

PSS 5000/PSX 6000

BOS-5000

Operating and Programming Manual, volume 2

Edition

104

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E 1999

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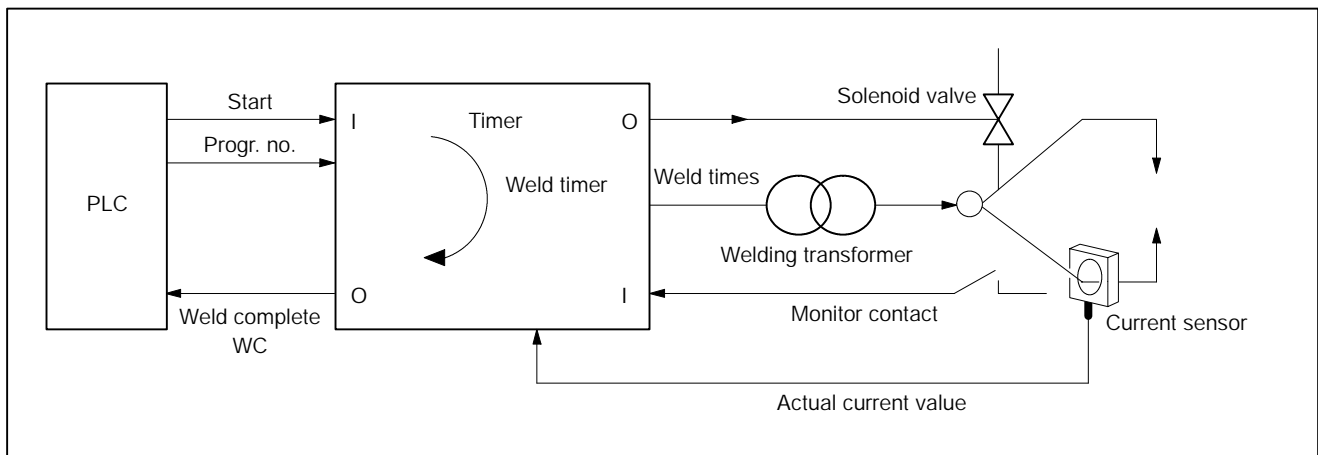
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8 Fundamental principles

8.1 Structure of a Welding System

A welding system is mainly composed of the following:

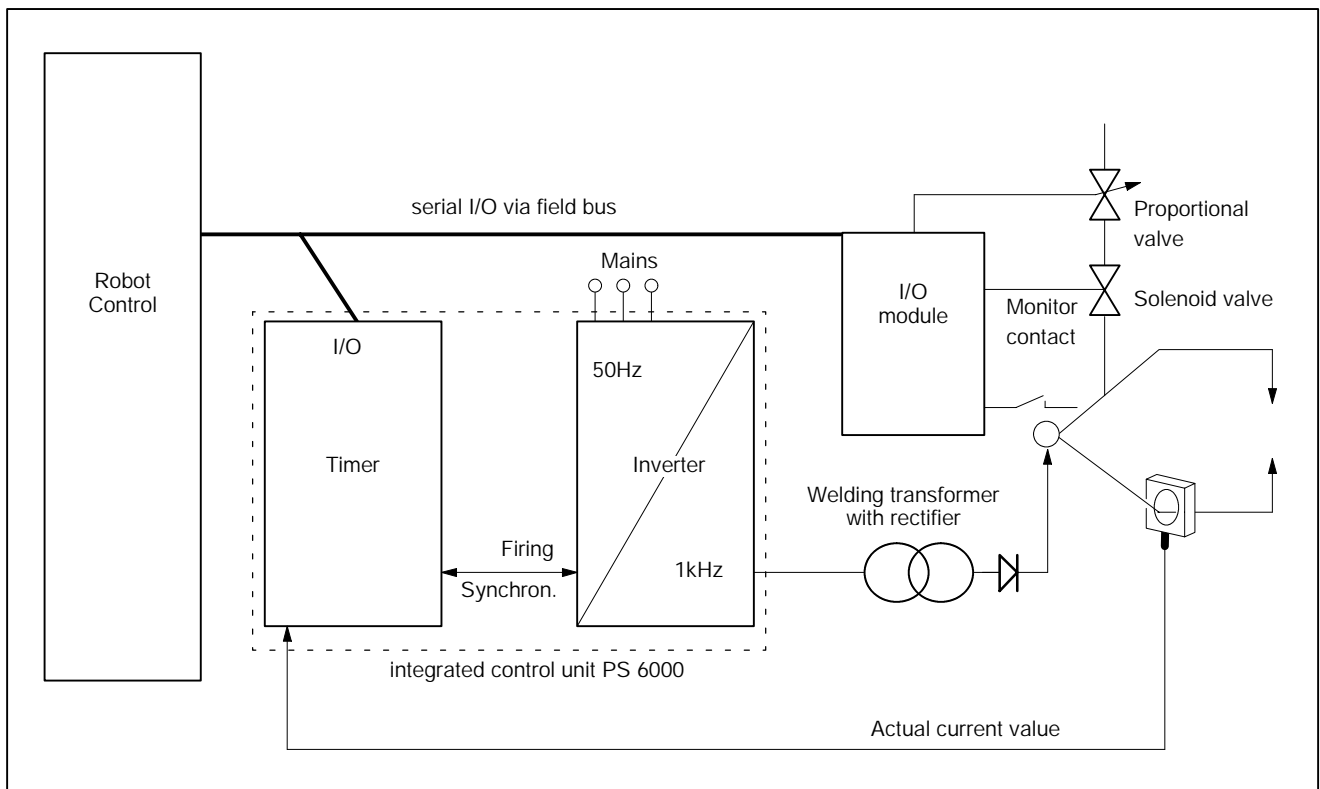
- Weld timer (Timer) with an up-front control system consisting of
 - a programmable logic controller PLC
 - a robot control or
 - a manual control mechanism for electrode guns
- a welding transformer
- a welding gun with electrodes, pressure (monitor) contact and solenoid valve,
- a current sensor (toroid)



In automated welding installations the exchange of the I/O-signals is increasingly executed via field buses.

A more refined application of the welding technique is medium-frequency welding with 1 kHz. In contrast to 50 Hz welding with pulsating welding current, 1kHz welding is done with direct current.

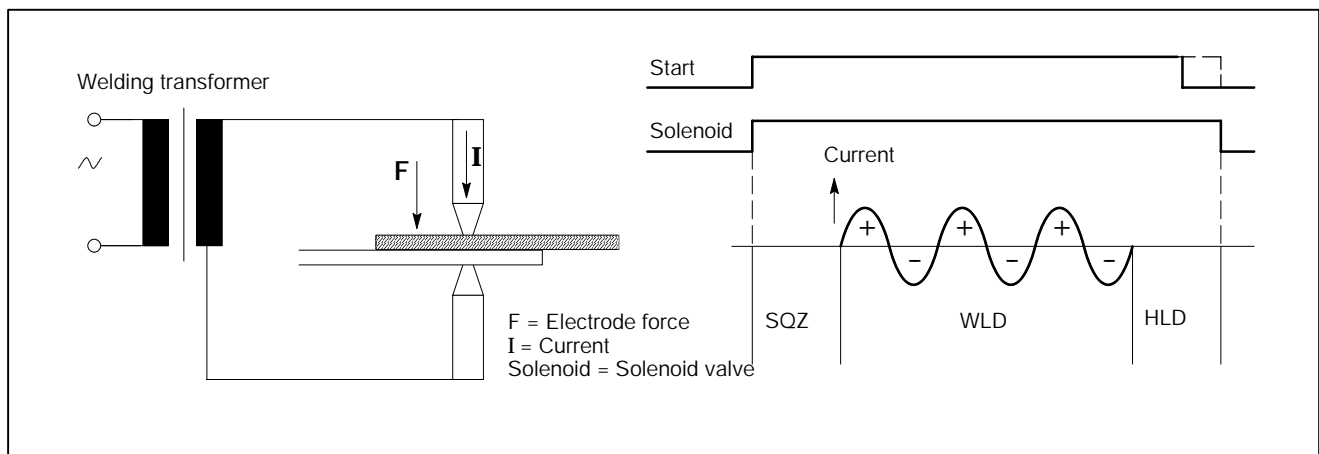
The new generation of welding installations has weld timers and inverters integrated into one device.



8.2 Tasks of the Weld Timer

In order to obtain a controlled welding process, the weld timer has to control or regulate several functions.

- Adjustment of the [Welding Current Intensity]
- Adjustment of the [weld time] in cycles or milliseconds
 - A difference is made between short-, medium- and long-time welds.
- Output of a voltage signal for the solenoid valve in order to close the electrodes
- Output of a voltage signal for a proportional pressure valve in order to control the electrode pressure
- Control, regulation and monitoring of the weld sequence (schedule)
- Weld complete or fault message for the [Schedule]



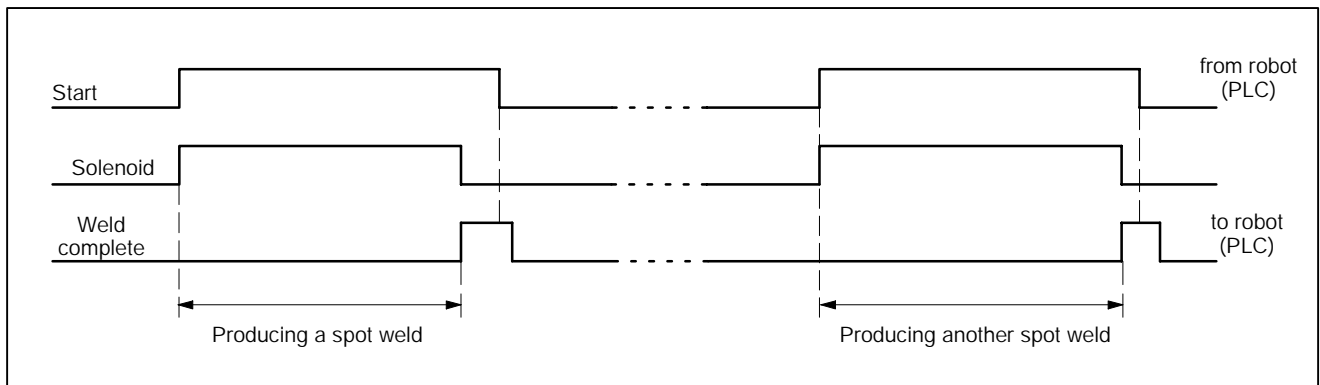
For performing the actual welding process, the timer can be operated with an automatic control system or controlled manually by an operator. This may result in different operating modes.

8.3 Modes

Single spot (for spot welds, projection welds, butt welds, ...)

A start signal at the input of the weld timer turns on the welding [sequence]. Once the weld has been completed, the timer issues the Weld Complete (WC) contact.

For a new [sequence], the start signal has to be toggled off/on. Single spot mode is suitable for applications involving robots, welding machines, automatic welding machines, and manual electrode guns.



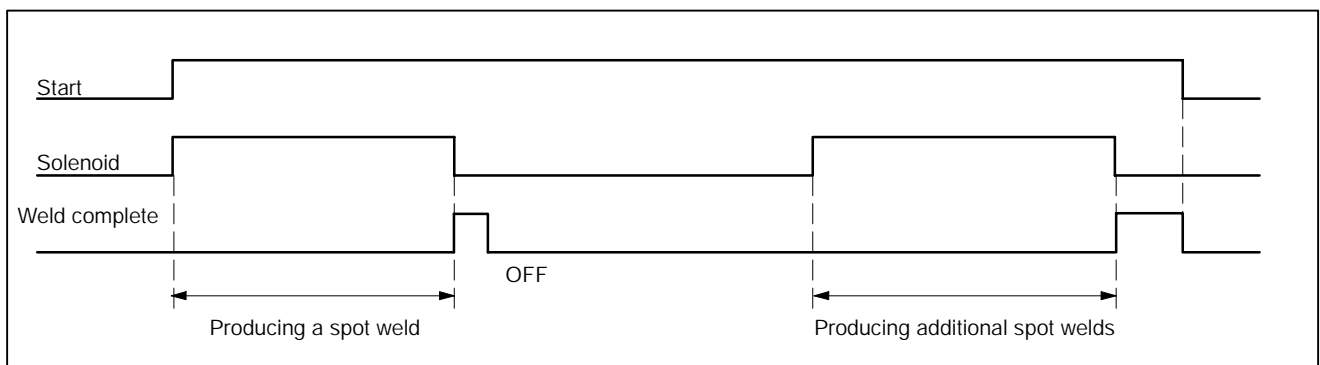
8.4 Repeat mode (for spot welds in manual systems)

As in single spot mode, the weld timer responds to the start signal and performs a spot weld.

For as long as the start signal is high, the solenoid is switched off after the [hold time]. The welding gun opens. The [OFF Time] runs. The operator can pull the welding gun to the next spot.

After the [OFF Time], the solenoid valve is activated again, and a new spot is welded.

This [sequence] will be repeated for as long as start is active. Repeat mode is suitable for manual electrode guns and for manually operated welding machines.



8.5 Seam Mode (for roller seam welding)

**NOTE**

A difference is made between seal welds and stitch welds!

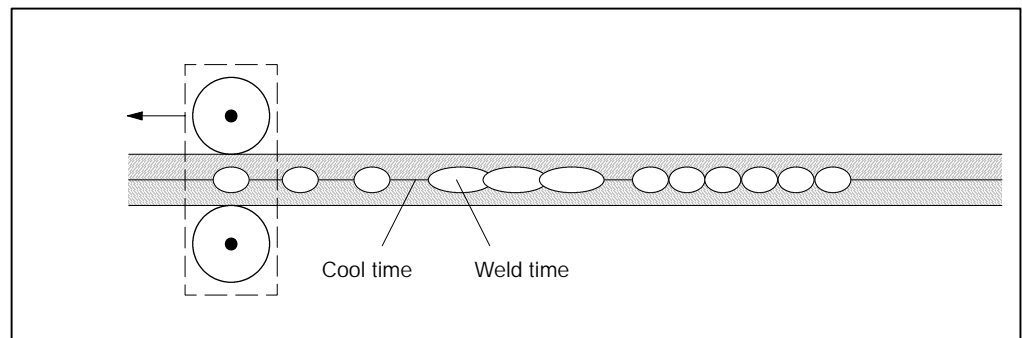
Stitch welds

When the rolling electrodes pass over the parts to be welded the material is joined by individual spot welds. The [cool time] separates the [weld times] of the individual spots.

