



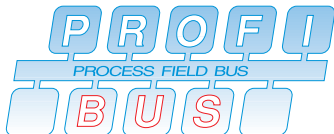
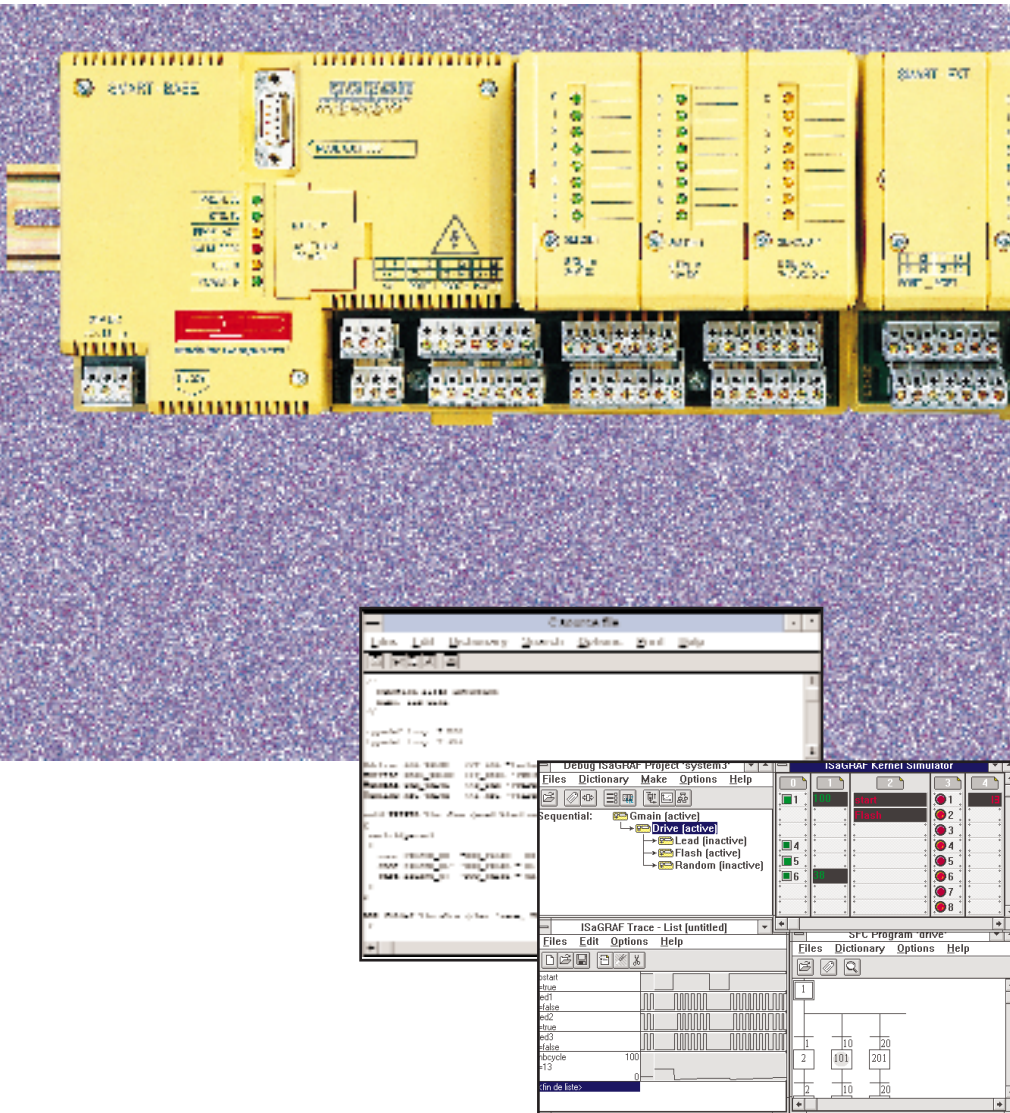
COMPLETE
OPEN
SYSTEMS

