holders of petrol stations. Not to forget a group of idealists who have been engaged in the development of EPSI and are now supporting the EPSI office and the EPSI task force with their fantastic knowledge.

And most of the manufacturers of petrol station devices are able to deliver their products with the EPSI interface.

European Petrol Station Interface

shortly as standard DIN 26050

Internet-Address **http://epsi.berlin.ptb.de**

The Dream of many Users is our Reality:

"Plug and Play" with Petrol Station Devices

Here your guide-line to EPSI-suppliers in hall 10

A71 Dresser Wayne	**A63** Tokheim-Sofitam	**A39** DOS TASK	**A31** Schlumberger
B61 PWM	**B14** Huth		
C41 Gilbarco/TA Salzkotten	**C30** Enraf GmbH	**C21** RATIO ELEKTRONIK	

EPSI-Information Desk: Guest at A39

- More than 70 EPSI-Petrol-Stations running
- Excellent know-how of petrol station constructors
- Neutral conformity test center for quality control
- Official standardization finished this year with DIN 26050
- Continuous information and technical progress by EPSI-office

Published by EPSI-Office, Hoher Wallgraben 43, 10318 Berlin — August 1998

Flyer for AUTOMECHANIKA '98

With the AUTOMECHANIKA of this year, 15-20 September 1998, many manufacturers demonstrated their capability to deliver EPSI-devices with the participation in an EPSI-flyer, published by the EPSI-Office and distributed among many visitors of this international important fair. There has been a great interest for EPSI from visitors outside Germany, which causes the hope that there will be many EPSI petrol stations in the rest of Europe soon.

Certification and Quality Assurance

The neutrality of the EPSI development was guaranteed by the leadership of official bodies (see below, history of

EPSI). But with the realization there might be proprietary or manufacturer specific changes. So it was very important to install a certification institute in order to control the current implementations of EPSI. This is even more important for the expected extensions of the standard for new devices in the future.

For EPSI a special competence centre in Chemnitz (CCC) performs this task. It is an institute (IWQ) associated with the Technical University of Chemnitz. The certification of EPSI has to be paid. There are three levels of certification for an EPSI device:

1. Certification of transport communication (layer 2 according to the international standardized Open System Interconnection). The actual price for this certification is DM 1500.-.[*)]
2. Certification of application communication (layer 7 of OSI). The actual price for this certification is DM 4000.-.[*)]
3. Certification of special EPSI appointments and device behaviour. This so-called **device passport** is the most important certification and can only be done, if the communication works correctly. The actual price for the device passport is DM 1750.-.

It is not only that the devices are tested at the EPSI-CCC, it is more that the developers of the devices may take part in the test procedures and they are allowed to carry their development tools with them and repair detected errors at once.

The EPSI competence centre also may be used as an arbitrator if problems occur at petrol stations. Not running multi-vendor projects are the weakness of any open system, because one manufacturer will blame the other and a referee is urgently needed.

The users' profile

Measurement Bus is often called the typical User-Fieldbus. If you compare the development of Measurement Bus and that of other fieldbus systems, you will find that there is no bigger supplier behind Measurement Bus as it is with most of the other systems. It is just a standard for communication without the need to buy special chips, development tools and technical descriptions. So there are a lot of small and middle-sized manufacturers producing equipment for Measurement Bus. This situation also defines the typical user of Measurement Bus, who is oriented on the small and middle-sized suppliers producing exactly the devices he wants to have. In this environment it often happens that users take part in the development of devices or at least define the application requirements.

Exactly this situation we find with EPSI. The demand for EPSI comes from the smaller and middle-sized petrol station holders, who really need an open communication system to cause a useful competition between device manufacturers. The big oil suppliers do not need a standard for this, they set up the competition between the device manufacturers by ordering a great number of devices for the cheapest possible price. Though DEA is one of the major oil suppliers in Germany, they see the big advantages with EPSI. Small and middle-sized manufacturers very often are much faster in development and are able to adjust their technology to local needs. And that is what we often have with petrol stations: changing technical requirements caused by trends and ideas in a public environment. And do not forget that there are many different requirements in various European countries.

History of EPSI

It was in 1990 when some involved members of the bigger oil companies (BP, ARAL, etc.) asked the PTB (Physikalisch-Technische Bundesanstalt, German official body for Weights & Measurement) to take the leadership for the development of a standard interface for petrol station equipment. Until then, all attempts to achieve this goal together with device manufacturers have been in vain.

