Rexroth
Bosch Group

Rexroth PSx 6xxx.624
Timer and I/O Level

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Edition 02

Technical Information

Title

Rexroth PSx 6xxx.624
Timer and I/O Level

Type of Documentation

Technical Information

Document Typecode

DOK-PS6000-E/A624*****-FK02-EN-P

Purpose of Documentation

The content of this manual refers to

- the mechanical structure
- the electrical connection (24 V supply and I/O) and
- the functionality

of the PSI/PST integrated weld timer.

Record of Revisions

Description	Release Date	Notes
DOK-PS6000-E/A624*****-FK01-EN-P	08.2003	
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Validity

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Notes:

1 Safety Instructions

The products described were developed, manufactured and tested in compliance with the fundamental safety requirements of the EU machinery directive. These products normally pose no danger to persons or property if used in accordance with the handling stipulations and safety notes prescribed for their configuration, mounting, and proper operation.

Nevertheless, there is some residual risk!

Therefore, you should read this manual before installing, connecting or commissioning the products or programming the welding system.
Store this manual in a place to which all users have access at any time!

The content of this manual refers to

- the mechanical structure
- the electrical connection (24 V supply and I/O) and
- the functionality

of the PSI/PST integrated weld timer.

The - according to the type of the product - integrated power supply units have their own manuals. They complete this manual!

★ Therefore, please pay attention to the following documentation as well:

- For PST 6xxx:
  Thyristor power unit, technical information (1070 080 059)
- For PSI 6xxx:
  Medium-frequency inverters, technical information (1070 080 058)

1.1 Possible Safety Markings on the Product

Warning of dangerous electrical voltage!

Warning of hazards associated with batteries!

Electrostatically sensitive components!

Lug for connecting PE conductor only!

Function ground, ground with low parasitic voltage

Connection of shield conductor only

1.2 Safety Instructions in this Manual

DANGEROUS ELECTRICAL VOLTAGE
This symbol is used to warn of **dangerous electrical voltage.** The failure to observe the instructions in this manual in whole or in part may result in **personal injury**.

DANGER
This symbol is used wherever insufficient or lacking compliance with instructions may result in **personal injury**.

CAUTION
This symbol is used wherever insufficient or lacking compliance with instructions may result in **damage to equipment or data files**.

☞ This symbol is used to draw the user's attention to special circumstances.

★ This symbol is used if user activities are required.

Modifications in this manual as compared to a previous edition are marked by black vertical bars in the margin.

Safety Instructions

1.3 Intended Use

The product described

- serves in connection with a welding transformer and the appropriate power supply unit for
  - resistance welding of metals

  and
- is suitable for operation in industrial environments in accordance with the following standards:
  - EN 50178
  - EN 50081-2
  - EN 50082-2
  - EN 60204-1

  In residential environments, in trade and commerce as well as small enterprises class A equipment may only be used if it does not inadmissibly interfere with other equipment.

It is not intended for any other use!

DANGER
Any use other than for the purpose indicated may result in personal injury of the user or third parties or in damage to equipment, the workpiece to be welded, or environmental damage.
Therefore, our products must never be used for any other than their respective intended purpose!

☞ **For operation in residential environments, in trade and commercial applications and small enterprises, an individual permit of the national authority or test institution is required; in Germany, please contact the Regulierungsbehörde für Telekommunikation und Post (RegTP) or its local branch offices.**

The faultless, safe functioning of the product requires proper transport, storage, assembly and installation as well as careful operation.

1.4 Qualified Personnel

The requirements as to qualified personnel are based on the requirement profiles defined by the ZVEI (Zentralverband Elektrotechnik und Elektronikindustrie - German Electrical and Electronic Manufacturers' Association) and the VDMA (Verband deutscher Maschinen- und Anlagenbau - German Engineering Federation) in:

Weiterbildung in der Automatisierungstechnik
edited by: ZVEI and VDMA
Maschinenbau Verlag
Postfach 71 08 64
D-60498 Frankfurt.

This manual is designed for technicians and engineers with special welding training and skills. They must have a sound knowledge of the software and hardware components of the weld timer, the power supply used, and the welding transformer.

Project engineering, programming, start and operation as well as the modification of program parameters is reserved to properly trained personnel! This personnel must be able to judge potential hazards arising from programming, program changes and in general from the mechanical, electrical, or electronic equipment.

Interventions in the hardware and software of our products, unless described otherwise in this manual, are reserved to specialized personnel. Tampering with the hardware or software, ignoring warning signs attached to the components, or non-compliance with the warning notes given in this manual can result in serious bodily injury or property damage.

Only skilled persons as defined in IEV 826-09-01 (modified) who are familiar with the contents of this manual may install and service the products described.

Such personnel are

- those who, being well trained and experienced in their field and familiar with the relevant standards, are able to analyze the work to be carried out and recognize any hazards.
- those who have acquired the same amount of expert knowledge through years of experience that would normally be acquired through formal technical training.

DANGER!
An exception are persons with cardiac pacemakers!
The strong magnetic fields occurring in resistance welding may affect the proper functioning of pacemakers. This may be fatal or cause serious personal injury!
Therefore, persons with pacemakers must stay clear of resistance welding systems.
We recommend that warning sings as per DIN 40023 are posted at every entrance to manufacturing shops housing resistance-welding equipment.

Safety Instructions

No entry for persons with cardiac pacemakers!
Danger!

Please note our comprehensive range of training courses. More information is available from our training center (Phone: +49 (6062) 78-258).

Safety Instructions

1.5 Installation and Assembly

DANGEROUS ELECTRICAL VOLTAGE
Danger of life during installation work while systems are switched on!
Make sure that all plant sections undergoing operations during the installation are de-energized and sufficiently protected against accidental reclosing!

DANGER
Non-workmanlike installation or mounting may lead to personal injury or damage to property.
Therefore, it is essential that you take the technical data (environmental conditions) into account for installation or mounting.
Installation or mounting must be carried out by skilled personnel only.

DANGER
Insufficient degree of protection may be life-threatening or cause damage to property!
The degree of protection of the products described is IP 20.
They must be installed in switchgear cubicles providing a degree of protection of no less than IP 54.

DANGER
Danger of injury and of damage to property through incorrect installation!
Devices and, in particular, operating means, must be installed so as to be properly safeguarded against unintentional operation or contact.

DANGER
Danger of personal injury and damage to property through inadequate fastening!
The place for installing the modules, and their method of fastening, must be suitable for their weight!

DANGER
Injuries and bruises may be caused by lifting weights which are too heavy or by sharp metal edges!
Due to the heavy weight of individual modules several persons are required for installation and assembly.

Safety Instructions

DANGER
The safety and accident prevention regulations as amended shall be observed!
Wear a protective helmet, safety shoes and gloves!

CAUTION
Short circuits!
When cut-outs are drilled or sawed in switchgear cubicles, metal burr may get into modules already installed there. Or, when cooling water lines are connected, water may leak into the modules installed.
The possibility of short circuits occurring in the process or even the destruction of the devices cannot be entirely ruled out.
Therefore, guard any existing modules well before you install a new module! Any and all warranty excluded in case of non-compliance.

CAUTION
Heat accumulation!
Modules must be mounted with a minimum clearance of 100 mm on top and at the bottom. Without this minimum clearance, heat may accumulate and cause inverter failure.

CAUTION
Leaks in the cooling water circuit may cause consequential damage!
Cooling water leaks may damage adjacent components. Therefore, when mounting water-cooled modules, always ensure that other devices in the switchgear cabinet are well protected against leaking cooling water.

CAUTION
Damage to property through insufficient water quality in the possibly required cooling water circuit!
Deposits in the cooling system may reduce the water flow, thus impairing the performance of the cooling system with time.

Therefore, you should ensure that your cooling water has the following properties:

- **pH value : 7 to 8.5**
- **Degree of hardness D_{max} : 10 German degrees**

(1 German degree = 1.25 British degrees = 1.05 US degrees = 1.8 French degrees)

- **Chlorides : max. 20 mg/l**
- **Nitrates : max. 10 mg/l**
- **Sulfates : max. 100 mg/l**
- **Insoluble substances : max. 250 mg/l**

Tap water usually meets these requirements. However, an algicide should be added.

★ For information about dimensions and installation accessories of the product as a whole as well as information about the cooling system, please refer to the manuals of the power supply units (see page 1-1).

Safety Instructions

1.6 Electrical Connection

DANGER
Danger of personal injury and damage to property through missing or false interpretation of fault messages!
Therefore, closing of the transformer temperature contact (thermostatic switch, break contact) must inhibit the connected timer!
As regards fault analysis, see also section 8.

DANGER
Danger of life through inappropriate EMERGENCY-STOP facilities!
EMERGENCY-STOP facilities must be operative in all modes of the system. Releasing the EMERGENCY-STOP facility must by no means result in an uncontrolled restart of the system! First check the EMERGENCY-STOP circuit, then switch the unit on!

CAUTION
Connecting lines and signal lines must be laid so as to avoid negative effects on the function of the units through capacitive or inductive interference!Interference is frequently coupled and decoupled in long cables.
Therefore, power and control cables must be routed separately.
The influence of interfering cables on cables susceptible to interference can be minimized by keeping the following distances:
> 100 mm if cables are run in parallel for < 10 m,
> 250 mm if cables are run in parallel for > 10 m.
The product should be mounted close to the welding systems so as to avoid cable lengths of more than 25 m.

★ In addition, please comply with all safety regulations regarding electrical connections and the EMC of the system as a whole in the manuals of the power supply units (see page 1-1).

★ Make sure that all contact surfaces are bright, i.e. free of paint, plastic coating or dirt/oxidation.

1.7 Operation of the Product

DANGER
In the environment of resistance welding systems, magnetic field strengths have to be expected which are above the limit values specified in VDE 0848 Part 4. Especially if manual guns are used, the limit values for extremities may be exceeded.
In cases of doubt, you should measure the field strength and take additional measures to ensure safety and health at work. Please comply with regulation BGV B11 of the German Berufsgenossenschaft (professional association) "Unfallverhütungsvorschrift elektromagnetische Felder".

DANGER
The strong magnetic fields occurring in resistance welding may affect the proper functioning of pacemakers. This may be fatal or cause serious personal injury!
Therefore, persons with pacemakers must stay clear of resistance welding systems.
We recommend that warning sings as per DIN 40023 are posted at every entrance to manufacturing shops housing resistance-welding equipment:

No entry for persons with cardiac pacemakers!
Danger!

DANGER
Danger of personal injury and damage to property if devices are operated before they have been properly installed!
The devices are designed to be installed in housings or switchgear cabinets and must not be operated unless properly installed and switchgear cabinet doors are closed!

DANGER
Danger of bruises through electrode movement!
All users, line designers, welding machine manufacturers and welding gun producers are obliged to connect output signals which initiate the electrode movement so that the applicable safety regulations are complied with.
For example, by means of ”Two-handed start”, fences, light barriers etc. the risk of bruises can be considerably reduced.

CAUTION
Overheating through inappropriate or insufficient cooling.
The temperature inside the housing must stay within the specified range.
Air-cooled medium-frequency inverters must always be operated under forced-air cooling conditions. Convection cooling will not be sufficient!
Water-cooled medium-frequency inverters may only be operated when the cooling water circuit is active! Condensation on water-carrying components must be prevented.

1.8 Retrofits and Modifications by the User

DANGER
Modifications to the product may have negative effects on the safety of the unit!
The possible consequences include death, severe or light injury (personal injury), damage to property or environmental hazards.
Therefore, please contact us prior to making any modifications. This is the only way to determine whether changes can be made without any problems.

1.9 Maintenance, Repair

DANGEROUS ELECTRICAL VOLTAGE
Prior to any maintenance work - unless described otherwise - the system must always be switched off and sufficiently secured!
In the event of necessary measurement or test procedures on the active system, these have to be performed by skilled electrical personnel.

Safety Instructions

DANGER
Lithium batteries can cause skin burns or explode in case of improper handling!
Therefore, do not forcefully open batteries, do not attempt to charge or heat up batteries over 100°C!

CAUTION
Please use only spare parts approved by us!
Use only original replacement batteries! In any case, spent batteries and accumulators should be disposed of as hazardous waste!

CAUTION
Danger to the module!
All ESD protection measures must be observed when using the module! Prevent electrostatic discharges!

The following protective measures must be observed for modules and components sensitive to electrostatic discharge (ESD)!

- Personnel responsible for storage, transport, and handling must have training in ESD protection.
- ESD-sensitive components must be stored and transported in the prescribed protective packaging.
- ESD-sensitive components may only be handled at special ESD-workplaces.
- Personnel, working surfaces, as well as all equipment and tools which may come into contact with ESD-sensitive components must have the same potential (e.g. by grounding).
- Wear an approved grounding bracelet. The grounding bracelet must be connected with the working surface through a cable with an integrated 1 MΩ resistor.
- ESD-sensitive components may by no means come into contact with chargeable objects, including most plastic materials.
- Beim Einsetzen von EGB in Geräte und bei ihrer Herausnahme muß das Gerät spannungsfrei sein.

Safety Instructions

1.10 Working Safely

DANGER
If the start signal is present on fault reset (acknowledge), the weld timer immediately starts the program sequence! Hazardous machine movements may be the result!
Therefore, before fault reset, you should make sure that there are no persons in the danger zone of the welding equipment!

DANGER
During operation of the welding equipment welding splashes are to be expected! They may cause eye injuries or burns. Therefore:
- wear protective goggles
- wear protective gloves
- wear flame-retardant clothes

DANGER
Danger of injury from sheet metal edges and danger of burns from weld metal!
Therefore: - wear protective gloves

CAUTION
The strong magnetic fields occurring in the resistance welding process may cause permanent damage to wrist watches, pocket watches, or cards with magnetic stripes (e.g. EC cards).
Therefore, you should not carry any such items on you when working in the immediate vicinity of the welding equipment.

1.11 CE mark

CAUTION
The CE mark for thyristor unit - welding transformer combinations (see section 9) refers to industrial applications.
For other combinations/applications, the certificate must be derived from the above, or a new certificate must be issued, if necessary, by the line designer / user.

Safety Instructions

Notes:

2 Overview

The PS 6000 series combines the following devices in one housing:

- Weld timer and
- Power supply unit.

The integrated weld timer is used for controlling the integrated power supply unit and is suitable for

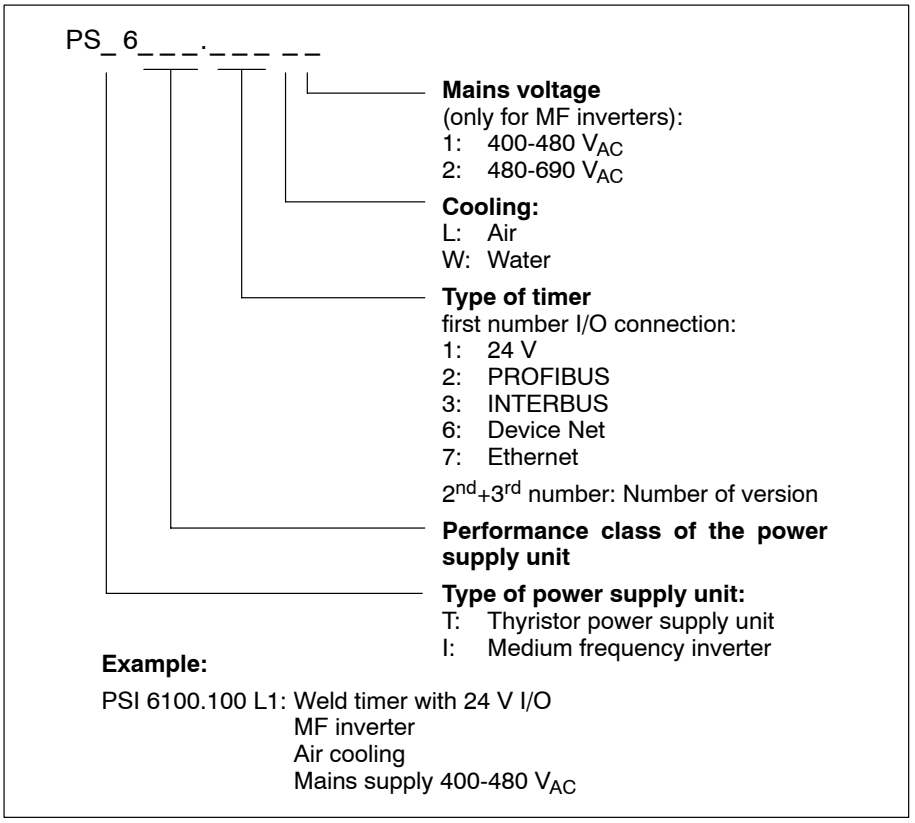
- Spot welding (e.g. in connection with a robot)
- Projection welding
- Repeat mode (e.g. manual welding guns) and
- Seam welding (e.g. roll seams).

In addition to a **variation of timers** whose main differences lie in their I/O connection to the higher-level PLC/robot unit and in their functionality, there are also

different power supply units (MF inverters/thyristor power supply units) with different cooling systems (air/water) of several different performance classes available for controlling the welding transformers.

2.1 Type code

The product name contains information about the corresponding product variation:



Type code of PS 6000 series

Overview

2.2 Features of PS 6000 series

☞ **For information about dimensions, mains connection, cooling or welding current, please refer to the manual of the power supply unit in use (see page LEERER MERKER).**

- User interface for operation, programming and diagnosis:
  - Standard: complete for graphic user interface BOS-5000; runs on PCs with Windows 95/98, NT4, or W2000 operating system.
  - Optional and with limited functions: via operating and diagnostic terminal BT 220 with PLC function (CL500) or BT 6. Connection: via V24.
- Optional access limitation for operation/programming
  - By password (interlocking disk)
- Programming connection to PC (BOS-5000):
  - Standard: for one single timer via V24 (e.g. for programming on location)
  - Optional: contemporary connection of more than on timer via field-bus interface: PROFIBUS-FMS
INTERBUS-PMS
Ethernet
- I/O connection (communication with e.g. robot/PLC):
  Available connections:
  - parallel (discrete I/O wiring)
  - serial (via bus system): PROFIBUS DP
INTERBUS S
DeviceNet
- Number of programs:
  - Maximum of 256 programs; symbolic spot addressing possible. Because of the great number of programs, in most cases it is possible to assign a program to each weld spot.
- Programming of times (depends on integrated power supply unit):
  - AC technology: in line cycles
  - MF technology: in milliseconds
- Universally adaptable welding schedule:
  - 3 programmable weld times (1. WLD: preheating weld time; 2. WLD: weld time; 3. WLD: postheating weld time).
    The welding times can be operated either together in one regulation mode (standard operation) or in different regulation modes (mixed operation).
  - The 1.WLD and 3.WLD can be turned off.
  - Programmable impulse mode for 2. WLD
  - Programmable slope mode (current rise/decay time) for 2. WLD
- Welding operation modes:
  - Spot welding (e.g. in connection with robots)
  - Repeat mode (e.g. in connection with manual guns)
  - Roll seams

Overview

- Half cycle operation
- Regulation modes:
  - PHA (Phase angle)
  - KSR (Constant Current Regulation)

  Mixed operation for individual welding times is possible.
- Current monitoring:
  - Reference currents are programmable independently from the regulation command values
  - Tolerance band in percent, asymmetrically programmable
  - Monitoring in standard and mixed mode possible
- Automatic spot repetition in case of low current
- Time monitoring
- Electrode Management:
  - Stepper function for current (%I stepper)
  - Electrode tipdressing including initial dressing
  - Stepper function for force (stepping of electrode force)
  - Prewarning table with graphic representation of electrode wear
- Proportional valve control:
  - Output signal is high after program selection
  - Analog and digital pressure control
  - Feedback possible
  - Electrode force programming in kN for all welding programs
  - Force scaling for adaptation to the valve characteristic curve
- Force profile:
  - up to 10 different electrode forces can be programmed during the execution of a program
- External weld time termination on half-wave
- Freely programmable output:

  Up to 3 turn-on/-off times can be programmed during the sequence of a program. Serves e.g. to control a back-pressure valve or for weld spot-synchronous preparation of components that are subject to welding.
- Scaling programs:
  - for current (adjustment of the welding device with regard to an external reference ammeter)
  - for force (adjustment of the electrode force with regard to an external reference dynamometer)
- Protocol function (ISO 9000):
  - Error Protocol
  - Weld Fault Protocol
  - Data Change Protocol
  - Weld Current Protocol
- Integrated diagnostic memory

Overview

- Fault allocation:
  - Events are programmable either as errors or warnings.
- Status display of I/O signals in online mode
- %I correction:
  - for selected programs
  - for all programs
  - for selected electrode pairs
- General overview of system for:
  - Start inhibit
  - Weld on internal
  - Time monitoring
  - Current monitoring
  - 2. WLD in PHA/KSR
  - Program-related electrode number
- Upload/Auto-Upload (Data backup)
- Restore (Data restoration)
- Copy of welding programs
- Exchange of timer (data backup and restoration of entire module, including counter content and actual values)
- Start simulation:
  - Program selection and start of schedule can be initialized via GUI
- Available languages:
  - German
  - English
  - NA English
  - Spanish
  - French
  - Swedish
  - Portuguese
  - Italian
  - Hungarian
- Online and offline programming possible
- Prepared for upgrade with an optional quality module or for extension with an optional ultrasonic control board (USR).

2.3 Programming and Operation

All necessary parameters will be stored in the timer's internal battery-buffered RAM.

Operation, programming, and diagnosis are handled via the connected PC. The PC can be either connected via

- the timer's V24 interface (X1) or via
- an optional fieldbus interface (e.g. PROFIBUS).

While the V24 connection allows for access to a single timer only (e.g. programming on location), the fieldbus interface allows for the contemporary connection of more than one timer.

Prerequisites for programming and operation via PC:

- Operating systems Windows95/98, NT4, or W2000
- Software BOS-5000 ("**B**edien**O**berfläche **S**chweißen" = GUI Welding)
- V24 connecting cable or in case of fieldbus interface corresponding installation.

☞ **For detailed information about BOS-5000, please refer to the BOS-5000 manual.**

☞ **With regard to time programming, PSI and PST differ from each other:**
PSI: spacing in 1 ms
PST: in line cycles
(at 50 Hz: 1 line cycle corresponds to 20 ms)
(at 60 Hz: 1 line cycle corresponds to 16.6 ms)

The timer can be programmed "online" as well as "offline".

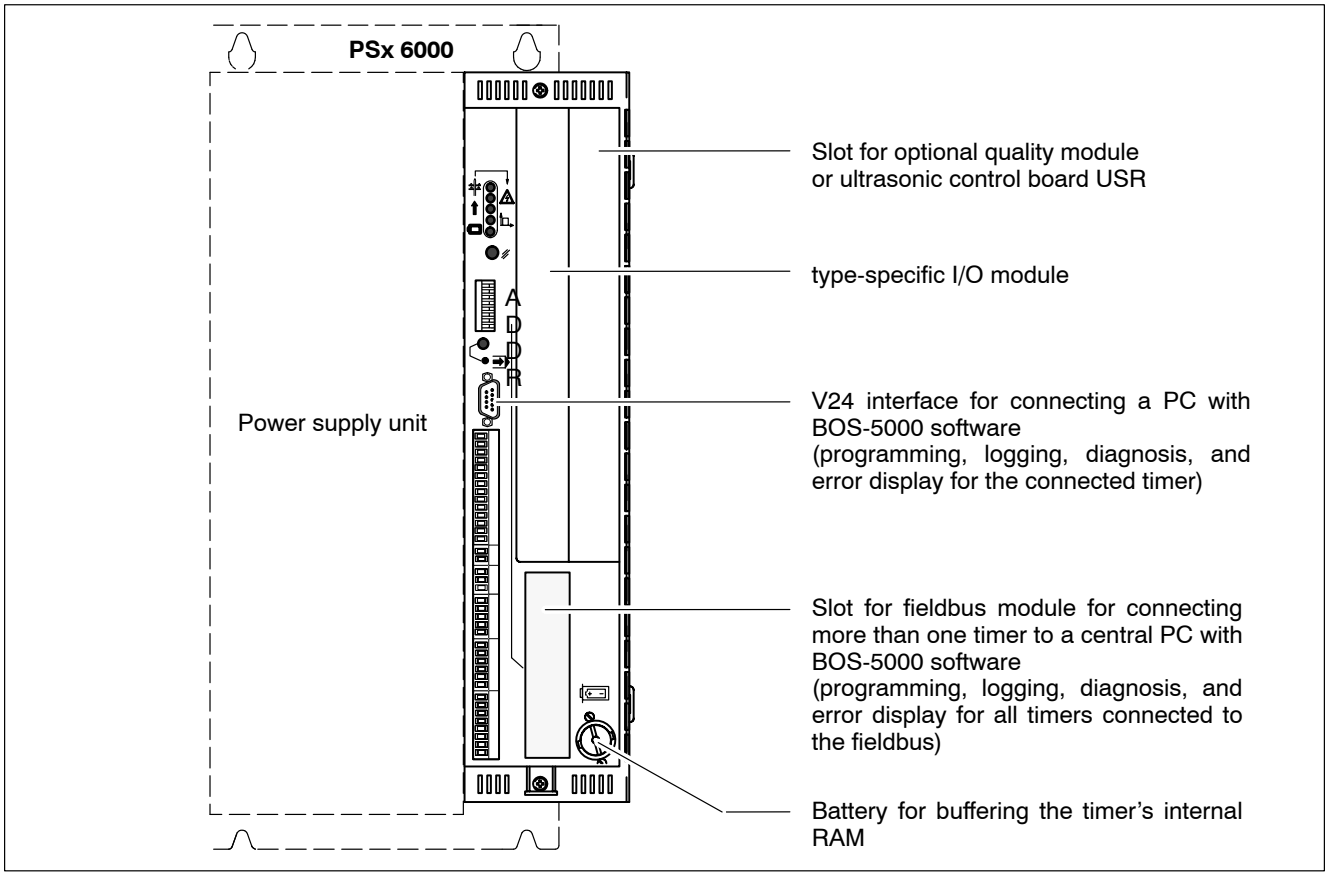
- **offline:**
  An active connection to the timer is not necessary.
  Diagnosis and visualization are not possible.
  The programming is handled and saved on the PC and can be transferred to the timer at a later point in time.
- **online:**
  An active connection to the timer is necessary.
  Diagnosis and visualization are possible.
  The programming is handled via PC. Each parameter will be read out and, after acknowledgement, written back to the timer. This way, modified and acknowledged parameters will be effective with the system's next program start at the latest.

Overview

2.4 Hardware Installation

The timer module is fastened to the right side of the global housing. In addition to the standard display and operating elements and terminals, it contains

- the corresponding I/O module for the timer's connection to the higher level PLC or the robot (is installed ex works and requires the corresponding timer firmware)
- a slot for the optional fieldbus module for programming/operation/diagnosis of all timers connected to the fieldbus
- a slot for an optional quality module or for extension with an optional ultrasonic control board (USR).