Seal welds

The [cool time] of seal welds is very short, or even 0 cycles. Thus, the spots lie closely side by side or overlap each other.

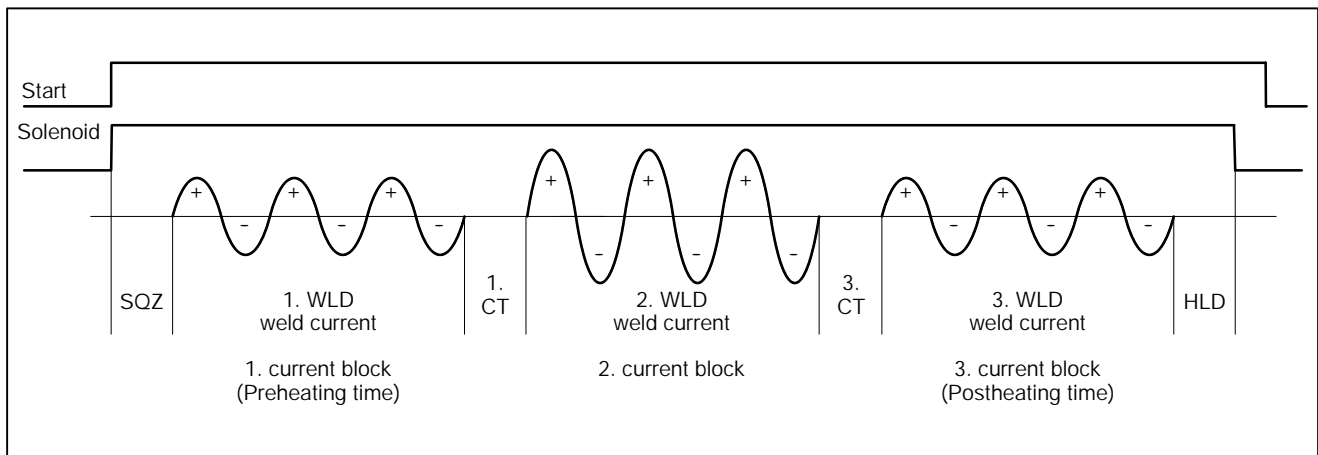
Seam operation is performed for as long as start is active. When the start signal is turned off, the [current impulse] is cancelled synchronously with the mains. After that the hold time is running. Seam operation is used with roller seam equipment.

8

8.6 Current Block Operation

In the welding example 8.2 the welding current for the spot weld was applied during a single [weld time]. However, the process may require to work with short consecutive current blocks.

A spot weld may comprise a maximum of 3 current blocks. The [cool time] separates the current blocks.



Preheating Time (1. WLD)

- This function is used to prewarm the metal with lower heat prior to the actual weld.
- Optional programming of a current (preheating current) with [weld time] (Preheating Time 1. WLD).

2. Current Block / 2. Weld Time (2. WLD)

- This function is used to perform the actual spot welding procedure.
- The current (%I) is delivered to the welding spot in form of one or more [Current Impulses]
- 2. Current Block / 2. Weld Time must always be programmed.

Postheating Time (3. WLD)

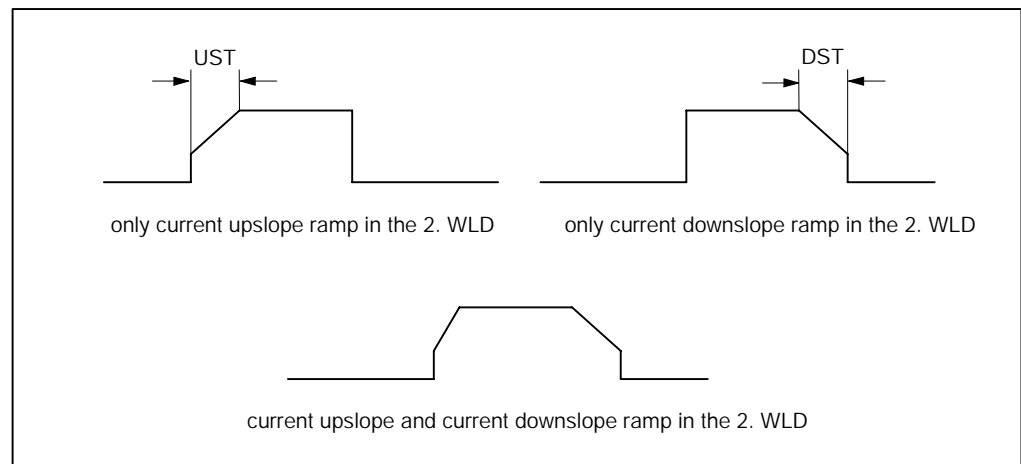
- This function is used to perform a postheating of the metal with lower heat after the actual weld.
- Programming a postheating current with [Weld Time] (Postheating Time 3. WLD) is optional. Postheating prevents weld stresses in the material.

8.7 Current Upslope/Current Downslope

The [Slope] function is used to increase the commanded current from an initial value up to a programmed final value. This function is equally possible in impulse mode and in simple mode (no impulses). The same is valid for Current Downslope.

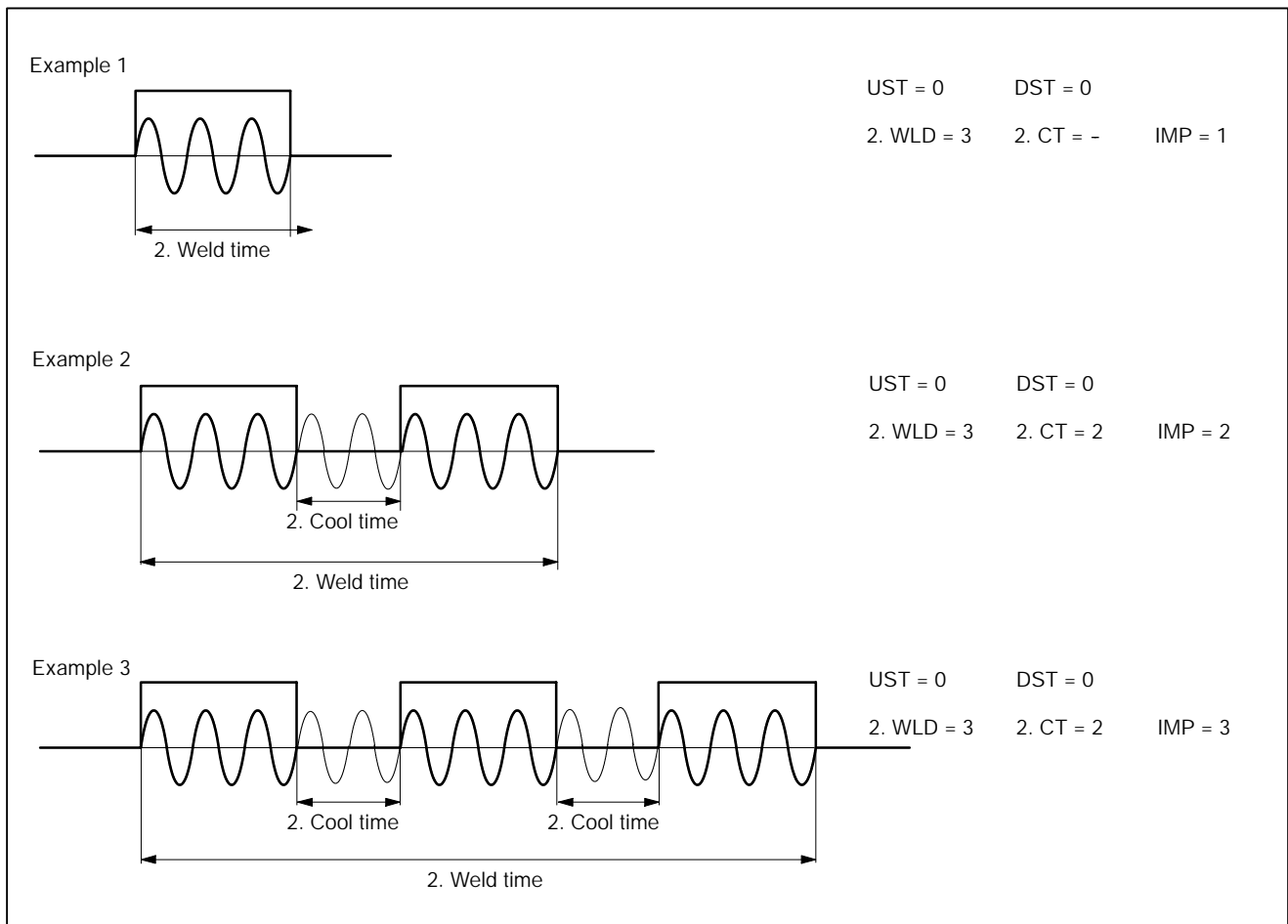
The upslope time [UST] and the downslope time [DST] can be specified by parameters.

The [Slope] function reduces the switch-on current peak and thus also the stress on the electrical welding devices (e.g. the welding transformer).

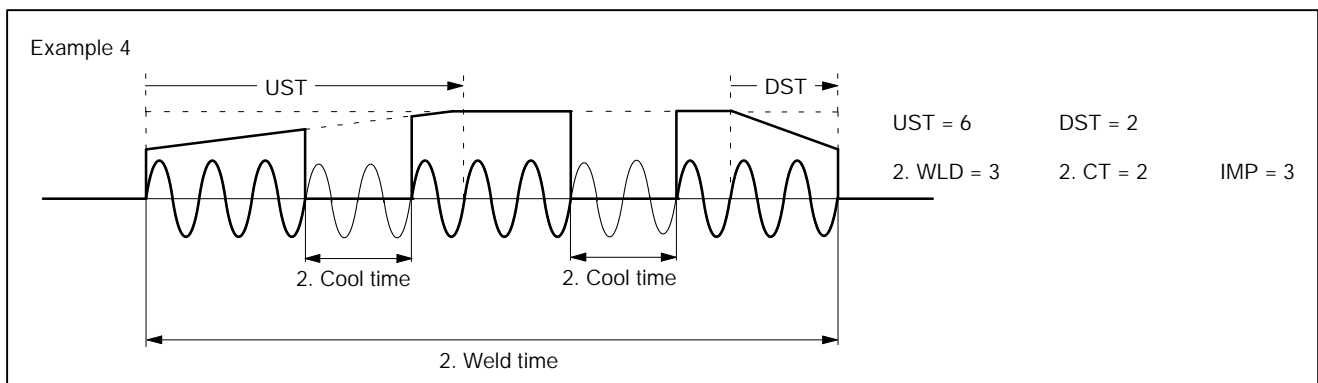


8.8 2. Current Block Consisting of Impulses

The number of [impulses] determines how often [2. weld time] and [2. cool time] alternate. The [2. cool time] is always interposed between the [impulses] of the [2.weld time]. (Examples: without the 1st and 3rd weld time)



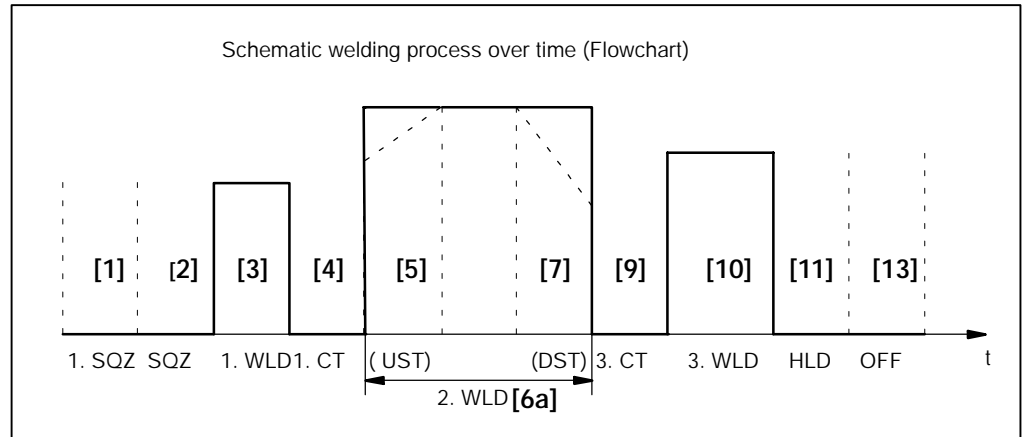
- The upslope and downslope times are independent from the [impulses], they take place within the [2. current block].
- The upslope time starts with the beginning of the [1. impulse].
- The downslope time terminates with the end of the last [impulse].



