INTERBUS-S CLUB

PROFILE

Welding Controllers
Device Control C0

Profile: Welding Controllers - Device Control

Profile No.: C0

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Geschäftsstelle
Postfach 23 47, D-67611 Kaiserslautern
Telephone: Germany - 6 31-7 94 24
Fax : Germany - 6 31- 9 76 58

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Preface

Within the framework of factory automation, increasingly powerful and flexible systems are needed in the field of industrial sensors and actuators. Welding controllers can meet these requirements. However, open and standardized communication capabilities are needed to enable their complete integration into complex production sequences.

The basic concept of open systems is to enable an exchange of information between application functions implemented on hardware from a diversity of manufacturers.

These functions include defined application functions, a standard user interface for communications and a standard transmission medium.

To be able to define the device functions of the welding controllers independently of the communication medium, the standardized user interface, DIN 19 245, Part 2, was used for communications. This created compatibility with MMS (Manufacturing Message Specification).

The InterBus-S system, which meets the requirements of sensors and actuators with regard to real-time response and a standardized user interface, was chosen as the communication medium.

The Welding Controller Profile is oriented to the user and manufacturer of welding controllers to be operated on the sensor/actuator bus.

For the user, the WELD COM profile definition is a useful addition to standardized communication and represents a generally valid convention concerning the contents of data and the response of devices. These function definitions standardize a few essential device parameters of a welding controller. Consequently, hardware from different manufacturers exhibits the same response in the communication medium when these standard parameters are used.

In October 1994 the welding controller working group was founded at instigation of the automotive industry. Its objective is to standardize the interface of welding controllers and to communicate all working results to all interested parties.

When the profile was worked out, the principle was followed that future additions to the specification can be incorporated without effects on the standardized functions. In addition, allowance was made for the use of manufacturer-specified functions.

Authors:

Dr. Hamm	AEG, D-Mülheim
Mr. Schaffarra	AEG, D-Warstein-Belecke
Mr. Bethäuser	Audi AG, D-Neckarsulm
Mr. Mangold	BMW AG, D-Landshut
Mr. Erras	BMW AG, D-München
Mr. Cambridge	British Federal Ltd., GB-Dudley
Mr. Scherübl	FASE GmbH, D-Gauting
Mr. Müller	Ford Werke AG, D-Köln
Dr. Karakas	Harms + Wende, D-Hamburg
Mr. Morsk	Harms + Wende, D-Hamburg
Mr. Schnurr	Mercedes Benz AG, D-Bremen
Mr. Höhmann	Mercedes Benz AG, D-Sindelfingen
Mr. Kramer	Mercedes Benz AG, D-Sindelfingen
Mr. Müller	Phoenix Contact, D-Blomberg
Mr. Krumsiek	Phoenix Contact, D-Blomberg
Mr. Siebel	Robert Bosch GmbH, D-Erbach
Mr. Stellwag	Robert Bosch GmbH, D-Erbach
Mr. Appler	SCIAKY GmbH, D-Wiesbaden
Mr. Barrachina	Serra soldadura, s.a., E-Barcelona
Mr. Kaninski	Societe SCIAKY INDUSTRIE, F-Vitry/Seine Cedex

Introduction

The approach toward modularization and decentralization of system functions and system components reduces the complexity of automation solutions and, therefore, their susceptibility to errors; it increases their availability, facilitates maintenance and, therefore, contributes to the improvement of their quality and the reduction of costs.

However, considering welding controllers as separate components in a complete system can only bring about real advantages when certain conditions are met. In this connection, the definition of profiles plays a particular part, as it provides standards between users and suppliers, thus facilitating the interchangeability of software as well as of hardware.

Profiles and standards only stand a chance of being accepted when they equally provide continuity, progress, and future-proof technologies. The conversion of existing solutions to the standard must be possible easily and efficiently; the welding controller standard functions must be efficient and suited to practical use, and there must be sufficient free areas for technical progress and user-specific and manufacturer-specific functions.

This profile defines a device control for welding controllers. This device control makes it possible to control the welding controller by means of a control word and to read out the device status by means of a status word.