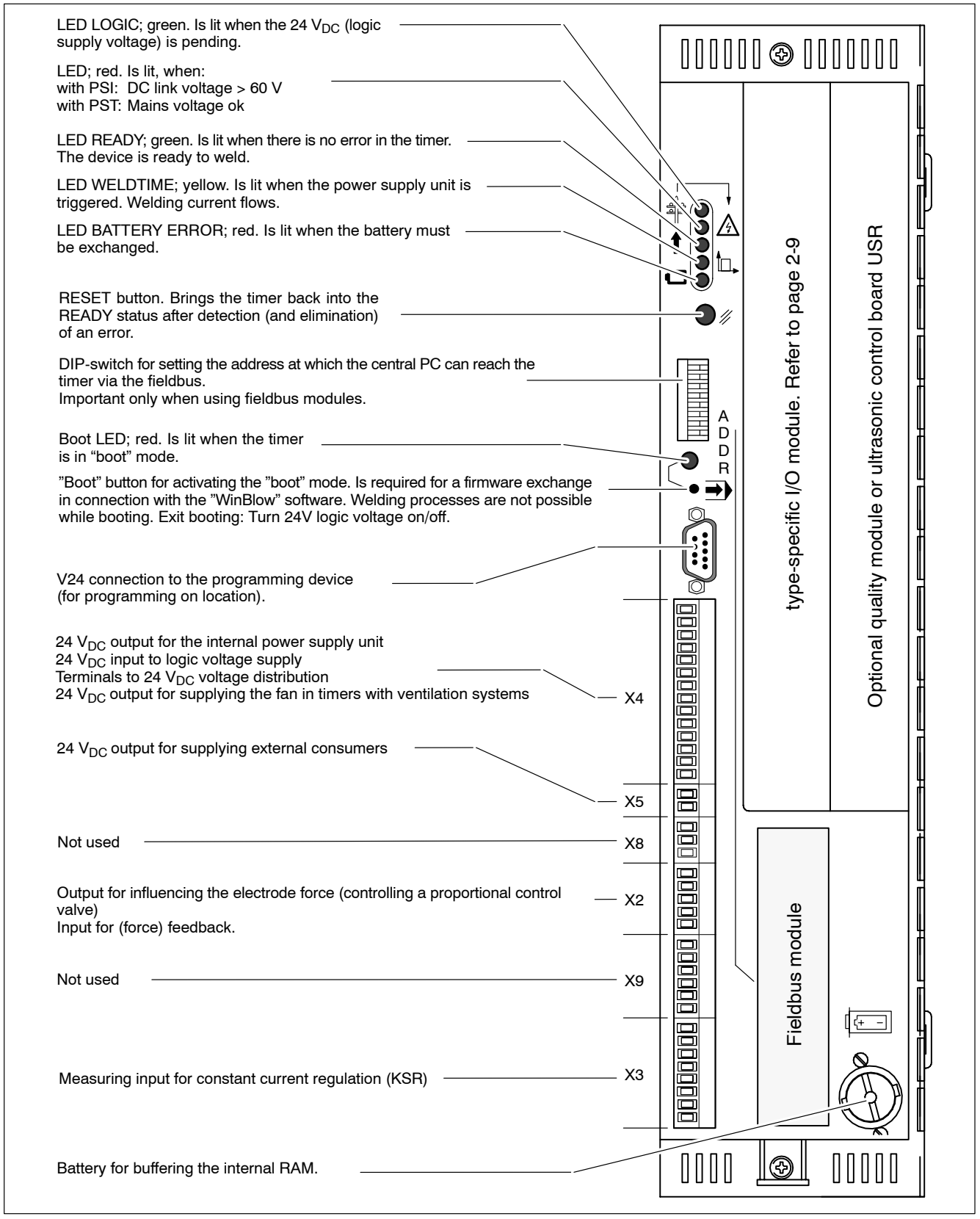
☞ **The dimensions of the global housing and the functional units for cooling depend on the size of the integrated power supply unit and can be slightly different than the above illustrated example.**

★ For installation and mounting, please refer to the corresponding manuals of the power supply unit in use (see page LEERER MERKER).

CAUTION
Malfunctions and damages are possible!
Incorrect installation, connection, or operation can provoke unexpected or erroneous reactions of the device, which may lead to dangerous situations in the welding station.
Please comply with all instructions in the manuals.

Overview

2.4.1 Timer front (without I/O module)



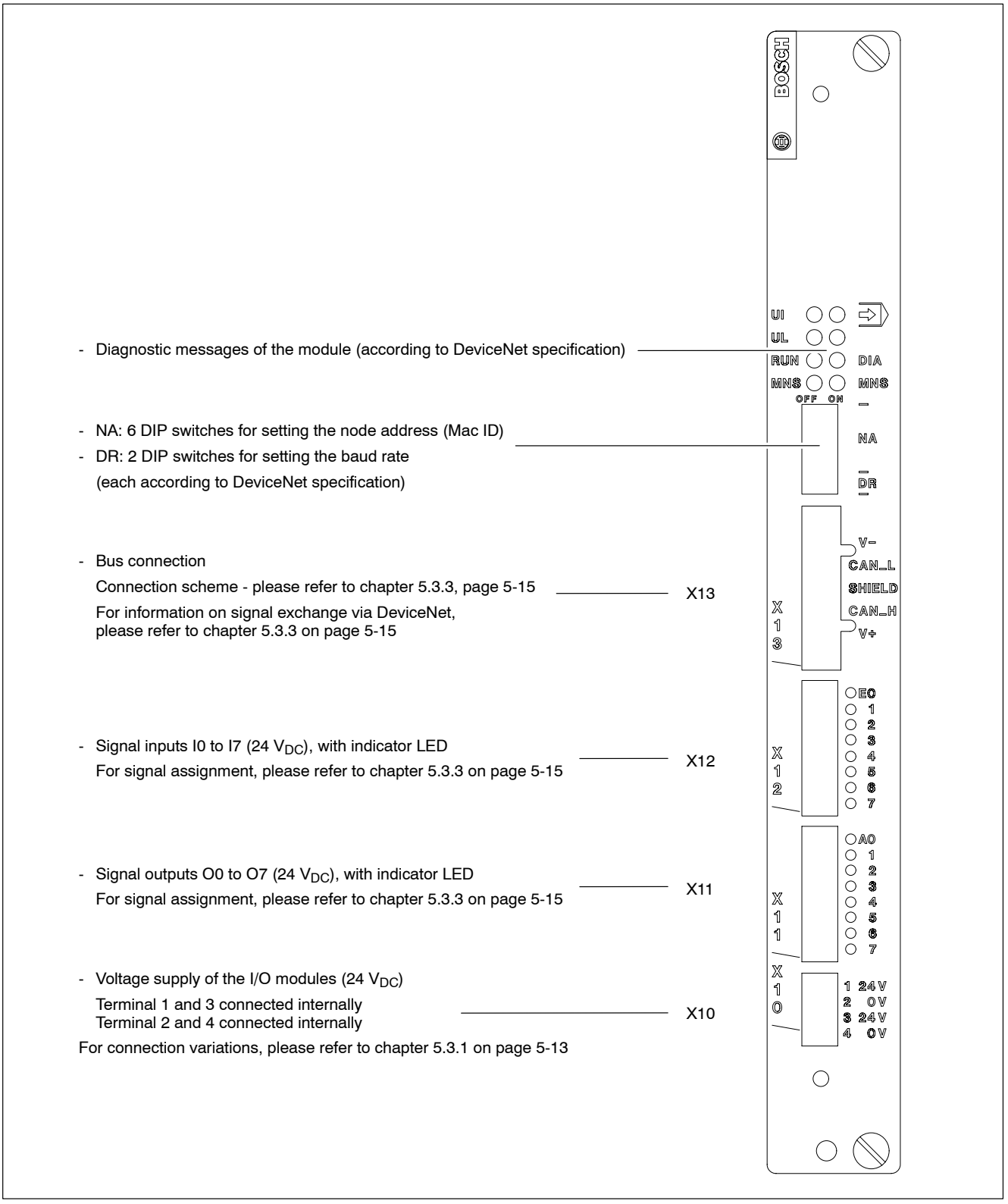
Overview

☞ **For Technical data of the timer, please refer to chapter 4.1 on page 4-1.**

CAUTION
Immediately upon pushing the ”boot” button, welding processes become impossible! The timer interrupts the program sequence, switches all signal outputs to 0 V and goes into ”boot” mode (for firmware exchange). The button shall
- never be pressed during operation and
- be pressed only by authorized personnel.

Overview

2.4.2 Front of the I/O module ”DEV-NET”



☞ **For technical data of the I/O module, please refer to chapter 4.2 on page 4-2.**

Overview

Notes:

3 Timer functions

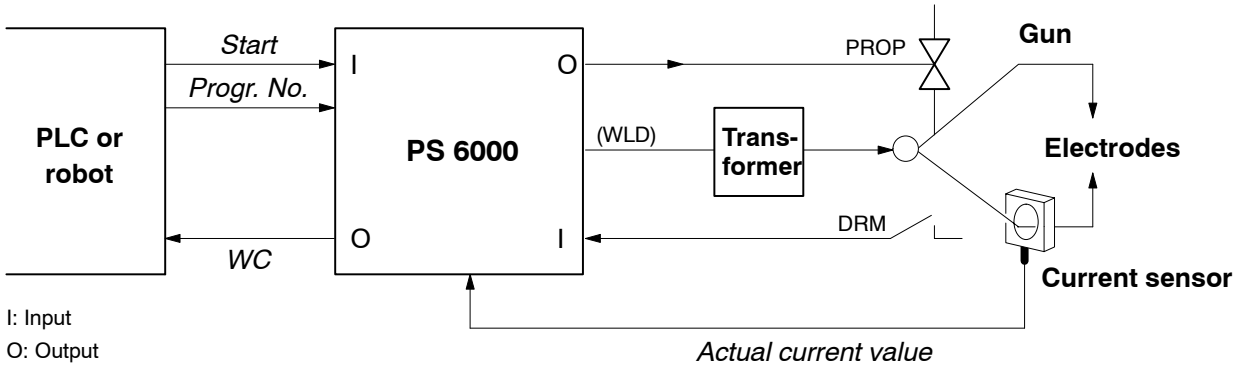
3.1 Main components of a welding station

Welding stations that are equipped with PS 6000 generally consist of the following main components:

- Weld timer with integrated power supply unit (in AC or MF technology; AC: thyristor power supply unit; MF: medium-frequency inverter)
- suitable weld transformer with current sensor and
- pneumatically or electrically driven gun, electrodes included.

In addition, an upstream control that controls the entire process regarding the work piece and monitors its safety is necessary. This can be provided by e.g.

- a programmable logic controller (PLC)
- a robot control
- a manual control (e.g. for manual welding guns) or
- a combination of the above.



I: Input
O: Output
PROP: Proportional control valve
DRM: Pressure feedback
WC: Weld complete contact
WLD: Weld time

Main components of a welding station

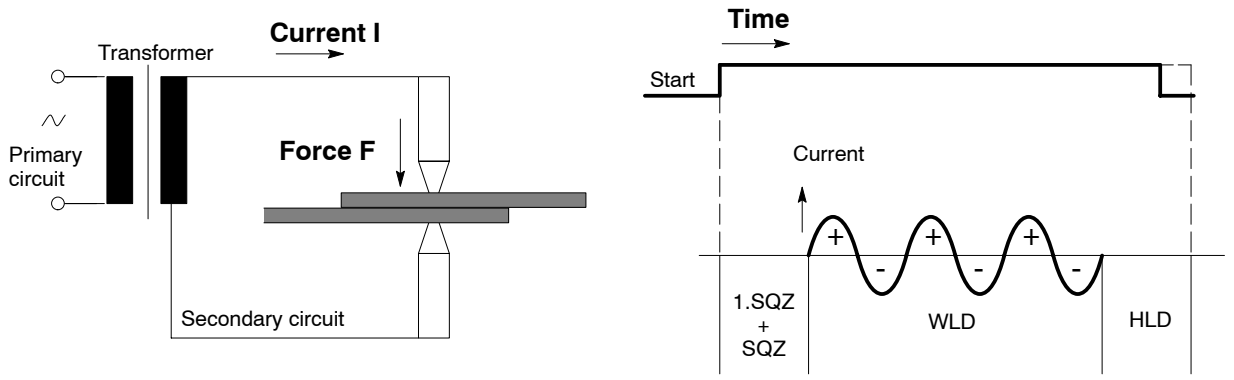
The weld timer ensures the controlled flow of the actual welding process. In order to do so, it must control and regulate a great number of functions and physical variables. Main tasks are e.g.

- the communication with a higher-level PLC or robot control via I/O signals
- triggering a proportional control valve or a servomotor in order to influence the electrode force

Timer functions

- making sure that the different times are scheduled correctly (e.g. squeeze, current, hold time etc.)
- controlling the power supply unit to produce a correct welding current
- indicating either a correct or erroneous weld at the end of the welding program.

☞ **The possibility to activate the solenoid valve (in order to close the gun) does not exist for this type of timer.**



SQZ: Squeeze time (for explanations please refer to chapter 3.3.4, page 3-8 ff)
WLD: Weld time
HLD: Hold time (for explanations please refer to chapter 3.3.4)

Physical variables for affecting the weld

3.2 Welding Operation Modes

In order to execute a welding process, the timer can be operated via PLC / robot or controlled manually by an operator.

To do so, the PS 6000 provides several different welding operation modes:

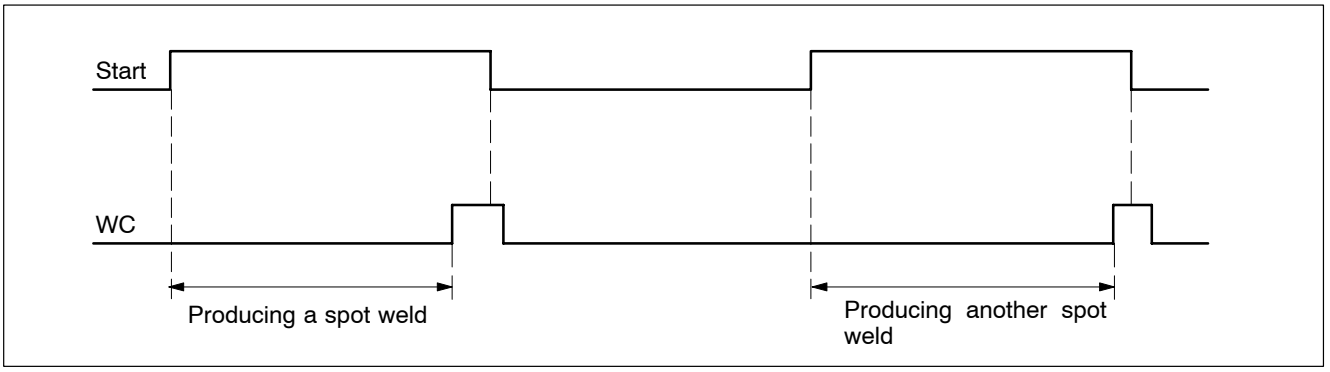
- Single spot mode
- Seam mode.

3.2.1 Single Spot

Is suitable for operation in connection with robots, welding machines, automatic welders and manual guns; for spot, projection, and butt welds.

A “high” level at the START input (see also page 6-2) starts the welding process (welding program) exactly 1x - starting with the 1.SQZ.
At the end of the program, the timer outputs the WELD COMPLETE (WC) output signal, as long as no welding error has been detected.
For a new welding process, the start signal has to be toggled off/on.

Timer functions



Welding operation mode single spot, signal schedule

3.2.2 Seam mode

Suitable for roll seam stations.
With this technique, you pass over the welded parts with rolling electrodes and the parts are connected by individual spot welds.

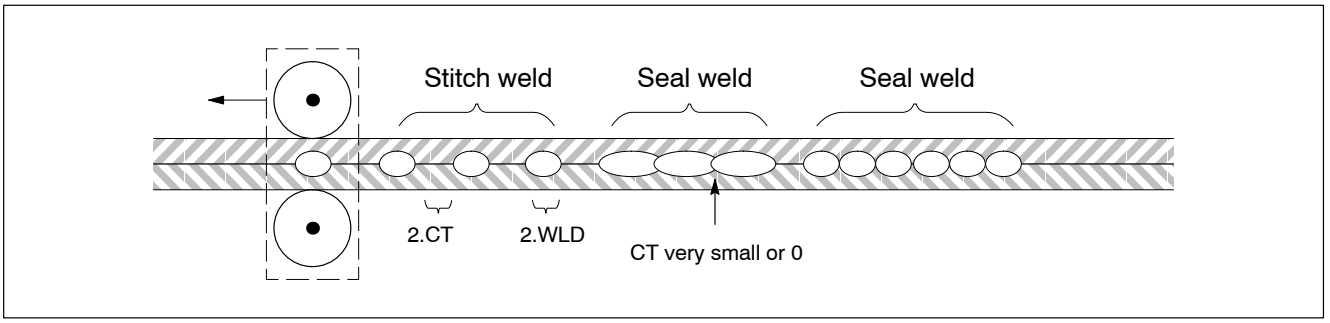
As in single spot mode, the weld timer reacts to the start signal and starts the welding process.
The weld time (2.WLD) and a possibly programmed cool time (2.CT) will be repeated, as long as the high level at the START input is pending.
If the start signal changes to low level, the timer interrupts the flowing current impulse and starts the hold time (HLD).

☞ **If you want to terminate the current time not abruptly but by a current ramp (current reduction, please refer to page 3-7), turn the pressure feedback off (refer to page 5-7) while the start signal is still high and the slope has been parameterized accordingly.**
If the start signal is still high, a possibly programmed 3.CT and a 3.WLD will be performed before the hold time starts.

Seam mode is divided in stitch and seal welds:

Stitch weld: Successive weld times are separated from each other by sufficiently rated cool times, so that successive spot welds neither touch each other nor overlap.

Seal weld: The cool time is so short that successive spot welds overlap.



Seam mode

Timer functions

3.3 Program

There are 256 different welding programs (program no. 0 - 255) available. First, select the program via the program selection inputs (refer to page 6-4), then start the welding process via high level at the START input (see also page 6-2).

Each welding program contains all parameters necessary for the exact definition of a weld. Basic parameters are e.g.

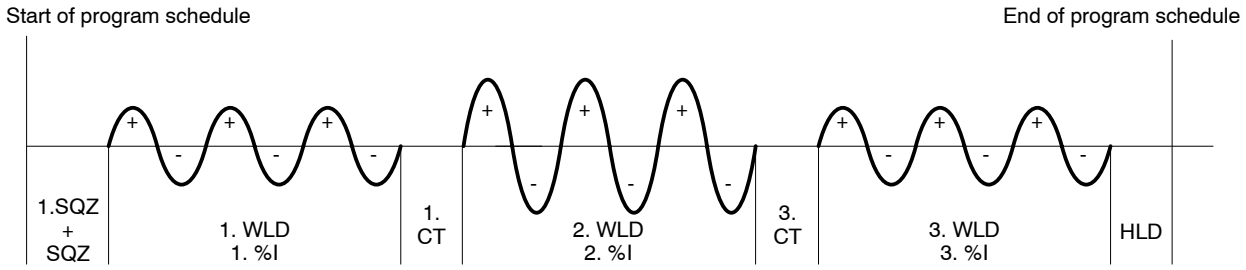
- Currents that are to be effective in different current blocks (refer to chapter 3.3.1 ff)
- Times that are supposed to run consecutively (please refer to chapter 3.3.4, page 3-8 ff)
- Electrode force (for further explanations, please refer to page 5-7).

3.3.1 Programmable Current Blocks

However, the process may require to produce the heat necessary for a single spot weld in consecutive current blocks. Therefore, you can execute a spot weld using up to three current blocks (1. WLD, 2. WLD, 3. WLD). With regard to its time and current, each block can be programmed separately.

☞ **Programming the currents depends on the active regulation mode (refer to page 3-11):**
PHA (Phase angle): in scale values
KSR (Constant Current Regulation): in kA

Between the blocks, cool times can be programmed (1.CT, 3.CT). If you set a cool time = 0, the two corresponding blocks lie seamlessly next to each other.



SQZ: Squeeze time (for explanations please refer to chapter 3.3.4, page 3-8 ff).
WLD: Weld time
HLD: Hold time (for explanations please refer to chapter 3.3.4)
%I: Current

Available current blocks

Timer functions

1.WLD (1st weld time / preheating time):

With this current block, you can preheat the metal with a smaller current (1.%I) prior to the actual welding process (in the 2nd current block), in order to reduce the risk of e.g. welding splashes.
If you do not want to use the 1.WLD, simply set 1.WLD = 0.

2.WLD (2nd weld time / 2nd current block):

With this current block, you actually weld a spot with the command current (2.%I).

- The 2nd weld time must always be programmed.
- Within the 2.WLD, the functions:
  - "Impulse mode" (refer to page 3-6) and
  - "Slope" (refer to page 3-7) are available.

3.WLD (3rd weld time / postheating time):

With this current block, you can heat the metal with a smaller current (3.%I) after the actual welding process (2nd current block).
This compensates e.g. for too rapid cooling of the spot welds caused by the electrode's cooling. It improves the structure of the welded part and serves to relieve weld stresses.
If you do not want to use the 3.WLD, simply set 3.WLD = 0.

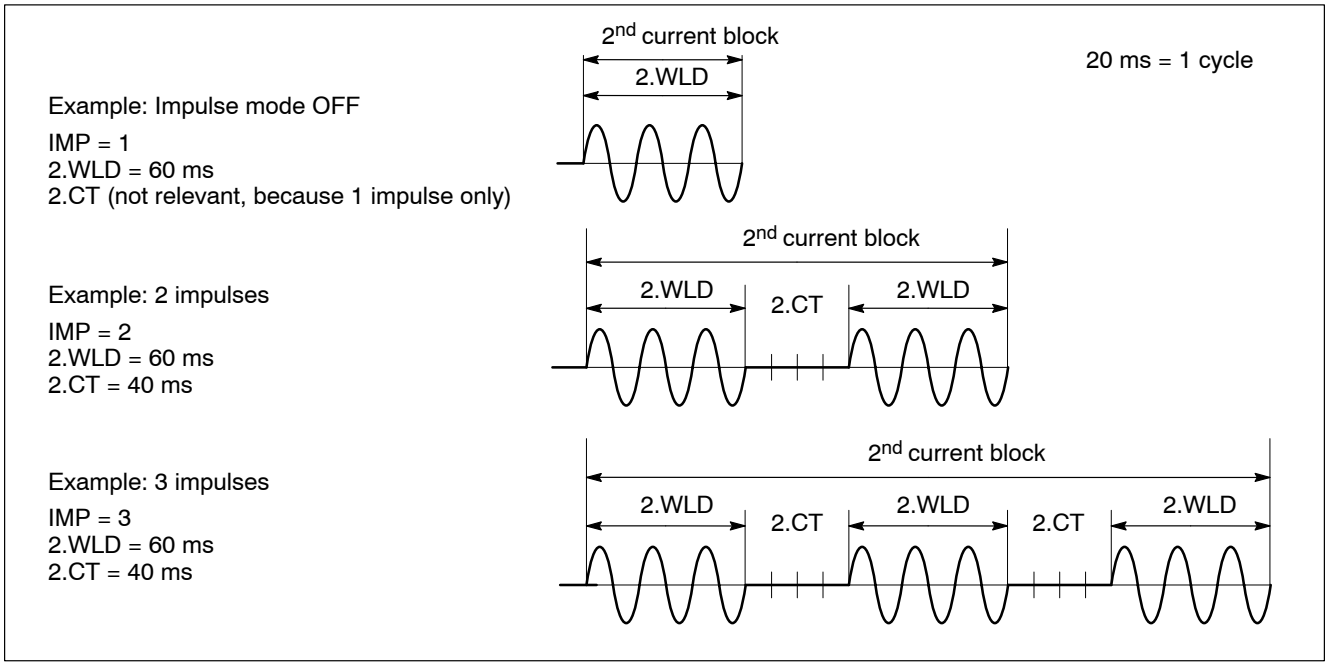
Timer functions

3.3.2 Impulse Mode

In addition to the possibility to distribute the heat necessary for one single spot weld on 3 successive current blocks (refer to page 3-4), you also have the **impulse mode** at your disposal.

Within the **2nd current block**, the heat necessary for welding a spot can be distributed on up to 9 successive impulses which reduce the risk of welding splashes as well.
Between the impulses, you can program a 2.CT.
If you set the 2.CT = 0, all impulses lie seamlessly next to each other.

You can set the impulse mode via parameter ”Impulse”.
This parameter determines how often the 2.WLD will be repeated taking into consideration a programmed 2.CT.



Examples of programming the impulse mode

Timer functions

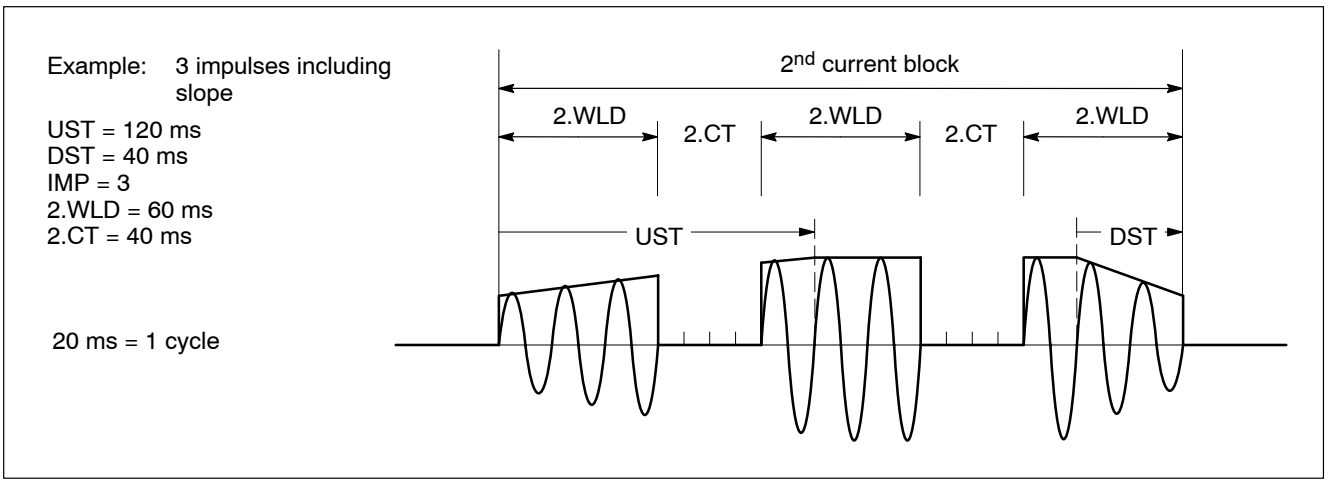
3.3.3 Slope (Current Ramp)

If the Slope function is activated, the timer independently produces a linear current increase (upslope) or decrease (downslope) for the **2nd current block** within a programmable time span. The Slope function reduces the switch-on current peak and thus the stress on the welding station.
For programming, use

- **current upslope time (UST)** to determine the time span in which the momentary current shall be increased from ”starting current” to the command current of the 2.WLD (2.%I), or
- **current downslope time (DST)** to determine the time span in which the command current of the 2.WLD (2.%I) shall be reduced to the ”final current”.

Please note:

- Current upslope and downslope times are always part of the 2nd current block.
  The current upslope time starts with the beginning of the 2nd current block.
  The current downslope time ends with the end of the 2nd current block.
- Current upslope and downslope times are not influenced by an activated impulse mode or a possibly programmed 2.CT. I.e. they ignore a possible 2.CT and proceed.
- If the sum of UST and DST is larger than the 2nd current block, the command current in the 2nd block (2.%I) will never be reached! Fault messages as e.g. ”current too low” appear.
- Please use, in connection with the slope, the fade-out time (refer to page 3-18).