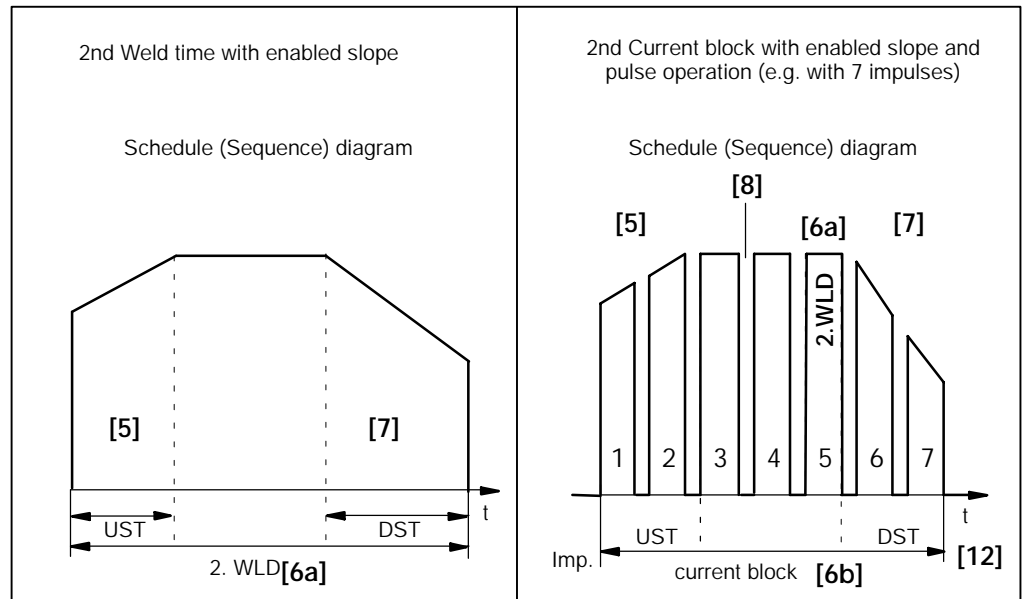


8.9 Schedule (Sequence)

A [Schedule] (sequence) is a diagram, which displays the welding process as a function over time. This time axis is thereby subdivided into different segments.



8



- [1] **1. SQZ [Pre-Squeeze Time]**
- The [pre-squeeze time] (1.SQZ) starts immediately after the start signal in the three operating modes single spot, repeat mode and seam mode.
 - When welding repeated spots, the [1.SQZ] runs only for the first spot of the series.
 - The welding gun starts its closing motion at the beginning of the [1. SQZ]. No current flows in this time segment.
 - The [1.SQZ] precedes the [SQZ] [Squeeze Time], in order to achieve a complete closing of the gun even in case of a long closing distance, e.g. with a manual gun.
- [2] **SQZ [Squeeze Time]**
- The working pressure of the electrodes is built up during the [SQZ]. The welding gun must be closed when the [SQZ] begins. No current is generated in this time segment.
 - If a manual electrode gun is closed with start, the path the electrodes have to travel before they are closed is usually fairly long. The process requires some time.
If a program works in repeat mode, the electrode gun is not opened widely during the short [OFF Time] (OFF) because the solenoid valve is immediately activated again.
Therefore, only a shorter [Squeeze Time], [SQZ], is required for the 2nd and subsequent spots.
- [3] **1.WLD [1st Weld Time]**
- Current is generated during the 1. Weld Time [1. WLD] to pre-heat the part being welded and to prepare for the actual weld.
- [4] **1. CT [1st Cool Time]**
- The [1.WLD] is followed by a cooling time without heat generation, to allow stress relief of the part being welded. The welding gun remains closed.
 - After the end of this time segment, the actual welding process starts.
- [5] **UST [Up Slope Time]**
- If [Slope] is enabled, the current (%) output increases gradually during a given time period, starting with an initial current and stopping at the programmed current. This time period is also called "Slope time to programmed current".
 - The [UST] is part of the 2. WLD [6a] and/or the [2nd Current Block] [6b].
 - The [UST] may be part of a complete [Impulse] or composed of several [Impulses].
 - The [1.WLD] and [3.WLD] use no [Slope].
- [6a] **2.WLD [2nd Weld Time]**
- With non-pulsed operation, the main weld starts at the beginning of the [2.WLD]. The [2.WLD] consists of a single [Impulse].
- [6b] **[2nd Current Block]**
- With pulsed operation, the main weld starts at the beginning of the [2. Current Block]. The second current block consists of up to nine [Impulses] with the length of a [2. WLD] each.



- [7] **DST [Down Slope Time]**
- During this time period, the current for producing the spot weld is gradually reduced.
 - If [Slope] is enabled, the current (%) output decreases gradually during a given time period, starting with the programmed current and stopping at the final current. This time period is also called "Slope time to final current".
 - The [DST] is part of the [2.WLD] [6a] and/or the [2nd Current Block] [6b].
 - The [DST] may be part of a complete [impulse] or composed of several [Impulses].
 - The [1.WLD] and [3.WLD] use no slope.
- [8] **2. CT [2nd Cool Time]**
- During the build-up of the [2. Current Block] with [Impulses], the [2. Cool Time] determines the interval between the single [Impulses]. During these [Cool Times] no current output takes place.
- [9] **3. CT [3rd Cool Time]**
- With the welding gun closed, the [2. WLD] or [2. Current Block] is followed by a [Cool Time] without current output to allow stress relief of the welded part.
- [10] **3.WLD [3rd Weld Time]**
- In the [3. WLD] a last current output may be given for post-heating purposes. This post-heating improves the structure of the welded part and serves to relieve weld stresses.
- [11] **HLD [Hold Time]**
- The welding process ends with the [HLD]. No current output takes place during the [HLD]. The weld spot is fixed in position during this cooling period. The solenoid valve closes at the end of the [HLD] and the welding gun opens up.
- [12] **[Impulse]**
- This parameter determines the number of [impulses] which make up the 2nd Current Block.
- [13] **OFF [OFF Time]**
- This time period is only used for repeat operations. The parameter determines the time period before the next [SQZ] during which the welding gun is open and the part to be welded can be moved to the next spot position.

**NOTE**

Current Cycles (cycles) or milliseconds (ms) are the units of measurement for programming the individual times. A time entry consists of a multiple of this unit.

Kilo Ampere (kA) is the unit of measurement for programming the intensity of the welding current under constant current regulation.

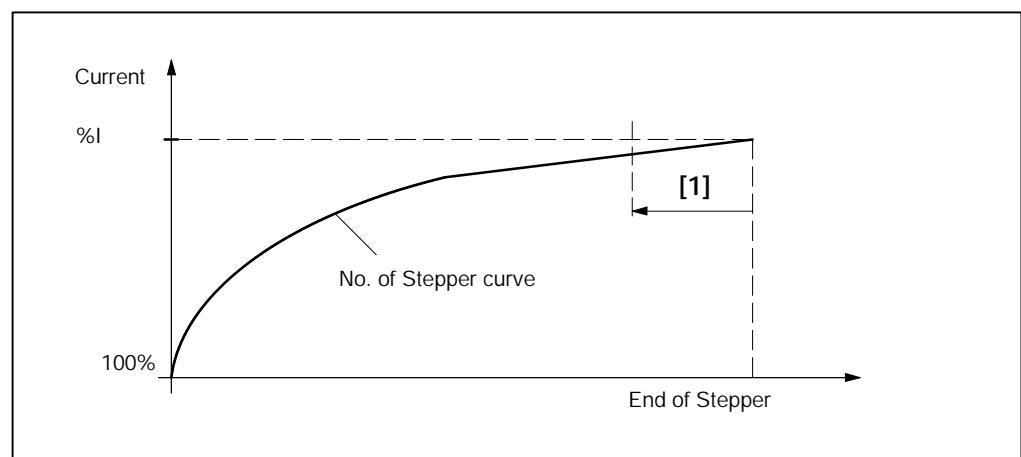
Scale units (%) are used for programming the intensity of the welding current for constant voltage or phase angle regulation.

8.10 Stepper function/Stepping/Tip dressing

This function provides for stepping of the welding current in order to compensate for the electrode wear. Stepping is done through stepping-curves that are set in *Basic-Setup*.

The following data is required:

- End of Stepper (max. counts (wear))
- [Current] (Stepping current in percent (%I))
- Number of the stepper curve (0-9).



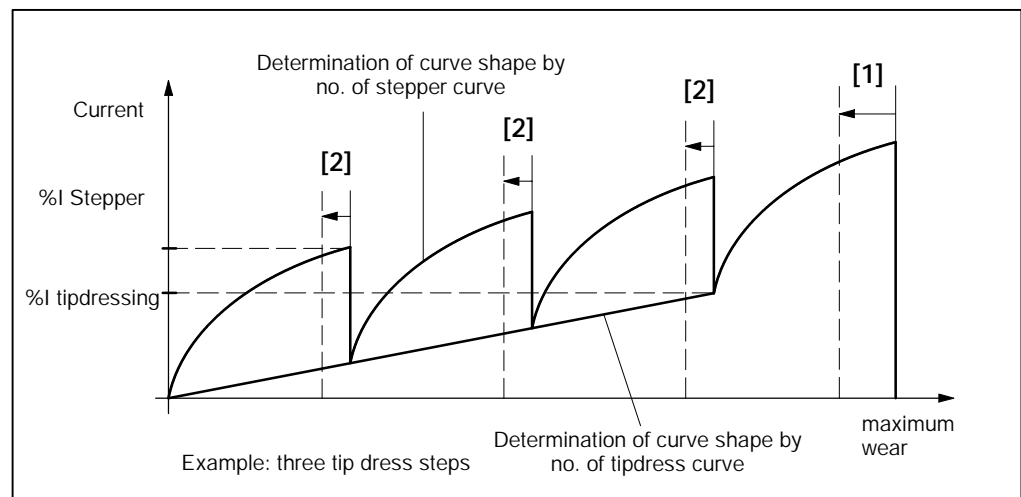
[1] Prewarning

The <Prewarning> signal indicates that the [End of Stepper] will be reached soon.

[2] Tip Dressing

In order to improve the electrode's tool life the electrode can be processed cyclically (tip dressed).

The stepping and the tip dressing functions can be combined.





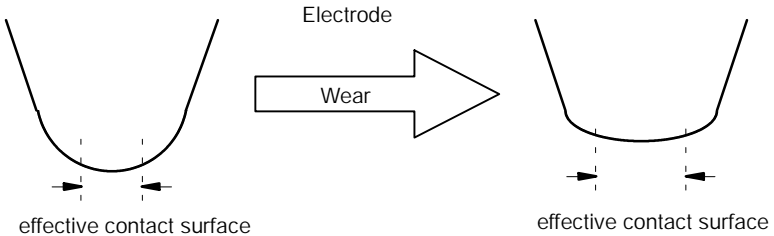
The following data is required:

- number of tip dress steps
- [Current] (percent Stepper at the beginning of a new tip dressing cycle)
- number (0 to 9) of tip dressing curve

Tip dress request (timer-specific)

The <Tip dress request> [2] signal indicates that machining (tipdressing) of the electrodes will be necessary soon.

8.11 Wear Factor



Some factors controlling wear:

- intensity of current
- materials
- electrode pressure and electrode material

Examples for the wear factor:

- low current - wear factor = 0.8
- high current - wear factor = 1.3
- sheet metal, steel - wear factor = 1.0
- galvanized sheet metal - wear factor = 2.8

(the cited values are not intended to be standard values)

With a wear factor = 1.0, the wear is the sum of the completed spot welds. With a wear factor greater than 1.0, fewer spot welds will be completed with identical wear. With a wear factor smaller than 1.0, more spot welds will be completed with identical wear.

Summing up, many spots with a low wear factor may result in the same wear as few spots with a high wear factor.

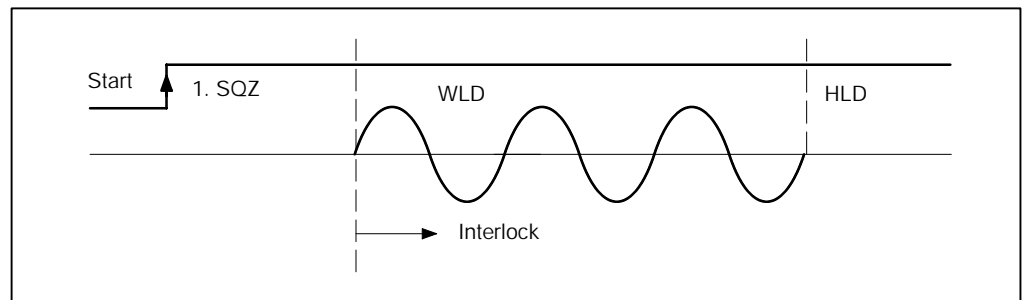
Example: Effect of wear factor and wear on the possible number of welds with different welding programs.

Program number	Wear factor	Number of Spot Welds	Wear
2	0.8	100	80
5	1.0	80	80
9	2.0	40	80

8.12 Start Interlock

When the first cycle of the [Weld Time] starts for a spot weld, the timer remains locked in, i.e. even if the start signal becomes logically 0, the initiated spot weld will be completed including the [Hold Time] (applies to single spot and repeat mode).

Only the <External Weld Time Termination> or the <Stop> signal can interrupt this process.

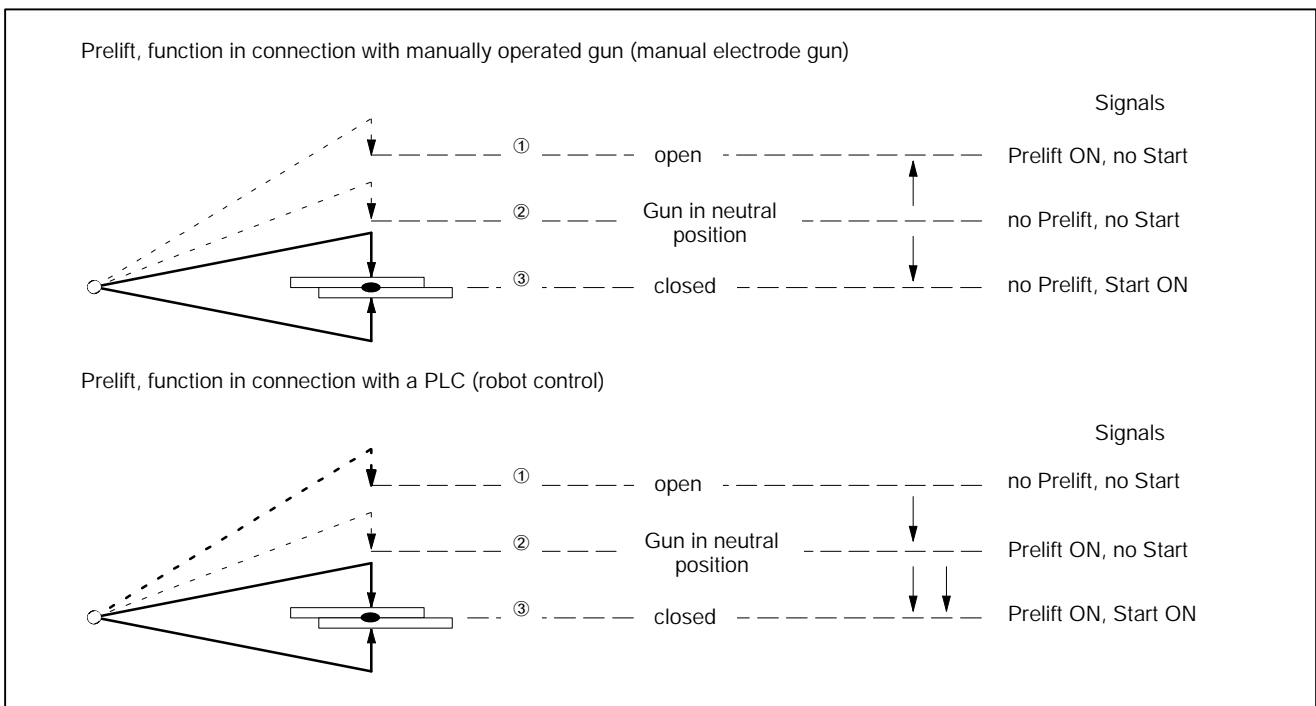


8.13 Prelift (timer-specific)

In order to reach the welding position of the parts to be welded with an open electrode gun it is useful to open the gun wider than normal.