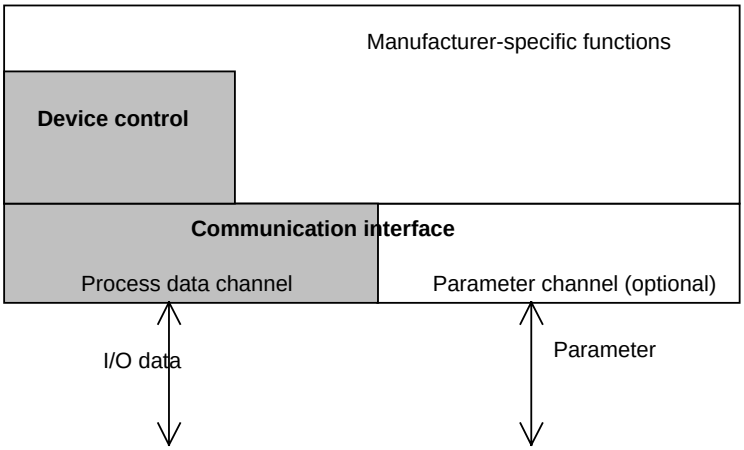

Figure 1: Device architecture

1. Scope

The definitions in this profile are oriented towards the use of welding controllers in a sensor/actuator network. The sensor/actuator network used is InterBus-S. The welding controllers are addressed via the process data channel.

2. References

The definitions for data transmission via the process data channel are based on the InterBus-S Club Guidelines and the draft standard DIN 19258.

This profile is based on the definitions of the Sensor/Actuator Profile 12 (InterBus-S Club e.V.).

3. Terms

3.1. General Terms

3.2. Communication-Specific Terms

InterBus-S

The InterBus-S sensor/actuator network is a digital, serial communication system for communication between a controller (e.g. programmable logic controllers, PLCs) and devices for the complete area of industrial sensors/actuators. This includes devices ranging from very simple limit switches and valves to sensors, transducers, actuators and even highly complex high-tech controls such as controlled drives, controllers for wrenching controllers, process controllers, welding controllers, etc.

Device Profile

The device profile defines the application functions that are visible through communication. The application functions are mapped onto communication by the following definitions:

- by the communication profile,
- by interaction between the application functions, insofar as they are executed through the communication system,

and

- by the communication services used, and the communication objects that can be manipulated with them.

The result of this mapping is the visible response of the application. The definitions contained in an application profile enable interoperability in a field of application if permitted by the device characteristics used.

Characteristics of devices significant to the user are also defined.

A distinction is made between mandatory functions, optional and manufacturer-specific device functions, and parameters.

If users restrict themselves to the mandatory functions or parameters, interchangeability of devices is possible if this is permitted by the device characteristics and settings used. With respect to communication, and regardless of the function, devices are always interchangeable if use is made of the same parameters.

Communication Profile

In relation to the specific application or hardware group, the communication profile limits or classifies the degrees of freedom contained in the specification of the data transmission medium. The communication profile defines communication services and parameters that are identified in the specification as being optional.

The profile also limits or defines value ranges of attributes and parameters.

The communication medium is InterBus-S.

Sensor/Actuator Profile

The Sensor/Actuator Profile is the basis for all devices with a server functionality. This profile contains the basic functions that every sensor and actuator must provide to a user. These are mainly the communication functions and the device information. All profiles for InterBus-S such as the Motion Control, Encoder and Process Controller Profiles are based on the Sensor/Actuator Profile.

Process Data Channel

The process data channel is used for a quick transfer of process data. The process data channel transfers data in an unacknowledged and equidistant form. Process data can be both read and written.

The direction specified for the process data is viewed from the bus, i.e.,

- Process output data is data transferred from the controller system to the device. The device reads this data from the process data channel and outputs it to the process.

- Process input data is data transferred from the device to the controller system. The device writes this data to the process data channel, thus transferring it to the controller system.

Parameter Channel

The parameter channel services allow an acknowledged access to all device parameters, i.e. the access to a device parameter is acknowledged by the device.