Example: Slope in connection with impulse mode

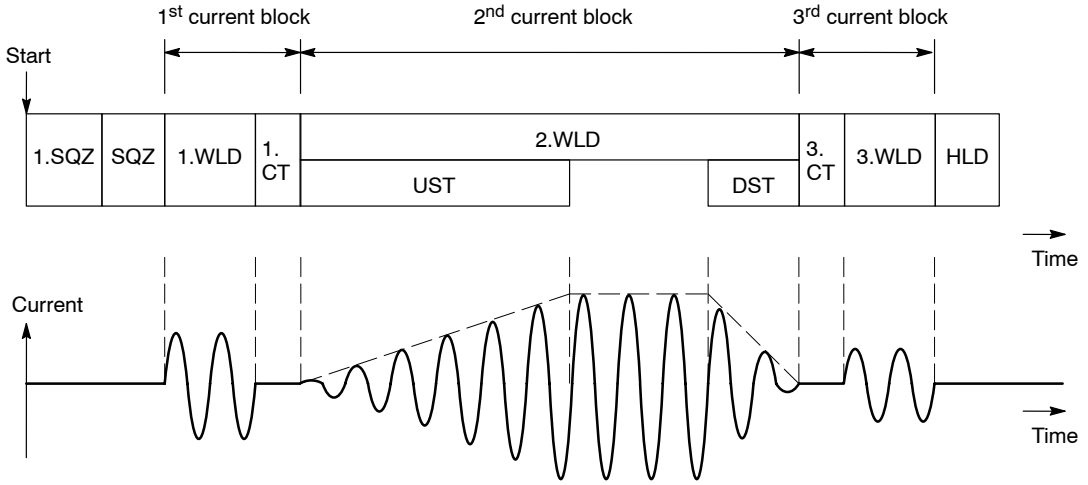
Timer functions

3.3.4 Programmable Times

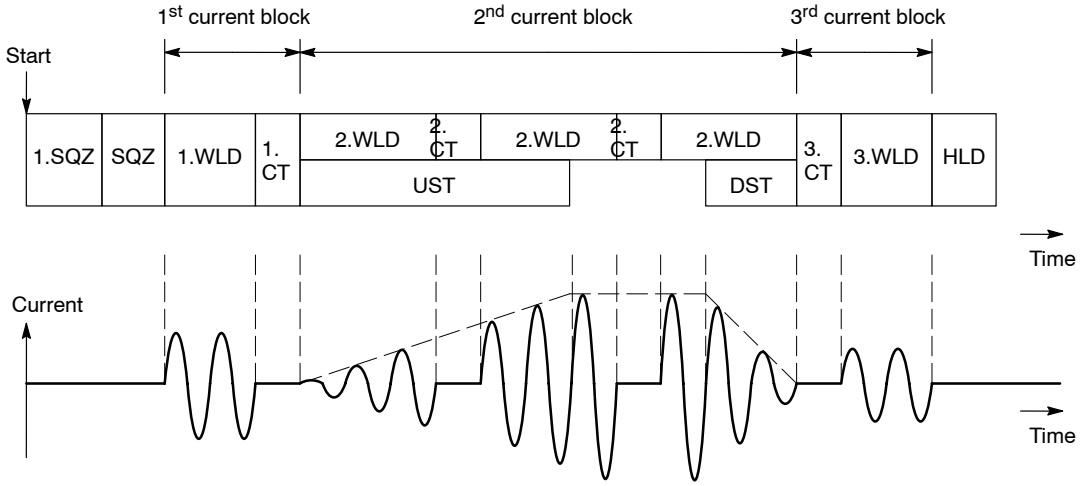
The schedule of a welding program depends on the use of different programmable time spans. Each time span serves a certain purpose within the program schedule.

☞ **With regard to time programming, PSI and PST differ from each other:**
PSI: spacing in 1 ms
PST: in line cycles (at 50 Hz: 1 line cycle corresponds to 20 ms at 60 Hz: 1 line cycle corresponds to 16.6 ms)

Welding program execution without impulse mode in the 2nd current block:



Welding program execution with impulse mode in the 2nd current block (example here: impulses = 3):



Example of a time diagram with all programmable time spans

Timer functions

1.SQZ (1st squeeze time):

During the 1.SQZ, the welding gun must be closed completely. No current flows in this time segment.

In all operating modes (single spot and seam mode), the 1.SQZ always starts immediately after the start signal.

SQZ (squeeze time):

The squeeze time is used to build up the working force of the electrodes. No current flows in this time segment.
The welding gun must be closed when the SQZ begins (see 1.SQZ).

The programmed squeeze time (SQZ) starts under the following conditions only:

- High level at input X2/4 (if 0 V at X2/2)
  (for required voltage, please refer to chapter 4.1 on page 4-1)

If this condition is missing, the welding program will be selected and started (and a possibly programmed 1. SQZ will begin), but the further process will be delayed until this one condition is met (also refer to chapter 5.2.5 on page 5-7).

☞ **The SQZ must always be higher than 0.**
Shortest possible SQZ with PST: 1 cycle
with PSI: 16 ms.

☞ **Within the SQZ, the timer checks, by measuring the ohmic resistance, if the connected measurement circuit is faultless or not. In case of an error (refer to page 5-11), the timer interrupts the welding program and deletes the output signal "Control ready".**

☞ **At the end of the SQZ, the timer checks the discrete input signal "Welding circuit feedback" (I0). If the signal is missing inspite of the discrete output "Welding circuit enable" (O0) being set, the error message "Welding circuit 1 not closed" is generated.**

1.WLD (1st weld time; preheating time)

Refer to page 3-5.

1.CT (1st cool time)

Separates the first from the second current block if the programmed value is higher than 0. Serves to relieve stress from the welded part.
Refer to page 3-4.

☞ **The 1.CT can only be programmed if the 1.WLD is larger than 0.**

Timer functions

2.WLD (2nd weld time)

Refer to page 3-5.

2.CT (2nd cool time)

Separates the impulses from each other during impulse mode if the programmed value is higher than 0. Serves to relieve stress from the welded part.
Refer to page 3-6.

☞ **The 2.CT can only be programmed if the impulse mode is activated (parameter ”impulses” > 1).**

UST (Upslope time / Current upslope time)

Refer to page 3-7.

DST (Downslope time / Current downslope time)

Refer to page 3-7.

3.WLD (3rd weld time; postheating time)

Refer to page 3-5.

3.CT (3rd Cool time)

Separates the second from the third current block if the programmed value is higher than 0. Serves to relieve stress from the welded part.
Refer to page 3-4.

☞ **The 3.CT can only be programmed if the 3.WLD is larger than 0.**

HLD (Hold time)

Is used, in order to fix the welded part during cooling. Current has stopped flowing in this time segment.
At the end of the HLD, the welding gun opens up. If there hasn’t been detected any welding fault, the output signal WELD COMPLETE (WC) will be output (refer to page 6-14).

Timer functions

3.4 Regulation Modes

The weld timer provides the following regulation modes:

- Phase angle (PHA) and
- Constant Current Regulation (KSR).

The allocation between program and regulation mode is very flexible: Thus, two different regulation possibilities are available:

- **Standard operation:**
  A regulation mode can be assigned to every welding program. The set regulation mode is valid for all weld times of the program.
- **Mixed operation:**
  Different regulation modes can be assigned to the program's weld times.

☞ **Regulation and monitoring are separate functions! This is why the current command values are separately parameterizable for regulation and monitoring.**
Please refer to chapter 3.6.1, page 3-15 ff.

3.4.1 Phase Angle (PHA)

Special case.

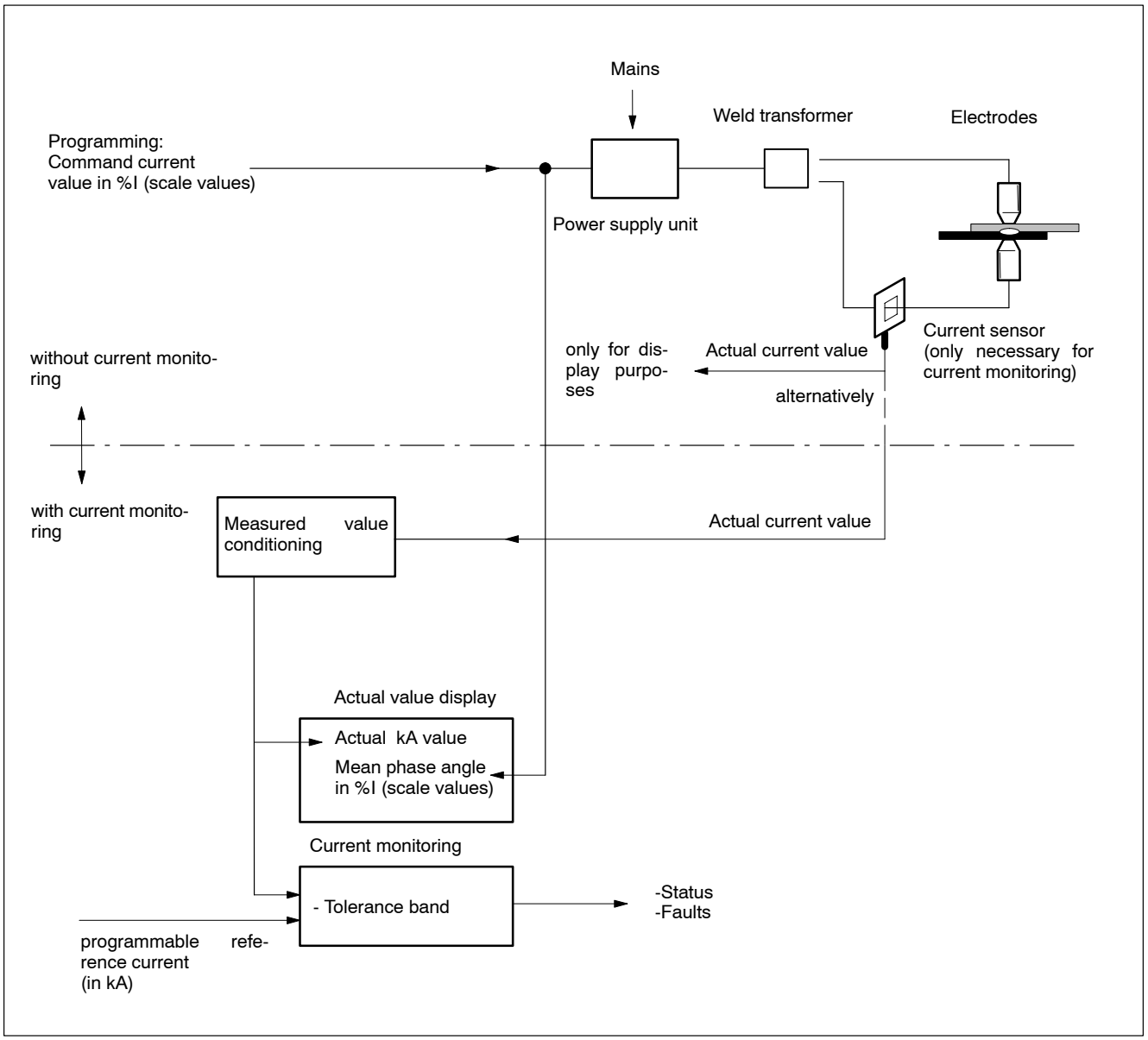
The operation mode PHA doesn't provide for the regulation of an actual variable (e.g. current), but triggers exclusively the power supply unit. In the PST, this causes a triggering of the thyristors during the sinusoidal half-wave (el. firing angle: 130 degrees to 30 degrees; the larger the firing angle, the less current flows in the secondary circuit); in the PSI, you can thus influence the pulse width.

Features PHA:

- Currents are programmed in scale values (%I).
  Programmable range: 0.0 to 100.0 scale values.
  Programming resolution: 0.01 scale values
- No regulation.
- The resulting current in the secondary circuit depends on the electrode/welded part contact resistance and the secondary voltage.
- A current sensor for measuring the actual current is not necessary.

☞ **Current and time monitoring can be enabled in PHA mode.**
Current monitoring though requires a current sensor (toroid).

Timer functions



Principle of the unregulated PHA operation

3.4.2 Constant Current Regulation (KSR)

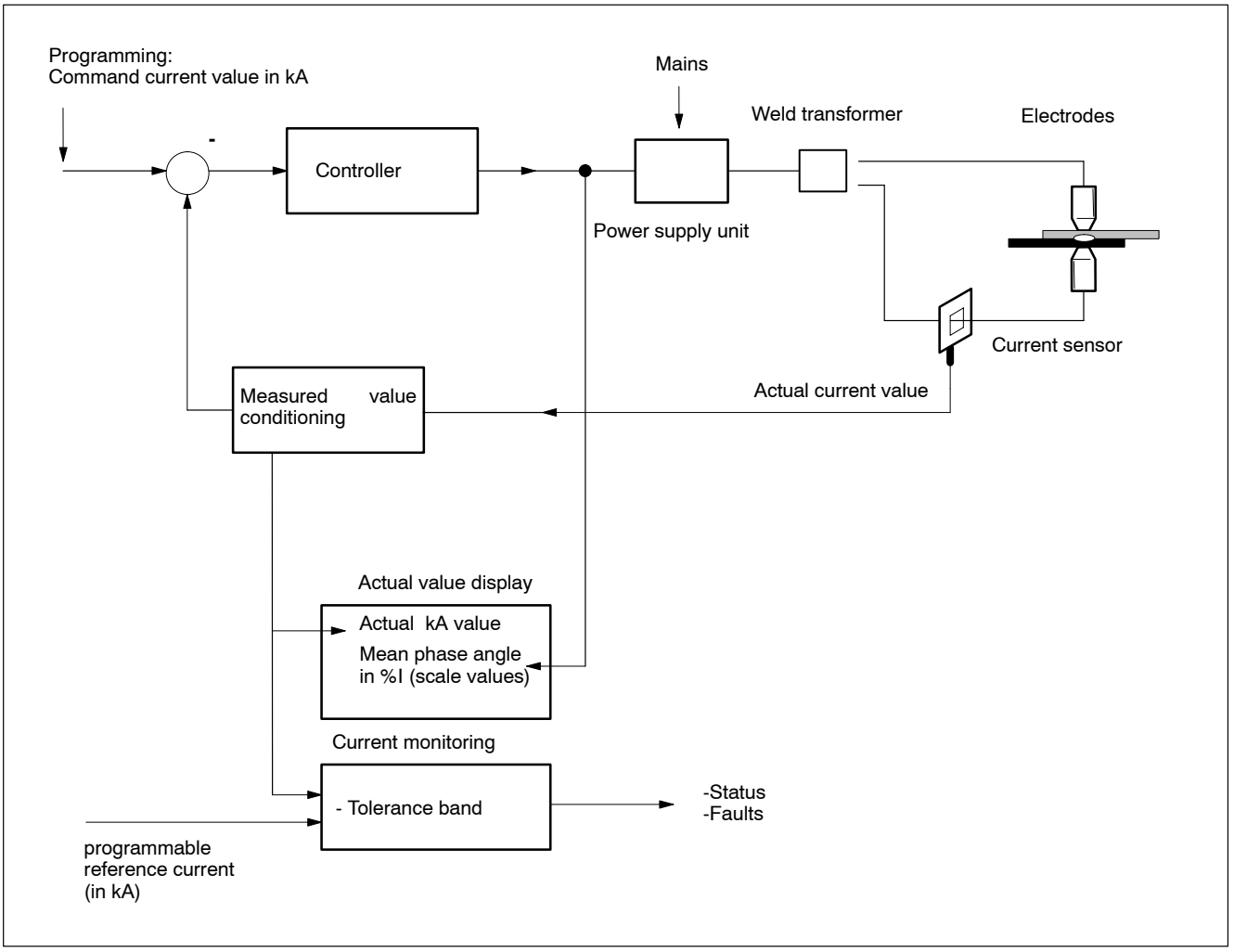
Standard case (e.g. with robot guns).

In KSR mode, current regulation is activated. The actual current is measured and continuously compared to the programmed command current. A series-connected controller processes the difference between the command and the actual value and controls the phase angle/the pulse width in the power supply unit in order to reach the command current.

Timer functions

Features KSR:

- Currents are programmed in kilo Ampere (kA).
  Programmable range: 0.5 to 250 kA
  (can be limited by parameterization and the power supply unit in use).
  Programming resolution: 10 A.
- The current in the secondary circuit is regulated.
- Eliminates the influence of the electric resistance on the weld process in the secondary circuit (e.g. electrode/welded part contact resistance).
- A current sensor for measuring the actual current is absolutely necessary (please refer to page 5-10).



Principle of the KSR regulation mode

Timer functions

3.5 Current Prewarning and Limitation

3.5.1 Current Prewarning

Via the ”Current prewarning” parameter it is possible to indicate,

- from which scale value on the message ”Phase Angle Prewarning has been reached” will be displayed.

This way, in KSR regulation mode, the timer can indicate e.g. an imminent current limitation, caused by e.g. cable losses in the secondary circuit.

☞ **The parameter value must be smaller than the current limitation value.**

3.5.2 Current Limitation

☞ **At first, parameterize the current prewarning.**

Via the ”current limitation” parameter, you determine the minimum phase angle (electric degree)

- in KSR mode by the controller’s command value and
- in PHA mode by programming.

To do so, please program the highest permissible scale value.

If the current limitation function reacts, the timer sends the message ”maximum phase angle”.

☞ **The input value for the current limitation is absolute!**
Therefore, the ”%I correction” function (see page 3-34) and the ”stepper” function (see page 3-27) might lead to an activation of the current limitation.

☞ **The parameter value must be higher than the current prewarning value.**

Timer functions

3.6 Monitoring

The timer can monitor welding processes with regard to the following variables:

- Current (please refer to chapter 3.6.1) and
- Time (please refer to chapter 3.6.2, page 3-20 ff).

Both monitor modes can be switched on and off separately.

Activated monitorings check the relevant actual value in comparison to the programmed reference values and tolerance bands.

Since the variables current and time affect the heat within the spot, correctly set reference values and activated monitorings are essential measures and prerequisites for quality assurance.

☞ **The reference values used for monitoring can be programmed independently from the regulation parameters.**
A modification of the command values for regulation (closed-loop control) does not affect the monitoring parameters!
Corresponding access rights allow the operator to set new reference values manually or accept a previously measured actual value as a new reference value.

3.6.1 Current Monitoring

☞ **A current sensor is absolutely necessary for measuring the actual current (please refer to page 5-10).**

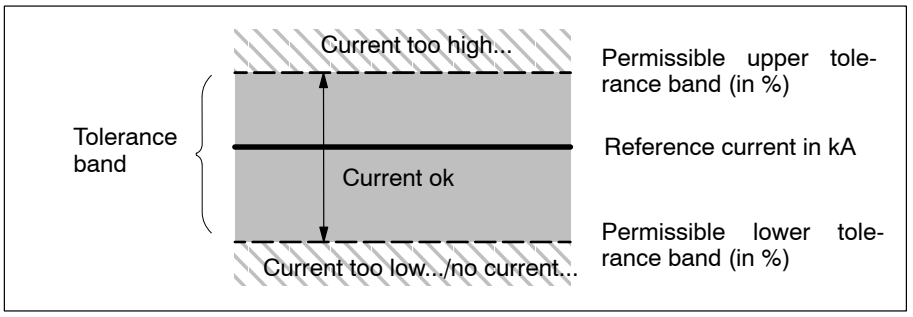
Tolerance range

Current monitoring compares the actual current that has been measured by means of the r.m.s. value with the ”tolerance band”.

It depends on the programmed tolerance band whether the timer identifies the measured actual current as ”good” or not. The following values are decisive for the definition of the tolerance band:

- Reference current in kA
- Positive tolerance in % of the reference current
  (Permissible upper tolerance band).
  Actual values above the upper tolerance band lead to the message ”Current too high...”.
- Negative tolerance in % of the reference current
  (Permissible lower tolerance band).
  Actual values below the lower tolerance band lead to the message ”Current too low...” or ”No current...”.

Timer functions



Principle: Tolerance band

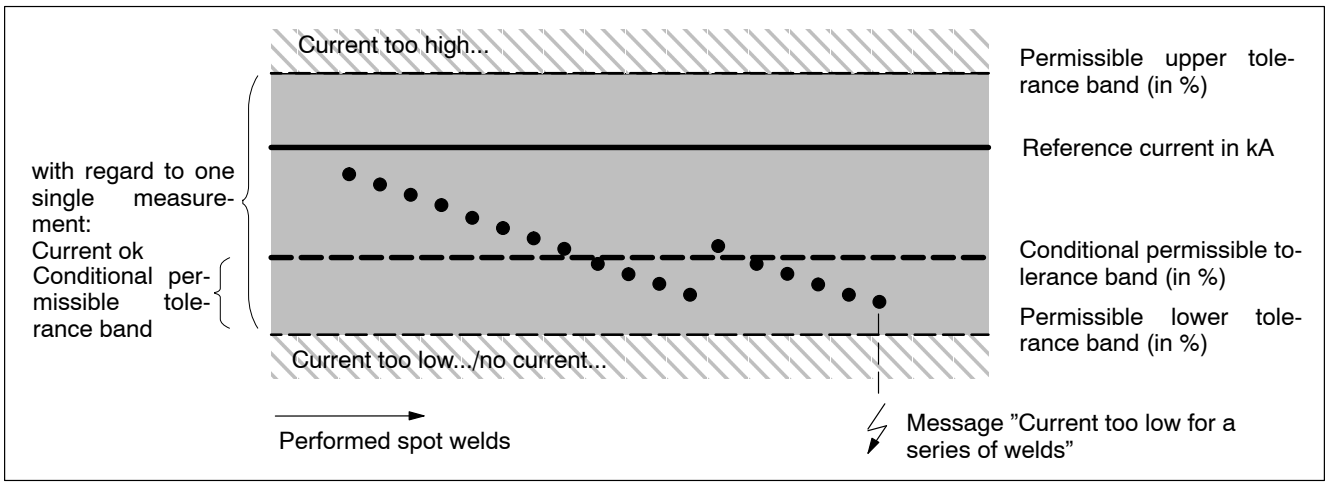
Conditional permissible tolerance band

In addition to a ”good/bad” statement, it is often desirable to be informed about the trend of the actual current values in time. In this regard, slow but continuously increasing actual current values in the lower segment of the tolerance band are especially interesting: Slowly developing errors in the system (e.g. slowly increasing cable resistance within the measuring circuit prior to a cable break) can lead to such effects. It is also possible that not perfectly set reference current values are the cause for actual current values in the lower segment of the tolerance band.

Therefore, the following additional parameters are at your disposal in connection with the tolerance band:

- Conditional permissible tolerance band (in % of the reference current) and
- ”Repeat factor”.

The parameter ”conditional permissible tolerance band” determines the upper limit of the conditional permissible tolerance range. The lower limit is defined via the parameter ”permissible lower tolerance band”.
The ”repeat factor” determines, how many **consecutive** spot welds may lie in the conditional permissible tolerance range.
If this value is exceeded, the timer sends the message ”Current too low for a series of welds”.



Example: Principle of the Conditional Tolerance Band with Repeat Factor = 4

Timer functions

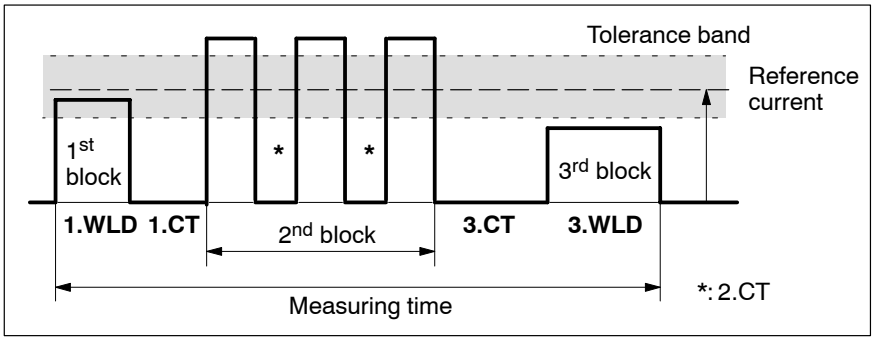
☞ **Messages can be defined either as a ”welding fault” or as a ”warning”. An event that has been defined as a ”warning” does not lead to a blocking of the timer. A ”welding fault” though always requires a ”Fault reset” (see page 6-6) in order to start the next welding process.**

Current monitoring modes

Since there are 3 programmable independent current blocks (refer to page 3-4), current monitoring should be flexible and easy to handle.

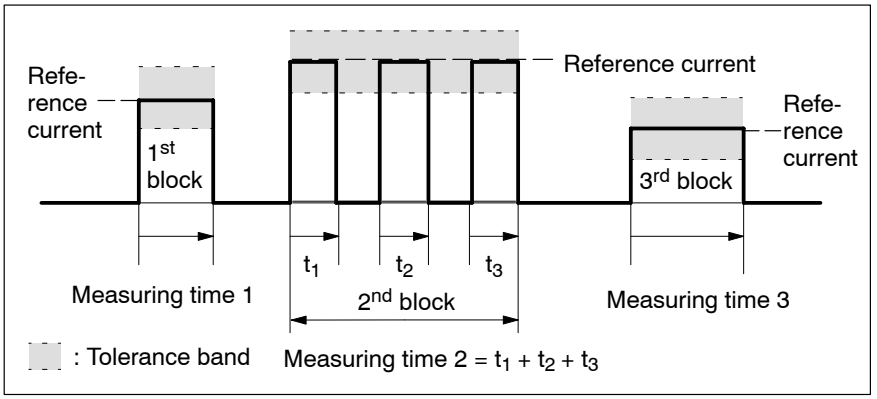
Therefore, the two different monitoring modes ”Standard” and ”Mix” are available:

- **Standard operation:**
  The entire current profile (1st, 2nd, and 3rd current block, cool times included) is part of the r.m.s. value measurement.
  It will be represented by one actual value and monitored by one tolerance band only.
  Because of this simple, but most of the time sufficient monitoring mode, the quantity of data to be processed remains small, but possible cool times and different currents within the individual blocks change the measurement result.
  In this case, the reference current should be measured via sample welds. If you use the 2.WLD only and no impulse mode, you can enter the command current programmed for the regulation as the reference current.



Principle of the monitoring mode ”Standard”

- **Mixed operation:**
  The r.m.s. value will be measured separately for each current block and monitored by the current blocks’ own tolerance bands (for 1st, 2nd, and 3rd current block). Programmed cool times are not taken into consideration when calculating the actual value for each current block.
  This leads to a better transparency for the single current blocks, but the quantity of data to be processed is larger.
  In mixed operation, you can always use the command currents programmed for regulation as the reference currents.



Principle of the monitoring mode "Mix"

Fade-out time and trail current

The above descriptions of the current's temporal schedule are ideal cases (rectangular form). In reality though, the current recovers and decays at the beginning and the end of a weld time. These effects have an influence on the r.m.s. value measurement.

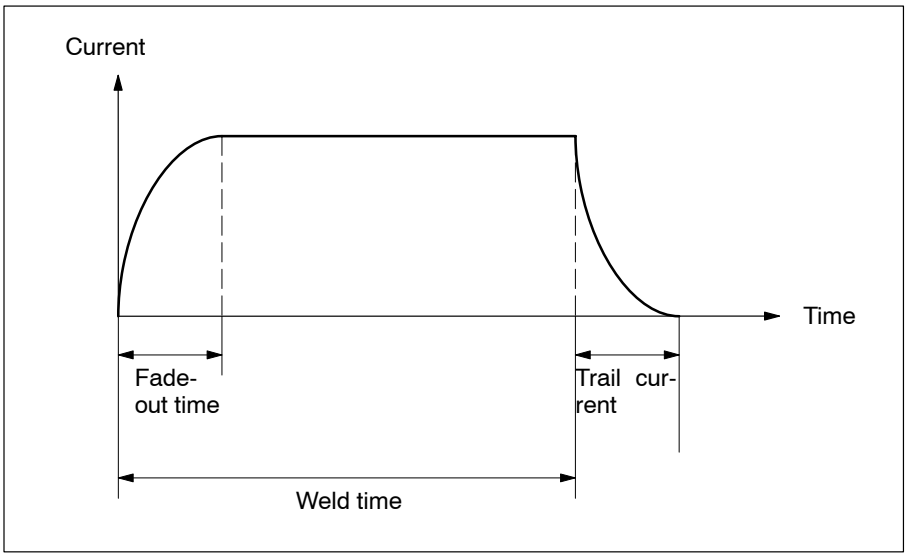
With the functions "Fade-out time" and "Trail current", you can affect the measurement specifically.

- **Fade-out time:**
  Indicates, for how long after the start of a weld time, measured current values are **not** to be taken into consideration for the calculation of the r.m.s. value. This way, if set correctly, you can fade out the entire transient recovery process.

  Use of fade-out time:
  - in connection with the "Slope" function (refer to page 3-7): please program the same value for the fade-out time as for the current upslope time (UST);
  - when welding thick sheets and when the use of a deeply immersing welding gun (gun reaches far into the material) is necessary;
  - in connection with current scaling:
    Measuring instruments for the reference welding current are provided with a "fade-out function" as well (e.g. Miyatchi: "First Cycle"; indication from which cycle of the weld time on measured values shall be taken into consideration).
    For current scaling, make sure that the measurement instrument in use is set to the timer's currently parameterized fade-out time.

- **Trail current:**
  Indicates if the decaying process after the end of the weld time shall be taken into consideration for the calculation of the r.m.s. value (trail current ON).
  In connection with fade-out times higher than "0", this may result in the determination of too low r.m.s. currents when calculating the measured value, even though the absolute command current in steady state has been reached.