The signal <Prelift> serves to activate a 2nd cylinder which opens the gun to the wider position. If Prelift is active, the welding program cannot be started.

Vice versa, Prelift is not possible while start is active. The <Start> and <Prelift> signals are **mutually interlocked** in the timer.



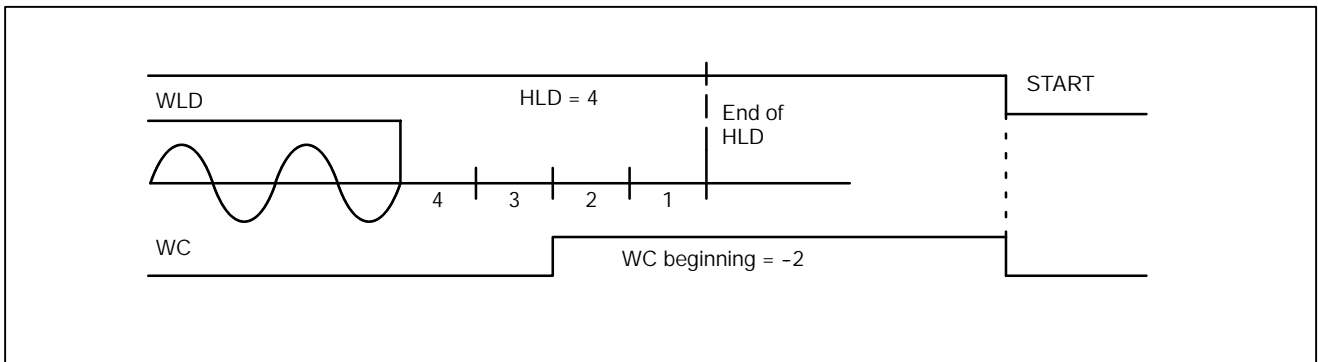
The robot-prelift function can work differently from the timer-prelift function. The robot uses the prelift function mainly to put the robot gun in the central position. To close the gun the signals <Prelift> and <Start> must be high. This function does not use the timer-prelift.



8.14 Weld Complete Contact (WC)

Normally the output of the <Weld Complete> contact begins at the end of the [Hold Time]. The beginning and the duration of the WC output can be programmed. They specify the number of cycles before the end of the [Hold Time] and for how long the <Weld Complete> (WC) signal is output.

Even in the case of high negative values, the earliest time the WC is issued, is one cycle after the end of the [Weld Time].



8.15 Automatic Spot Repetition

If current monitoring is enabled and the fault "no current" or "current too low" occurs, automatic spot repetition is possible.

- Spot repetition with current values below the tolerance range (maximum number of repetitions).
A spot is repeated only once at the most.
All repetitions are counted and if their maximum number is exceeded it is reported.
A weld within the tolerance band resets the repetition counter.

The gun remains closed, [Squeeze Time], [Weld Time], ... , [Hold Time] are started again.

If the Repeat factor, i.e. the maximum number of repetitions, is exceeded, the timer loses its ready state.



NOTE

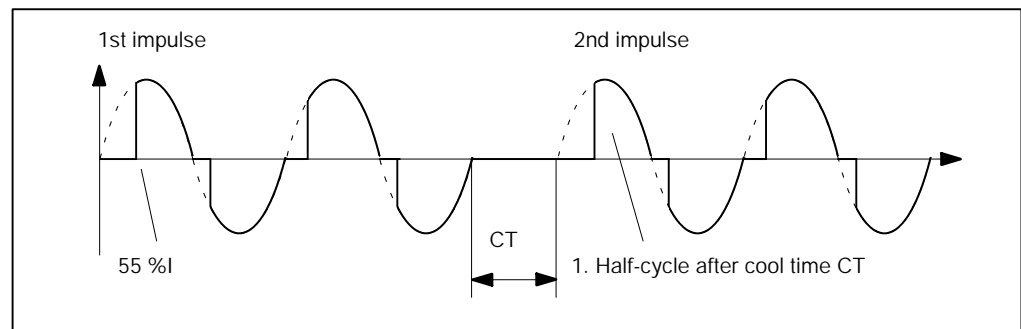
The Current Monitoring function must be active for automatic spot repetition.

8.16 1. Half-Cycle/1.Half-Cycle after Cool Time (1. HC a. PAUSE)

Activating the first current halfcycle of each weld can be limited to a certain value in order to protect the welding transformer and the thyristor unit. The default value is 55 %I and can be adjusted.

For lower [Current] values (0...55%I) the 1st halfcycle is not changed. If higher values are programmed (56...99%I), only the 1st halfcycle is limited to 55%I.

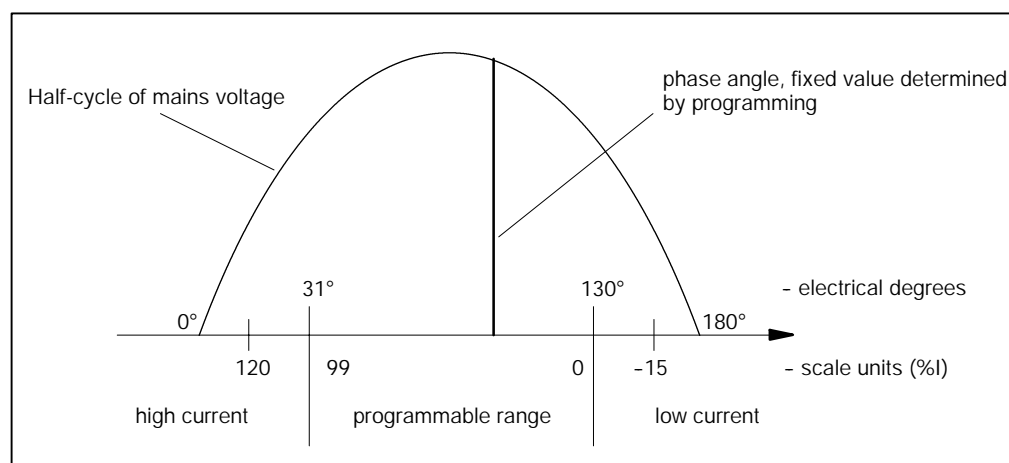
- Limit 1. halfcycle
The first halfcycle of a weld is limited.
- 1. Half-cycle after Cool time
When welding with several [Weld Times]/[Impulses], an additional limitation can be programmed after each [Cool Time].



8.17 PHA: Phase Angle Regulation

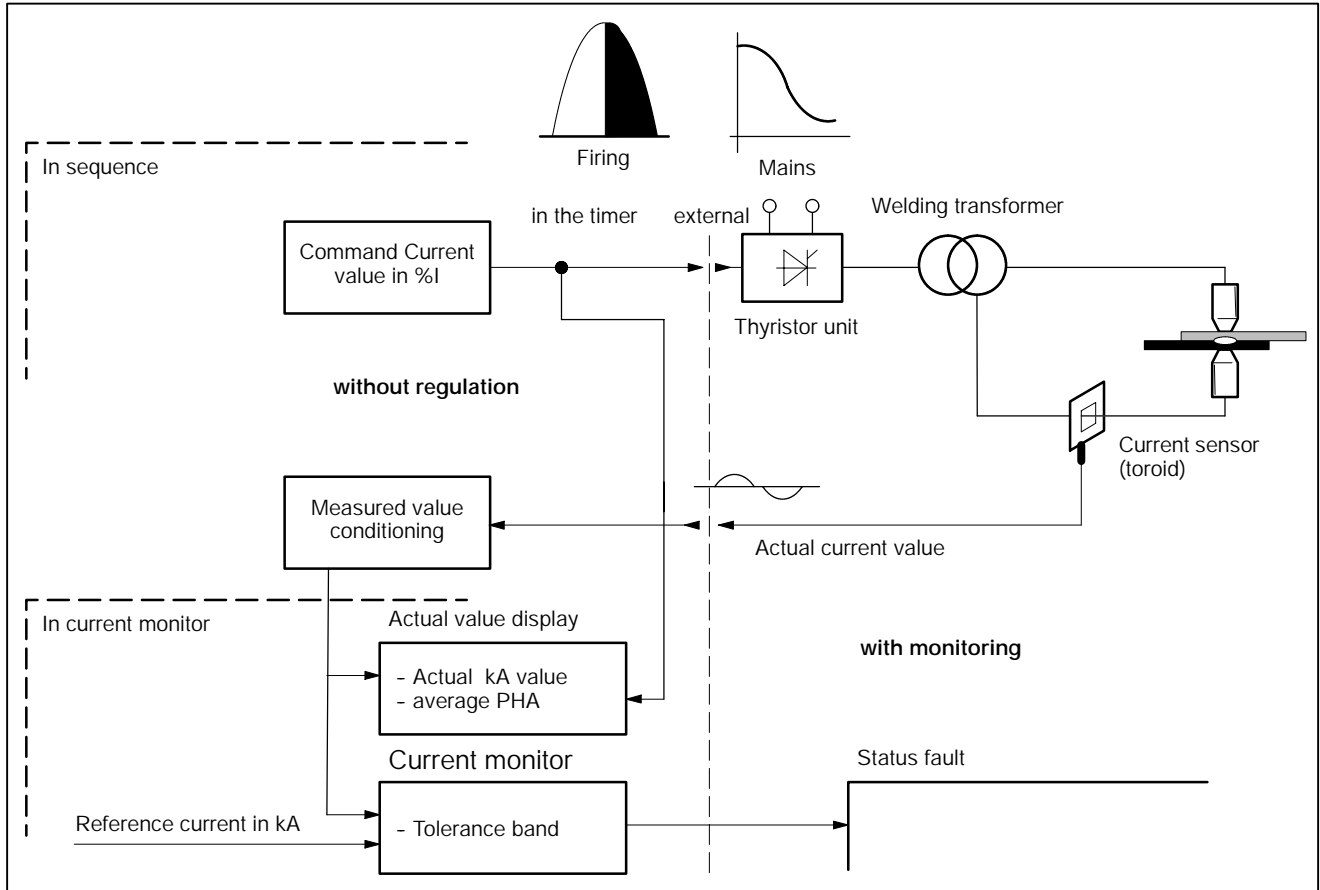
Programming the electrical [Current Command Value] (activation of the sinusoidal half-wave) is done in [Scale Units] (%). The current intensity is exclusively determined by the electrical quantities in the welding circuit.

There is no regulating function; the programmed [Scale Units] serve as command values. Current and Time monitoring can be enabled.





[PHA] without regulation, with monitoring



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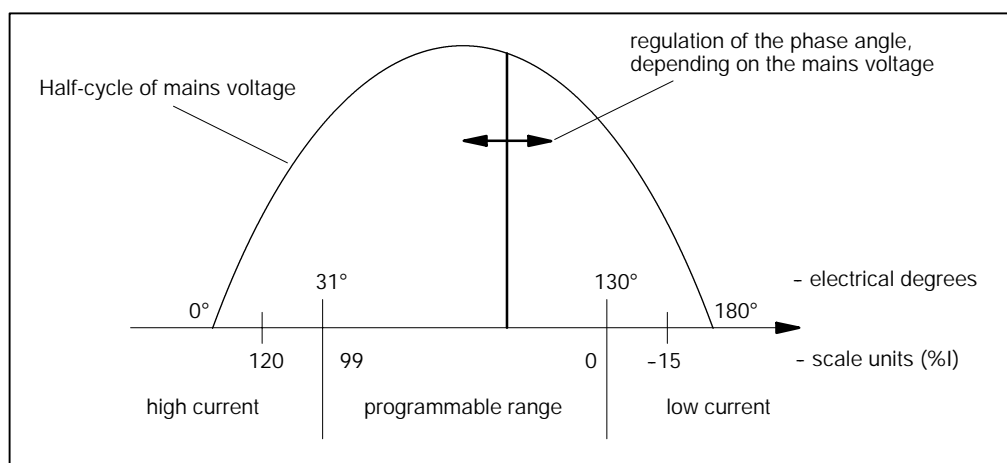
D Current monitoring requires a current sensor (toroid).

8.18 KUR: Constant Voltage Regulation

**NOTE**

The KUR regulation mode cannot be selected for all types of weld timers.

The Constant Voltage Regulation [KUR] must be programmed in [Scale Units] (%). This mode is used when the mains voltage fluctuates and the [KSR] regulation mode is not available. The primary voltage of the weld transformer is measured and used to adjust the phase angle accordingly in case of mains voltage fluctuations.