SMART I/O

Micro PLC and Real-Time Computer

Power Computation and Communications Performance

- ▶ A PLC based on Real-Time Computer Technology
- ▶ Distributed Intelligent I/O System
- ▶ Programmable with all 5 IEC1131-3 Languages
- ▶ Application SW compatible with VME and IUC Systems
- ▶ Programmable in ANSI-'C'
- ▶ Embedded Real-Time O/S with Multitasking ability
- ▶ Reduced Cabling and Maintenance costs
- ▶ Standard and Extended Operating Temperature ranges



The Smart I/O concept is based on a cost effective open system for industrial automation and real-time computing. Derived from the PEP VME 3U technology, SMART I/O is 100% application software compatible with VME9000 and IUC9000 controllers.

Approved by the
Deutsche Bundesbahn



Reg. No. 0548 - 02



Modular Computers®

Ordering Information

SMART I/O



Product	Description	Order No.
SMART-BASE	Micro-PLC and real-time computer with 1 MByte EPROM, isolated 24-bit counter/timer, OS-9 v3.0.x, ISaGRAF v3.0.x, RS485 9-pin D-Sub connector for PROFIBUS v3.12, layer 2 & 7. Full Modem RS232 (8-pin RJ45 connector,) housing and screw terminal block for the main power supply and battery	14817
SMART-BASE	As product 14817 but with additional 1 MByte FLASH memory on the solder side. (2 MByte for application code)	14818
SMART-EXT	Extension carrier module with 2 slots for SMART-Modules	4228
SM-SCR-2x3	For the SMART-BASE Timer I/O. Pack of 5, 2 x 3 array	10892
SM-SCR-2x7	For the SMART-Modules. Pack of 5, 2 x 7 array	10893
SM-DUMMY FP	For unused SMART-Module slots, available in packs of 20	10894
SM-BATTERY	3V, 190 mAh piggyback for standard operating temperature range (0°C to +70°C)	11281
SM-BATTERY E2	3V, 850 mAh piggyback for extended operating temperature range (-40°C to +85°C)	11282
CABLE RS232-9	3 metres with 9-pin D-Sub (female) and RJ45 connectors for PC	10890
CABLE RS232-M	3 metres with 25-pin D-Sub (male) and RJ45 connectors for Modem	10891
MAN-SMARTIO	Hardback technical user's manual with detailed SMART-BASE, SMART-EXT and SMART-Module information	9901
MAN-SMARTIO	Updated handbook showing amendments to the SMART I/O family	12916

Important: The DC/DC converter of the SMART-BASE is capable of supplying 6.75 W (max.) for the internal 5V supply to power the Counter/Timer, SMART EXT modules and the isolated Profibus interface. It is possible to drive the SMART-I/O system to the limit of its capability but it is advisable to build a configuration where the worst case total value stays below the limit. The power consumption of individual modules depends on the activity taking place at the time and therefore an accurate figure cannot be guaranteed. An empty SMART-BASE unit consumes a maximum of 1700mW. PEP has allowed a nominal consumption of 300mW for each SM-Module slot. If that limit is exceeded, the maximum number of SM-Modules must be reduced. Refer to the data-sheets of these SMART-Modules to gain a better estimate of the power consumption and their operational capabilities.

Application Areas

- ▶ Industrial Computing
- ▶ Industrial Process Control
- ▶ Data Logging
- ▶ Flexible Loop Control
- ▶ Transportation/Railway
- ▶ Fuzzy-Logic Control
- ▶ Construction Automation
- ▶ Factory Automation
- ▶ Modem Controlled Applications
- ▶ Power Plant Control
- ▶ Environmental Control
- ▶ Water Treatment Plant Control
- ▶ Intelligent Distributed I/O



PROFIBUS SMART I/O

PROFIBUS is an open standard (DIN 19245) fieldbus network, enabling devices from various vendors (more than 150 worldwide) to be interoperable.

As it is based on the real-time capable asynchronous tokenbus principle, PROFIBUS can achieve data transfer rates of up to 500 kbit/s multi-master, multi-slave or hybrid topologies.