Pilot Installation, 11/1991-12/1992

In November 1991, a joint project was founded by PTB and the German Scientific Society for Mineral Oil (DGMK, Deutsche Wissenschaftliche Gesellschaft für Erdöl, Erdgas und Kohle e.V.), sponsored by the mineral oil industries. The scientists of PTB started the project by looking for a fieldbus system which had to meet the following requirements:

- The fieldbus should fit in the actual structure of petrol stations.
- It should be easy to implement the fieldbus into existing petrol station devices. The favouritism of special development tools or microcontrollers was not allowed.
- The fieldbus should be robust and should have proven its efficiency in existing industrial installations.
- The fieldbus should be real open, there should be no advantage for a single supplier or manufacturer by choosing a special bus.
- There should be a flexible application layer definition, so that it would be possible to follow changes of technical demands (MMS of ISO 9506 was seen as a perfect example).

[*)] The certification of layer 2 and layer 7 may be omitted, if certified small communication boards (EPSI-boards) are used, delivered by a few competent manufacturers.

To get a neutral touch to the fieldbus systems, the engineers of PTB put themselves into the situation of a manufacturer by trying to adapt given petrol station dispensers of different manufacturers to any fieldbus. The market was analyzed and offers for different fieldbus systems were ordered. But out of all possible fitting fieldbus systems only **Measurement Bus** permitted to perform this task with low cost and in a short time. So there was a clear decision to take this fieldbus.

Next gateways had been developed in order to couple given petrol station devices to Measurement Bus, including the application layer protocol. A first definition of the structure of petrol station devices was fixed, based on the variable model of MMS (Manufacturing Message Specification, ISO 9506).

In the PTB-laboratories then a petrol station was installed, consisting of different dispensers and a combined cash desk/controller system on a standard personal computer (PC). The investigations with this laboratory petrol station have shown that the chosen fieldbus was able to do this task with a great reserve.

Field Trial 01/1993-12/1993

Based on the laboratory equipment a real petrol station in Berlin with heavy traffic was put into operation. A lot of investigations have been made and a lot of errors had to be handled. The result was that the fieldbus worked without any problem, all errors had been with the original devices, in many cases with the communication between the gateways and the devices. One of the most important results was that even the peaks of traffic could not drive the bus over a load of about 5%. And that with a rather slow communication speed of 9600 bits/s. So it was proved that Measurement Bus works very efficiently and will have enough reserve for increasing communication expense in the future. At the moment, investigations take place to run EPSI with 57600 bit/s, which is a speed that does not lead to restrictions for free topologies (see below).

Implementation 05/1993-04/1995

As it became obvious that Measurement Bus was the correct decision, one started to define the profiles for petrol station equipment.. Since February 1994, the descriptions of the profiles have been available, concerning the following topics:

- general communication description for all different devices to be plugged to EPSI and
- special description for
  petrol dispensers,
  price signs,
  tank gauges,
  lorry electronics,
  card readers and
  car wash stations.

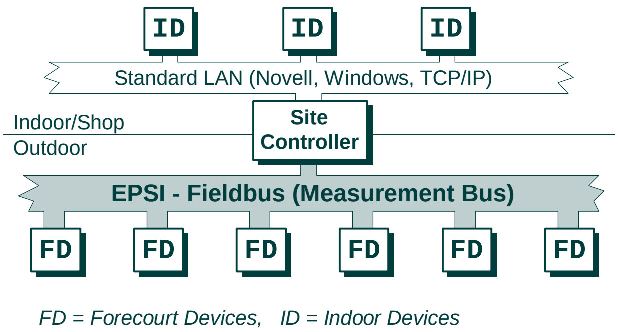
Consolidation since 1995

A real open system has more enemies than friends and there is a lot of strength necessary to get it stabilized. So there are many steps to be taken to get a stable standard:

- building the EPSI conformance test centre,
- installing the EPSI task force,
- installing the EPSI office,
- educating of people who are responsible for the equipment of petrol stations in seminars (at present 3 seminars each year) and
- publicizing the idea of EPSI wherever possible.

A few technical details

It was mentioned above that the fieldbus should fit in the structure of existing petrol stations. In any petrol station we find a central controller for all forecourt devices and a cash desk system connected to the controller, in most cases with an open cash desk interface (UTAX-interface). In many cases the cash desk is connected to a back office station via a standard LAN. Based on this, EPSI is nothing else than modernizing and standardizing this proven concept.