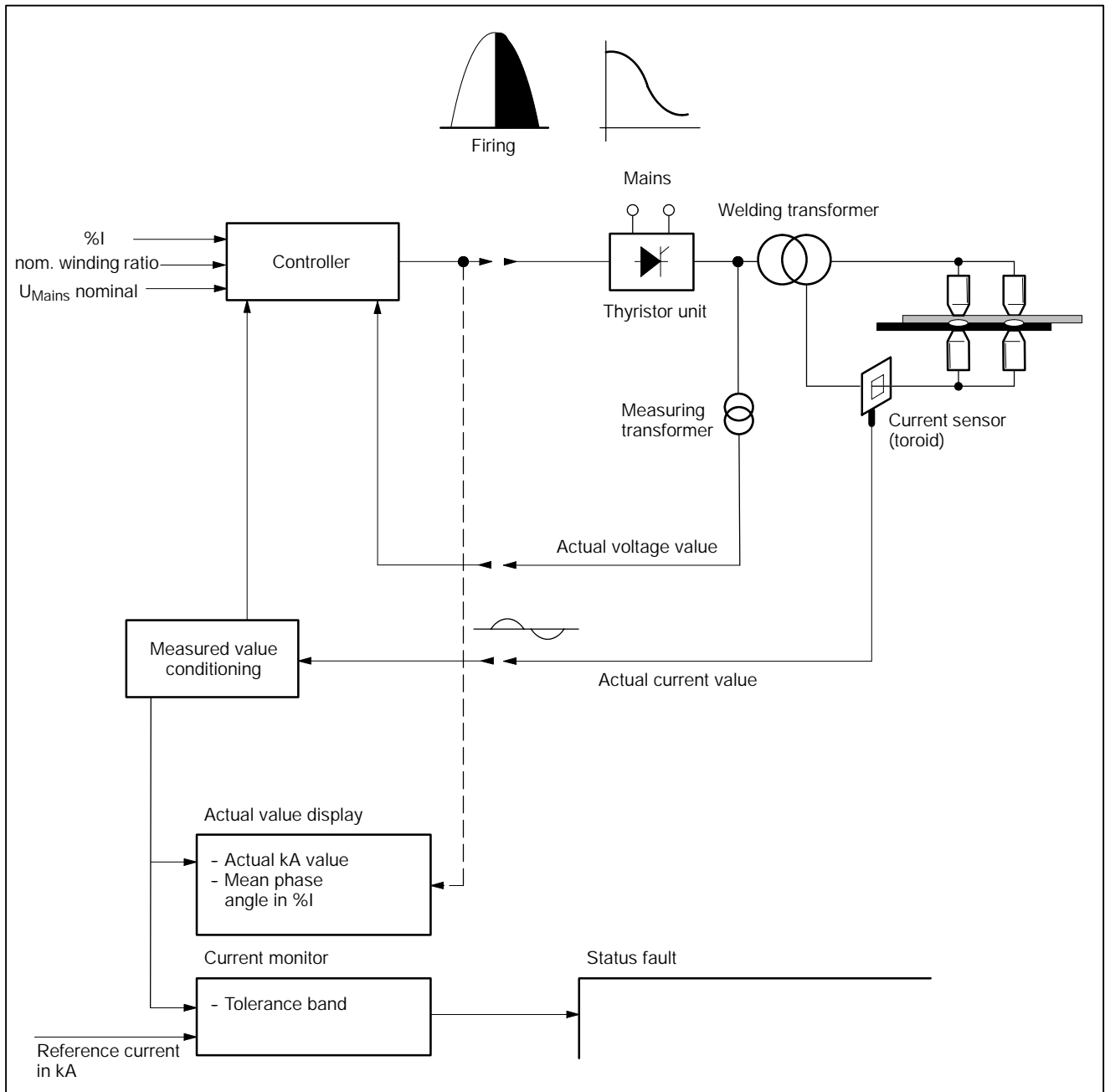
While in the *Starting Window - Operation - Modify - Programming - Basic-Setup - Thyristor-Unit Setup* menu enter:

- the nominal mains voltage (Supply-Volt.)
- the transformer ratio of the feedback transformer (Prim. Transf. Ratio).

These two entries, the measured voltage from the feedback transformer and the actual current value, determine the control of the phase angle which compensates for mains voltage fluctuations in the regulation mode [KUR].

NOTE

A voltage measuring circuit (feedback transformer) is required. This transformer's primary winding lies parallel to the primary winding of the welding transformer. The secondary winding feeds the UPR timer input.

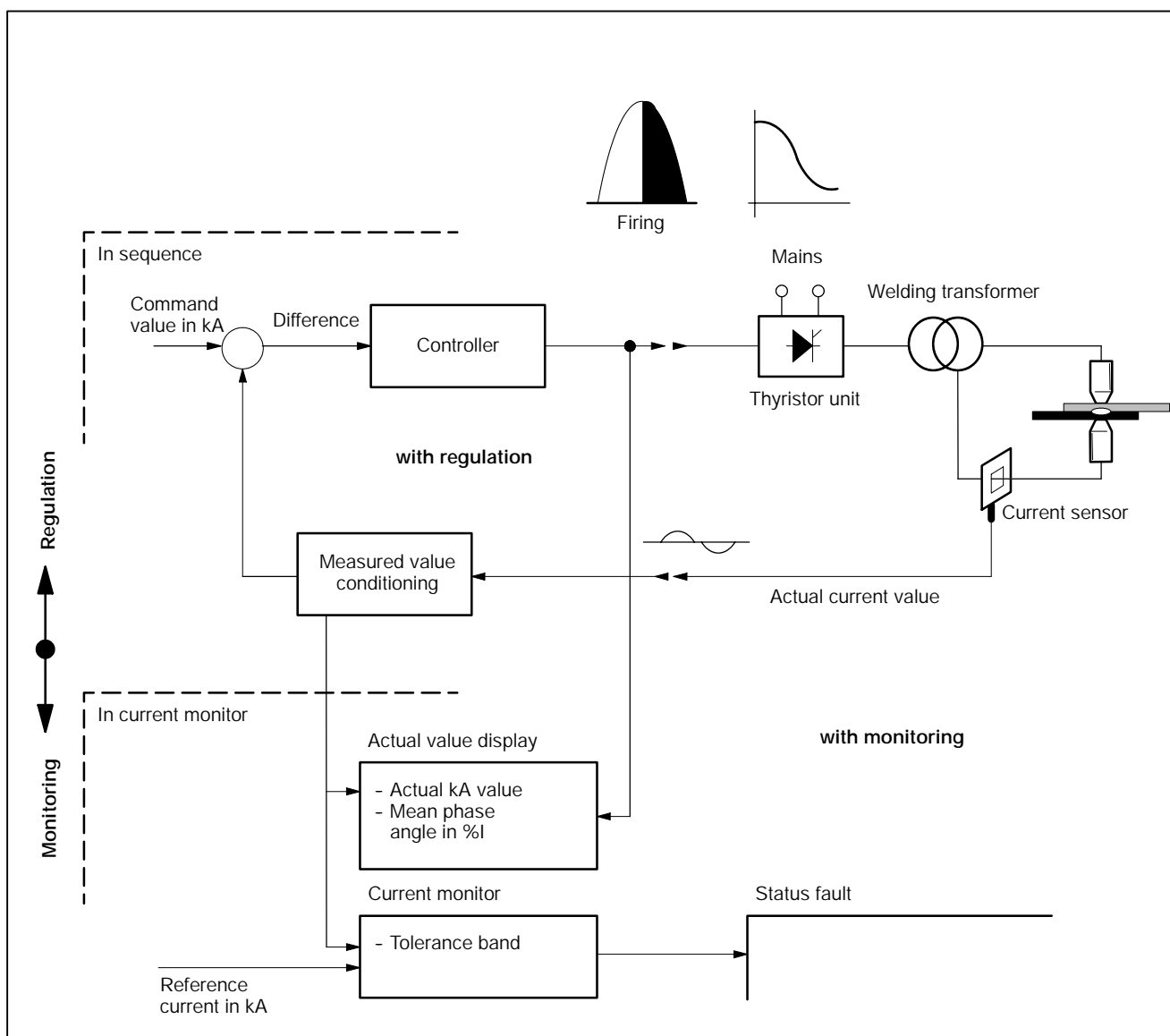
[KUR] (voltage regulation) with current monitoring

- D The mains nominal voltage must be entered.
- D A measuring transformer is required, the transformer ratio must be entered.
- D A current sensor (toroid) is required.

8.19 KSR: Constant Current Regulation

Programming of the welding current command value is done in kilo Amperes (kA). The current measuring device (current sensor or toroid) determines the actual current which is then compared to the command value. The following controller processes the difference and controls the phase angle in such a way that the current command value can be reached. It is the standard mode for robot electrode guns.

[KSR] with regulation and with monitoring



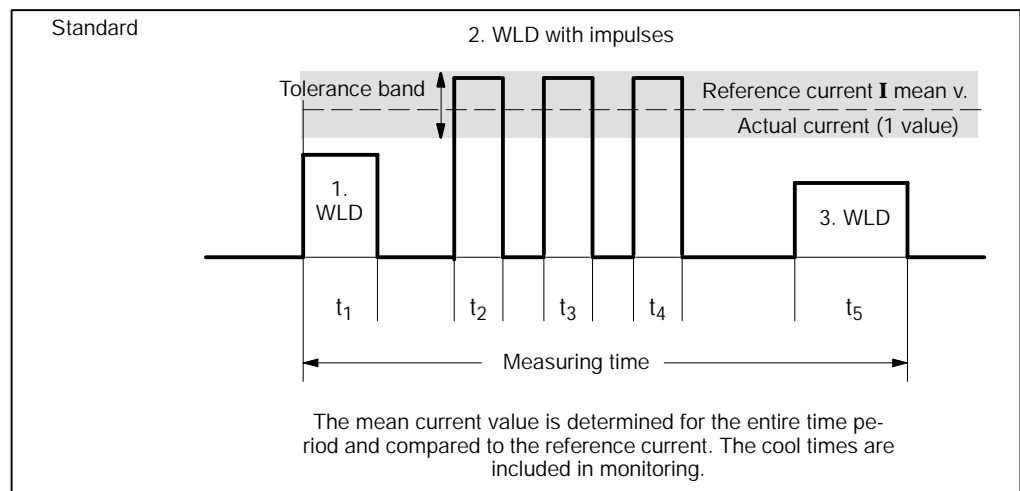
- D A current sensor is required.
- D Regulation on/off - Monitoring on/off - Regulation mode standard/mixed - Monitoring mode standard/mixed - Current monitor on/off - enter reference current - enter tolerance band.

8.20 *Current Monitoring*

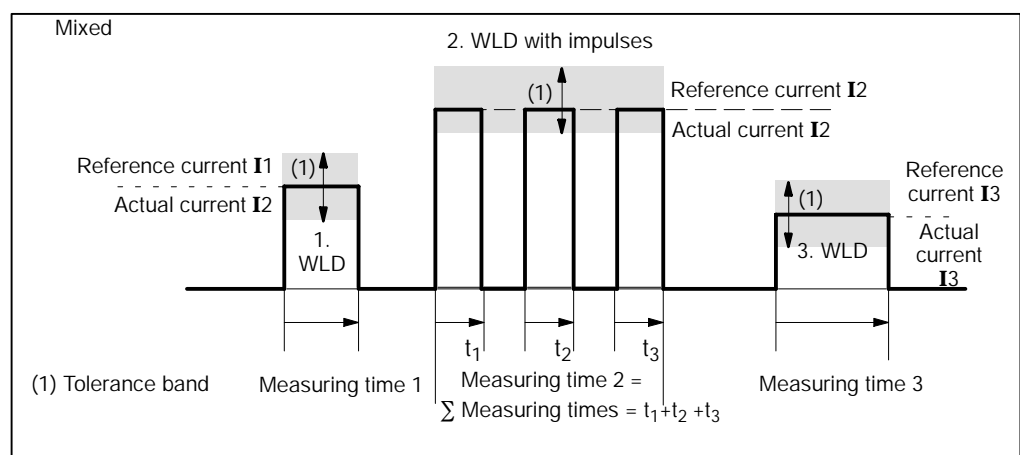
The actual current for *Current Monitoring* is determined by the following measuring procedures.

- In standard mode, an actual current is determined for the entire welding cycle (including all cool times). The measuring time runs from the beginning of the 1. Weld Time [1. WLD] till the end of the 3. Weld Time [3.WLD].
- In mixed mode, a separate actual current is determined for each weld time (pre-heating [1.WLD], main weld [2.WLD], post-heating [3.WLD]). If the main weld consists of several [Impulses] with intermediate cool times, the current is only measured during the [Weld Times] of the [Impulses].

8.20.1 *Standard Current Monitoring*



8.20.2 *Mixed Current Monitoring*



In the above examples, the time characteristics of the current curve is idealized and shown as a rectangular impulse. In reality, there is a recovery and a decay at the beginning and at the end of each rectangular impulse. For some timer types the current measurement can be restricted to the constant part of the current flow by entering a fade-out time at the beginning of the impulse and by enabling "Trail Current Off". The best fade-out time must be determined through several trials.