PEP's SMART I/O concept conforms in full to the OSI reference model supporting layer 2, the data layer and layer 7, the application layer. This latter layer communicates via the Application Layer Interface (ALI). Object orientated integration of a Virtual Field Device (VFD) includes communication objects entered into Object Dictionaries and manipulated by application services. PROFIBUS distinguishes between confirmed and unconfirmed services (broadcasts and multicasts).

Layer 2/7 Programming

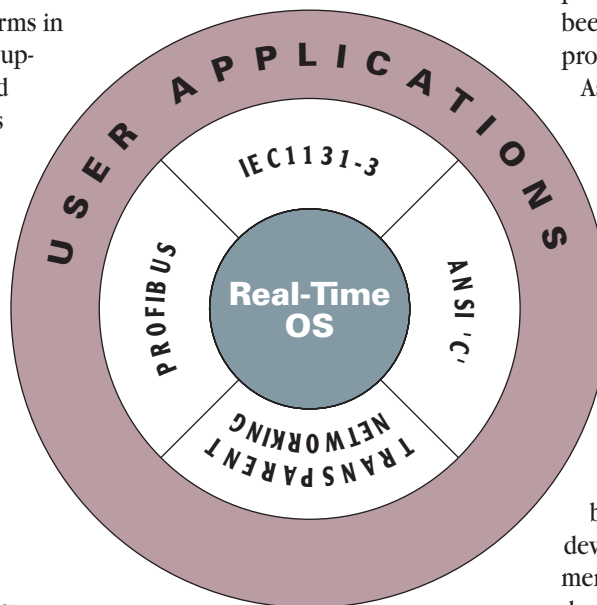
- ▶ LLF: The Lower Layer Function allows access to all services and data structures.
- ▶ HLF: The Higher Layer Function allows fast and easy programming with ready to use sub-routines for basic services.

Refer to the PEP PROFIBUS data sheet for further information.

OS-9 Operating System SMART I/O

Microware's OS-9® is a modular operating system providing deterministic, high performance operations for 680x0 applications.

Its powerful features make OS-9 the optimum real-time target for industrial, scientific, medical, telecommunications and consumer electronic applications.



Real-time features include task switching, process execution control, flexible interrupt service routines (ISRs) and fast interprocess communication facilities.

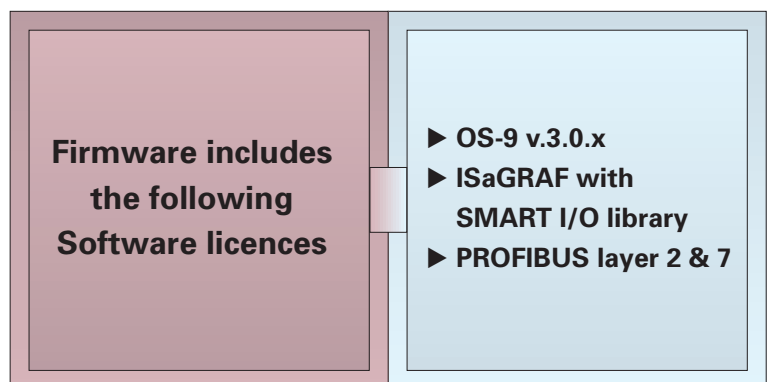
The OS-9 kernel's multitasking services include priority based task scheduling, dynamic memory allocation together with complete interrupt exception and task management facilities. Interprocess communication options include alarms, events, binary semaphores, data modules, signals, pipes and sockets.

Having an excellent and long term partnership with Microware, PEP has been able to port and adapt its own products to Microware's OS-9 V3.0.x.

As a result, PEP can offer a wide range of OS-9 products running on its own hardware with adequate OS-9 support. It offers full application software compatibility with VME and IUC systems.