Index, Subindex

The index is used for addressing a parameter (communication object). The subindex addresses a subparameter (element of a communication object) within a parameter established as a structure.

State Machine

Some functions are described in this profile with the aid of a state machine. A state represents a specific internal and external response. It can only be terminated by means of defined events. Corresponding state transitions are assigned to events. Actions can be executed at a transition. The response of the state is changed at the transition. When the transition is ended, the current state is followed by the new state.

4. Abbreviations

CRC	Cyclic redundancy check
EOS	End of sequence
ID code	Identification code
m	mandatory
o	optional
PD channel	Process data channel
PLC	Programmable logic controller
RC	Robot controller

5. Device Characterization

5.1. Device Data

This profile defines a 16-bit control word and a 16-bit status word for the first two bytes of the process data channel for the welding controller. The length of the process data channel is manufacturer-specific which allows to select a larger value.

6. Application and Device Characteristics

6.1. Diagnostic Indicators

As the welding controller is implemented as a remote bus device, diagnostic indicators are required to indicate the network status in accordance with the Sensor/Actuator Profile 12.

6.2. Device Control

The device control is influenced by the control word, by internal signals and by malfunctions. Device control affects the welding controller functions. The status word is generated from the device state and internal signals, and can be read out via the bus.

6.2.1. Device States

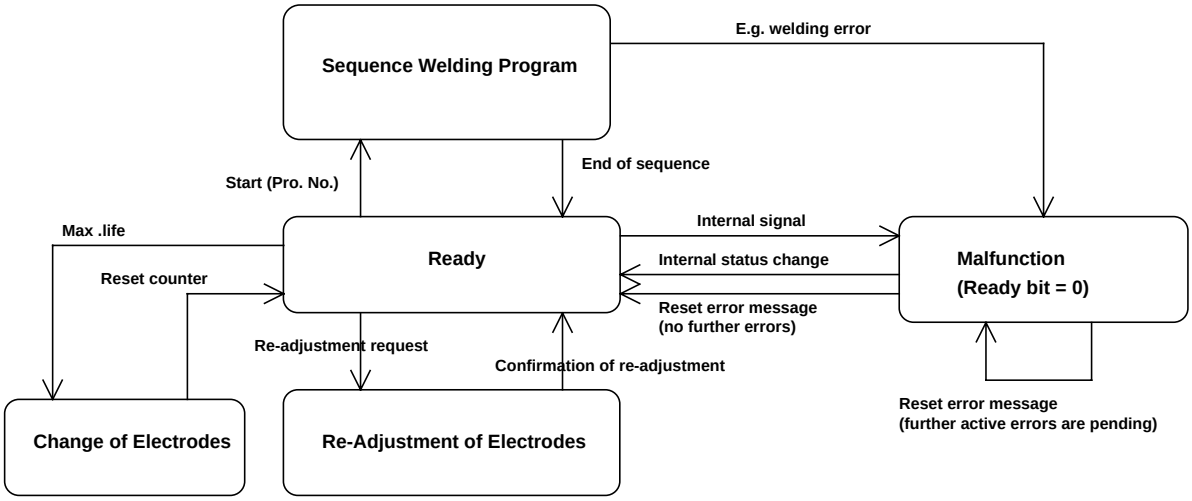

Figure 2: Device states

Ready

The sequence of a welding process can be activated with "Start".

Sequence Welding Program No.

The welding sequence is carried out with the parameter record which is defined by the welding program no.

Malfunction

If the welding controller detects a malfunction it automatically changes to the malfunction state. The welding controller can exit this state automatically or with the "Reset Error Message" confirmation. In each case, no error must be pending.

Change of Electrodes

It is necessary to change the electrodes. After the change the welding controller must be notified of this change.

Re-Adjustment of Electrodes

It is necessary to re-adjust the electrodes. After the re-adjustment the welding controller must be notified of the re-adjustment of the electrodes.