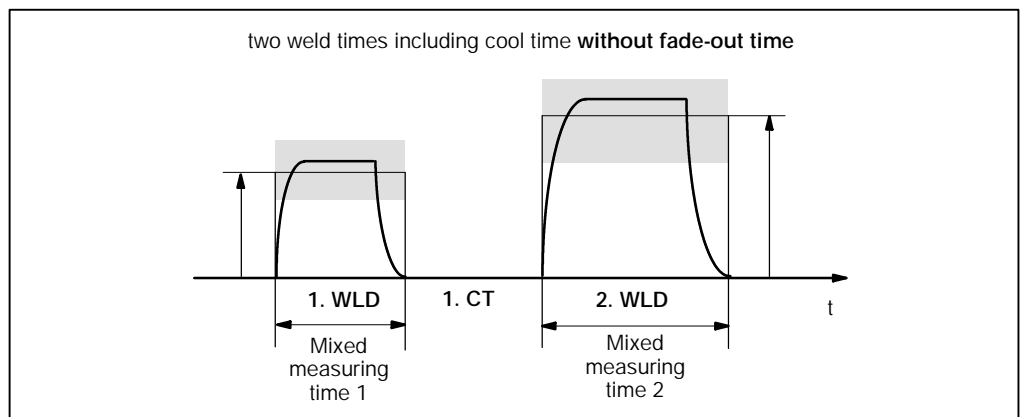
8.20.3 Fade-out Time and Trail Current



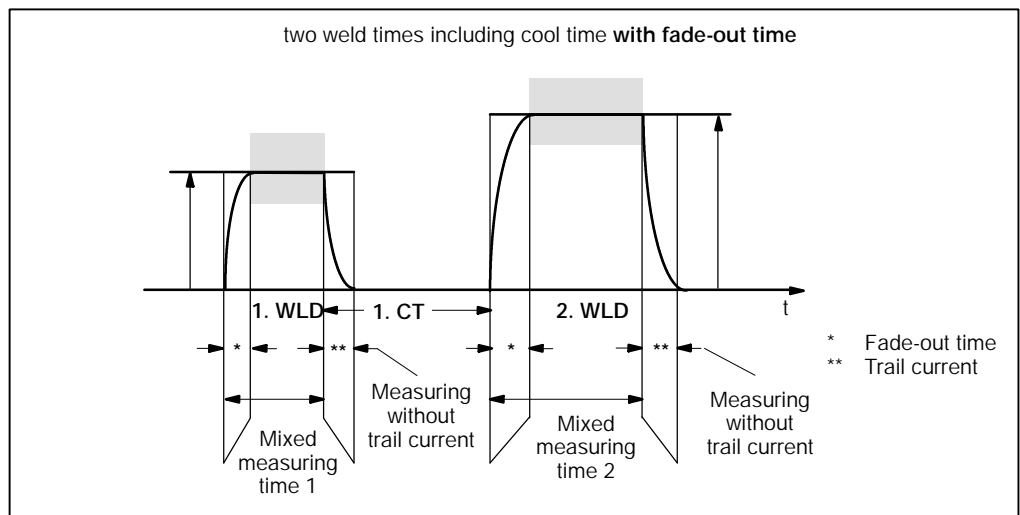
NOTE

Programming of the fade-out time and deactivation of the trail current depend on the timer type used.

The fade-out time (time for current increase at the beginning of a pulse) and the "Trail Current off" function (trail current at the end of the pulse) apply to each rectangular pulse of the entire [Sequence].



8

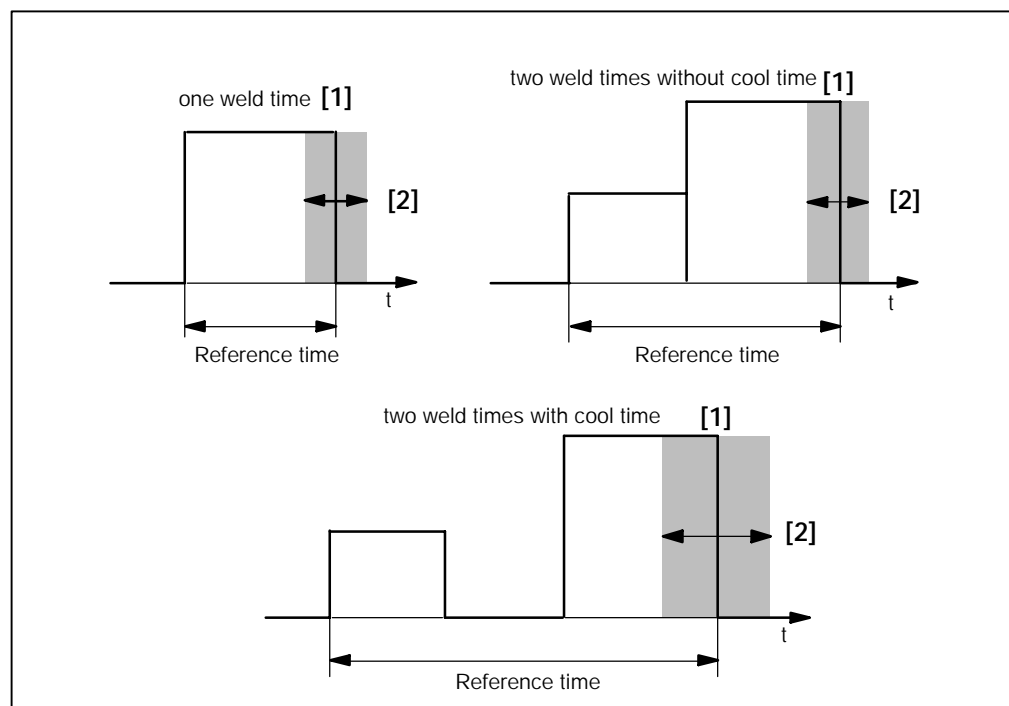


8.21 *Time Monitoring*

The actual time for *Time Monitoring* is determined by the following measuring procedures.

- In Standard mode, a reference time is entered and monitored for the entire welding [sequence].

8.21.1 Standard *Time Monitoring* Mode



[1] Reference time for *Time Monitoring*

[2] Tolerance band of good welds

**8.22 "7-Item-Check"**

If you encounter a timer with an unknown condition, you should first check the following 7 items:

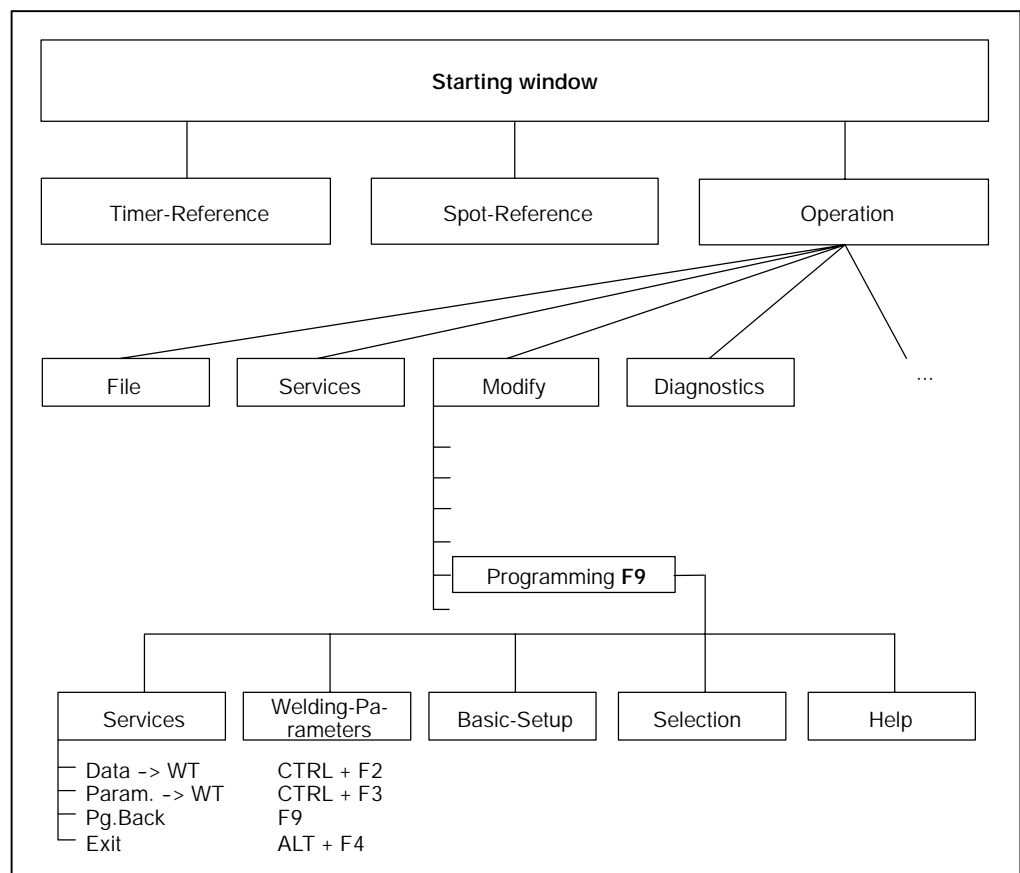
- **1. Program no.:**
Which program is started (e.g. by the robot), which program do you see at the programming unit?
(Is Start 1 or Start 2 active?)
- **2. Which mode is active? SINGLE, REPEAT or SEAM?**
For repeat mode one OFF-time is required.
Is Weld on/Weld Off (external/internal) enabled?
- **3. Number of [Weld Times]/[Impulses]:**
 - One [Weld Time]:
Only [2. Weld Time] and [Current] are used.
 - With preheating:
[1. Weld Time] and [1. Current] are also used.
 - With postheating:
[3. Weld Time] and [3. Current] are also used.
 - [2. Current Block] with [Impulses]:
[No. of Impulses] > 1, [2. Cool Time] may be used.
- **4. Stepper yes/no?**
 - Valid curve shape?
 - Are the [current values] %I or kA entered correctly?
 - Is the wear factor entered correctly?
 - Does the program use the correct electrode?
 - Has an electrode reached the "End of stepper"?
- **5. Current function PHA-KSR-KUR**
 - Is the tolerance band entered?
 - Is the right reference current used?
- **6. Is Inhibit Regulation switched ON/OFF?**
- **7. Is Inhibit Monitoring switched ON/OFF?**

Your notes:

9 Programming

9.1 Services

- Transmit timer data to the weld timer
- Transmit parameters to the weld timer
- Exit *Programming*, return to *Operation* window



9.1.1 Data -> WT (<Ctrl> + <F2>)

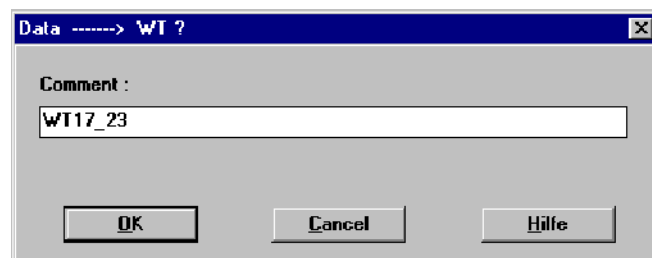
Transfers all program data from the current window to the selected program and/or the selected electrode. This function is available only in the *Welding Parameters* windows and in some of the *Basic Setup* windows.



NOTE

Offline data are stored in the selected offline directory. Already existing files are overwritten.

- D Select *Starting window - Operation - Modify - Programming - Services - Data -> WT*.



Command buttons:

- D <OK>:
transmits data to the timer or cancels data transmission, closes the window.

Data transmission can be given a comment. The comment (max. 48 characters) is saved in the protocol memory for data modifications of the timer.

Changes made at the programming unit will not become effective unless they have been transferred to the timer.

If in *Operation - Services*, the menu item *Auto. Data -> WT* is checked (activated) this window will be automatically displayed whenever a modified input field is exited.



9.1.2 Param. -> WT (<Ctrl> + <F3>)

Transfers individual parameters to selected programs and/or for selected electrodes from the current window. This function is available only in the *Welding Parameters* windows and in some of the *Basic Setup* windows.

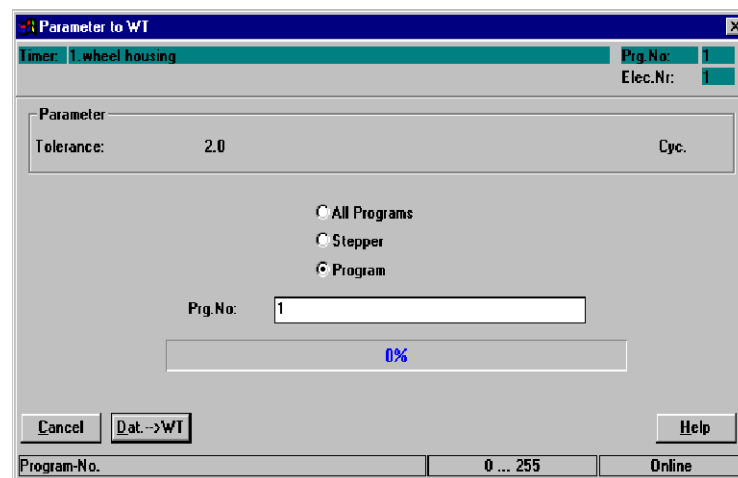
**NOTE**

Offline data are stored in the selected offline directory. Already existing files are overwritten.

- D Select *Modify - Programming - Welding parameters / Basic-Setup - Services - Param. -> WT*. This function can also be activated by clicking with your right mouse button on an input field.

According to the type of the parameter a window with variable contents will be displayed. The last modified parameter is transferred.

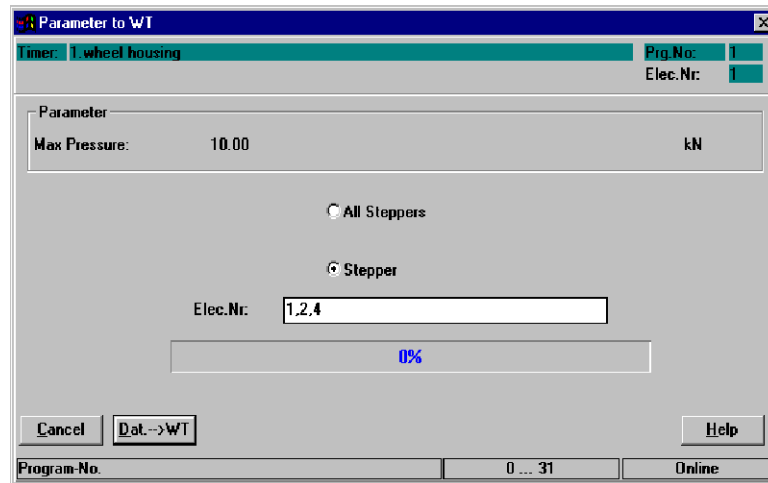
Example: Window for the time monitoring parameter

**9**

Input and/or selection fields:

- **All programs**
The displayed parameter is changed in all programs of the timer.
- **Stepper**
The displayed parameter is changed in those weld timer programs that work with the displayed electrode.
- **Program**
The displayed parameter is changed in the program/s that is/are listed in the input field *Prg. No.*
- **Prg.No.**
Enter the program number(s) for data transmission. It is also possible to enter several programs at the same time.
 - Example: 2-5,7,11,22-24,
Transmission for programs 2, 3, 4, 5, 7, 11, 22, 23 and 24.