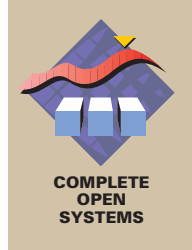
Based on an open system protocol, PEP's SMART I/O concept allows the user the freedom to define and develop his own end applications. OS-9 based applications can be easily developed using PEP OS-9 development systems or the FasTrak cross-development environment.

Refer to the PEP OS-9 data sheet for further information.



Product Overview

SMART I/O

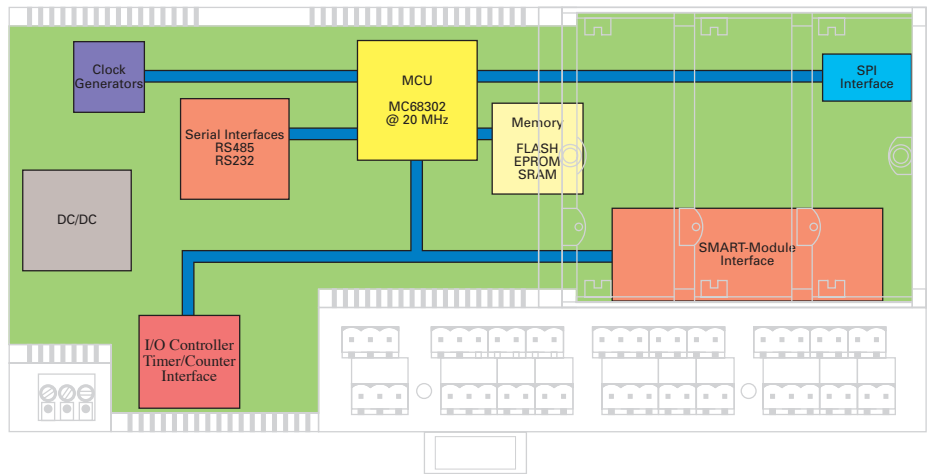


Using the standard ISaGRAF® workbench for IEC 1131-3 PLC programming languages and the Ultra C compiler for ANSI-'C' real-time programming, SMART I/O can be used as a micro PLC as well as a real-time, multitasking system.

SMART I/O is equipped with PROFIBUS, the industry standard real-time fieldbus. This allows the SMART I/O to be used in a fully transparent real-time network architecture enabling open communications between PEP systems and third party devices and MMI. Fieldbus systems such as Profibus, facilitate not only I/O handling and inter-system communications, but also file transfer, remote login and remote debugging facilities.

Intelligent I/O subsystems, such as PEP SMART I/O, act as local controllers attached directly to electro-mechanical devices. Consequently, design, maintenance and cabling are quicker, simpler and cheaper.

SMART I/O communicates with other systems by object oriented methods. In intelligent I/O sub-systems, the only fieldbus traffic is data exchange; for example, SETPOINTS, FLAGS, synchronization messages, START/STOP commands, etc. The advantage of SMART I/O technology over DUMB remote I/O technology is a clear network. The latter, in which the fieldbus is controlled by a centralized CPU, results in an overloaded network.



The SMART I/O core is Motorola's MC68302 CPU with two on-chip processors. One is the 20MHz industry standard 68HC000, while the second is a communications oriented RISC processor. Fieldbus protocols use the power of this RISC CPU, freeing the 68HC000 for application tasks. In addition, the 68302 includes an SIB (System Integration Block), consisting of 3 serial channels, 3 timers and an interrupt controller.

This micro PLC with an unprecedented memory size, smoothes the application of efficient programming tools, such as ISaGRAF (IEC1131-3 automation development system), as well as real-time operating systems and their environments (ANSI-'C', multitasking, networking, etc).