6.2.2. Control Word

Control word:

Bit	Meaning	m/o		
0	Start	m	from RC	in addition as an input contact
1	Confirmation of re-adjustment	o	from RC	
2	Free			
3	Reset counter	m	from PLC	
4	Reset error	m	from PLC	
5	Error reset no	o	from PLC	
6	Error reset no.	o	from PLC	
7	With welding current	m	from PLC	
8	Welding program no.	m	from RC	
9	Welding program no.	m	from RC	
10	Welding program no.	m	from RC	
11	Welding program no.	m	from RC	
12	Welding program no.	m	from RC	
13	Free			
14	Free			
15	Free			

Start

With the change from 0 -> 1 the welding program no. is accepted and the corresponding sequence is started.

Confirmation of Re-Adjustment

The change from 0 -> 1 indicates that the previously requested re-adjustment has been terminated.

Reset Counter

The wear-out counter of one or several electrodes is reset if bit changes from 0 -> 1. The signal must be pending for at least 10 ms.

Suggestion for implementation:
The electrode is selected with the selection no. The selection no. = 0 means that all counters are reset.

A different implementation must be described by the manufacturer.

Reset Error Message

All error message which are no longer pending are reset depending on the "Error Message Reset No." if the bit changes from 0 -> 1. The signal must be present for at least 10 ms.

Reset Error Message No.

These bits define the response to the "Reset Error Message" signal.

Reset error message no.	Meaning
0	Reset error message
1	Reset error message with EOS
2	Reset error message and repeat sequence
3	Manufacturer-specific

Reset error message:
All error messages which are no longer pending are reset without any further response of the welding controller.

Reset error message with EOS
All welding process error messages which are no longer pending are reset. As long as the start signal is still pending, the EOS signal is additionally output.

Reset error message and repeat sequence
All welding process error messages which are no longer pending are reset. The last welding sequence will be repeated.

With Welding Current

Bit = 1:
The welding sequence is to be carried out with welding current, i.e. by driving the power circuit.

Welding Program No.

With the welding program no. the parameter set is selected that is to be executed with "Start".

6.2.3. Status Word

Status word:

Bit	Meaning	m/o		
0	End of sequence	m	to RC	in addition as an output contact
1	Request of re-adjustment	o	to RC	
2	Prewarning	m	to PLC	
3	Max. life reached	m	to PLC	
4	Ready	m	to PLC, PC	
5	Welding error	m	to PLC, PC	
6	Welding process monitoring	o	to PLC, PC	
7	With welding current	m	to PLC	
8	Free			
9	Free			
10	Free			
11	Free			
12	Free			
13	Free			
14	Free			
15	Free			

End of Sequence

In the "single spot" operating mode this bit is set to 1, provided that the welding sequence was terminated without errors.

Request of Re-Adjustment

If the bit = 1, the welding controller requests a rework of the electrodes. The bit is set to 0, when the re-adjustment is confirmed with the "Electrode Re-Adjustment Terminated" signal.

Prewarning

Bit =1:
An electrode reached the set value for prewarning of the "Max. Life".

Max. Life Reached

The max. life of an electrode is reached. The bit is set to 0 if the corresponding counter was reset.

Ready

Bit=1
The welding controller is ready to carry out a welding sequence.

Bit=0
The welding controller is not ready to carry out a welding sequence. There is an error.

Welding Error

Bit=1:
A welding process error occurred during the last welding sequence. After "Reset Error Message" the bit is set to 0.

Welding Process Monitoring

Bit=1:
The welding process is monitored. The bit is only changed when a welding sequence is started.

With Welding Current

Bit=1:
The welding sequence is carried out with welding current , i.e. by driving the power circuit.

Mapping the Device Functions onto Communication

Mapping onto the PD Channel

Process Data Channel of a Welding Controller:

	Byte 0	Byte 1	Byte 2	Byte 3	...	...
IN	Control word		Manufacturer-specific		...	
OUT	Status word		Manufacturer-specific		...	

7. Operating Phases of the Application

This section describes the possible operating phases of the device. The section is broken down as follows:

- Initialization/abort
- Operation.

7.1. Initialization/Abort

Initialization

Initialization is started after power on or a reset of the device.