Example: Window for the stepper parameter



Input and/or selection fields:

- **All steppers**
The displayed parameter is changed for all steppers (electrodes) of the timer.
- **Stepper**
The displayed parameter is changed for the stepper(s) (electrode/s) of the timer that is/are listed in the *Elec.No.* input field.
- **Elec.No.**
Enter the stepper (electrode) number for data transmission. It is also possible to enter several steppers at the same time.
 - Example: 2-4,9
Transmission for electrodes 2, 3, 4 and 9.

9.1.3 Pg.Back (<F9>)

Change back from the current *Programming* window to the *Operation* window showing the plant layout (alternatively <F9>). *Programming* is put into background.

The *Operation* menu is displayed.

9.1.4 Exit

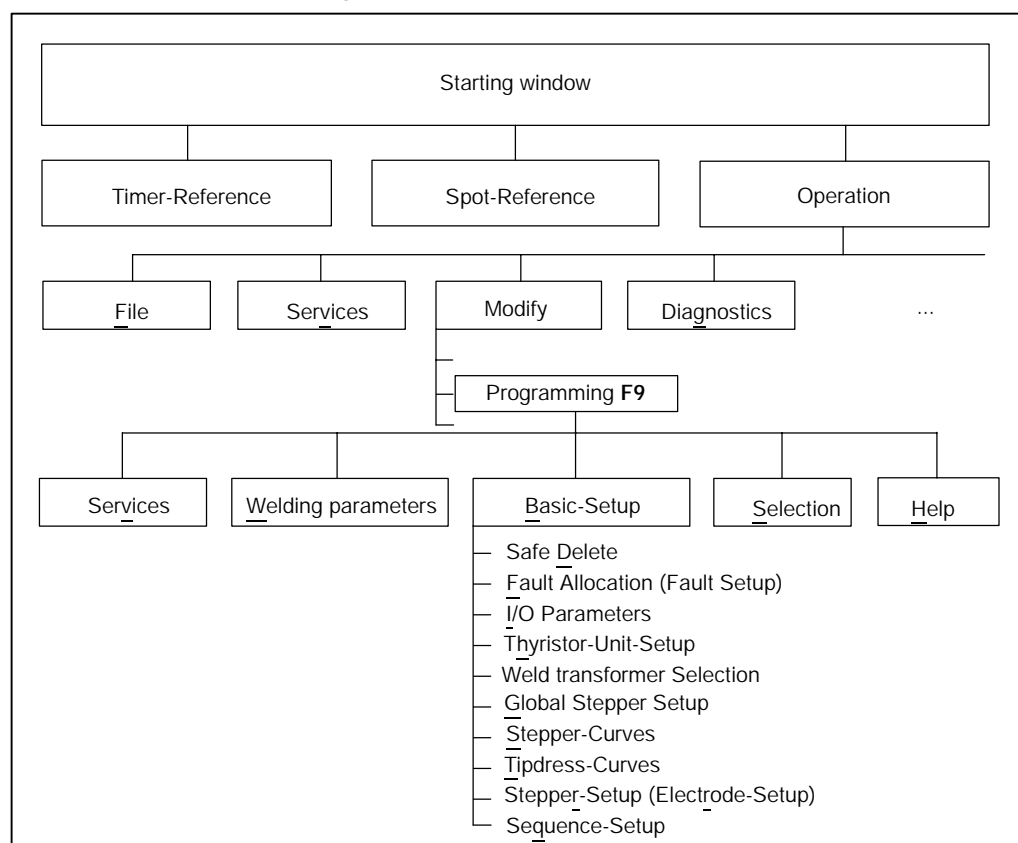
Exit *Programming*.

10 Basic Setup

Many parameters are timer- and plant-specific and have to be determined in the Basic-Setup when starting the system.

In *Basic Setup* basic functions are assigned to the timer (WT) (e.g. the reaction of the WT to events in the weld circuit). They adapt the WT to the environment of the welding equipment (e.g. selection of the thyristor unit). By assigning electrodes and programs and by further definitions you prepare the programming of the welding parameters.

- Delete memory in the timer
- Response of the timer to events (e.g. deviations from command values) in the sequence
- Definition of I/O parameters
- Definition of the electrodes parameters and maintenance concept ...
- Entries for all timers such as Start-Inhibit, Max. Weld Time ...
- Interaction with different units like AC, inverter ...
- Measurement, control, and monitoring processes ...
- Sequence modes Single, Repeat, and Seam.

**10**

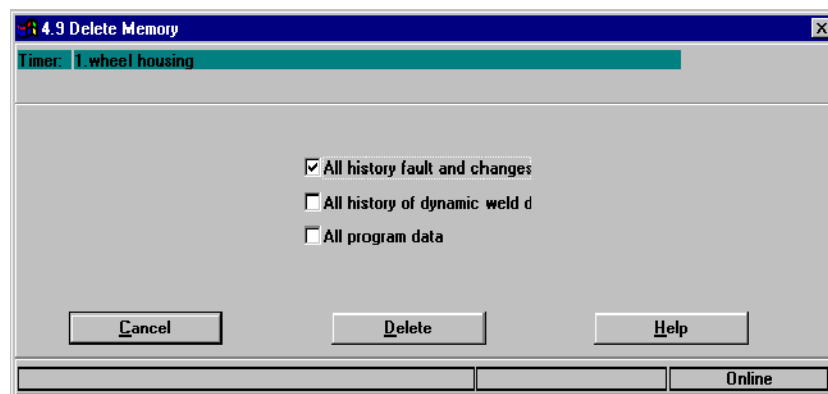
Operation of *Basic-Setup*

In order to operate the *Basic-Setup* the windows *Timer-Selection* and *Program-Selection* are opened. If no timer or *spot* has been selected yet, an appropriate dialog will be opened.

10.1 Safe Delete (Delete Memory)

Memories in the timer are deleted or set to default values. For this purpose, the desired data must be selected. It will be deleted with the <Delete> command button without an additional query.

D Select *Starting window - Operation - Modify - Programming - Basic-Setup - Safe Delete*.



All history fault and changes

The protocol memory contains (including time and date):

- fault messages
- current fault messages
- data changes
- current values

All history of dynamic weld data

The actual values memory contains:

- Actual current, voltage and phase values of the last weldings including time and date
- counter status (e.g. electrode wear)

All program data

All *Welding Parameters* and *Basic Setups* are set to default values. Data that are e.g. relevant for setting up the interfaces (V24 and fieldbus) are copied from the timer's flash memory to its random access memory (RAM).



NOTE

This will delete all welding parameters and basic setups previously set in the weld timer.

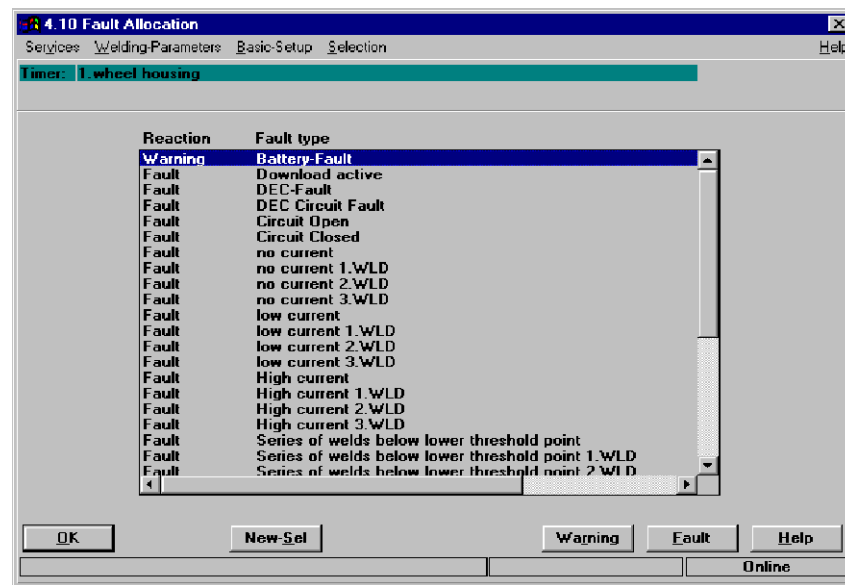


10.2 Fault Allocation

The displayed list contains the types of faults and the timer's response upon their occurrence. With the command buttons <Warning> and <Fault> the appropriate response of the timer can be assigned to the marked fault type.

Each change is transmitted to the timer as soon as the command button is pressed and becomes effective immediately.

D Select *Starting window - Operation - Modify - Programming - Basic-Setup - Fault-Setup.*



Command buttons:

- <New Sel> corresponds to the *Selection* menu in *Programming*, see chapter 12.
- <Warning> selects *Warning* for the marked event. When the event occurs, the timer will not lose its Ready state. Other [sequences] can be performed. The output *Warning* (type-specific) is set and a message is displayed at the programming unit. The source of the warning is to be eliminated, the message acknowledged. Warnings concerning the [sequence] are cleared with the next <Start>.
- <Fault> selects *Fault* for the marked event. Upon occurrence of the event the timer loses the Ready status. No further [sequences] are possible. The output *Welding Fault* (not available for all types) is set and a message is displayed at the programming unit. The source of the fault is to be eliminated, then the fault message is to be acknowledged.

NOTE



Changing the fault type in the *Fault Allocation* window becomes active even if the window is exited with <Cancel> .

Your notes:

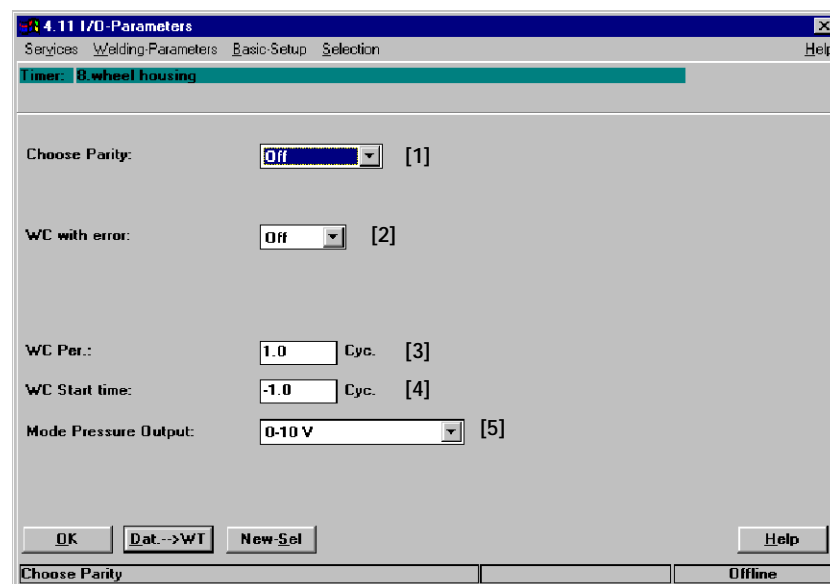


10.3 I/O Parameters

Signals of the I/O interface are defined.

- Parity (only in timers with parallel I-interface)
When starting a welding program a parity check can verify the program selection. Parity check serves the safety of the program selection using parallel inputs.
- **<Weld complete>** (WC)
Announces the end of the welding process to external timers, especially in automated welding installations.

D Select *Starting window - Operation - Modify - Programming - Basic-Setup - I/O Parameters*.

**10**

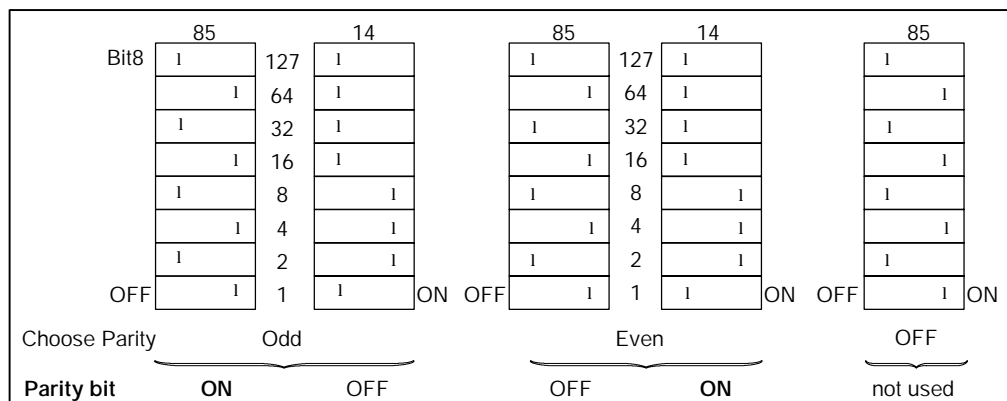
Command buttons:

- **<OK>**
transmits data to the timer or cancels the transmission, closes the window.
- **<Dat. -> WT>** transmits data to timer.
- **<New Sel>** *New Select* corresponds to the *Selection* menu in *Programming*, see chapter 12.

Parity

Examples for the meaning of the parity bit:

Program number = $1 + 4 + 16 + 64 = 85$ or $2 + 4 + 8 = 14$



The parity bit is used when a program is selected using parallel inputs.

Inputs and selections:

[1] Choose Parity

- **OFF**
Parity bit is not evaluated.
- **Even**
The sum of the program selection bits with status 1 must result in an **even number**. If not it must be supplemented with the parity bit with status 1 in order to become even.
- **Odd**
The sum of the program selection bits with status 1 must result in an **odd number**. If not it must be supplemented with the parity bit with status 1 in order to become odd.

When parity errors occur the message *Program Parity Fault* is displayed.