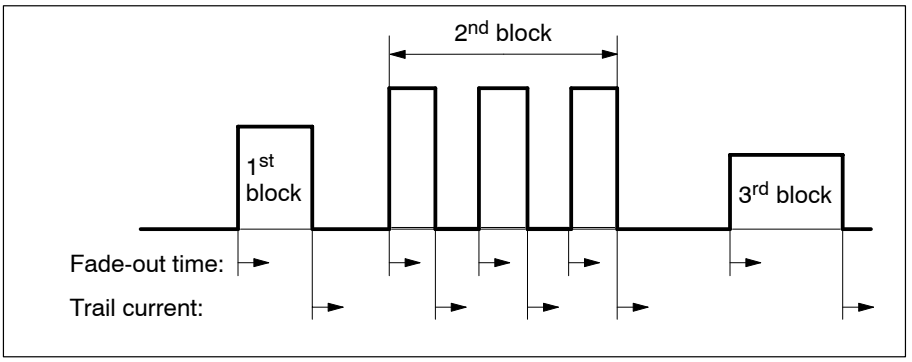
Timer functions



Fade-out time and trail current

The programmed fade-out time always starts
- at the beginning of a current block
- at the beginning of an impulse.

An activated trail current always starts
- at the end of a current block
- at the end of an impulse.



Starting points of the fade-out time and the trail current

☞ **The programmed fade-out time is identical for all weld times and for all welding programs!**
Therefore, please make sure, that the fade-out time is always smaller than the smallest programmed weld time.

☞ **An activated trail current is valid for all weld times and all welding programs.**

☞ **If for your application the only quality criteria is the heat introduced into the spot weld (heat: $Q \approx i^2 \times t \times R$), please program the fade-out time with the value ”0” and switch ON the trail current.**

Timer functions

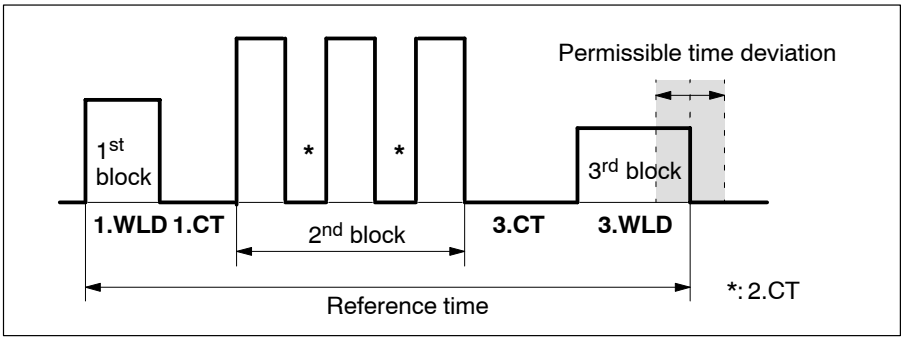
3.6.2 Time Monitoring

Time monitoring is separately adaptable to each program and compares the actual time necessary for the complete current profile to a programmed reference time.
As actual time we understand the time span from the beginning of the first current block till the end of the last current block, cool times included.

This way, you can avoid the execution of too big weld time changes in the individual welding programs.

The following values are decisive for programming the time monitoring function:

- Time monitoring ON/OFF
- Reference time
- Permissible time deviation from the programmed reference time.
  Actual times above the permissible time deviation lead to the message ”Weld time too long...”.
  Actual times below the permissible time deviation lead to the message ”Weld time too short...”.



Principle: Time monitoring

Timer functions

3.6.3 Monitor Stepper

☞ **A current sensor is absolutely necessary for measuring the actual current (please refer to page 5-10).**

It serves when executing the electrode maintenance functions

- ”Stepper” (refer to page 3-27) and
- ”Electrode tipdressing” (refer to page 3-27)

for monitoring the programmed %I stepper.

This way, you can avoid the execution of too big changes in the individual stepper or tipdressing curves.

With an activated stepper, the timer changes the programmed command current in dependence of the electrode wear.
The ”Monitor Stepper” gives you the possibility to program, separately for each singular stepper or tipdressing curve, stepper values in percent which then will be taken into consideration as reference values for the monitoring process.

3.7 Interlock

In the welding operation mode ”single spot”, the timer goes into ”Interlock” upon the end of the SQZ. While in ”Interlock”, the 1., 2., and 3.WLD and the HLD are processed even after the input signal ”Start” has been reset.

☞ **”Interlock” can be interrupted only by opening the stop circuit (see page 5-14).**

☞ **In the welding operation mode ”seam mode”, there is no ”Interlock”. If the input signal ”Start” is reset during a weld time, the timer terminates the cycle that has just begun and continues with the hold time.**

For more information regarding ”Interlock”, please refer to input signal START on page 6-2.

Timer functions

3.8 Measuring Circuit Test

This function checks the measuring circuit for interruptions and short circuits during the squeeze time (see page 5-11). This way, errors in the cables/current sensor can be detected in time.

If an error is detected, the weld timer interrupts the current welding program before entering the first programmed weld time and generates a corresponding message (”measuring circuit open” or ”short circuit in measuring circuit”).

To activate the function, switch parameter ”Measuring circuit test” to ”On”.

Conditions:

- The parameter ”monitoring stopped” is switched off **and**
- the function ”current monitoring” (refer to page 3-15) is activated.

☞ **Messages can be defined either as a ”fault” or as a ”warning”. An event that has been defined as a ”warning” does not lead to a blokking of the timer. A ”fault” though always requires a ”Fault reset” (see page 6-6) in order to start the next welding process.**

CAUTION
Welding current might be too high!
Both messages must always be defined as a ”fault”.
Otherwise the controller receives no or erroneous information about the actual value. This might result in the controller triggering the power supply unit fully.
After 40 ms at the latest, the welding schedule will be interrupted with the message ”weld time termination/no current” (”no current”: refers to the measured actual value).

Timer functions

3.9 Limitation of the 1st Half Cycle (for PST only)

The activation of the first current half cycle can be limited in order to protect the weld transformer and the thyristor power supply unit.

Example: A command value of 55 scale units means that

- in welds with smaller command currents (0 to 55 scale units), the 1st half cycle is not affected
- with higher command currents (> 55 scale units), the 1st half cycle is limited to 55 scale values.

For programming you have 2 parameters at your disposal:

- ”Limit 1. half cycle”:
  Parameter affecting the entire module.
  Only the first half cycle of a weld is limited.
- ”1. Half-cycle after cool time”:
  Can be set separately for each welding program.
  The first half cycle of each weld time or each impulse is limited if previously a cool time has been programmed > 0.

Timer functions

3.10 Automatic Spot Repetition

This function serves to reduce necessary user intervention in the case of occasional ”current too low...” or ”no current...” welding faults.

Conditions:

- Current monitoring is activated **and**
- the function ”monitoring stopped” is switched off.

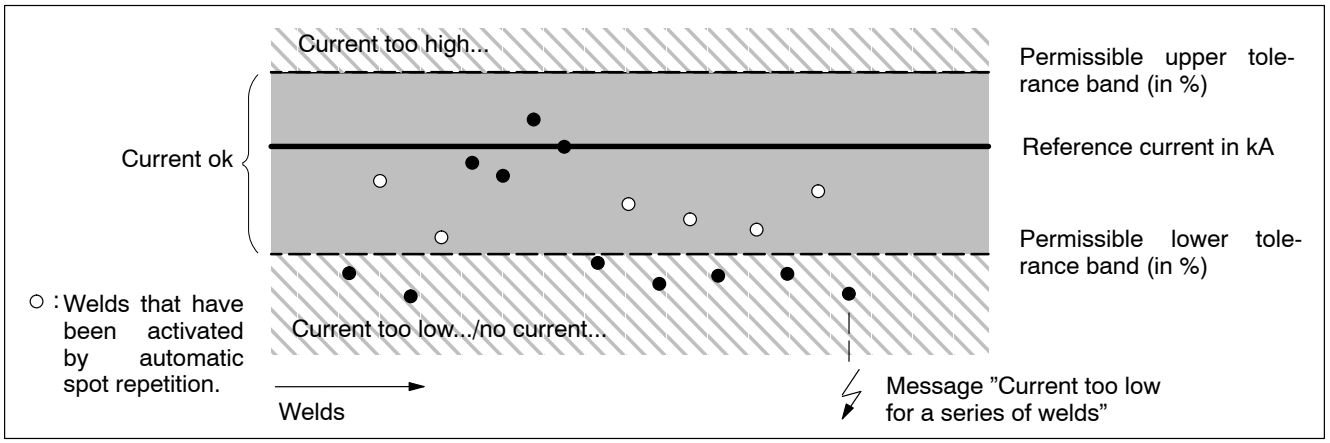
The function ”Automatic spot repetition” can be switched on and off separately for each welding program via the parameter ”Spot Repeat”.

If the automatic spot repetition is activated, the timer is able to repeat - starting with the SQZ - an erroneous welding process automatically once, in case of a ”current too low...” or ”no current...” message. In this case, the gun remains closed after the erroneous process and programmed squeeze time, weld times, and hold times are repeated.

If the repetition leads to a correct weld, the welding station continues its normal process afterwards. If during repetition, another error is detected, a corresponding message will be displayed (”Current too low...”, ”no current...”).

If automatic spot repetition is activated, bad fittings or not perfectly lying electrodes might lead in extreme cases to a repetition of each single spot weld. I.e.: the clock time might increase very fast and maybe even unnoticed.

Therefore, the timer provides the parameter ”Max. repetition” (highest permissible amount of spot repetitions in sequence).
An internal counter will always be reset to 0 if a welding process has been successful straight away. Otherwise, if the value falls below the ”permissible lower tolerance band” and the automatic spot repetition is activated, the counter will be incremented.
Automatic spot repetition will only take place if the internal counter value is smaller/equals the ”max. repetition” parameter. If this is not the case, the timer generates the message ”Current too low for a series of welds”.



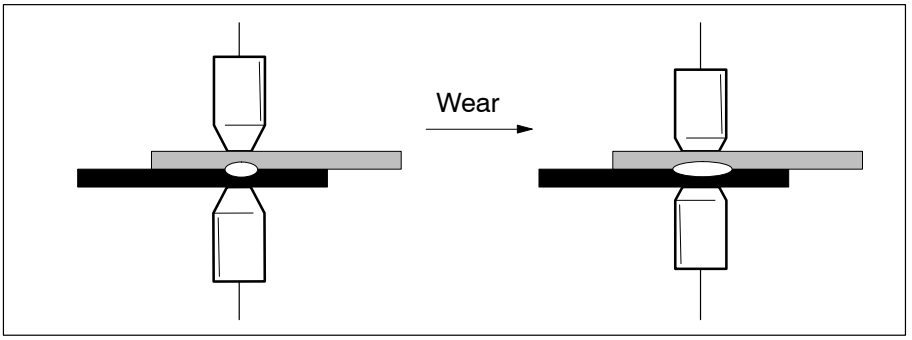
Example: Principle of the automatic spot repetition with ”max. repetition” = 4

Timer functions

☞ **Messages can be defined either as a ”fault” or as a ”warning”. An event that has been defined as a ”warning” does not lead to a blokking of the timer. A ”fault” though always requires a ”Fault reset” (see page 6-6) in order to start the next welding process.**

3.11 Electrode Maintenance

During their life, electrodes are subject to a process-related wear (see chapter 3.11.1) which can be noticed by e.g. an enlargement of the electrode’s contact point.



Enlargement of the contact point caused by electrode wear

To compensate for this effect, the timer provides two different procedures:

- ”Automatic stepper” (refer to page 3-27) and
- “Electrode tipdressing” (refer to page 3-27).

Both procedures can be activated either separately or combined.

3.11.1 Wear Factor and Wear per Welded Part

The wear of the electrodes depends on different factors, like e.g. programmed current, thickness and material of the welded part.

As long as you perform welds of only one type of material with the same thickness and the same current during the life of an electrode, it can be easily predicted, after how many welds the electrode is worn and must be exchanged. The electrode wear can be displayed by means of a ”spot counter”. The spot counter will be incremented by ”1” after each performed welding process.

If the parts that are welded during an electrode life consist of different materials or different gauges, the wear per spot weld is not constant. In this case, a spot counter is not sufficient anymore.

Therefore, the wear of an electrode in the timer is monitored via a ”wear counter”.
To do so, the timer increases the wear counter by the ”wear factor” after each welding process. The wear counter cannot only be incremented by ”1” (as for the spot counter), but by any value.
Since you can enter the right wear factor for the weld in each program, a correct measurement of the electrode wear is guaranteed.

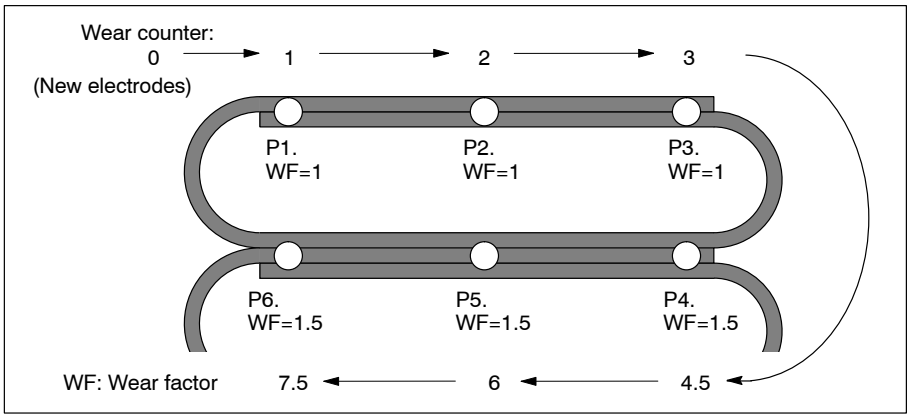
Wear per part

Via the parameter ”Wear/Part” you can enter the electrode wear that is caused by the welding process of one single piece. With this variable, the timer can calculate how many pieces can be welded with the electrode until the end of stepper (maximum electrode life). The amount of the remaining parts will be displayed in the ”Prewarning table” (see page 3-28).

Example:

A piece needs 6 welds.
Each spot weld (P1 to P6) is produced by a separate welding program (Prog1 to Prog6).
For the upper spots (P1 to P3), 2 sheets must be welded, for the lower 3 spots (P4 to P6) 3 sheets.
The electrode wear for the spot welds P4 to P6 is higher (thicker material). Therefore, the program-specific wear factor in Prog1 to Prog3 must be programmed with ”1”, while the wear factor in Prog4 to Prog6 is ”1.5”.
The wear per piece is therefore 7.5.

☞ **The wear factors in this example have only exemplary meaning. In reality the wear factors for the materials and gauges in use will be calculated in advance.**



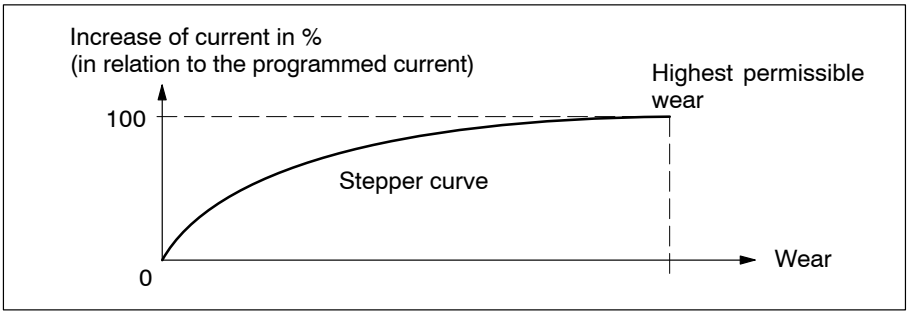
Example: Calculation of the wear

Timer functions

3.11.2 %I Stepper (Stepper)

The stepper function keeps the current density in the spot weld constant while during the electrode's life, the spot weld becomes larger and larger.

To do so, you can define separate stepper curves for up to 10 different electrode types. A stepper curve determines the percentage with which the programmed command current should be increased automatically in dependence of the current electrode wear.



Principle: %I stepper

☞ **The resulting current modifications can be monitored by the function "Monitor Stepper" (refer to page 3-21).**

3.11.3 Electrode Tipdressing

With electrode tipdressing you can periodically restore the desired contact area during the electrode's life.

Therefore, after a certain wear, the electrodes must be treated in a tipdressing station for electrodes.

The timer uses the output signal "tipdress request" (see page 6-17) to request electrode tipdressing.

The additional possibility to define up to 10 different tipdressing curves offers a perfect adaptability to different types of electrodes. A tipdressing curve determines the percentage with which the programmed command current should be increased automatically in dependence of the current electrode wear.

☞ **The resulting current modifications can be monitored by the function "Monitor Stepper" (refer to page 3-21).**

☞ **The initial dressing function can be activated via parameter "tipdressing of new electrodes".**
If initial dressing is activated, the timer requests immediate tipdressing if an electrode has been exchanged (refer to "Initial dressing request", page 6-13).
With freshly inserted electrodes this serves e.g.
- to create a defined weld spot diameter
- to create a defined contact angle
- to eliminate a protective sheet.

Timer functions

3.11.4 Prewarning and End of Stepper

When the highest tolerable wear has been reached, new electrodes must be inserted.

Here, the output signals

- ”Prewarning” (see page 6-18) and
- ”End of stepper” (see page 6-18)

are at your disposal. They shall only be used if the electrode maintenance functions are activated (parameter ”Stepper”: ON).

3.11.5 Prewarning Table

The prewarning table offers you an overview with fast access to all important information and operations regarding electrodes with an activated electrode maintenance function:

- Weld timers, to which the individual electrodes have been assigned.
- Current wear (in percent, numerical, and graphical).
  The graphic illustration is color coded. This way, upcoming prewarnings, tipdress requests, or the end of stepper can be easily recognized.
- Remaining parts that can still be welded with the relative electrode.
- Reset of one or more wear counters after the cap has been exchanged.

3.12 Electrode Force

The indication which force the electrodes shall use to press the welded parts together (in kilonewton: kN) is part of any welding program.

Therefore, the timer generates - with an internal characteristic curve - for each programmed force value a corresponding output signal that can be used as an actuating variable for the electrode’s force.

In order to output the force actuating variable,

- an analog signal is at your disposal at X2. For more information, please refer to page 5-7.

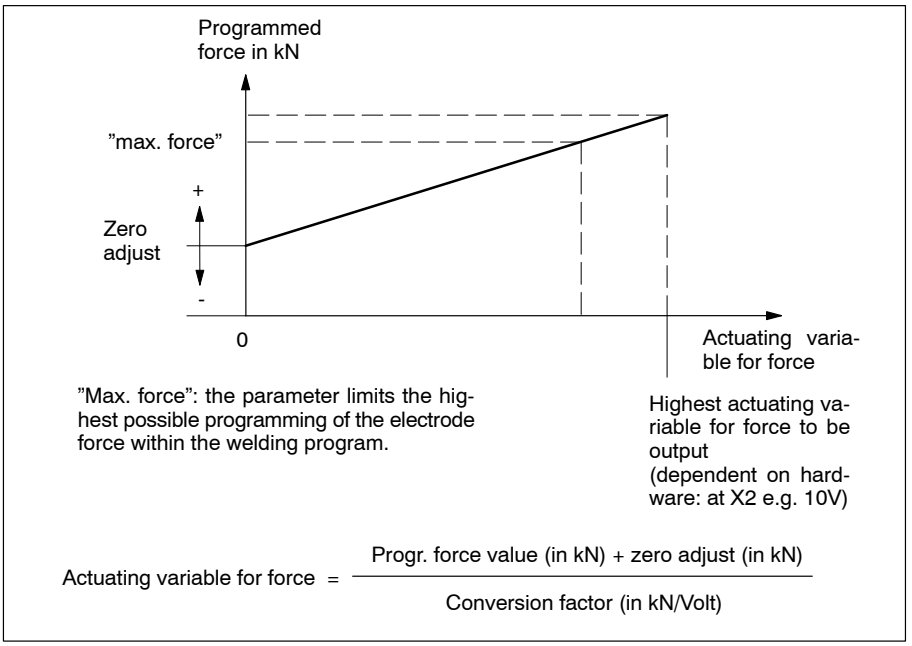
The internal characteristic curve can be created either

- automatically by force scaling (please refer to chapter 3.13.1, page 3-30 ff).
  or
- manually with the parameters ”conversion factor” and ”zero adjust”.

Timer functions

”Conversion factor” (in kN/Volt):
With this factor, the timer calculates the output value of the actuating variable for the force. See illustration.

”Zero adjust” (in kN):
Moves the zero crossing of the characteristic curve. This way the characteristic curve can be adapted to the working zero of the actuator system in use. See illustration.



Characteristic curve for output of force value

☞ **In order to make the programmed force work on the electrodes, it is necessary to set the characteristic curve properly!**

☞ **During force scaling, the timer automatically calculates the necessary values for the parameters ”conversion factor” and ”zero adjust”. After that, the parameters may not be altered manually!**

In addition to the possibility to program an electrode force that is constant for the entire welding process, the timer also offers the following functions:

- Force profile:
  It is possible to program 10 different force values for each welding program. These force values can then be activated at certain times within the welding process.
- Force Stepper:
  Depending on the selected stepper or tipdress curve, you can determine the percentage with which the programmed basic force value should be increased in dependence of the current electrode wear.

Timer functions

3.13 Scaling

☞ **Always scale the force first, then the current!**

3.13.1 Force Scaling

With the function ”force scaling”, you adjust all components of the welding station that are part of the force build-up to their reference dynamometer (e.g. force transducer). This bears the following advantages:

- Presetting the gun force in kilonewton (kN)
- Exact reproducibility of logged force values (ISO 9000)
- Force values of all scaled stations can be compared to each other and transferred to other stations
- Comparable documentation.

☞ **Basically, the timer also works without force scaling. But you can only benefit from the above mentioned advantages after a force scaling procedure.**

CAUTION
Gun damages possible!
If you don’t use force scaling, the timer cannot make a correct connection between the programmed force and the actuating variable for force that is to be output (necessary for controlling the force of the gun).
Therefore, the force that actually works on the gun can deviate immensely from the programmed force.
The consequences might be erroneous welds and even damages to the gun.
If you don’t use the force scaling function, it is absolutely necessary to calculate empirically, after each gun exchange, the basic force value for each required electrode force - starting with the value ”0”.

Prerequisites for force scaling:

- Proportional control valve, servo gun, or other suitable equipment that can convert the timer’s actuating variable for force into a mechanical force at the gun.
- External reference dynamometer with appropriate measuring range.

Timer functions

For force scaling, preset 2 different force actuating values in % (in relation to the highest value that can be output), use the reference dynamometer to measure the resulting forces between the electrodes, and enter the measured forces (in kN) into the timer.
The timer then calculates internally all data necessary for the adjustment.

When executing the force scaling function, please pay special attention to the following:

★ For the two actuating values used for force scaling, the following is applicable:
If possible, the higher value shall generate the maximum force used for welding (upper end of the force working range).
Both values should differ from each other by at least 20%. The force required for electrode tipdressing is not to be assigned to the normal working range (because most of the times it is lower).
If you do not know which value is to be entered for force scaling, use small values to execute sample scalings in order to see which forces will be generated at the gun. This way, you make sure not to overstress or damage the gun when force scaling. Then, slowly increase the preset value while executing further force scalings until the higher preset value generates the maximum force that you can use for welding.

★ Please use for all comparable stations the same reference dynamometer.

★ Execute for each gun in the welding station and after each gun exchange a scaling procedure.

★ Verify an executed scaling by comparing the basic force values programmed in test welding programs with the actual values at the gun.
Make sure that the test programs run **without current** and that people are safe during the measurements (possible danger caused by robot movements).

★ Execute a new scaling if a component actively participating in force generation (weld timer, proportional control valve, gun...) has been exchanged.

☞ **Force scaling changes the parameter ”Conversion factor” and ”Zero adjust” (in electrode setup, also refer to page 3-28). Therefore, after a force scaling procedure, the parameters may not be manually altered!**

Timer functions

3.13.2 Current Scaling

The function ”Current scaling” serves to adapt the timer’s entire measuring and control loop to your reference welding current measuring instrument. This bears the following advantages:

- Reproducible, presettable currents with a maximum error below +/-2%
  (in relation to the current value of the reference welding current measuring instrument)
- Exact reproducibility of logged current values (ISO 9000)
- Currents of all scaled stations can be compared better to each other and transferred to other stations
- Comparable documentation.

☞ **The timer also works without current scaling.**
But you can only benefit from the above mentioned advantages after a current scaling procedure.

Prerequisites for current scaling:

- A current sensor connected to X3 (see page 5-10).
- External reference welding current measuring instrument with current sensor.

☞ **Before executing a current scaling always execute a force scaling procedure (see page 3-30).**

For current scaling, preset 2 different currents in scale values, then use the reference welding current measuring instrument to measure the resulting currents in the secondary circuit, and enter the measured current values into the timer.
The timer then calculates internally all data necessary for the adjustment.

When executing the current scaling function, please pay special attention to the following:

★ Make sure that the current sensor of the reference welding current measuring instrument is installed correctly in the secondary circuit. This means:
- always install it in the same place
- install it vertically with regard to the current carrying conductor
- the sensor cable faces away form the current carrying conductor.

★ For the two currents (in scale values) used for current scaling, the following is applicable:
If possible, the higher value should lie at the upper end of the normal working range of your weld station.
Both values should differ from each other by at least 20 scale values.

Timer functions

★ Please use for all comparable stations the same reference welding current measuring instrument.

★ Set your reference welding current measuring instrument to the right type of current (”AC” for PST, ”DC” for PSI) and set the appropriate measuring range.

★ Programmed fade-out times and an activated trail current are also effective during current scaling!
Therefore, prior to the scaling procedure, please check if the corresponding functions are available and correctly set in your measuring instrument.

★ Always scale without a welded part and with closed electrodes.

★ Execute for each gun in the welding station and after each gun exchange a scaling procedure.

★ Verify an executed scaling by doing a test weld comparing the current shown in the timer with the current shown in the reference welding current measuring instrument.

★ Execute a new scaling if a component actively participating in the control loop (weld timer, transformer, sensor...) has been exchanged.

Timer functions

3.14 Corrections

The timer's correction functions allow

- changes of current and
- changes of force (electrode force).

This way you can quickly execute process-related adjustments and adaptations of the welding process without changing the originally programmed data. The corrections function as an addition to the programmed basic values.

You can activate both types of correction

- for a certain electrode/gun (= Corr. (E)) and
- for individual programs or individual program sectors (= Corr. (P)).

☞ **When the current correction is changed, the reference current that is to be monitored will also be internally adjusted.**

☞ **The correction values can be limited in the basic settings. This limit can be set within the range of +/-20%.**

3.15 Weld Transformer Selection (PSI only)

In order for the PSI's power supply unit to function correctly, the timer must "know" certain technical data about the weld transformer in use. Therefore, the proper setting of certain parameters in the "Weld Transformer Selection" is necessary:

When using PSG weld transformers:

- "Type":
  Model of the PSG transformer according to name plate (e.g. "PSG 3100.00") and
- "Number":
  Number of parallel transformers.

With this data, the PSI knows the type of the diodes, the diode selection, and the highest permissible current for the welding station.

When using other weld transformers:

- "Type":
  Please switch to "Other transform.".
- "Number":
  Number of parallel transformers.

Timer functions

- ”Transformer secondary current”:
  Maximum secondary current of the transformer. The maximum welding current is limited to this value.
- ”Transformation ratio”:
  Transformation ratio primary/secondary. This parameter is necessary for converting primary and secondary current if for current measuring you use the current sensors integrated in the primary circuit (primary current regulation; used e.g. with transformers without integrated KSR sensor).
- ”Number of diodes”:
  Number of diodes connected in parallel in the secondary circuit.
- ”Type of diodes”:
  Type of diodes used in the weld transformer.

Diode monitoring:

The parameter ”diode monitoring” is used to switch the monitoring function of the weld transformer in the secondary circuit on and off.

CAUTION
Destruction of the power supply unit and/or the weld transformer is possible!
If diode monitoring is switched off, the PSI ceases to monitor the diodes in the weld transformer. Under a high load this can lead to major damages to the welding station.
Therefore, always turn diode monitoring on!