The device carries out the following:

- Configuration of the process input and output data
- Initialization of the process data

The process input and output data registers are preset with zeros.

Abort

The device carries out the following:

- A reset of the process data

If the communication and the welding controller are independent of each other, the process input data is set to zero when the device fails.

7.2. Operation

The following function is active in the "Operation" phase:

- Device control

8. Communication Profile

8.1. Layer 1

This section describes the defined the interface to the transmission medium.

The remote bus interface in accordance with the Sensor/Actuator Profile 12 is selected for welding controllers.

8.2. Layer 2

This section describes all definitions concerning Layer 2.

8.2.1. Configuration of the InterBus-S Registers

See Sensor/Actuator Profile 12

8.2.2. Identification of the InterBus-S Devices

The ID register consists of the following:

b15 b13	b12 b8	b7 b0
Message	**Data width**	**ID code**

Message

These bits in the ID register are used to transfer messages to the controller board.

Table 1: Messages

b 15	b 14	b13	Meaning
1	x	x	Device message
x	1	x	CRC error
x	x	1	Reserved

Device message
This message is generated when the device detected a malfunction of the periphery.

CRC error
This message is generated when transmission errors have been detected (by the protocol chip).

Data Width

The data width indicates how many bits the device uses on the bus. If a device has, for example, 16-bit inputs and 32-bit outputs, it occupies 32 bits (4 bytes) in the ring (the higher value is decisive). The length of the parameter channel is defined in the ID code.

Table 2: Data width

Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Data width
0	0	0	0	1	2 Bytes
0	1	0	1	1	3 Bytes
0	0	0	1	0	4 Bytes
0	0	0	1	1	6 Bytes
0	0	1	0	0	8 Bytes

ID Code

The following ID code is defined for welding controllers:

Description of the device function		**ID Code (dec)**	**ID Code (hex)**
Profile-conforming digital devices with I/O addresses	PROFILE DIO	47	2F

8.3. Layer 7

The parameter channel is not supported.

Appendix Application Areas and Networking Concepts of Welding Controllers

Welding controllers, for instance, are used in systems with the following configuration:

Number	Device type	I/O Data
1	PLC (30 ... 100 ms cycle time)	
1	PC	
12	Welding controllers	20 IN/10 OUT
8	Robots	48 IN/OUT
4	Valve terminals	16 OUT
1	Wrenching controller	16 IN/OUT
	Switch cabinets	300 IN/OUT
2	Servos/frequency inverters	16 IN/OUT
2	Operator panels	64 IN/OUT
1	Stud welder	16 IN/OUT

The communication relationships in such systems are as follows:

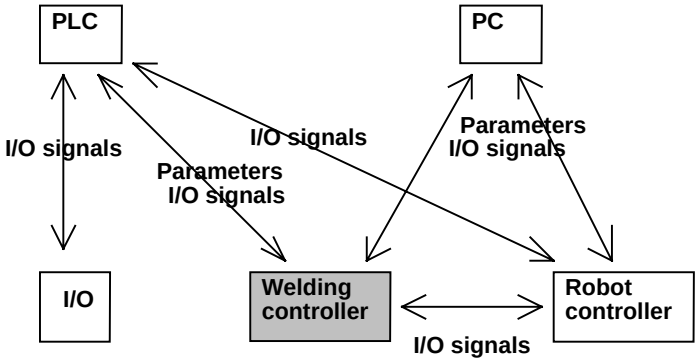

Figure 3: Communication relationships

Networking Concept

In typical systems the I/O signals are transmitted within 6 ms to the PLC. Lateral communication of I/O signals (via the bus master), for instance to the robot controller, takes place in 18 ms.

In order to transfer large amounts of data (e.g. 100 kbytes) from the PC to every welding controller, a network with a short cycle time between PC and PLC should be installed.