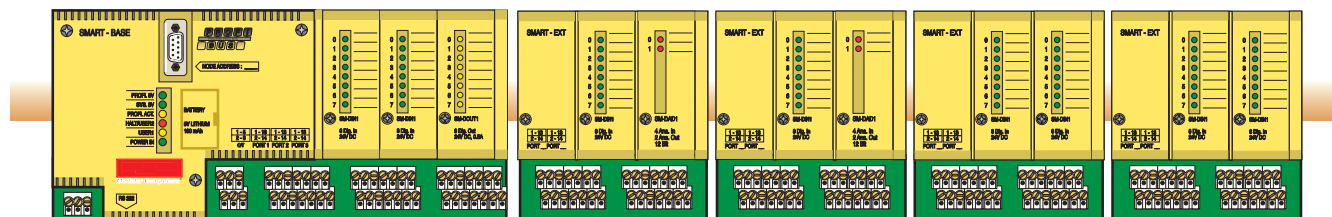
The SMART I/O concept is engineered around a SMART-BASE module, including a DC/DC converter and CPU core. Input and Output are realized by the addition of up to four cascaded

SMART-EXT extension modules which increase the I/O capacity of the system.

The SMART-BASE possesses 3 connectors for SMART MODULES. Each slot provides eight bidirectional TTL digital lines and a 3-wire SPI (Serial Peripheral Interface) line, with one of the digital lines generating an interrupt to the CPU. SMART-MODULES can be either DIGITAL I/O, ANALOG I/O or COUNTER I/O. Custom modules are easily developed due to an OPEN interface specification.

Each SMART-EXT supports up to 2 SMART MODULES each possessing 8 digital lines and an SPI line. To achieve a common interface between modules, a SMART I/O SPI port 'C' library is provided by PEP.

A complete SMART I/O configuration allows up to 11 SMART MODULES to be cascaded.



Complete SMART I/O system example showing 4 fully-equipped SMART-EXT units mounted on a DIN rail

Specifications

SMART I/O

DC-DC Converter

Two isolated (1000V DC) 5V Output Channels
Input 18V-36V DC, 24V DC (Nominal)
Outputs 1 & 2 Isolated 5V DC @ 1.2A (system)
Isolated 5V DC @ 150mA (RS485)

CPU

MC68302 @ 20MHz

Memory

EPROM and/or FLASH up to 2 MByte
512 kByte DRAM
64 kByte SRAM with battery backup

Interfaces

Serial RS232 Modem compatible
Isolated RS485 (PROFIBUS) up to 500 kbit/s
SPI/SPC local interface & RTC
Isolated timer I/O with:
 T_{in} (20 kHz), T_{out} (5 kHz)
Gate (24V DC)

Interrupt Vectors

10ms (100 Hz) IRQ6
24-bit timer IRQ4
Parallel I/O (4 lines) IRQ1

Data Retention

3V, 190mA button lithium cell (standard temperature)
3V, 850mA cylinder lithium cell (extended - E2 temperature)

Housing/Connectors

Housing for DIN-rail mounting
3 slots for SMART-Modules on the SMART-BASE
2 slots for each SMART-EXT
RJ45 for RS232 interface
9-pin D-Sub connector for the RS485 (PROFIBUS) interface

Screw Terminal Connectors

Array 2x3 and 2x7
Mating Cycles 100
Contact Resistance <5m Ω
Max. Amperage 6A
Operating Voltage <250V

Software

OS-9 v3.0x real-time kernel (disk-based as standard)
PROFIBUS layer 2 & 7 v.3.12
IEC 1131-3 with IsaGRAF for Windows

Power Consumption

SMART-BASE: 1500/1700mW
PROFIBUS: 250/750mW
SM-slots: <300mW
SMART-EXT: 15/35mW

Dimensions (mm) l, w, h

SMART-BASE: 247.5 x 114.5 x 86.8
SMART-EXT: 110.0 x 114.5 x 86.6

Operating Temperature

Standard: 0°C to +70°C
Extended: -40°C to +85°C

Operating Humidity

Up to 95% non-condensing

Cooling

Free-air convection

Weights

SMART-BASE: 650g
SMART-EXT: 250g

SMART-Modules Available#

Digital:

SM-DIN1	8 inputs	24V DC
SM-DOUT1	8 outputs	24V DC/0.5A
SM-REL1	6 normally open	relay outputs
SM-ACI1	8 inputs	120/230V AC
SM-ACO1	6 outputs	120/230V AC/0.3A
SM-ACO2	2 outputs	120/230V AC/1.0A