Timer functions

Notes:

4 Technical data

4.1 Integrated weld timer

Degree of protection	IP 20
Operating voltage	+24 V_{DC} ; +20 %, -15 % with max. +/-5 % ripple
Rated current at 24 V (without I/O module and without additional consumers at X5)	PSI: approx. 1.5 A PST: approx. 1.0 A
Starting current (without I/O module and without additional consumers at X5)	PSI: approx. 2.0 A for 10 ms PST: approx. 1.5 A for 10 ms
Operating temperature Temp. for storage/transportation Air pressure Humidity Climatic category	0 ... +55 °C -25□.. +70°C 0 to 2000 m above sea level condensation not permissible. 3K3 to EN60721-3-3
Number of programs	max. 256; the programs can be referenced via the spot assignment
Programming on location	V24/RS232 interface, isolated. X1 connection: 9-pin D-Sub
Fieldbus for programming (option)	PROFIBUS-FMS or INTERBUS-PMS or Ethernet
Operating software (firmware)	Stored in Flash-Memory; can be loaded via ”WinBlow” software package (optional)
Program memory	buffered RAM memory
Backup battery	Lithium battery Type AA 3.6 V to buffer RAM data and internal clock with MAINS OFF. Battery life approx. 2 years.
Pressure control for proportional valve	analog output (at X2): 0 to +10 V, max. 20 mA or 0 to 20 mA or 4 to 20 mA (at max. 500 ohms). Input feedback (at X2): logic 1: +16 V ... +30 V, 20 mA logic 0: -1 V ... +4 V
Electrodes	max. 32 (no. 0 to no. 31)

Technical data

4.2 I/O Module ”DEV-NET”

Function:

Connection of the timer’s I/O to the higher-level PLC or the robot

- via DeviceNet with bus copper cable (serial I/Os) and
- via discrete 24 V signals at X11 and X12 (parallel I/Os).

Operating voltage (at X10)	+24 V_{DC} +20 %, -15 % with max. +/-5 % ripple
Current input	max. 2 A depending on the wiring of the signal in-/outputs
Power loss	0.5 VA per active input 2.4 VA per active output
Signal input field via DeviceNet	4 byte, max. 32 signals (0 to 31)
Signal output field via DeviceNet	4 byte, max. 32 signals (0 to 31)
Signal inputs (X12)	logic 1: +16 V ... +30 V, 20 mA logic 0: -1 V ... +4 V
Signal outputs (X11)	+24 V, max. 0.1 A, short circuit-proof

5 Electrical connection

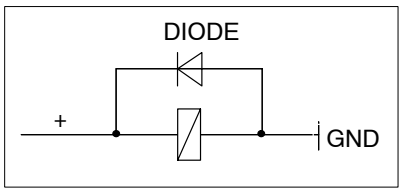
5.1 Suppression of RF noise

Interferences (RF noise) are caused by transient peaks and can be spread into the timer either directly or by coupling via connecting lines. Therefore, interference suppression measures are necessary.

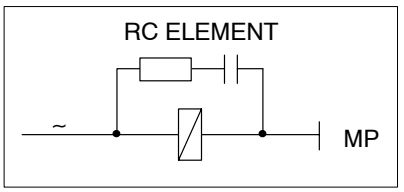
★ Eliminate interferences already at their source. If this is not possible, install the interference suppression devices as close to the interference source as possible.

★ Make sure that all components that contain inductivities or switch elements are properly cleared.

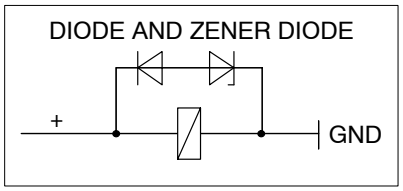
★ Install interference suppression devices always in such a way that they cannot break since machines are often subject to strong vibrations.



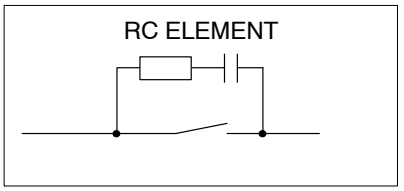
Diode, suitable for small DC relays



RC element for AC relays and AC motors



DI-ZD attenuation element for large DC contactors and defined drop-out times



RC element for spark quenching of inductive loads

Examples of interference (noise) suppression

☞ **The following table is only an example. The dimensions of the necessary modules depend on the actual load ratios.**

	Resistor	Capacitor	Diode
24 V_{DC}	-	-	1 N 5060/ZL 12
48 V_{DC}	-	-	1 N 5060/ZL 22
110 V_{AC}	220 ohms / 1 W	0.5 µF 400/600 V	
220 V_{AC}	220 ohms / 5 W	0.1 µF 500 V	
440 V_{AC}	220 ohms / 5 W	0.1 µF 1000 V	

Electrical connection

5.2 Integrated weld timer

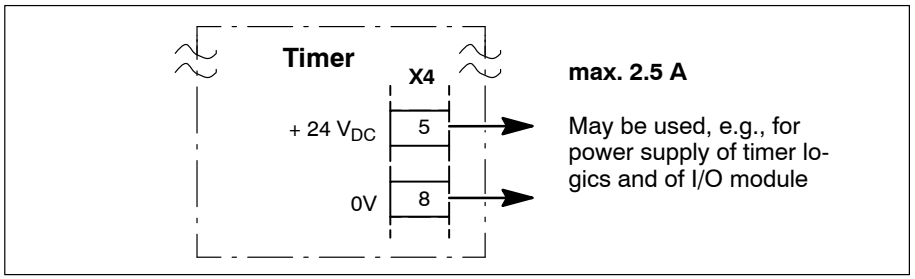
☞ **For technical data, please refer to chapter 4.1, on page 4-1.**

5.2.1 Output of the Internal 24 V_{DC} Voltage Source (X4)

Connection:	at X4; plug-in terminal, spacing 3.5 mm, 14-pin, max. 1.5 mm^2. Mating connector included in shipment.
Cable length:	(From the voltage source to the consumer) max. 10 m with 0.75 mm^2 max. 75 m with 1.5 mm^2
Type of cable:	unshielded, VDE 0281, 0812 (e.g.: Ölflex)

At X4, a 24 V_{DC} supply voltage that the power supply unit derives from the mains voltage is at your disposal.

☞ **The supply through the internal 24 V_{DC} voltage source and therefore the functionality of all devices fed from this source is guaranteed only if mains voltage is applied at the mains input of the power supply unit!**



Internally generated 24 V_{DC} power supply

★ Please consider the following facts when using the internal 24 V_{DC} voltage source:

- max. current load: 2.5 A
- When supplying the timer logics:
  If you switch off the mains voltage at the mains input of the power supply unit, you automatically switch off the timer as well. In this state,
  - neither programming, diagnosis, or visualization via the timer
  - nor communication between timer and PLC/robot is possible.
- When supplying the I/O module:
  If you switch off the mains voltage at the mains input of the power supply unit, you automatically switch off the I/O module as well. In this state,
  - communication between timer and PLC/robot is not possible anymore.

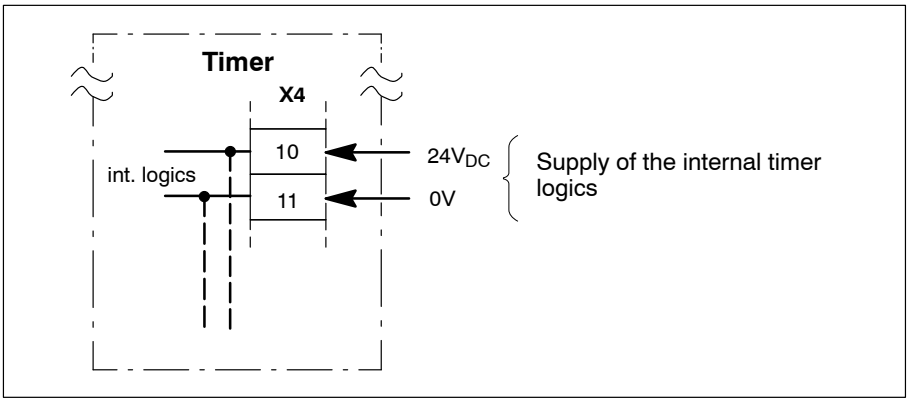
☞ **If the above describe facts are not compatible with your application, the 24 V_{DC} supply of timer or I/O module must be provided by external power supply units.**

Electrical connection

5.2.2 Supply of the Timer Logics (X4)

Connection:	at X4; plug-in terminal, spacing 3.5 mm, 14-pin, max. 1.5 mm. Mating connector included in shipment.
Cable length:	(From the voltage source to the consumer) max. 10 m with 0.75 mm^2 max. 75 m with 1.5 mm^2
Type of cable:	unshielded, VDE 0281, 0812 (e.g.: Ölflex)

The timer logics must be supplied with 24 V_{DC}.



Logics supply input of the timer

The remaining wiring of X4 determines which voltage source supplies the timer. You can select

- either the internal voltage source (refer to page 5-2) or
- an external power supply unit.

To do so, you only have to set/remove some jumpers at X4.

☞ **For more information about the interconnections of X4, please refer to chapter 5.2.4 on page 5-4 ff.**

While a supply through the internal voltage source is preferred in standalone installations (e.g. suspended welding station; additional 24 V_{DC} power supply units are not necessary), a supply via external power supply units is mainly used in networked timers (timer can be programmed even if the welding network has been switched off e.g. via the line PC).

★ If you use external voltage sources, please make sure that they are specified as ”safely separated” according to the Low-Voltage Directive (72/23/EEC, 93/68/EEC and 93/44/EEC)!

Electrical connection

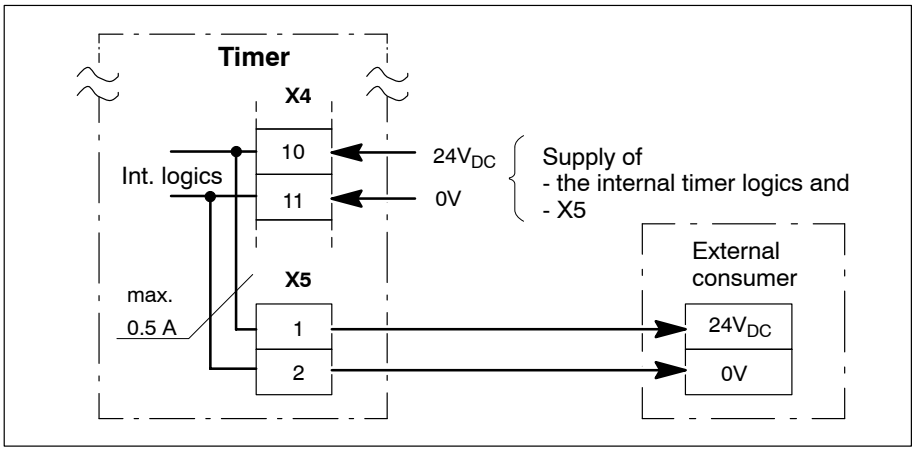
5.2.3 Supply of External Devices (X5)

Connection: at X5; plug-in terminal, spacing 3.5 mm, 2-pin, max. 1.5 mm^2.
Mating connector included in shipment.

Cable length: Depends on the wiring at X4. See description below.

Type of cable: unshielded, VDE 0281, 0812 (e.g.: Ölflex)

X5 is at your disposal for the 24 V_{DC} supply of an external device (e.g. force sensor).
The maximum current load/cable length at X5 depends on the voltage source in use and the entire length of the cable between source and external consumer. The maximum current load at X5 must not exceed 0.5 A.



Connection of external devices to X5

★ Make sure not to exceed the limit values specified for current load (source, connections) and cable lengths!

☞ **The remaining wiring of X4 determines which voltage source supplies X5.**
You can use either the internal voltage source (see page 5-2) or an external power supply unit. To do so, you only have to set/remove some jumpers at X4.
For more information about the interconnections of X4, please refer to chapter 5.2.4 on page 5-4 ff.

5.2.4 24 V_{DC} Voltage Distribution (X4)

Connection: at X4; plug-in terminal, spacing 3.5 mm, 14-pin, max. 1.5 mm^2.
Mating connector included in shipment.

Cable length: (From the voltage source to the consumer)
max. 10 m with 0.75 mm^2
max. 75 m with 1.5 mm^2

Type of cable: unshielded, VDE 0281, 0812 (e.g.: Ölflex)

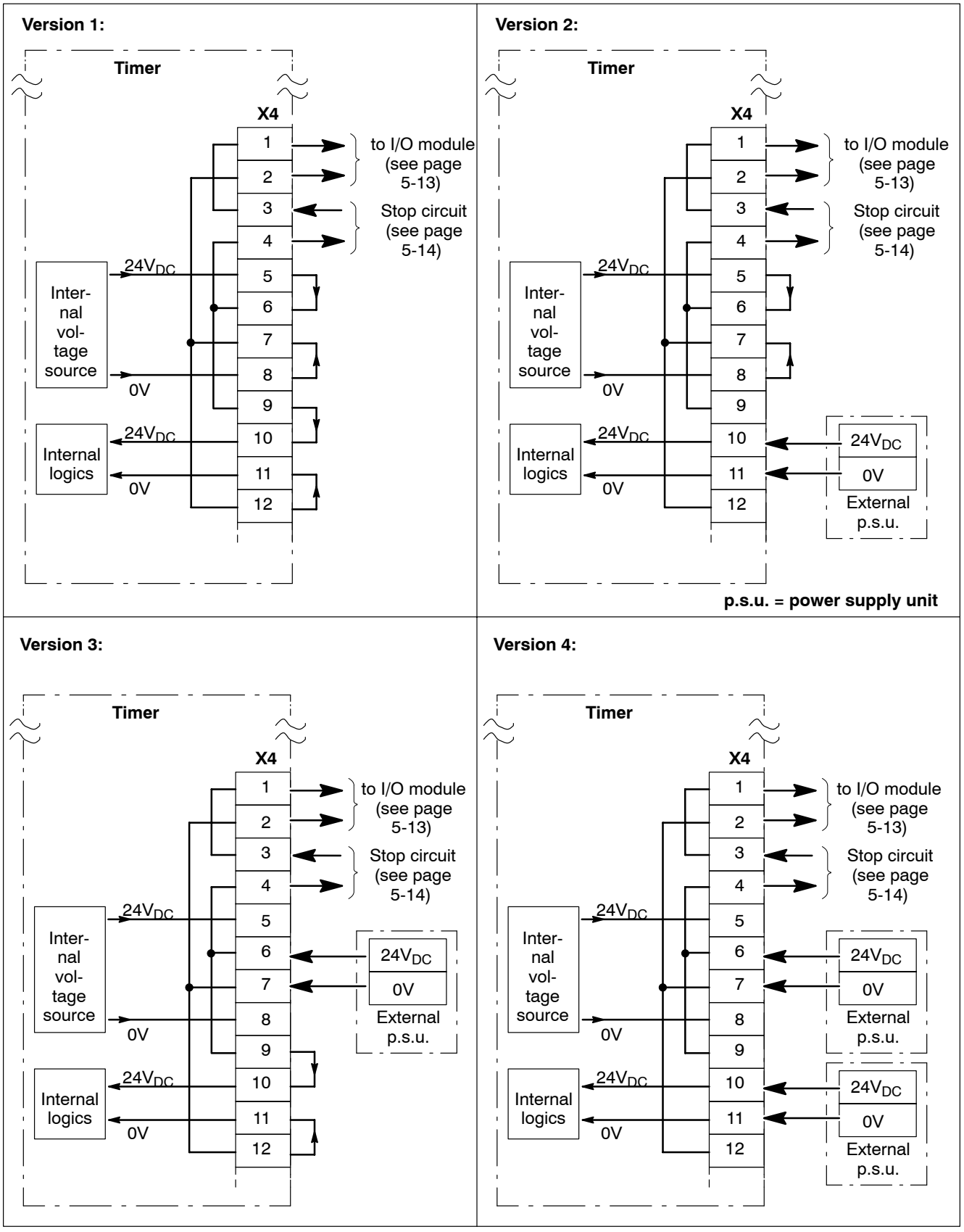
Electrical connection

The internal circuit of X4 facilitates the wiring of the 24 V_{DC} supply branches for the timer and the I/O module substantially. By plugging or removing certain jumpers, you can realize different supply variations without altering the remaining wirings in the switch cabinet.
To do so, connect the relevant voltage source to X4/6 (24 V_{DC}) and X4/7 (0 V).

Below you find descriptions of some possibilities. On the next page, you find the corresponding illustrations representing the appropriate wiring. Which kind of wiring is suitable for you, depends on the requirements of your application.

1. Timer **and** I/O module are fed by an **internal** 24 V_{DC} voltage source.
   Application: Used preferably in standalone installations.
   Advantage: Separate power supply units are not necessary.
   Disadvantage: 24 V_{DC} will only be generated if the mains voltage is present at the power supply's mains input.
2. The I/O module is fed by an **internal** 24 V_{DC} voltage source, the timer is fed by an **external** power supply unit.
   Application: Used in networked installations.
   Advantage: Programming, diagnosis, and visualization are still possible even after the mains voltage at the power supply unit's mains input has been switched off.
   Electrical isolation between timer and I/O module with discrete in-/outputs (parallel I/O) is possible.
   Disadvantage: If you switch off the mains voltage at the mains input of the power supply unit, I/O communication between timer and PLC/robot is not possible anymore.
3. Timer **and** I/O module are both supplied by a **mutual external** 24V power supply unit.
   Application: Used preferably in networked installations.
   Advantage: I/O communication between timer and PLC/robot, programming, diagnosis, and visualization are still possible even after the mains voltage at the power supply unit's mains input has been switched off.
   Disadvantage: Electrical isolation between timer and I/O module with discrete in-/outputs (parallel I/O) is not possible.
4. Timer **and** I/O module are both supplied by **separate external** 24V power supply units.
   Application: Used in networked installations.
   Advantage: I/O communication between timer and PLC/robot, programming, diagnosis, and visualization are still possible even after the mains voltage at the power supply unit's mains input has been switched off.
   Electrical isolation between timer and I/O module with discrete in-/outputs (parallel I/O) is possible.
   Disadvantage: 2 external power supply units are necessary.

Electrical connection



Examples for wiring

Electrical connection

5.2.5 Pressure Control and Feedback (X2)

Connection:	at X2; plug-in terminal, spacing 3.5 mm, 5-pin, max. 1.5 mm^2. Mating connector included in shipment.
Cable length:	max. 50 m with 0.5 mm^2 max. 100 m with 0.75 mm^2
Type of cable:	shielded (e.g.: NFL 13, Metrofunk; LiYCY)

An analog output signal that can be used for controlling a proportional control valve is at your disposal at X2. The type of the output signal can be alternatively programmed as

- a voltage signal (0 to +10 V, max. 20 mA),
- a current signal 0 to 20 mA or
- a current signal 4 to 20 mA.

The proportional control valve converts the pending signal into a pressure which will be applied to the gun cylinder. According to the mechanics of the gun, this will result in the force available at the electrodes (see also page 3-28).

☞ **The output signal at X2 will be output immediately after the selection of a welding program and not only upon its start!**

In order to signal to the timer that the gun is closed or that the command force has been reached, you use

- the input terminal 4 at X2.

The programmed squeeze time (SQZ) starts under the following condition only:

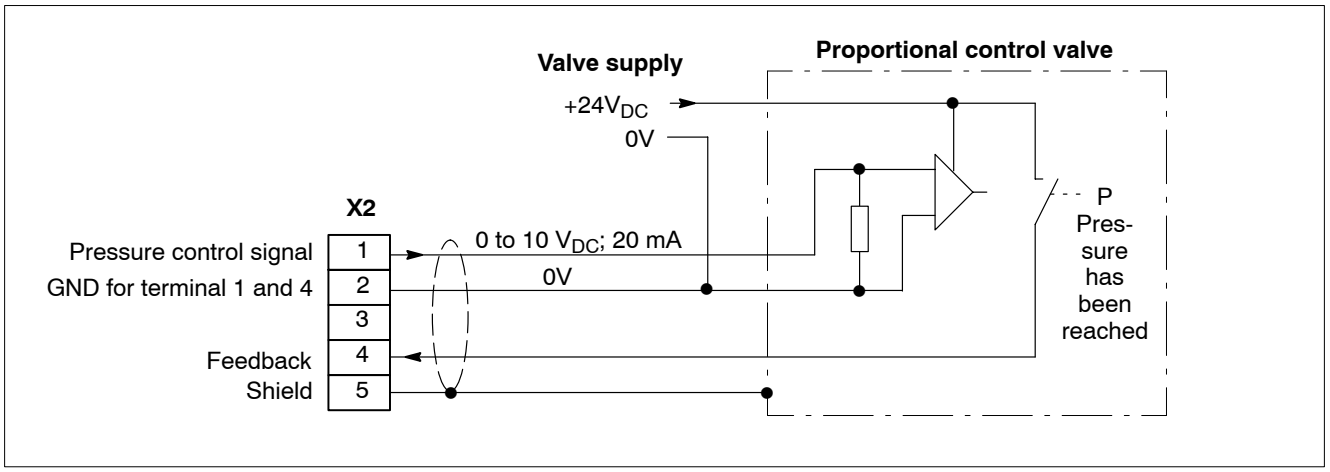
- High level at input X2/4 (in relation to 0V at X2/2)
  (for required voltage, please refer to chapter 4.1, on page 4-1).

If this condition is missing, the welding program will be selected and started (and a possibly programmed 1. SQZ will begin), but the further processes (schedule) will be delayed until this one condition is met.
After a waiting period of 5 seconds, the schedule will be interrupted with the message ”No welding pressure”.

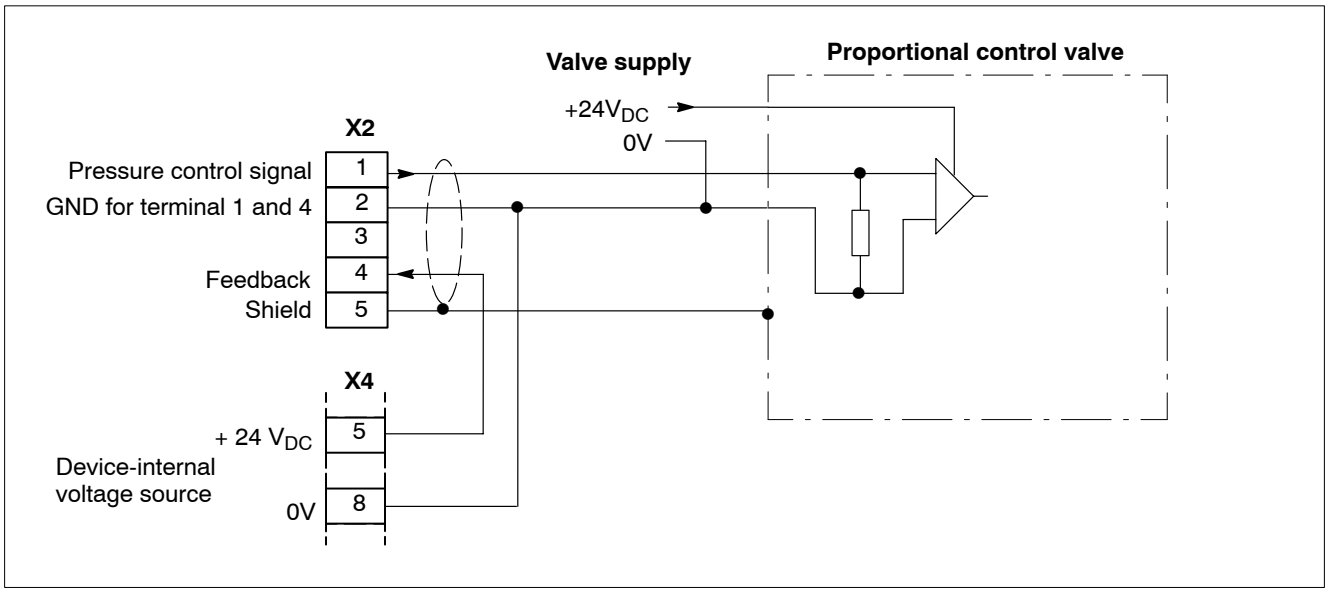
Which sensors and input signals are used for feedback depends on the application. The entire pressure control and feedback e.g. can also be handled via PLC program (if proportional control valve and feedback are not connected to the timer itself but to the PLC or the robot).
In addition, applications without feedback or proportional control valve are possible as well.
The following illustrations represent several connection possibilities.

Electrical connection

★ Make sure that in installations without feedback signal, the welded part has been perfectly pressed together before the weld time starts!
In order to do so, you have to program sufficiently long squeeze times.
Insufficient squeeze times lead to a large amount of welding splashes!
This might lead to damage to the electrodes and work pieces.



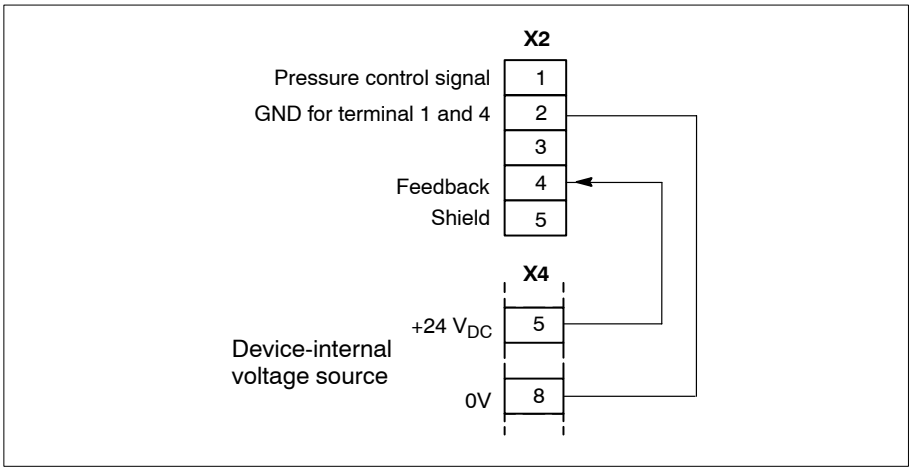
Connection of a proportional control valve with feedback



Connection of a proportional control valve without feedback

☞ **The connection ”without feedback” is applicable if**
- you don’t use the feedback function or
- if the feedback signal is connected to the PLC/robot.

Electrical connection

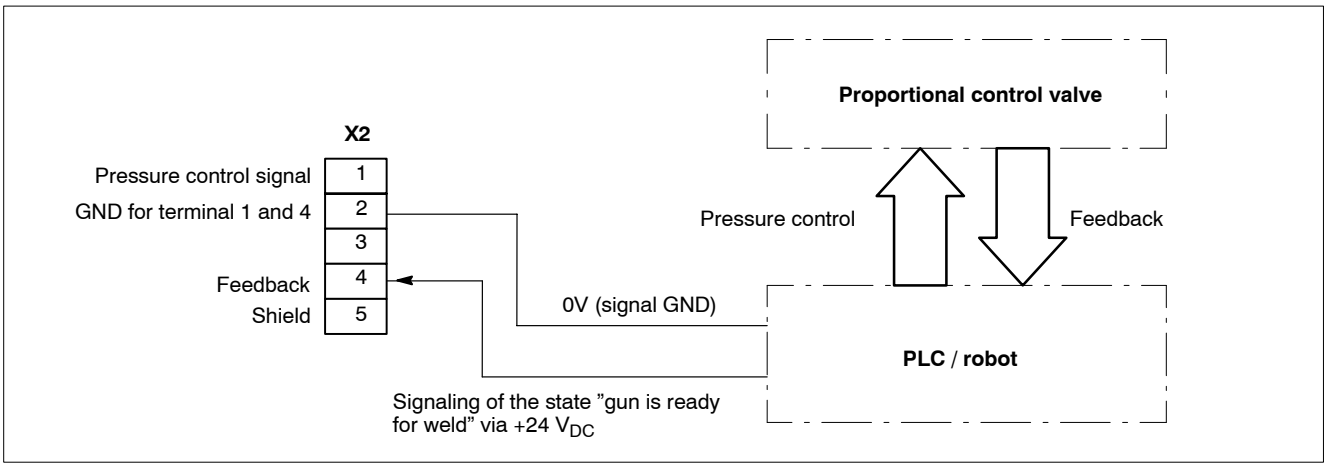


Wiring without proportional control valve

☞ **The connection "wiring without proportional control valve" is applicable if**
- you don't use a proportional control valve or
- the proportional control valve and the feedback signal are connected to the PLC/robot.