Network Structures with EPSI

The old cash desk interface (UTAX) is no longer used; instead there is a direct connection between the cash desk and the site controller, in some cases via a LAN (Local Area Network). In most cases, the site controller is integrated directly into the cash desk system. So from the view of the user, there is no site controller anymore, the cash desk system has a direct interface to the forecourt devices instead.

Real Time Behaviour

It is expected that in future the bus system will be used for more communication tasks than now. An example is the controlling of tank filling with the already installed tank gauge system. So there must be a real time communication path with very short reaction time between the lorry and the tank gauge. The real time behaviour must be guaranteed independent of the actual bus load. This may be perfectly realized with EPSI by the site controller, detecting the arrival of a lorry and organizing a suitable communication schedule. The master/slave-structure itself is the guarantee that such schedules stay valid also in situations with unexpected much traffic.

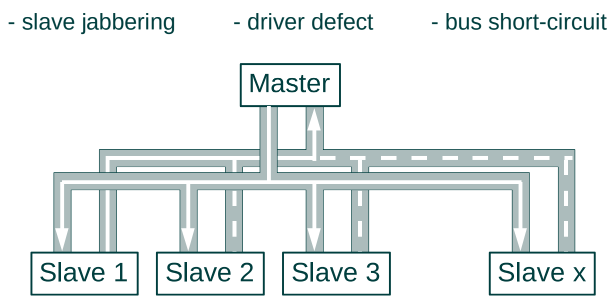
With the requirement to have the bus running for all devices (tanking possible without delays noticed by the customer), several real time links may be guaranteed with a reaction time of less than 0.1s at a transmission speed of 57600 bit/s.

Security Aspects

A master/slave-structure is often criticized because of the failure of the whole communication in case of a defect with the master. But if the application itself has a centralized control structure, as it is with petrol stations, this criticism is meaningless, because the loss of the central controller is the main problem. Central controller and bus master will be the same device. Plans for redundancy have to include the controller.

If you discuss security aspects with experienced technicians at petrol stations, they will tell you that they do not trust a bus system because of the loss of the communication in the case of defect (e.g. jabbering) devices. Often, they want to stick to elder point-to-point connections. The central controller is said to be very reliable, defects with it are very seldom compared to device defects.

Provided that this is true, there should be a strategy for raising the reliability of a bus system. So with EPSI the full duplex communication is recommended, which allows to set the devices into defined states via broadcast although one device blocks the line.



Emergency Broadcast with Full Duplex

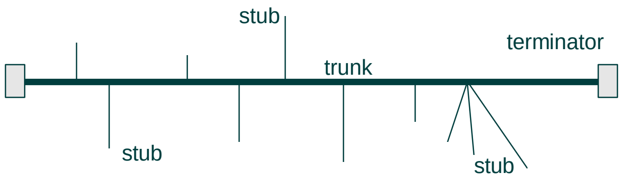
Only in cases where not enough wires exist, e.g. only two wires are installed, the half duplex communication, which is also defined for EPSI, may be used.

A few months ago, a combined cash desk/controller system was brought into the market, which has more than one master interface (Huth). So the user may choose whether he installs only one bus or many, in an extreme design he gets the old structure with point-to-point connections.

Other manufacturers deliver their cash desks with an EPSI controller/master on principle (TrieSoft). So if more than one cash desk is used, there is an automatic redundancy of the controller. If one cash desk/controller dies, the other may take the part. This tackles the criticism against single master systems and is a perfect redundancy concept, taking into account defects with cash desks and controllers.

Free Topologies

Normally bus systems are presented in a line topology. A trunk cable (backbone) defines the bus itself and the devices are connected to the bus via stubs.

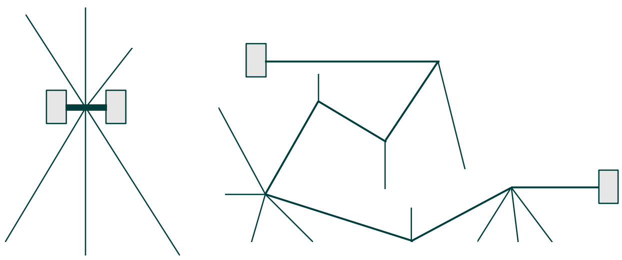


Standard Line Topology

In reality it is not always possible to install cables in the proper manner. So it happened that very complex, sometimes chaotic, installations have been tried and the responsible engineers themselves are very astonished that the fieldbus runs perfectly.