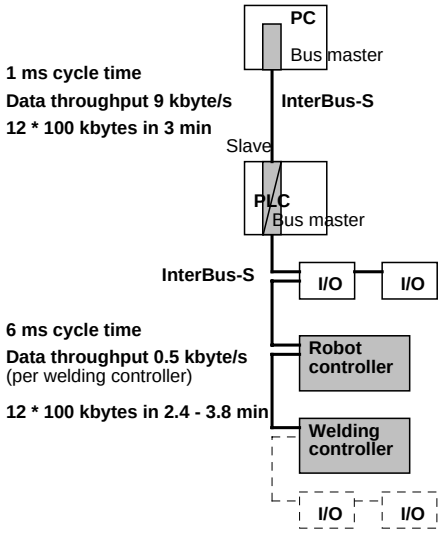

Figure 4: Welding controller as a slave, directly controlled by the PLC

If the robot controller together with the associated I/Os and the welding controller is to be operated independently without a PLC, the already installed sub-system can be directly taken into operation with the PC being the bus master.

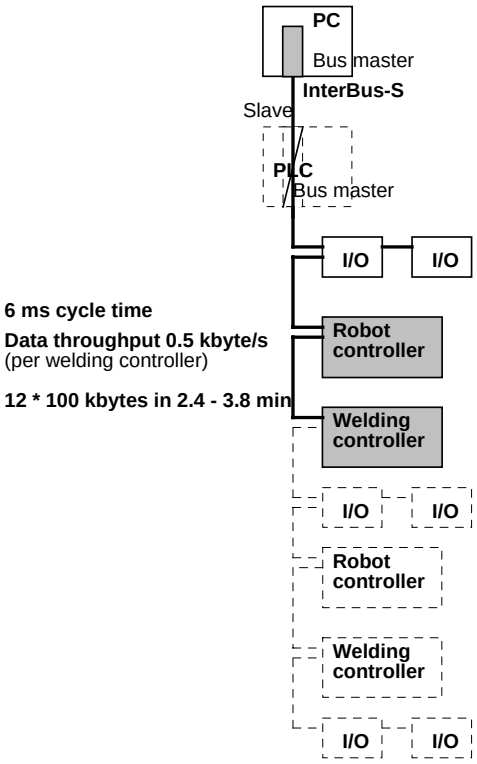

Figure 5: Partial startup with the PC being the bus master

Robot Controller with Bus Master for Welding Controllers

If the robot controller with the associated I/Os and the welding controller is to be operated independently without a PLC, the robot controller is equipped with a bus master.

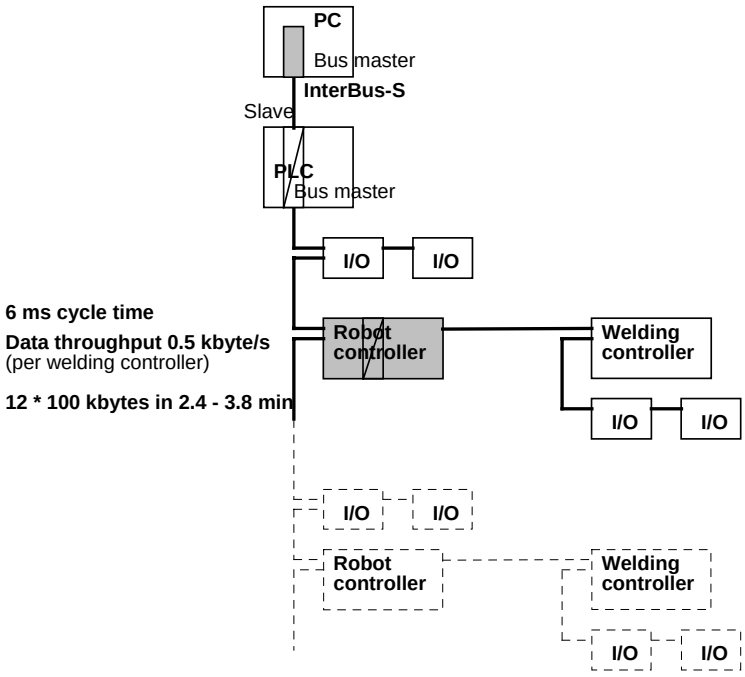

Figure 6: Partial startup with the robot being the bus master