★ If pressure control and feedback are completely handled by the PLC program, the PLC/robot must make sure that the programmed weld time will be started only if the gun/electrodes are in proper condition.
To do so, two solutions are possible:

1. The PLC informs the weld timer via input X2/4.
   With this solution, the welding program will be started, but the SQZ starts running only when a "high" level is available at the input mentioned.



Wiring for timer types with pressure feedback via input X2/4

2. The PLC starts the welding program only if the proper condition of the gun/electrodes can be guaranteed.
   With this solution, always program the lowest SQZ in all welding programs (PST: 1 line cycle; PSI: 16 ms).

Electrical connection

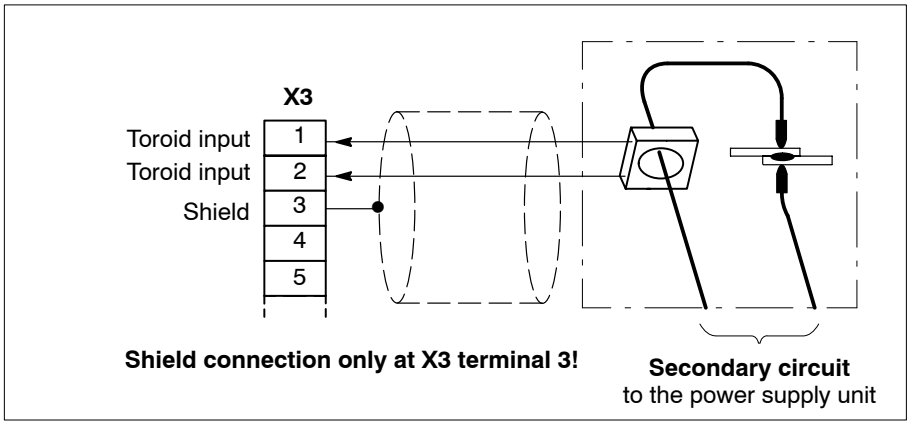
5.2.6 KSR Sensor (X3)

Connection:	at X3; plug-in terminal, spacing 3.5 mm, 8-pin, max. 1.5 mm^2. Mating connector included in shipment.
Cable length:	max. 100 m (with recommended type of cable)
Type of cable:	shielded, core cross section min. 0.75 mm^2, (e.g.: 2 x 2 x 0.75 mm^2 LiYCY, Bosch order no.: 1070 913 494)

The timers are provided with an integrated Constant Current Regulation (KSR). The timer controls the current flow in the secondary circuit so that the programmed command current can actually be reached.
This way, it is possible to compensate process- and handling-related fluctuations of the contact resistance between electrode - workpiece - electrode.

A sensor which indicates the current flow in the primary and secondary circuit of the welding transformer is required for the regulation.
A current sensor installed in the secondary circuit can be connected via the toroid input (X3; terminal 1 and 2).

☞ **PSI devices have an additional integrated current sensor for the welding transformer's primary circuit. This way, by using the software (BOS), you can switch between secondary and primary measurement.**
In ideal circumstances, the welding current is picked off at the secondary circuit of the welding transformer.
In special cases though (e.g. in case of very long weld times or for temporary bridging in case of a failure of the sensors in the secondary circuit) you can still switch to primary measurement if necessary.



Connection of the KSR sensor on the secondary side

Electrical connection

In order to ensure the proper operation of the sensor, please comply with the following:

★ Install the sensor in such a way that it is safe from damage caused by the work piece and from welding splashes.
Choose places with the highest possible distance to the busbars or high current cables. This reduces the influence of externally originating magnetic induction. Please comply with the above mentioned cable specifications.
Never use magnetizable metal parts for fastening, but preferably copper or brass.

★ Make sure that the current-carrying conductor is lead straight and centrically through the sensor. The voltage induced in the sensor (and therefore the measuring variable) has reached its maximum when the conductor runs vertically to the spanned sensor plane.

★ If the sensor is used in movable equipment (e.g. robots), certain parts of the cables are subject to very strong mechanical stress (e.g. trailing chain).
In such cases, please use appropriate cables and set the connecting lines in such a way that in case of an error, they can be exchanged quickly and easily.

★ Connect the cable shield only at the side where the timer is located!

★ Adjust the timer's entire control loop regularly in order to avoid measuring faults (current scaling). For this purpose, an external reference welding current measuring instrument is required.

During the SQZ, the timer checks, by measuring the ohmic resistance, if the connected measurement circuit is faultless or not. This way, problems in the area sensor - cable - plug can be detected.

The following test criteria apply:

Measured ohmic resistance	Result
< 7 ohms	short circuit of measuring circuit
12 to 950 ohms	measuring circuit ok
> 1100 ohms	measuring circuit open

☞ **Measuring values in between lead to an ambiguously assessable result.**

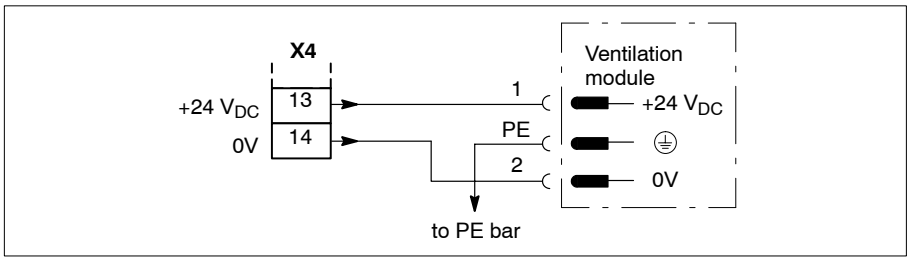
In case of an error, the timer interrupts the welding process and deletes the output signal "Ready".

Electrical connection

5.2.7 Fan Connection (X4)

Connection:	at X4; plug-in terminal, spacing 3.5 mm, 14-pin, max. 1.5 mm^2. Mating connector included in shipment.
Cable length:	max. 10 m with 0.75 mm^2 max. 75 m with 1.5 mm^2
Type of cable:	unshielded, VDE 0281, 0812 (e.g.: Ölflex)

☞ **Not all timers can provide a temperature-controlled 24 V_{DC} connection of an external forced ventilation (max. 2 A). See wiring diagram of the corresponding timer.**
Forced ventilation modules are used in several Bosch 'Schweisskoffer' types.

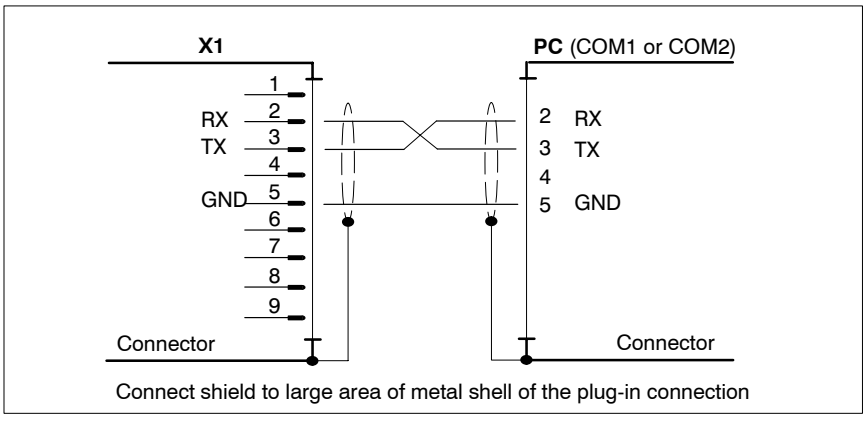


Connection of an external Bosch ventilation module

5.2.8 Programming Device (X1)

Connection:	at X1; D-sub, 9-pin, at the cable via socket
Cable length:	max. 20 m (with recommended type of cable)
Type of cable:	shielded, core cross section min. 0.2 mm^2, Capacity max. 2.5 nF (e.g.: 3 x 2 x 0.2 mm^2 LifYCY, Metrofunk)

For connecting the programming device (PC, Laptop), please use the RS232 interface X1.



Transmission rate:	19200 bits/s
Parameters:	8E1 (8 data bits, even parity, 1 stop bit)
Transmission:	PS5000 block protocol with CRC16

Electrical connection

5.3 I/O Module ”DEV-NET”

Communication between timer and higher-level PLC or robot is primarily handled via DeviceNet (copper cable).
In addition, there are discrete 24 V_{DC} signals available, which can be used via PLC, robot or control panel.
Therefore, the I/O module provides

- 8 inputs (24 V_{DC}, at X12)
- 8 outputs (24 V_{DC}, at X11)
- 4 byte input field (DeviceNet connection)
- 4 byte output field (DeviceNet connection).

5.3.1 Power Supply (X10)

Connection:	at X10; plug-in terminal, spacing 3.5 mm, 4-pin, max. 1.5 mm^2. Mating connector included in shipment.
Cable length:	(From the voltage source to the consumer) max. 10 m with 0.75 mm^2 max. 75 m with 1.5 mm^2
Type of cable:	unshielded, VDE 0281, 0812 (e.g.: Ölflex)

☞ **For further technical data, please refer to chapter 4.2 on page 4-2.**

Two types of connection are possible:

1. Connection of the I/O module supply to X4 of the timer or
2. direct connection of the I/O module supply to a separate 24 V_{DC} power supply unit.

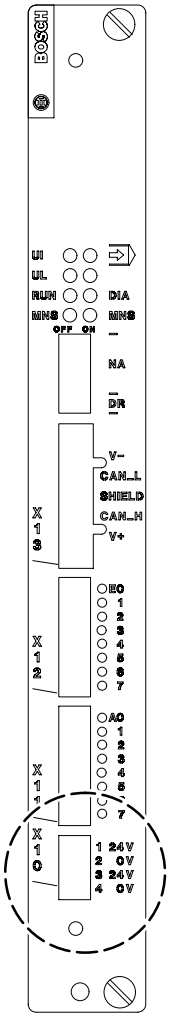
☞ **If you connect the I/O module to the timer’s X4 (1st type of connection), you can use either the internal voltage supply (see page 5-2) or an external power supply unit. To do so, you only have to set/remove some jumpers at X4.**
For more information about the interconnections of X4, please refer to chapter 5.2.4 on page 5-4 ff.

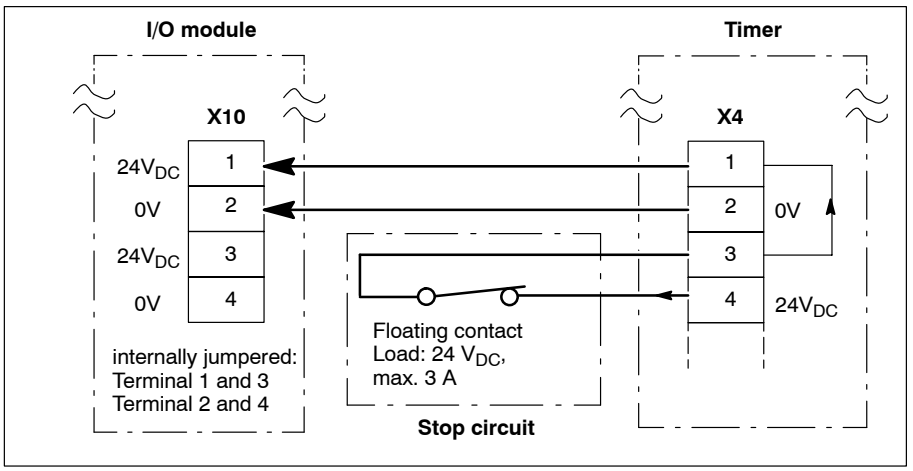
★ Make sure to use only such external voltage sources that are specified as ”safely separated” according to the Low-Voltage Directive (72/23/EEC, 93/68/EEC and 93/44/EEC)!

★ If an electrical isolation between I/O and timer is necessary, the timer and the I/O module must be operated via separate 24 V_{DC} voltage supply units!

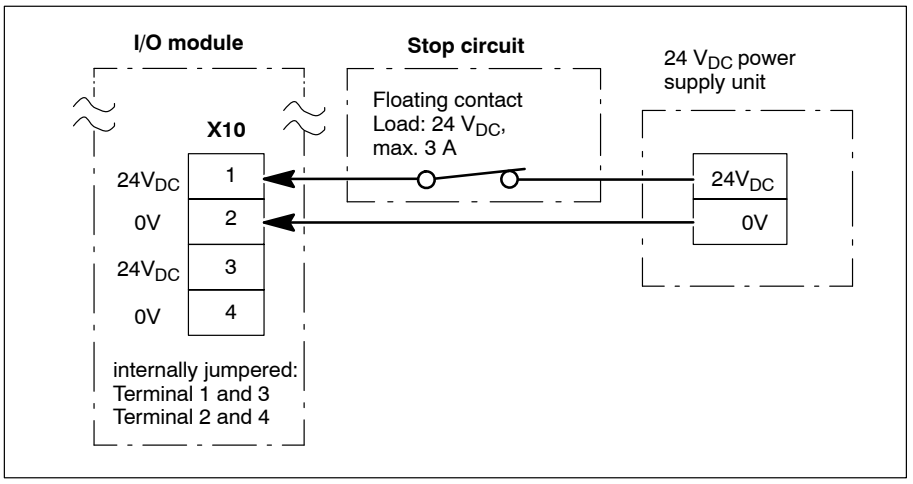
Electrical connection

★ Please make sure that the correct function of the **stop circuit** (see illustrations below) is guaranteed in every connection type!
In dangerous situations at the welding station or in case of intended switch-off of the weld timer, the in- and outputs of the I/O module are to be switched to low level. To do so, an external monitoring device must open the floating contact which then interrupts the power supply at X10.
In case of an open stop circuit, the timer sends the following message: ”Stop circuit open / no 24 V”. This message is automatically reset, i.e. it disappears automatically when the stop circuit is closed.





Connection of the I/O module supply to X4 of the timer



Direct connection of the I/O module supply to a separated 24 V_{DC} power supply unit.

★ Use terminal 3 at X10 as a 24 V source for triggering the inputs at X12.
Use terminal 4 at X10 as a 0 V reference potential at X11.

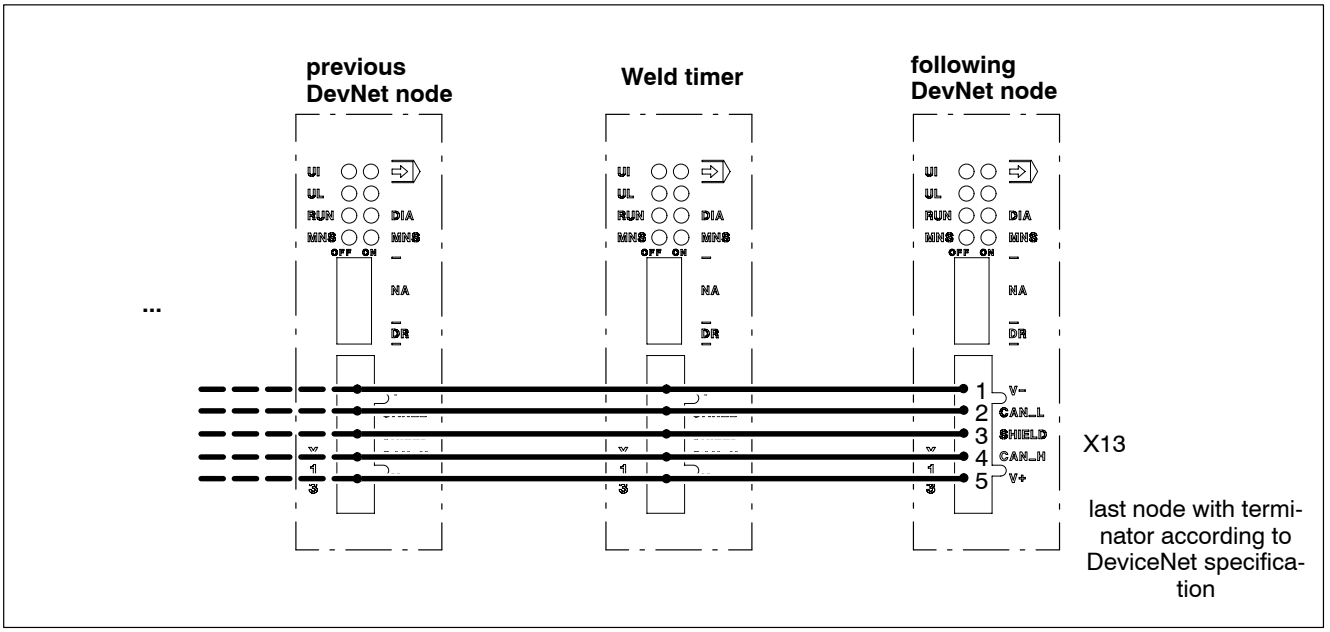
★ Because of the internal jumper at X10, the incoming supply voltage can be transferred to further devices.
Make sure, though, not to exceed the limit values specified for current load (voltage source, connections) and cable lengths!

Electrical connection

5.3.2 DeviceNet Connection

In order to integrate the timer in a DeviceNet bus system, please use X13.

Cable length:	according to DeviceNet specification
Type of cable:	copper, shielded, according to DeviceNet specification



Example: DeviceNet connection of the last 3 weld timers at the bus

☞ **For more information on which I/O signals are exchanged between the weld timer and the DevNet host, please refer to chapter 5.3.3.**

Setting the DeviceNet address:
via NA switch. Address (MAC ID) according to DeviceNet specification.

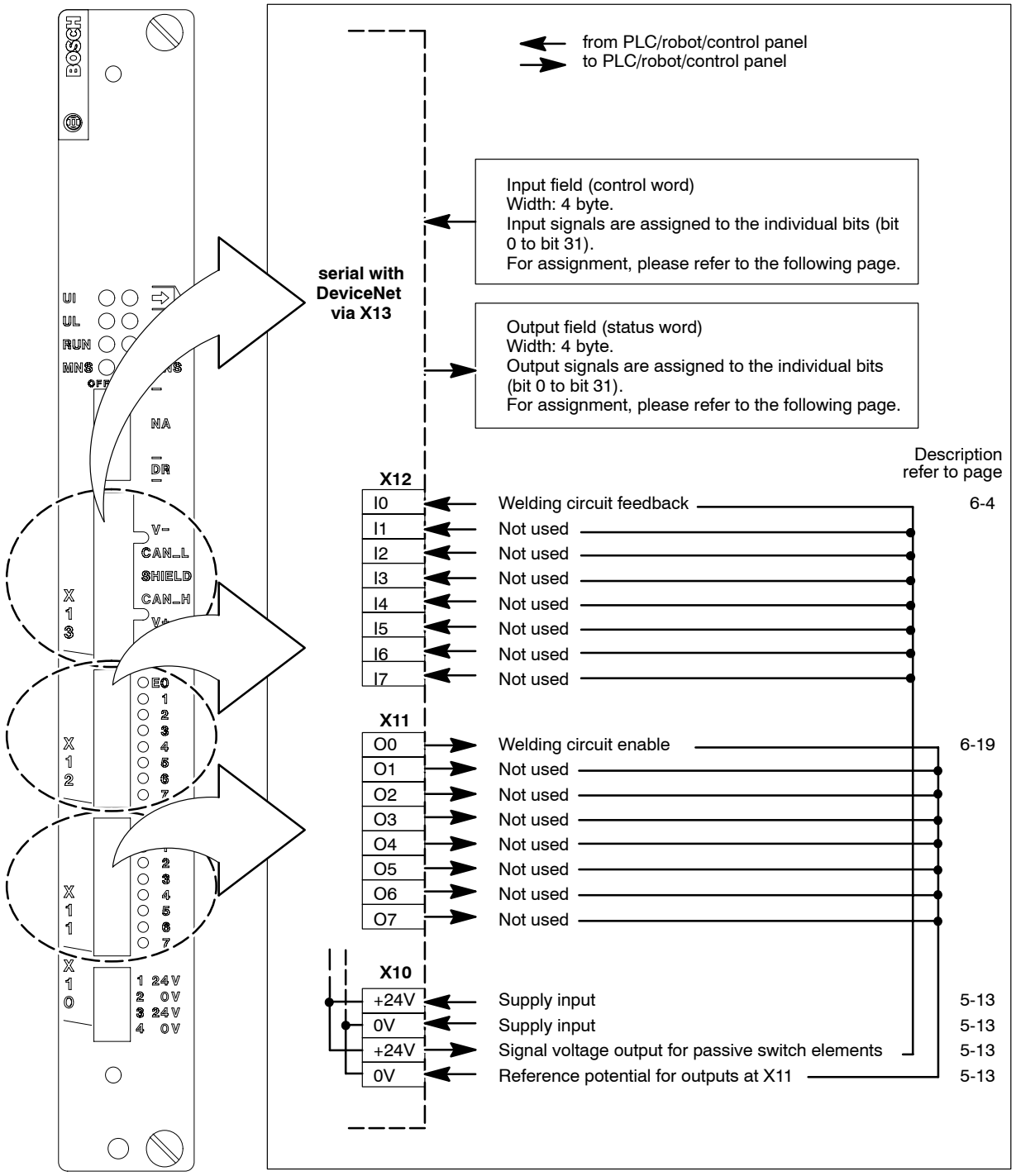
Setting the DeviceNet baud rate:
via DR switch, according to DeviceNet specification.

5.3.3 Signal outputs and inputs

Connection X11, X12:	Plug-in terminal, spacing 3.5 mm, max. 1.5 mm^2. Mating connector included in shipment.
Cable length:	max. 100 m at 0.5 mm^2
Type of cable:	Unshielded, VDE 0281, 0812 (e.g.: Ölflex)

Electrical connection

☞ **For further technical data, please refer to chapter 4.2, on page 4-2. For information regarding the functionality of all signals, please refer to chapter 6.**



Assignment of all signal in- and outputs

Electrical connection

Input field

Bit	Signal name	Description Refer to page
0	START	6-2
1	TIPS HAVE BEEN DRESSED	6-9
2	WELDING CIRCUIT RELEASE	6-3
3	ELECTRODES HAVE BEEN REPLACED	6-11
4	RESET FAULT	6-6
5	RESET FAULT WITH WC	6-7
6	RESET FAULT WITH SPOT REPEAT	6-8
7	WELD ON EXTERNAL	6-5
8	SPOT SELECTION 01	6-4
9	SPOT SELECTION 02	6-4
10	SPOT SELECTION 04	6-4
11	SPOT SELECTION 08	6-4
12	SPOT SELECTION 16	6-4
13	SPOT SELECTION 32	6-4
14	SPOT SELECTION 64	6-4
15	SPOT SELECTION 128	6-4
16	SPOT SELECTION 256	6-4
17	SPOT SELECTION 512	6-4
18	SPOT SELECTION 1024	6-4
19	SPOT SELECTION 2048	6-4
20	SPOT SELECTION 4096	6-4
21	SPOT SELECTION 8192	6-4
22	SPOT SELECTION 16384	6-4
23	SPOT SELECTION 32768	6-4
24	SPOT SELECTION 65536	6-4
25	SPOT SELECTION 131072	6-4
26	SPOT SELECTION 262144	6-4
27	SPOT SELECTION 524288	6-4
28	SPOT SELECTION 1048576	6-4
29	SPOT SELECTION 2097152	6-4
30	SPOT SELECTION 4194304	6-4
31	SPOT SELECTION 8388608	6-4

Output field

Bit	Signal name	Description Refer to page
0	WELD COMPLETE (WC)	6-14
1	TIP DRESS REQUEST	6-17
2	PREWARNING	6-18
3	END OF STEPPER	6-18
4	CONTROL READY	6-16
5	WELDING FAULT	6-17
6	WITHOUT MONITORING	6-19
7	WELD / NO WELD	6-17
8	INITIAL DRESSING REQUEST	6-13
9	NEW ELECTRODE	6-19
10	Not used	
11	Not used	
12	Not used	
13	Not used	
14	PRESSURE FEEDBACK	6-13
15	Not used	
16	STATUS 01	6-20
17	STATUS 02	6-20
18	STATUS 04	6-20
19	STATUS 08	6-20
20	STATUS 16	6-20
21	STATUS 32	6-20
22	STATUS 64	6-20
23	STATUS 128	6-20
24	STATUS 256	6-20
25	STATUS 512	6-20
26	STATUS 1024	6-20
27	STATUS 2048	6-20
28	STATUS 4096	6-20
29	STATUS 8192	6-20
30	STATUS 16384	6-20
31	STATUS 32768	6-20

Assignment of the signal in- and output field for DeviceNet connection

Electrical connection

Notes:

6 I/O Signal Descriptions

This chapter contains the descriptions of all I/O signals regarding their importance for the timer. Signal names are always put in quotation marks (”Signal name”).

☞ **For information regarding the assignment of all in-/output signals of the ”DEV-NET” I/O module, please refer to chapter 5.3.3 from page 5-15 ff.**

6.1 Input Signals

6.1.1 Alphabetical Overview

I/O Signal Descriptions

6.1.2 Start

A positive edge at the input triggers the acceptance of the currently selected welding program (for more information regarding program selection, see page 6-4 ff) if the timer is in ”Ready” (see page 6-16).

Schedule:

1. The welding program starts.
   If programmed, the 1.SQZ starts running.
2. SQZ starts.
   Until the end of the SQZ, it is possible to interrupt the welding process by resetting ”Start”.

☞ **The start of the SQZ depends on the pressure feedback. For more information, please refer to page 5-7.**

☞ **Within the SQZ, the timer checks, by measuring the ohmic resistance, whether the connected measurement circuit is faultless or not.**
In case of an error (refer to page 5-11), the timer interrupts the welding program and deletes the output signal ”Control ready”.

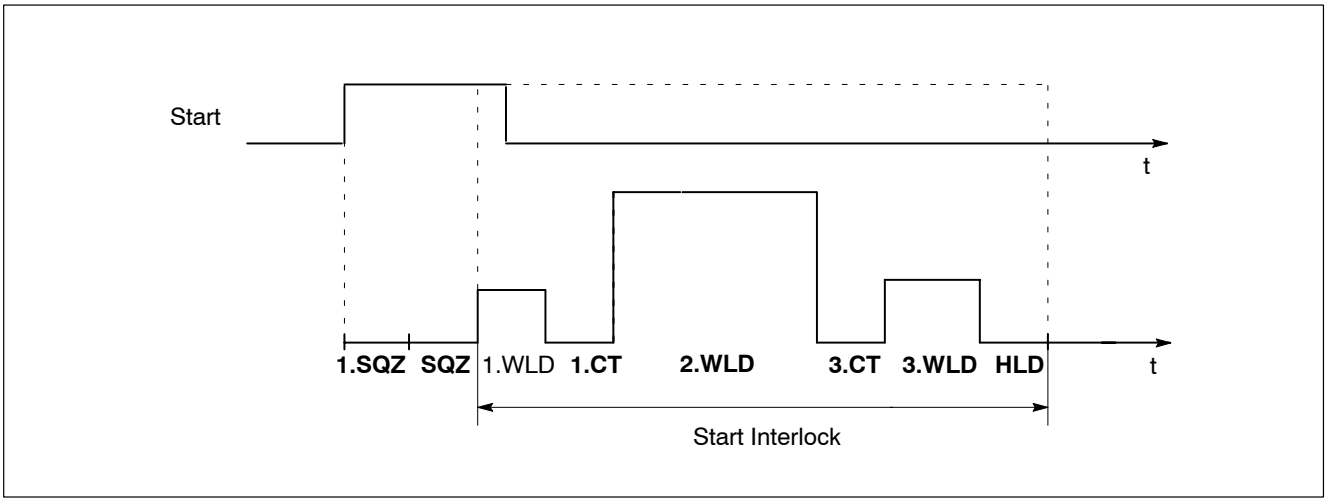
3. If ”Start” continues to be high after the end of the SQZ, Interlock starts in single mode. While in Interlock, the 1., 2., and 3.WLD run even after resetting ”Start”.
   After resetting ”Start” in seam mode, only a current cycle that has already begun will be finished.