Analog:

SM-DAD1	4 In, 2 out	\pm 10V DC
SM-ADC1	6 inputs	\pm 10V DC/20mA
SM-DAC1	2/6 outputs	\pm 10V DC/20mA
SM-THERM	4 inputs	R, S, B, J, T, E, K
SM-PT100	4 inputs	2, 3 or 4 wire

Counter/Timer:

SM-COUNT1	1 channel	24-bit increm. encoder
SM-COUNT2	2 channel	16-bit counter

Serial Interfaces:

SM-RS232	1 channel	max. 19200 Baud
SM-SSI	1 channel	24-bit, max. 500kHz

ISaGRAF

SMART I/O

IRQ Abilities

SMART I/O

ISaGRAF Introduction

ISaGRAF is a Windows based integrated Computer Aided Software Engineering (CASE) environment. It conforms to IEC 1131-3, the international PLC language standard. All listed languages are included in ISaGRAF together with the option to integrate 'C' code. Programmed applications run on the SMART I/O under the OS-9 real-time operating system. The IEC 1131-3 languages are:

Sequential Function Chart (Grafcet)

This the core language of the IEC 1131-3 standard which divide the process cycle into a number of defined successive steps separated by transitions.

Function Block Diagram

This a graphical language allowing the user to build complex procedures by taking existing functions and function blocks from the ISaGRAF library.

Ladder Diagram

The Ladder Diagram is one of the most familiar methods of representing logical equations and simple actions. ISaGRAF provides a full graphic ladder logic editor.

Structured Text

This is a language with a syntax similar to Pascal but adapted to be more intuitive to the automation engineer.

Instruction List

The Instruction List is a low-level language similar to assembler and is highly effective for smaller applications or for optimising parts of an application.

C Programming

Procedures written in 'C' can be called from any of the five supported languages. On multitasking systems such as OS-9, complete user written tasks can run parallel with the ISaGRAF application. Such tasks could be used for the creation of loop control or mathematic algorithms, communication, Fuzzy logic etc.

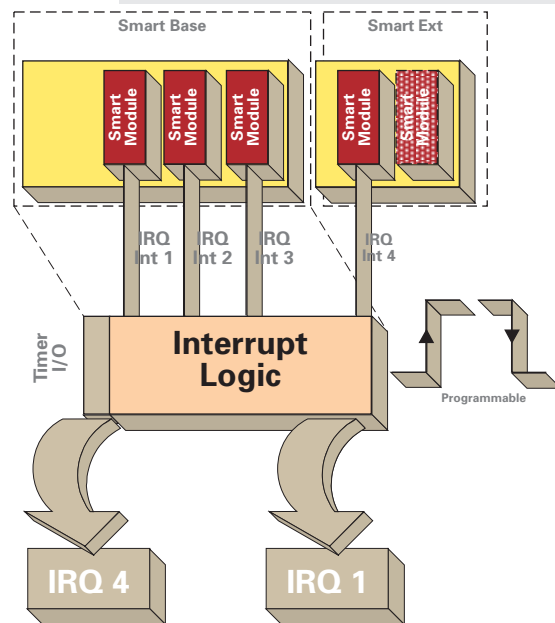
Of the various interrupt sources available, the following are generated on-board:

Tick

The 10 ms tick issues interrupts at level 6.

Power Fail

This non-maskable IRQ on level 7 has the highest priority and is generated when the main 5V supply falls below 4.70V. If the supply falls below 4.65V then the system enters a RESET state.



The Interrupt Logic generates 2 IRQ signals as follows:

Timer

This IRQ source has level 4 priority.

Parallel I/O

These interrupt lines have level 1 priority. Four of the SMART-MODULES (three on the SMART-BASE and the first slot of the first SMART-EXTension), are connected to the interrupt logic configured to generate an interrupt IRQ on level 1.