Natural Speed Limit

In 1997 a special investigation started dealing with the bus behaviour in different topologies.



Topologies at Will

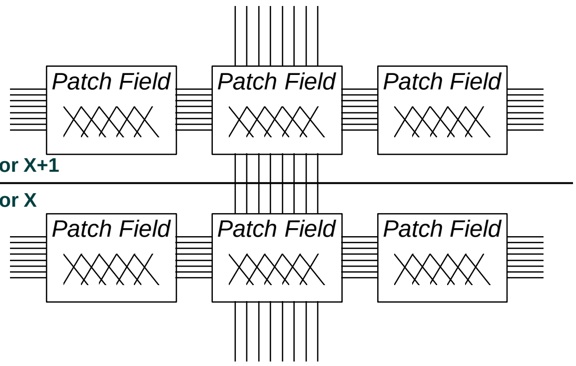
In a first step, the stubs have been modified up to a length of 50 m (later up to 200 m) in a standard line topology. After that, a lot of different topologies have been constructed, just at will.

For standard computer cable (twisted pairs) driven with RS-485 it was found that if the information bit on the line (0 or 1) is detected in the middle of the bit (normal bit detection with a standard interface, UART) and the bit time is longer than 10 microseconds, the line reflections at long stubs or at open bus ends may be neglected. The corresponding **maximum transmission speed is 100 kbit/s**. So below this speed, the possible length of a transmission line is only limited by the losses and may be optimized with a higher termination resistor at line end. The resistor should not be omitted completely, because it reduces the influence of noise and crosstalk.

A Big Installation with Free Topology

Based on the results of this investigation, the drink delivering automates in a big building in Berlin (Treptower) are controlled via **Measurement Bus** in a free topology.

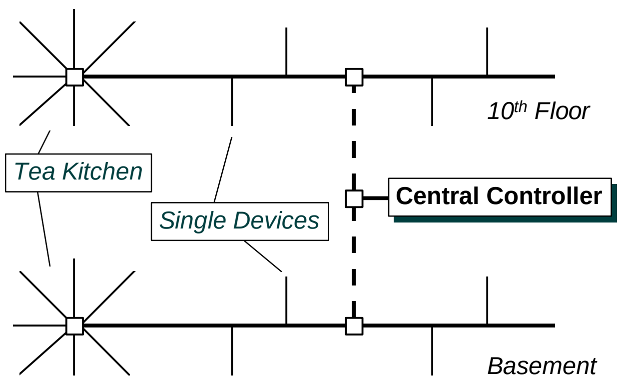
The *Treptower* is a new big building in Berlin for *Allianz*, one of the biggest insurance companies in Europe. When the building was erected, cables for communication were installed from room to room, ending in so-called patch fields. The patch fields in the floor centres also have cables from floor to floor.



General Cable Structure in *Treptower*

By connecting the wires in the patch fields it is possible to construct a link from any room to any other room.

In some rooms, so-called tea kitchens, there are several drink delivering and pay card automates (about 10 devices) to be connected to one central controller. In other rooms, there is only one device. Altogether there are 120 devices to be connected to the central controller.



Installed Bus Topology in *Treptower*

From the view of a puritanical bus installation, this is a crazy constellation, but it runs perfectly with 9600 bit/s. The signals on the line have been measured at several locations and it was confirmed that line reflections may be neglected. The longest distance between the central controller and a device is more than 1000 m. It is not easy to make a reliable computation, because the cables from one room to the next are not installed as short as possible. In most cases, the installation of cables is subordinated to other building constructions.

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[2] Zisky, N., Schumny H.: Open Communication with a Fieldbus at Petrol Stations. New Frontiers of Information Technology, Proceedings of 23rd Euromicro Conference, Budapest, IEEE Computer Society. Los Alamito, 1997. ISBN 0-8186-8215-9

[3] http://epsi.berlin.ptb.de

[4] http://www.measurement-bus.de

Robert Patzke received his doctorate in electronic engineering in 1987 from the University of Hannover. He has been heavily involved in fieldbus technology since 1986 and is member of various committees concerned with fieldbus standardization. He takes care of the Measurement Bus (DIN 66348) in CENELEC TC65CX and in various German committees. Since 1988 he is senior manager of a small firm producing measurement and fieldbus equipment, first and foremost for Measurement Bus, Interbus S and Profibus. He is board member of ADM, the ***Measurement Bus User Group*** and in that function he is presenting Measurement bus at FieldComms UK.