☞ **”Interlock” can be interrupted only by opening the stop circuit (see page 5-14).**

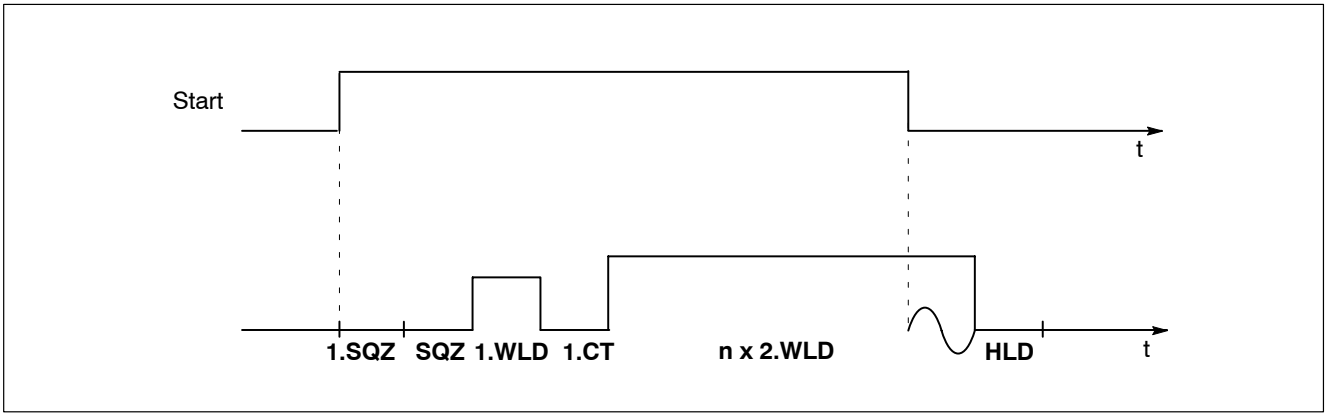
☞ **Whether the weld times are executed with or without welding current depends on the input signal ”Weld on external” (refer to page 6-5).**

4. HLD runs.
5. The output ”Weld complete” (refer to page 6-14) acknowledges the weld schedule.

I/O Signal Descriptions



Interlock in single mode



Reset of "Start" during 2.WLD in seam mode

6.1.3 Welding Circuit Release

The input signal will always be set except during an electrode exchange. If "welding circuit release" is missing during a program start with Weld/No Weld turned on, the timer generates the error message: "No welding circuit release".

☞ **"Welding circuit release" is the prerequisite for the output signal "Welding circuit enable" (refer to page 6-19).**

6.1.4 Welding Circuit Feedback

Input for the feedback contact of the welding circuit contactor. Needs to be triggered with high level while the contactor is closed.

The timer checks the input ”Welding circuit feedback”

- at the end of the SQZ.
  If the output signal ”Welding circuit enable” is set and ”Welding circuit feedback” is missing, the error message ”Welding circuit 1 not closed” will be output.
- after opening the welding circuit contactor.
  If ”welding circuit feedback” is still set after 100 ms after the contactor has been opened, the error message ”Welding circuit 1 not opened” will be output.

6.1.5 Spot Selection, Program Selection

A maximum of 24 input signals (spot selection ”x”) is at your disposal for selecting the desired welding program (program no. 0 to 255) or the desired spot weld (spot no. 256 to 8388608).
To do so, the binary coded program/spot number will be applied to the inputs. The illustration below contains examples.

☞ **The spots 0 to 255 are linked and fixed to the corresponding programs 0 to 255, but spot numbers higher than 255 can be assigned freely to the programs 0 to 255 via spot selection.**
When you select a spot then you always select the corresponding program as well.

☞ **The binary coded spot/program number must be transferred to the timer via DeviceNet in one single bus cycle.**
Otherwise the data transferred in the corresponding bus cycle will be interpreted as separate spot/program numbers and selected one after the other.

☞ **Immediately after selection of a welding program, the timer outputs the command force of the electrodes programmed there.**

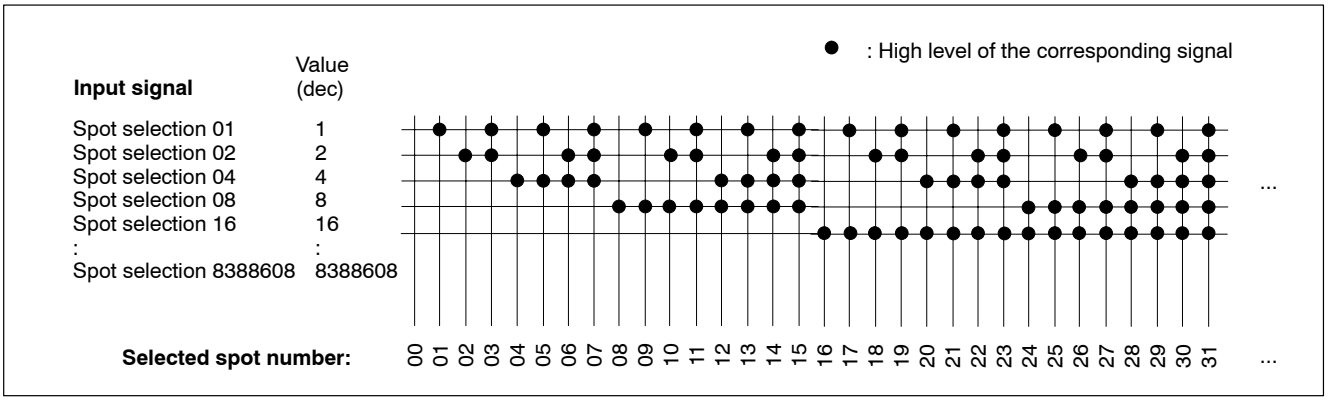
☞ **In case of a positive edge of the input signals**

- **”Tips have been dressed” (refer to page 6-9) or**
- **”Electrodes have been replaced” (refer to page 6-11)**

the pending bit pattern will be temporarily interpreted as the number of an electrode! For method of operation, please refer to the indicated cross references.

☞ **The function ”Start simulation” within the user interface (BOS) always refers to program numbers!**

I/O Signal Descriptions



Binary coded selection of a spot (of an electrode) via input signals "Spot selection x"

6.1.6 Weld On External

Sometimes it is necessary to execute a welding program without weld current (e.g. within the scope of a clock time optimization at the welding line or for other settings/tests).

Therefore, an external device (robot, PLC, keylock switch at the control panel) can determine via this input signal

1. whether the timer should execute all welding programs without current as a rule or
2. whether the timer itself, based on the parameterization, has an influence on this decision (with or without current).

Regarding point 1.:
If "Weld on external" **is not set**, all welding programs in the timer - independent from the rest of the timer's parameterization - will be executed without current. The power supply unit will not be triggered in this case.

Regarding point 2.:
If "Weld on external" **is set**, the reaction depends on the following parameters:

- Weld on internal (globally affects all programs in the timer) and
- program-related weld (is part of each welding program and is effective in the corresponding program only).

The execution of a welding program **with current** is possible only if

- "Weld On External" is set and
- Weld internal and
- the program-related weld (firing) has been switched on.

This corresponds to an AND operation of all 3 mentioned conditions.

☞ **For feedback of this AND operation to an external device, please use the output signal "Weld / No weld" (see page 6-17).**

I/O Signal Descriptions

6.1.7 Reset Fault

If an error occurs, the timer goes into ”Block”.
In this state,

- it is not possible to start a welding process
- the LED READY at the timer’s front goes off (see page 2-7)
- and the output signal ”Control Ready” will be reset (refer to page 6-16).

☞ **Error and status messages are listed in the ”Error list PS5000/PS6000” (No.: 1070 087 001).**

While the timer automatically deletes ”self-resetting” errors after the cause of the error has been eliminated, ”not self-resetting” errors require a ”reset fault” after the elimination.

This operation can be executed either via

- Software (BOS),
- the reset button at the timer’s front (see page 2-7) or
- a positive edge of the ”Reset fault” input signal.

★ Please note that after ”Reset fault”, the timer only restores the ”Ready” state. In ”Ready” the following is applicable:

- it is possible to start a new welding process
- the LED READY at the timer’s front is lit
- and the output signal ”Control ready” is set.

☞ **The timer does not execute any other actions!**
If the error occurs during a welding process, the gun might still be closed and the robot e.g. remains on the current welding position.

Via the input signals ”Reset fault with WC” (see page 6-7) and ”Reset fault with spot repeat” (see page 6-8), other operations can be initiated in addition to ”Reset fault”. Please refer to the indicated cross references.

I/O Signal Descriptions

6.1.8 Reset Fault with WC

☞ **For basic information, please refer to page 6-6!**

A positive signal edge leads to

1. Reset fault" and subsequently
2. to the setting of the signal "Weld complete" if the input signal "Start" is still pending.

DANGER
Dangerous machine movements possible!
The signal "Weld complete" initiates the robot's positioning to the next weld spot.
Therefore, make sure to avoid dangerous situations at the welding station caused by "Reset fault with WC"!

☞ **"Reset fault with WC" can also be initiated via the GUI (BOS).**

"Reset Fault with WC" is used

- in connection with robots and
- in connection with errors except "Current too low" and "Current too low for a series of welds".

☞ **In connection with errors except "Current too low" and "Current too low for a series of welds", please note the signal "Reset fault with spot repeat". Refer to page 6-8.**

If an error occurs while a part is being welded, the robot usually remains at the welding position with the gun closed.
Via "Reset Fault with WC", it is now possible

- to continue the process at the next spot weld.

CAUTION
The current spot weld is erroneous!
Please check the part!

I/O Signal Descriptions

6.1.9 Reset Fault with Spot Repeat

☞ **For basic information, please refer to page 6-6!**

A positive signal edge leads to

1. ”Reset fault” and subsequent
2. repetition of the welding program schedule provided that the input signal ”Start” is still pending.
   If the repetition is completed without another error, the signal ”Weld complete” will be set.

DANGER
Dangerous machine movements possible!
The signal ”Weld complete” initiates the robot’s positioning to the next weld spot.
Therefore, make sure to avoid dangerous situations at the welding station caused by ”Reset fault with spot repeat”!

☞ **”Reset fault with spot repeat” can also be initiated via the GUI (BOS).**

”Reset Fault with spot repeat” is used

- in connection with robots and
- in connection with the errors ”Current too low” and ”Current too low for a series of welds”.

☞ **In connection with other errors, please note the signal ”Reset fault with WC”. Refer to page 6-7.**

If the error ”Current too low” or ”Current too low for a series of welds” occurs while a part is being welded, the robot usually remains at the welding position with the gun closed. Via ”Reset Fault with spot repeat”, it is now possible

- to repeat the current, erroneous spot weld.

If, after that, another error occurs, please use ”Reset fault with WC”.

I/O Signal Descriptions

6.1.10 Acknowledgment ”Tips have been dressed”

The timer informs the robot via the output signal ”Tipdress Request” (see page 6-17) that a tipdress procedure must be executed ”soon” (see page 3-27).

☞ **The time for outputting the signal ”Tipdress Request” is parameterizable (BOS).**

If the robot recognizes the ”Tipdress Request”, it must move the relevant electrode to the tipdress station - at the latest after its maximum wear has been reached. Dependent on the setting of the parameter ”Stop at end of stepper” (BOS), the timer goes into ”block”, sends the message ”tipdressing necessary”, and waits for the acknowledgment ”Tips have been dressed”.

☞ **The programming of the robot determines when the robot recognizes the ”Tipdress Request”. The relevant robot inputs are often scanned only before welding of a new part and not after each spot. This behavior requires the following:**

- **The time between the output of the signal ”Tipdress Request” and the maximum wear must be sufficiently set. Only this way it can be guaranteed that the part can be completely welded before reaching the maximum wear.**

The robot tells the timer that the electrode dressing procedure is finished by sending the message ”Tips have been dressed”.

☞ **Since a timer can control and handle more than one electrode, the robot must not only send the message ”Tips have been dressed” but also the number of the recently dressed electrode. At its spot selection inputs (see page 6-4), the timer expects the binary coded electrode number contemporarily with the signal ”Tips have been dressed”.**

As long as a new electrode tipdressing process is still possible at this point, the timer reacts to a positive signal edge at the ”Tips have been dressed” acknowledgement as follows:

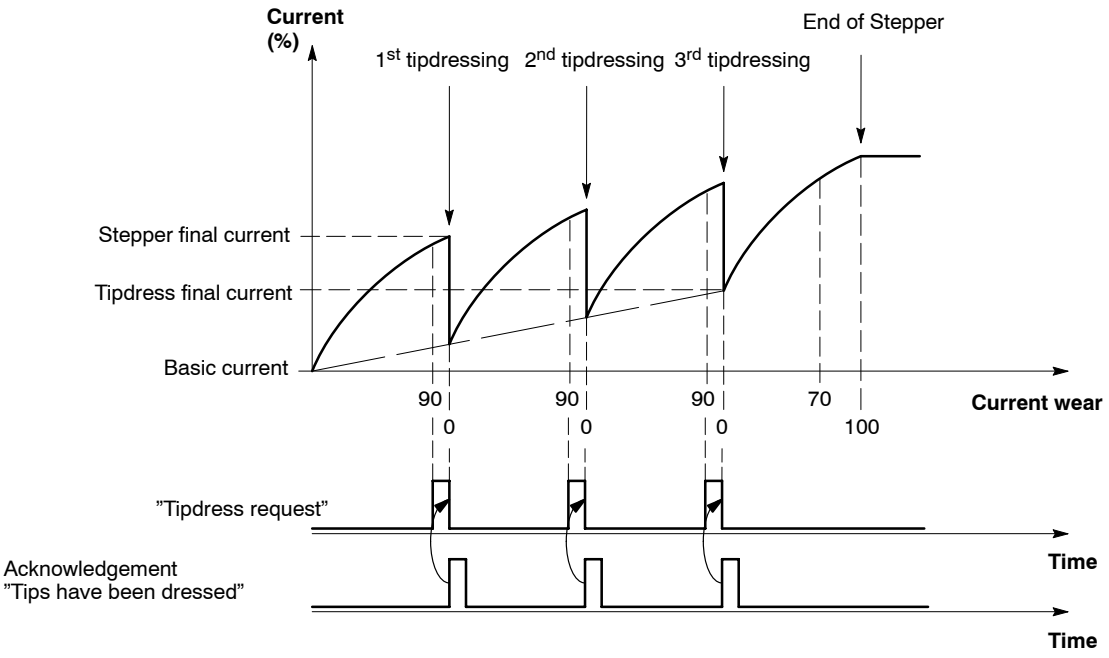
1. The bit pattern pending at the spot selection inputs (see page 6-4) will be interpreted as a binary coded electrode number.
2. The tipdress counter of the recognized electrode number will be incremented.
3. The wear counter of the recognized electrode number will be reset to 0.
4. The output signal ”Tipdress Request” (refer to page 6-17) will be reset.

☞ **A transferral of electrode number ”0” mutually triggers the actions 2. and 3. for all electrodes!**

I/O Signal Descriptions

Example. The following settings are used:

%I Stepper:	On
Stepper:	active (if Stepper final current > basic current)
Tipdressing:	On (if max. tipdressing steps > 0. Here: max. tipdressing steps = 3)
Tipdress Curve:	active (if tipdressing final current > basic current)
Wear factor:	1.0
Wear start section (offset):	0
Wear stepper section:	100
Max. wear:	100 (= wear stepper section - offset)
Tipdress request:	10 (= 10 before max. wear)
Prewarning:	30 (= 30 before max. wear)



Example: Electrode tipdressing process

I/O Signal Descriptions

6.1.11 Acknowledgment “Electrodes have been replaced”

First, the timer informs the robot via the output signal ”Prewarning” (see page 6-18) that an electrode must be exchanged ”soon”.

☞ **Prior to the end of stepper (see page 6-18), the time for outputting the signal ”Prewarning” is parameterizable (BOS) as wear. If ”electrode tipdressing” is activated, the timer outputs ”Prewarning” only when no further tipdressing procedure is allowed.**

It depends on the parameterization of the timer whether further welds are still possible after exceeding the end of stepper.

If the robot recognizes the ”Prewarning”, in ideal circumstances, it moves the gun to the gun maintenance position in order to exchange the electrodes.

☞ **The programming of the robot determines when the robot recognizes the ”Prewarning”. Normally, the relevant robot inputs are scanned only before welding of a new part and not after each spot.**
This behavior requires the following:

- **The time between the output of the signal ”Prewarning” and the end of stepper must be sufficiently set.**
- **The function ”Stop at end of stepper” is switched off.**

Only this way, it can be guaranteed that the part can be completely welded.

The timer must be informed about the executed electrode exchange either via ”Electrodes have been replaced” or via GUI (BOS).

☞ **Since a timer can control and handle more than one electrode, the robot must not only send the acknowledgement ”Electrodes have been replaced” but also the number of the recently exchanged electrode.**
At its program selection inputs, the timer expects contemporarily with the signal ”Electrodes have been replaced” the binary coded electrode number.

The timer must be informed about the executed electrode exchange either via ”Electrodes have been replaced” or via GUI (BOS).

☞ **Since a timer can control and handle more than one electrode, the robot must not only send the acknowledgement ”Electrodes have been replaced” but also the number of the recently exchanged electrode.**
At its spot/program selection inputs, the timer expects the binary coded electrode number contemporarily with the signal ”Electrodes have been replaced”.

The timer reacts to a positive signal edge at the ”Electrodes have been replaced” acknowledgement as follows:

1. The bit pattern pending at the spot/program selection inputs (see page 6-4) will be interpreted as a binary coded electrode number.

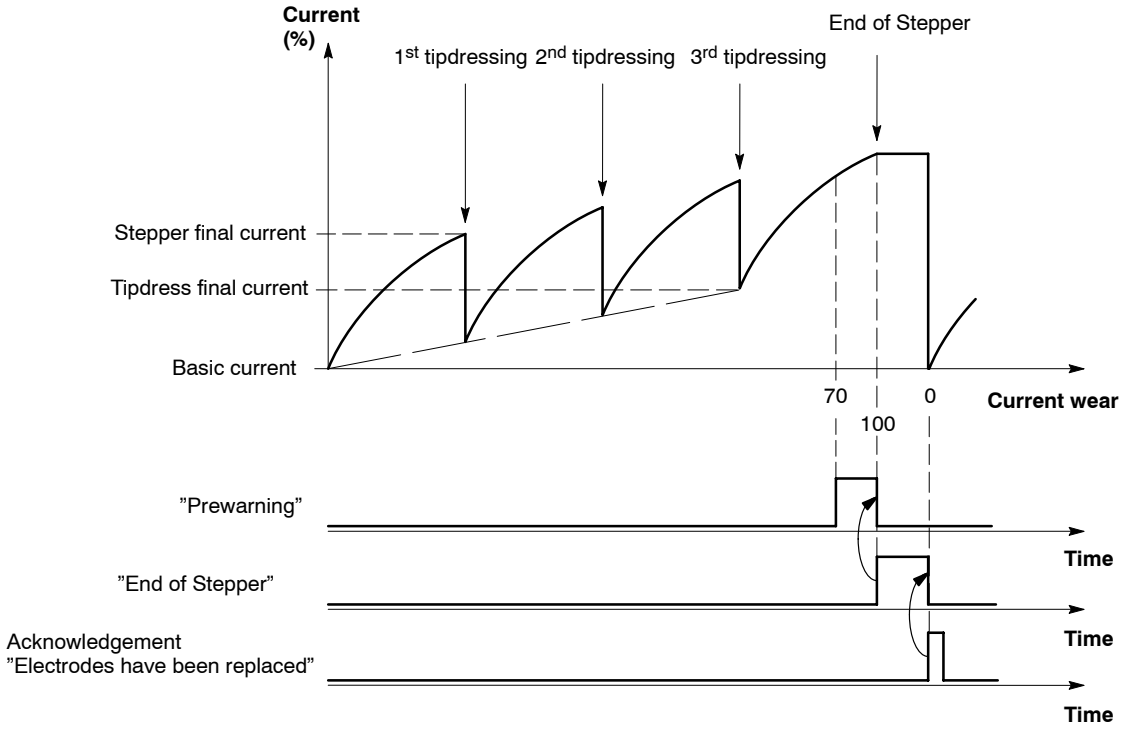
I/O Signal Descriptions

2. The tipdress counter of the recognized electrode number will be reset.
3. The wear counter of the recognized electrode number will be reset to 0.
4. The output signal ”Prewarning” or ”End of stepper” will be reset.
5. When ”Tipdressing of new electrodes” is activated (initial dressing; please refer to page 3-27), the output ”Initial dressing request” (see page 6-13) will be activated.

☞ **A transferral of electrode number ”0” mutually triggers the actions 2. and 3. for all electrodes!**

Example. The following settings are used:

%I Stepper:	On
Stepper:	active (if Stepper final current > basic current)
Tipdressing:	On (if max. tipdressing steps > 0. Here: max. tipdressing steps = 3)
Tipdress Curve:	active (if tipdressing final current > basic current)
Wear factor:	1.0
Wear start section (offset):	0
Wear stepper section:	100
Max. wear:	100 (= wear stepper section - offset)
Tipdress request:	10 (= 10 before max. wear)
Prewarning:	30 (= 30 before max. wear)
Stop at End of Stepper:	Off



Example: Electrode replacement

I/O Signal Descriptions

6.2 Output Signals

6.2.1 Alphabetical Overview

6.2.2 Pressure Feedback

Indicates if high level is pending at the pressure input (X2/4; please refer to chapter 5.2.5 on page 5-7).

6.2.3 Initial Dressing Request

Informs the PLC/robot that the active electrode requires initial dressing. If the function ”tipdressing of new electrodes” (BOS) is activated, the signal will be set after the relevant electrode has been exchanged.
”Tips have been dressed” (refer to page 6-9) resets ”Initial dressing request”.

I/O Signal Descriptions

6.2.4 Weld complete (WC)

The output signal ”Weld complete” informs the connected peripherals (PLC/robot) about the termination of the welding process.
This way, the next step of the working process can be initiated. The logics for generating a WC is activated in the following cases:

1. in case of single spot welding (e.g. in connection with robots) after each spot
2. in case of seam mode (e.g. roll seam welds) at the end of the seam
3. upon ”set WC” (possible only via BOS)
4. upon ”Reset Fault with WC” (see page 6-7).

☞ **How long the WC remains set, depends on the input signal ”Start”. See ”WC period”.**

The 1. and 2. case give you the possibility to adjust the WC to your application via parameterization (BOS).

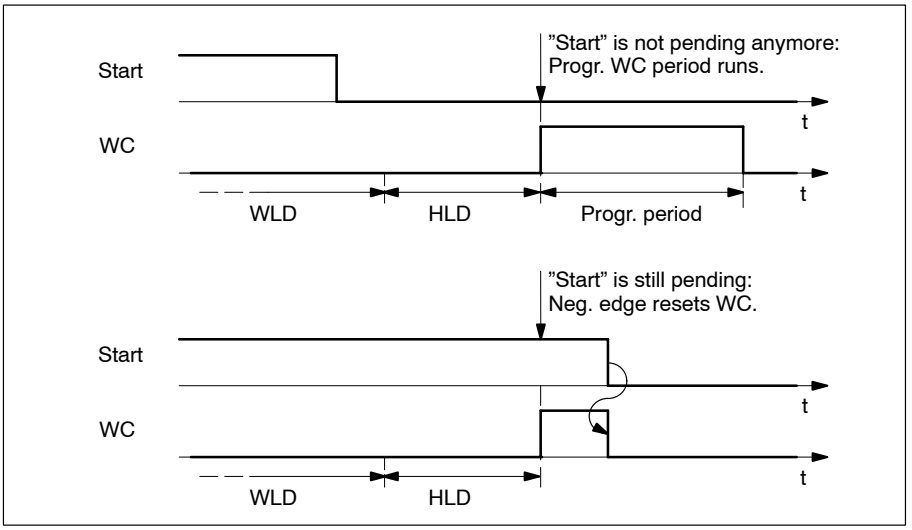
- Automatic output of the WC only after a proper weld, or even after an erroneous weld.
- Time at which the WC should be set (see ”WC starting time”).

WC period

Normally, the timer resets the signal ”Weld complete” automatically if it recognizes a negative edge at the input ”Start”.
Nevertheless, there are situations possible in which the ”Start” signal is reset prior to setting the WC. Here, a triggering on the negative edge of ”Start” is not possible. Therefore, when setting the WC, the timer checks whether ”Start” is still pending and reacts as follows:

”Start” is set:	WC will be reset only after a negative edge of ”Start”
Start” is not set:	WC will be reset after the parameterized WC period (GUI (BOS); default: 20 ms) has expired.

I/O Signal Descriptions



WC period depends on signal "Start"

☞ **The programmed WC period also runs during start simulation (BOS)!**

WC starting period

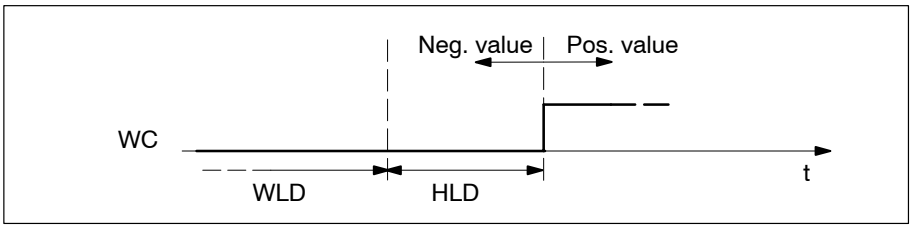
The time, at which "Weld complete" shall be output, is **- in relation to the end of the HLD -** parameterizable within the following limits:

- with PSI: +/-1000 ms
- with PST: +/-50 cycles.

Restriction: The earliest possible output of the WC is possible after 20 ms or 1 cycle after the start of the HLD.

Default setting: End of HLD minus 20 ms or 1 cycle (see "example").

This way, the starting time of the WC can be anticipated and moved into the HLD time as well as delayed.



Moving of WC starting time

Example: ”Fast robot communication”

If ”Weld complete” is used as a command for positioning the robot to the next spot, you can compensate constant response times (caused by signal processing in the robot, drive, or PLC area) by anticipating the starting time of the WC. This will lead to shorter clock times.

CAUTION
Damage to the installation caused by positioning movements with a closed gun are possible!
Therefore, make sure that the electrodes are already open when the robots’ drives start!

6.2.5 Control Ready

The output signal indicates that the timer is ready to weld.
In this state,

- you can start a new welding schedule (see page 6-2)
- the LED READY at the timer’s front is lit (see page 2-7).

If an error occurs, the timer goes into ”Block”.
In this state,

- it is not possible to start a welding process
- the LED READY at the timer’s front goes off
- the output signal ”Control ready” is reset.

☞ **Error and status messages are listed in the ”Error list PS5000/PS6000” (No.: 1070 087 001).**

In order to restore the ”Ready”-state of the timer after an error, you have the following possibilities at your disposal:

1. Push the reset button at the timer’s front (see page 2-7) or
2. a positive edge at the ”Reset fault” input signal (refer to page 6-6) or
3. a positive edge at the ”Reset fault with WC” input signal (refer to page 6-7) or
4. a positive edge at the ”Reset fault with spot repeat” input signal (refer to page 6-8) or
5. operation via software (”Reset fault”, ”Reset fault with WC”, and ”Reset fault with spot repeat” are also possible via BOS).

I/O Signal Descriptions

6.2.6 Welding Fault

If an error occurs during welding,

- the timer sets the output ”Welding Fault” and
- deletes the output signal ”Control Ready” (refer to page 6-16).

Further welding processes can only be started, when all pending errors are eliminated and acknowledged (reset). Please refer to ”Reset fault” on page 6-6 ff.

☞ **Error and status messages are listed in the ”Error list PS5000/PS6000” (No.: 1070 087 001).**

☞ **It depends on the parameterization of the timer (BOS; fault allocation) whether an event is interpreted as an error or a warning.**

6.2.7 Weld/No Weld

Via the output signal ”Weld/No weld” you can check whether the currently selected welding program is executed

- with current (output is set) or
- without current (output is not set).

During a welding program you can work **with current** only if

- ”Weld on External” (see page 6-5) is set and
- Weld internal (parameterizable via BOS) and
- program-related weld (parameterizable via BOS) have been switched on.

I.e. that ”Weld/No weld” is the result of an AND operation of all 3 mentioned conditions.

6.2.8 Tipdress Request

Informs the PLC/robot that the active electrode must be tipdressed as soon as possible.
If further electrode tipdressing is still allowed at this point, the signal will be set when a parameterizable wear value is reached.
The acknowledgement ”Tips have been dressed” resets ”Tipdress request”.

☞ **For more information, refer to ”Tips have been dressed” on page 6-9 ff.**

I/O Signal Descriptions

6.2.9 Prewarning

Will be set, when a parameterizable wear value is reached. The output signal informs the PLC/robot that the active electrode will reach the end of stepper soon and that the electrode must therefore be replaced.

The output signal will be

- set with Start if the active electrode is in Prewarning
- updated at the end of the weld time
- reset via ”Electrodes have been replaced”.

☞ **For more information, refer to ”Electrodes have been replaced” on page 6-11 ff.**

6.2.10 End of Stepper

Will be set, when a parameterizable wear value is reached. The output signal informs the PLC/robot that the active electrode has reached the end of stepper.

☞ **It depends on the parameterization of the timer whether or not further welds are still possible after exceeding the end of stepper (parameter ”stop at end of stepper”).**

The output signal will be

- set with Start if the active electrode has reached the end of stepper
- updated at the end of the weld time
- reset via ”Electrodes have been replaced”.

☞ **For more information, refer to ”Electrodes have been replaced” on page 6-11 ff.**

I/O Signal Descriptions

6.2.11 Without Monitoring

Via the output signal ”Without monitoring” you can check whether the currently selected welding program is executed

- without current monitoring (output is set) or
- with current monitoring (output is not set).

CAUTION
Faulty welds are possible!
If current monitoring is switched off, actual current values that lie outside the permissible tolerance bands do not lead to a welding fault!
Therefore, make sure that all weldings that might be executed ”without monitoring” are checked sufficiently!

During the process of a welding program, current monitoring is active only in the following cases (”Without monitoring” is not set):

- the timer-related Monitoring stopped (effective for all programs) is switched off
- the program-related current monitoring is active for **all** weld times.

6.2.12 New Electrode

The output will be set if the welding program selected via spot selection has been assigned to an electrode with count ”0”.

6.2.13 Welding Circuit Enable

Is output at the beginning of a welding process if

- ”Welding circuit release” (see page 6-3) is set **and**
- Weld/No Weld is turned on.

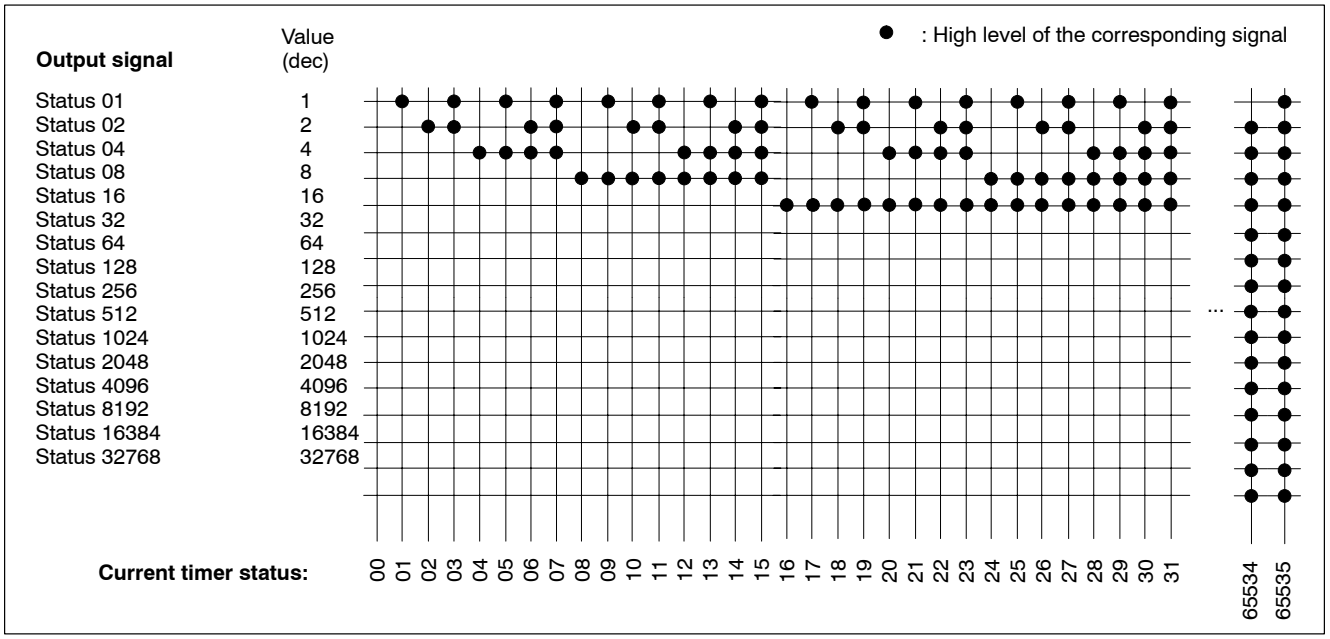
”Welding circuit release” is reset if

- “Welding circuit release” changes to low level,
- an error occurs, or if
- within 60 seconds, no new start signal has been recognized.

I/O Signal Descriptions

6.2.14 Status

The timer transmits its current binary coded status via the 16 ”status x” outputs with DeviceNet.



Binary coded output of current timer status

Currently, the following messages are defined:

Code (dec)	Description
00	OK
80	Stop circuit open / no +24 V
81	Current passed without command
84	Battery error
85	Memory deleted ==RAM checksum error
86	Data Restore active
87	No welding program == invalid parameter
88	Hardware error
89	I/O bus error (only in timers with serial I/O bus)
93	Synchronization error
94	Sequence inhibited
98	Command value too large
99	Welding process error
100	Supply voltage error
107	No enable for weld circuit
120	Welding circuit 1 not closed
122	Welding circuit 1 not opened
124	No welding pressure
160	Heat-sink temperature too high
165	Hardware error driver module
166	24 V supply voltage error

7 Maintenance

7.1 Battery

In order to buffer the RAM (contains the entire parameterization with all welding programs) and the internal clock, an integrated battery is provided.

Type of battery:	Lithium
Size:	AA
Voltage:	3.6 V
Order No.:	1070 914446

When the remaining battery capacity becomes critical, the timer generates an error message or warning (parameterizable). The LED BATTERY FAULT at the timer's front is lit (see page 2-7).
If the event has been defined as an error message, a welding process is not possible in this state.

★ Include battery replacement in the regular maintenance schedule of the installation! Replacement: at least every 2 years.

CAUTION
Damage caused by improper handling of electronic components!
Therefore, batteries must be replaced by authorized technical personnel only!

CAUTION
Data loss!
Without a pending supply voltage and after removal of the battery, data back-up is guaranteed for up to 24 hours only.
Therefore, always have at your disposal a new battery and insert it immediately upon removal of the old one.

Battery replacement

The battery may be exchanged while the timer is running.

1. Turn the battery cover on the timer's front (see page 2-7) to the left and remove the old battery.
2. Insert the new battery correctly. For correct polarity, please refer to the illustration on the front of the timer.
3. Now, close the battery compartment with the battery cover.

Maintenance

7.2 Firmware

The timer will be shipped with the latest firmware installed. Via the programming device (BOS), the version of the firmware can be displayed.

In rare cases, it may be necessary to update the firmware.

CAUTION
Damage caused by improper handling.
Firmware updates may therefore be carried out upon our instruction and by authorized technical personnel only!

For a firmware update, you need

- a pointed object for operating the ”boot” button (for position, refer to page 2-7),
- a PC with ”WinBlow” software,
- a suitable connecting cable (timer <-> PC, for wiring, refer to page 5-12) and
- a data carrier (floppy disk, CD) with the corresponding firmware.

★ Proceed as follows:

1. Connect one of the PC’s V24 interfaces (COM1 or COM2) to the timer’s X1.
2. Start the ”WinBlow” software. Select the desired language and the V24 interface.
3. Insert the data carrier containing the firmware into your PC. Select the path and file name of the firmware. Firmware files carry the extension ”.hex”.
4. Click on ”Backup - Load Firmware - Restore”.
   You are prompted to set the bootstrap mode on the unit.

☞ **Further welding processes are not possible anymore!**
If you want to exit the bootstrap mode at this point, you have to interrupt the timer’s 24 V_{DC} power supply (see page 5-3).

5. Push the recessed ”boot” button on the front of the timer. This way, the unit is switched from operating to bootstrap mode. This condition is indicated by the ”Boot” LED above the button.

☞ **After having initiated the next step, do not interrupt the power supply until the complete firmware has been loaded!**

6. Confirm at the PC that the bootstrap mode has been activated. The firmware is now being loaded. A bar indicates the current status of the process.
7. Wait until the PC signals the end of the transmission.
8. Interrupt the timer’s 24 V_{DC} power supply for at least 5 seconds (remove X4). Then reinstall X4.
   The timer is booted with the new firmware.
9. Check the firmware version via the programming device (BOS).

8 Status and Error Messages

If timer-relevant events occur during operation, you are informed by the timer.

Primarily you can differ between

- faults and
- warnings.

In case of faults

- it is not possible to start a welding process (schedule)
- the LED READY at the timer's front goes off (see page 2-7)
- the serial output signals "Status" (refer to page 6-20) show important higher level causes for errors
- the output signal "Control Ready" will be reset (refer to page 6-16).

In case of warnings

- other welding processes can still be executed.

☞ **It depends on the parameterization of the timer (BOS; fault allocation) whether an event is interpreted as a fault or a warning.**

Faults as well as warnings can be "self-resetting".

"Self-resetting" means that the timer automatically deletes such events after elimination of the error's or warning's cause. They do not require a manual "Reset fault".

Examples for self-resetting faults:

- Stop circuit open / no 24 V
- Power voltage off / too low
- Synchronization / mains voltage error.

The timer uses code numbers to signal faults and warnings. Only in the programming device or in the line PC, the code numbers are substituted by text. This saves memory resources in the timer and reduces the time necessary for communication.

☞ **Error and status messages are listed in the "Error list PS5000/PS6000" (No.: 1070 087 001).**

Status and Error Messages

Notes:

9 CE Declaration of Conformity

EG Konformitätserklärung
EC declaration of conformity
Déclaration "CE"

Hiermit erklären wir, daß unser Produkt, Typ:
We hereby declare that our product, type:
Nous déclarons par la présente que notre produit, type:

PST 6000

Typen gemäß beiliegender Liste

folgenden einschlägigen Bestimmungen entspricht:
complies with the following relevant provisions:
correspond aux dispositions pertinentes suivantes:

☒ Maschinenrichtlinie (89/392/EWG, 91/368/EWG, 93/68/EWG und 93/44/EWG)
Machinery Directive (89/392/EEC, 91/368/EEC, 93/68/EEC and 93/44/EEC)
Directive sur les machines (89/392/CEE, 91/368/CEE, 93/68/CEE et 93/44/CEE)

☒ Niederspannungsrichtlinie (73/23/EWG, 93/68/EWG und 93/44/EWG)
Low voltage Directive (73/23/EEC, 93/68/EEC and 93/44/EEC)
Directive sur les basses tensions (73/23/CEE, 93/68/CEE et 93/44/CEE)

☒ EMV-Richtlinie (89/336/EWG, 93/68/EWG und 93/44/EWG)
EMC Directive (89/336/EEC, 93/68/EEC and 93/44/EEC)
Directive EMV (89/336/CEE, 93/68/CEE et 93/44/CEE)

Angewendete harmonisierte Normen, insbesondere:
Applied harmonized standards, in particular:
Normes harmonisées utilisées, notamment:

EN 50081-2
EN 50082-2
EN 50178
EN 60204-1

Angewendete nationale Normen und technische Spezifikationen, insbesondere:
Applied national technical standards and spezifications, in particular:
Normes et specifications techniques nationales qui ont été utilisées, notamment:

29.11.99 TEO
Datum / Unterschrift / Technische Betriebsleitung

25.11.1999 AT/EWS
Datum / Unterschrift / Entwicklungsleitung

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CE Declaration of Conformity

EG Konformitätserklärung
EC declaration of conformity
Déclaration "CE"

Hiermit erklären wir, daß unser Produkt, Typ: PSI 6000
We hereby declare that our product, type:
Nous déclarons par la présente que notre produit, type: Typen gemäß beiliegender Liste

folgenden einschlägigen Bestimmungen entspricht:
complies with the following relevant provisions:
correspond aux dispositions pertinentes suivantes:

☒ **Maschinenrichtlinie** (89/392/EWG, 91/368/EWG, 93/68/EWG und 93/44/EWG)
Machinery Directive (89/392/EEC, 91/368/EEC, 93/68/EEC and 93/44/EEC)
Directive sur les machines (89/392/CEE, 91/368/CEE, 93/68/CEE et 93/44/CEE)

☒ **Niederspannungsrichtlinie** (73/23/EWG, 93/68/EWG und 93/44/EWG)
Low voltage Directive (73/23/EEC, 93/68/EEC and 93/44/EEC)
Directive sur les basses tensions (73/23/CEE, 93/68/CEE et 93/44/CEE)

☒ **EMV-Richtlinie** (89/336/EWG, 93/68/EWG und 93/44/EWG)
EMC Directive (89/336/EEC, 93/68/EEC and 93/44/EEC)
Directive EMV (89/336/CEE, 93/68/CEE et 93/44/CEE)

Angewendete harmonisierte Normen, insbesondere:
Applied harmonized standards, in particular:
Normes harmonisées utilisées, notamment:

EN 50081-2
EN 50082-2
EN 50178
EN 60204-1

Angewendete nationale Normen und technische Spezifikationen, insbesondere:
Applied national technical standards and spezifications, in particular:
Normes et specifications techniques nationales qui ont été utilisées, notamment:

29.11.99 ppa. TEL
Datum / Unterschrift / Technische Betriebsleitung

25.11.1999 AT/EWS
Datum / Unterschrift / Entwicklungsleitung

BOSCH

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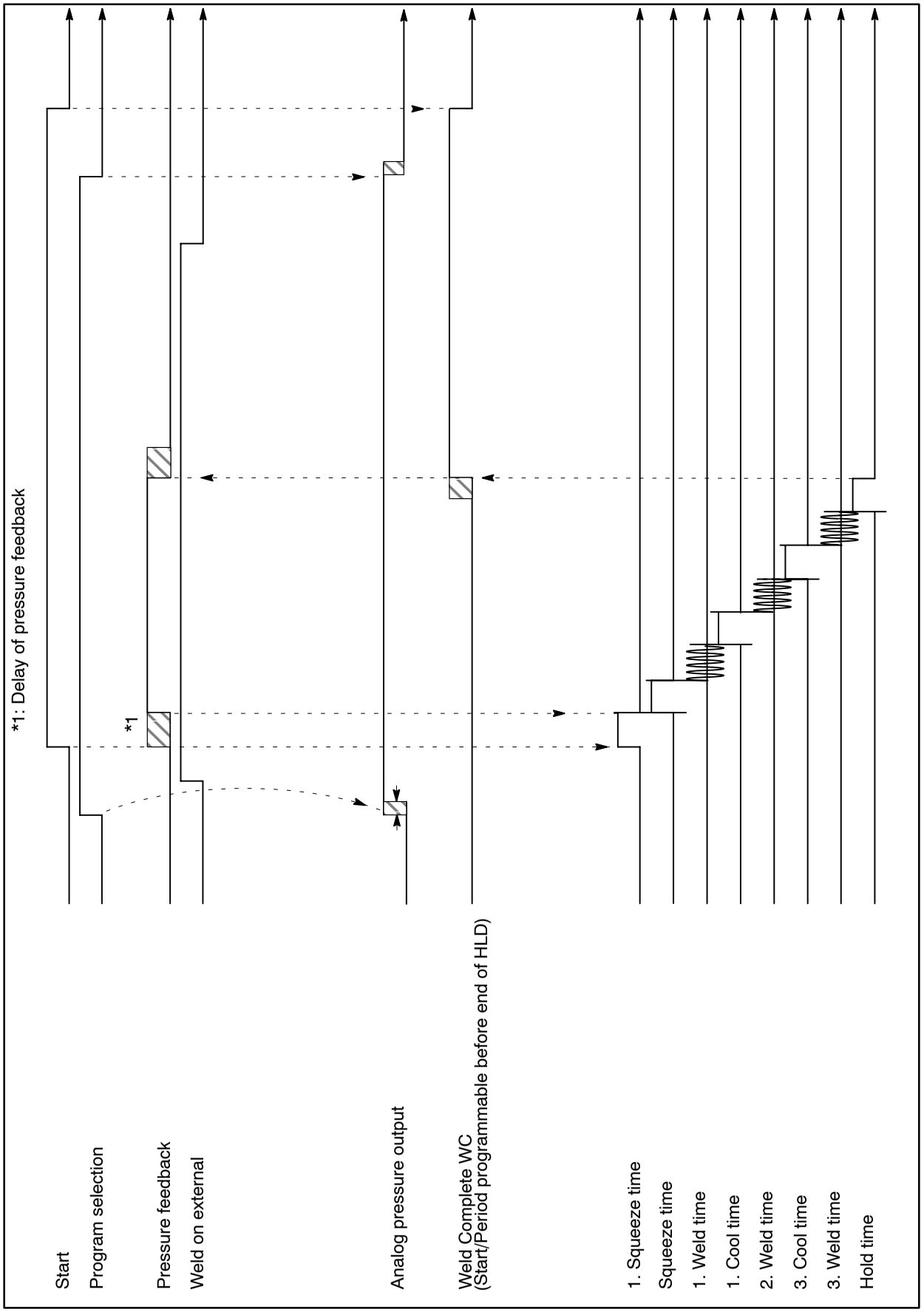
Formular 1070074976 - 102W611

10 Timer Diagrams

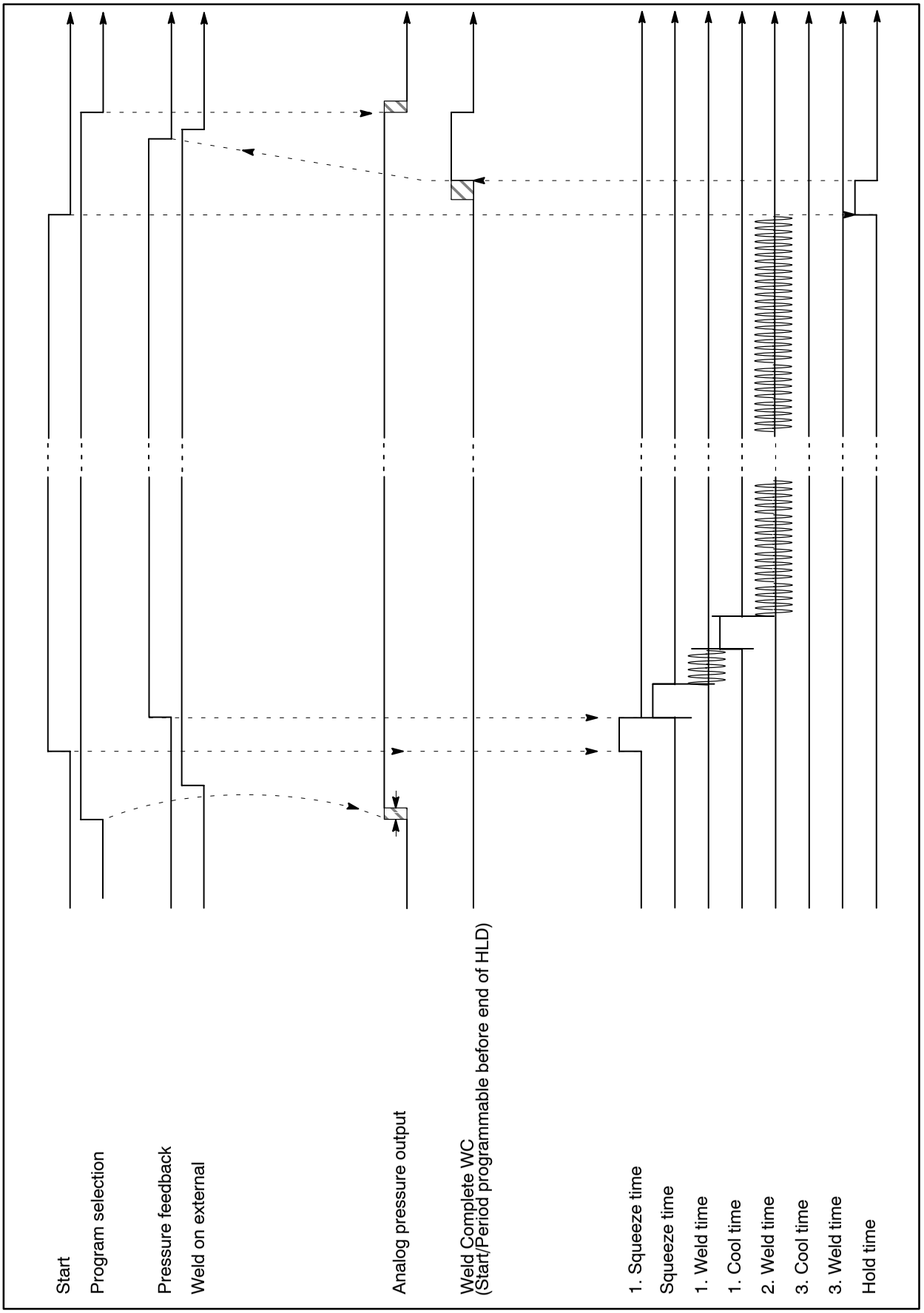
The following pages contain some examples of timer diagrams.

Timer Diagrams



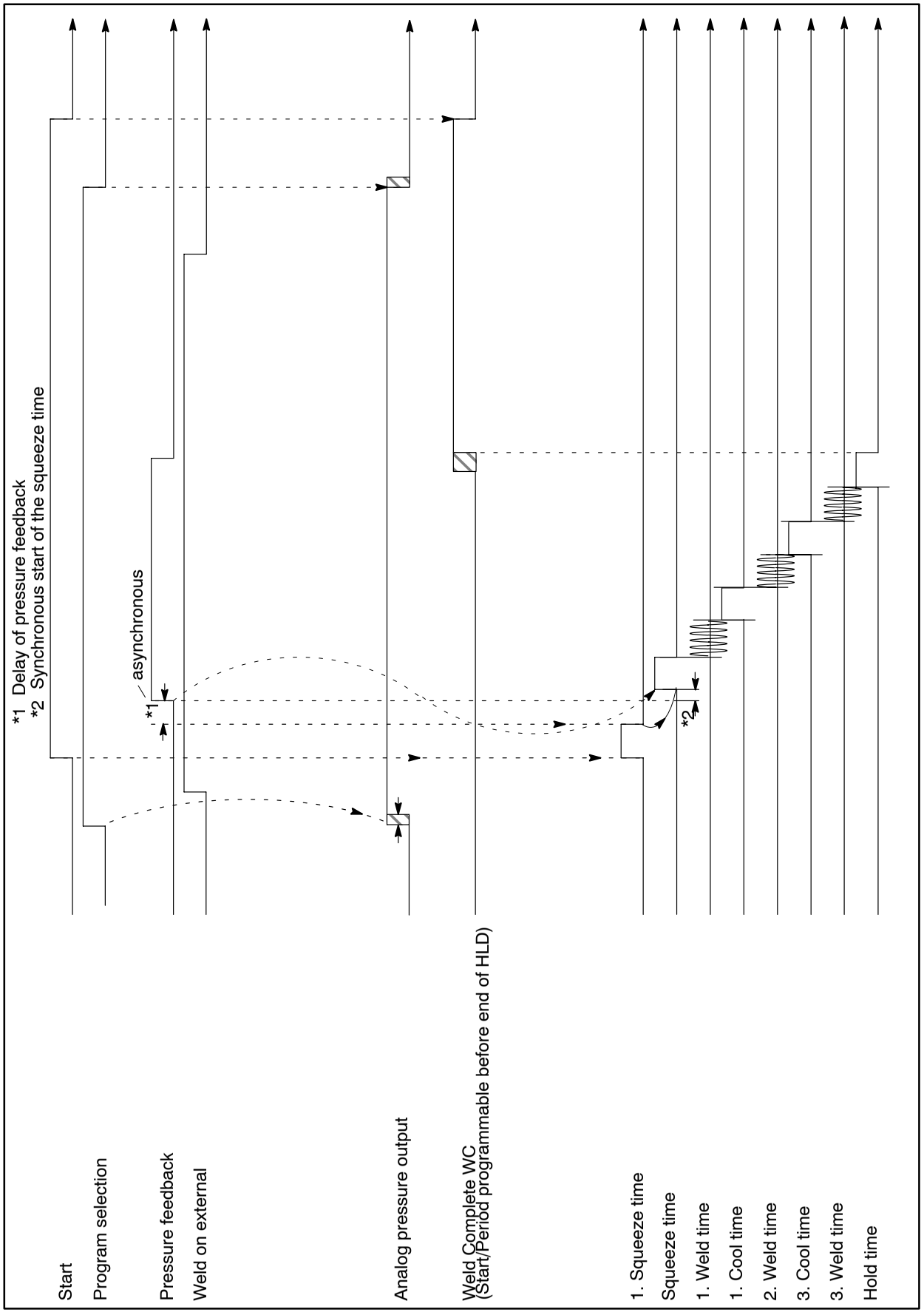
Example for normal schedule, single spot

Timer Diagrams



Example for normal schedule, seam mode

Timer Diagrams



Example for delay of pressure feedback during 1. SQZ

Appendix

A Appendix

A.1 Abbreviations

%I	General abbreviation for current, can be measured in kA or in SKT (scale values)
AC	Alternating Current
CT	Cool time, time between the current impulses/blocks (1., 2., 3.CT)
DC	Direct Current
DST	Downslope time. Time in which the %I decreases until the end of the 2.WLD.
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge, abbreviation for all terms that concern electrostatic discharges, e.g. ESD protection, ESD hazard, ESD-sensitive components
ext.	External, e.g. in connection with a +24V voltage for signal transducers (switches) and actuators (valves) outside the timer.
GUI	Graphical user interface
HLD	Hold time, time after the last weld time, in which the welded part can cool down.
HSA	Main Switch Trip
IMP	Number of impulses that form the 2.WLD
kA	Kilo-Ampere
KSR	Constant current regulation. Keeps the current in the welding circuit constant.
KUR	Constant voltage regulation. Balances line fluctuations.
LT	Power supply unit (thyristor or inverter)
MC	Monitoring contact, e.g. for monitoring the pressure inside the cylinder that closes the electrodes or monitoring of the electrode position, e.g. ”gun closed”
NBS	see WI
NWZ	Post-heating time, also referred to as 3.WLD
OFF	Off time, time between two spot welds in which the solenoid valve is not triggered. Relevant for Repeat mode only.
PE	Protective Earth
PG	Programming device / welding computer
PHA	Phase angle (shift)
PLC	Programmable Logic Controller
PSG	Transformer-rectifier unit for the PSI inverter series
RA (RO)	Relay output
REPEAT	Repeat mode. Mode for manually operated systems only
SKT (scale values)	Measure of the electric phase angle
Slope	Current ramp, current increases/decreases from an initial to a final current value
Solenoid	Solenoid valve, controls the cylinders for closing the electrodes
SING	Single spot mode. For automatic and manual welding machines
SQZ	Squeeze time. Time that runs before the weld time. The electrodes squeeze the parts to be welded together.
Stepper	Current stepping for compensation of electrode wear
Temp.	Temperature
UST	Up-slope time. Time in which the %I increases from the beginning of the 2.WLD.
VWZ	Preheating time, also referred to as 1.WLD
WC	Weld complete. Signal is output when the spot has been welded
Weld / No weld	Ignition, firing pulses for triggering the power unit are switched on and off
WI	Mains load limitation control (Welder interlock), monitors and influences the mains load
WLD	Weld time. The following types of WLD exist: 1.WLD (preheating weld time); 2.WLD (main weld time); 3.WLD (postheating weld time) Time and current (%I) of all 3 weld times can be programmed separately. Programming of impulses and slope is only possible in the 2.WLD
WT	Weld timer, also referred to as timer, or resistance weld timer

Appendix

A.2 Index

Appendix

Appendix

Appendix

Notes:

Rexroth
Bosch Group

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