NOTE

Parity is not applicable if the program is selected via an I/O bus.

[2] <Weld complete> WC with error in the [sequence]

In automated welding installations it might be necessary to output <Weld Complete> also in the case of errors; for fault definition, see section 10.2.

- WC with error
 - ON
<Weld complete> WC is also issued if an error is detected.
 - OFF
<Weld complete> WC is issued only if no errors are detected during [sequence].

<Weld complete> WC without errors in the sequence

In automated welding installations the WC is processed by external control mechanisms (e.g. robot controls). The duration and the starting time are thus dependent on the demands made on the external processes.

[3] WC Period, minimum duration of WC signal in cycles or milliseconds (depending on type of timer) with starting signal turned off.

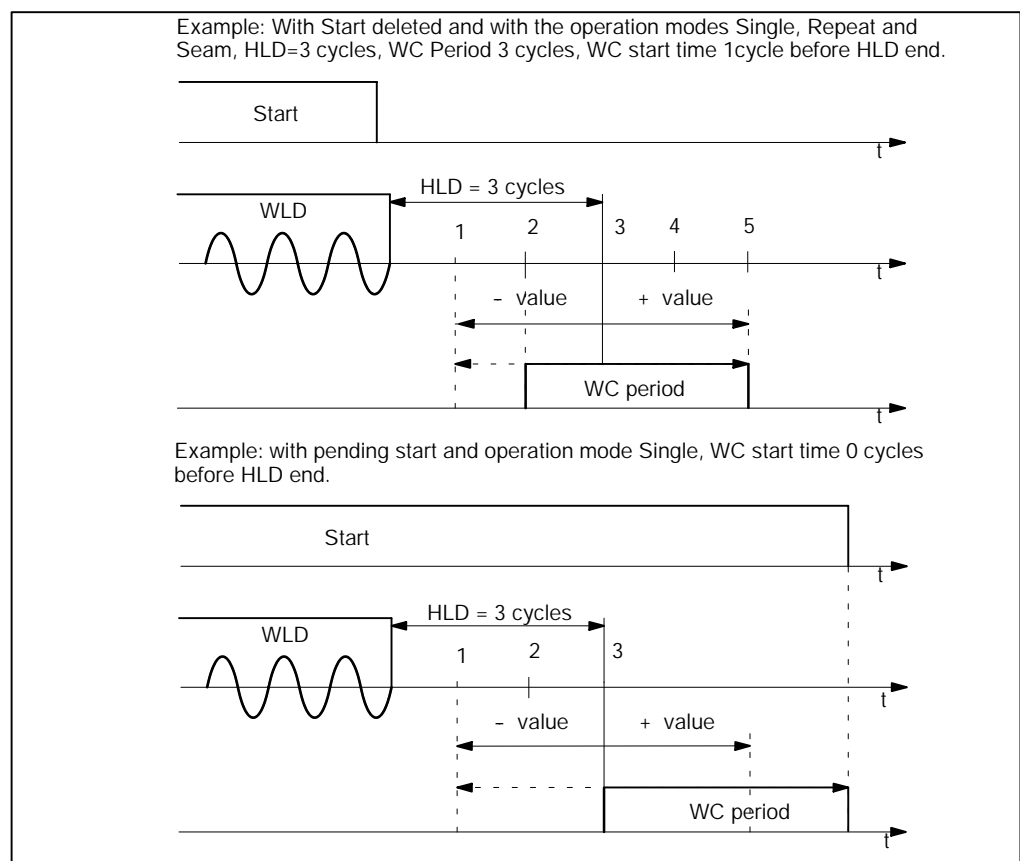
Input range: 0 to 50 cycles (or 0 to 1,000 ms). If no start is pending, a WC pulse of the set duration is given, starting at the point of output. If start is still pending the WC remains as long as the start signal.

[4] WC Start Time

Normally, WC starts with the end of the hold time (HLD).

Negative values cause the beginning of the WC before the end of the HLD. The earliest possible start time of the WC is after the first cycle (ms-WT: millisecond) of the hold time (HLD).

Positive values activate the WC after the end of the hold time (HLD).



In order to activate a proportional valve some timers have a pressure output.

[5] Operating mode pressure output, setting of signal (type-specific).

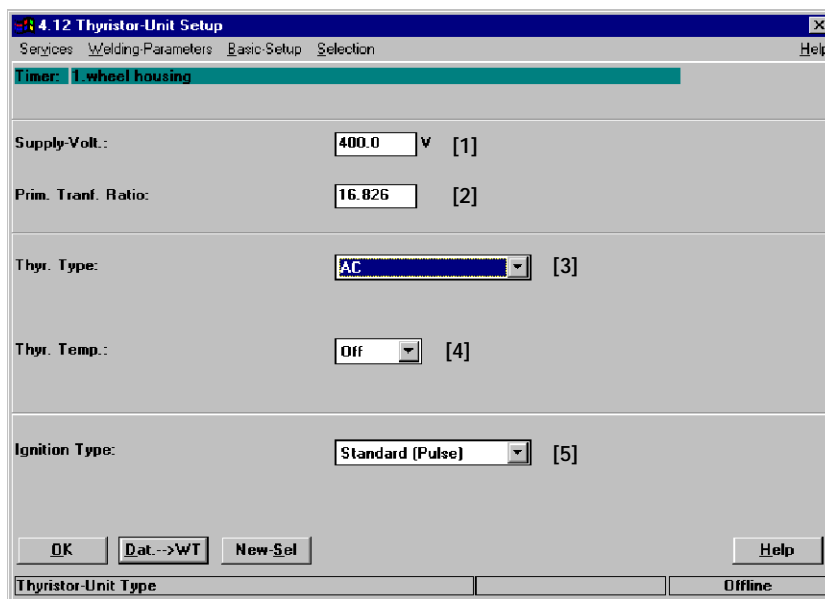
- 0 - 10 V
- 0 - 20 mA
- 4 - 20 mA

10.4 Thyristor-Unit Setup

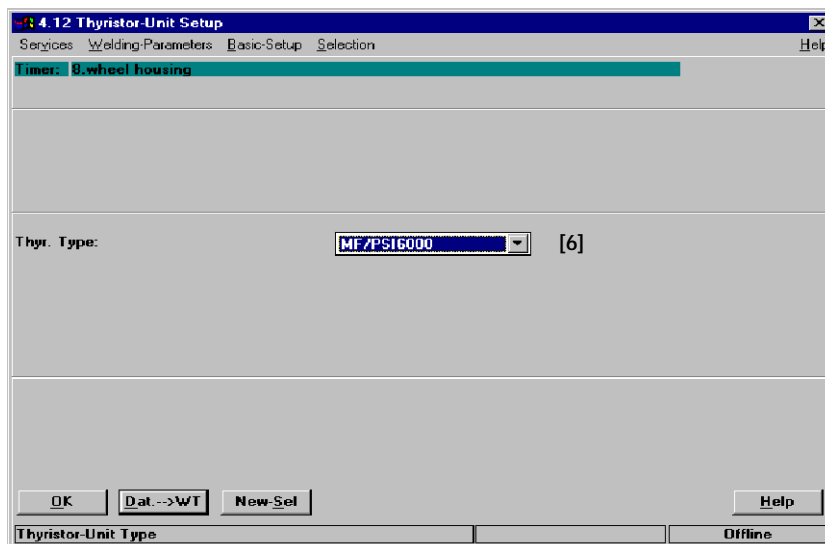
The timer must have the technical data of the thyristor unit used.

D Select *Starting window - Operation - Modify - Programming - Basic-Setup - Thyristor-Unit Setup*.

“Stand-alone” module PSS 5000



Integrated modules PSI 6000/PST 6000



Command buttons:

- <OK>
transmits data to the timer or cancels the transmission, closes the window.
- <Dat. -> WT> transmits data to timer.
- <New Sel> *New Select* corresponds to the *Selection* menu in *Programming*, see chapter 12.



Inputs and selections:

- [1] Supply Volts, valid for PSS 5000, PSI 6000, PST 6000 (only for regulation mode KUR)
Enter the nominal supply voltage of the welding transformer here.
The nominal supply voltage is used as a control parameter.
- [2] Prim. Transf. Ratio (only for regulation mode KUR)
The KUR function employs a feedback transformer. Enter its nominal transformer ratio here, e.g. 380V : 24V=15.833.
If your feedback transformer works at a lower or higher voltage rating enter the nominal transformer ratio all the same.
- [3] Thyr. Type, thyristor type, valid for PSS 5000
The selection of the thyristor unit type (AC, DC 2-phase, DC 3-phase, inverter) provides the timer with additional technical information.
For PSI and PST types there is no Info display.
- [4] Thyr. Temp, thyristor temperature contact
Specify whether the contact of the thyristor unit is open (normally-closed contact, off) or closed (normally-open contact, on) in the event of a fault.
- [5] Ignition type
Setting up the type of drive power to the thyristor unit:
- Standard 5 kHz impulse chain (burst)
 - CNOMO, predetermined impulse generation.
- [6] Thyr. Type, thyristor type, (power unit type), valid for PSI/PST.
With the selection the timer receives further technical data.

10.5 Weld Transformer Selection

For several functions of the thyristor units PSI/PST and the weld timer it is necessary to select or enter the technical data of the welding transformer and the diodes in the secondary circuit of the welding transformer.



NOTE

The Welding Transformer Selection will only be displayed if the integrated timer PSI is selected.

D Select *Starting window - Operation - Modify - Programming - Basic-Setup - Weld Transformer Selection.*

When using Bosch weld transformers (diode type and diode selection are known):

4.18 Weld Transformer Selection

Services Welding-Parameters Basic-Setup Selection Help

Timer: 8.wheel housing Prg.No: 1
Elec.No: 1

Transformer

Type: [1] PSG3100.00A Number: [2] 1

Diodes

Supervision: [5] On Switch of temp.: [8] 150 °C

OK Dat.-->WT New_Sel Help

Number of Transformer 1 ... 4 Offline

When using other weld transformers:

Command buttons:

- **<OK>**
transmits data to the timer or cancels the transmission, closes the window.
- **<Dat. -> WT>** transmits data to timer.
- **<New Sel>** *New Select corresponds to the Selection menu in Programming, see chapter 12.*

10

Inputs and selections:

- [1]** Transformer Type
Select the model of the used transformer (name plate). This and the number of transformers lets the PSI recognize the maximum current of the welding installation.
The selection of another transformer (non-Bosch) requires further entries after transmitting this setting to the timer.
- [2]** Number of Transformers
Enter the number of the used transformers (with parallel connection).
This and the type of the transformer lets the PSI recognize the maximum current of the welding installation.
- [3]** (Nominal) Transformer Ratio (only with setting Other Transformer)
For nominal transformer ratio of the weld transformer see name plate.
With primary current control, sensors are used that are incorporated in the primary circuit. The transformer ratio of the transformer is necessary in order to convert the primary current values into secondary current values.

- [4] Maximum Secondary current (only with setting Other Transformer)
Enter the maximum secondary current taken from the name plate of the transformer. The maximum welding current is limited to this value.
- [5] Diode Supervision
Monitoring of secondary diodes (diodes in the secondary circuit of the weld transformer) is turned on or off.

**CAUTION!**

If diode monitoring is turned off the thyristor unit and the diodes can be destroyed. There is no warranty for damage when diode monitoring is turned off.

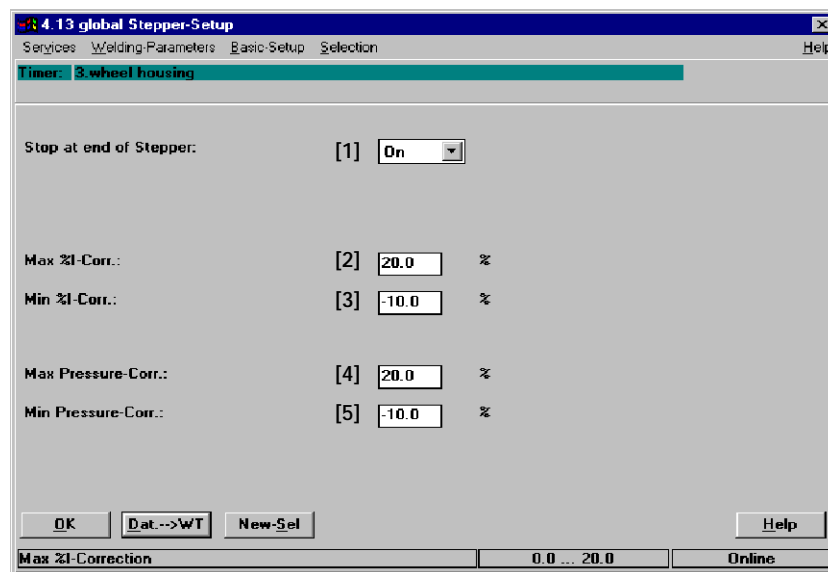
- [6] Diode Type (only with setting Other Transformer)
The type of the diode must be selected if diode monitoring is turned on and non-Bosch transformers are used.
- [7] Number of Diodes (only with setting Other Transformer)
Enter the number of diodes in parallel connection if diode monitoring is turned on and non-Bosch transformers are used.
- [8] Switch-Off Temperature
The maximum junction temperature of the diodes of 150 °C in relation to 30 °C water temperature is displayed. The value refers to the specification of the selected type of diode.



Your notes:

10.6 Global Stepper-Setup

- Behavior of the timer when end of stepper has been reached.
 - Presetting the maximum number of allowable corrections for all electrodes that the operator can make in the *Operation* window.
- D Select *Starting window - Operation - Modify - Programming - Basic-Setup - Global Stepper-Setup*



Command buttons:

- **<OK>**
transmits data to the timer or cancels the transmission, closes the window.
- **<Dat. -> WT>** transmits data to timer.
- **<New Sel>** *New Select* corresponds to the *Selection* menu in *Programming*, see chapter 12.



Inputs and selections:

- [1] Stop at end of stepper, when maximum electrode wear has been reached. Is effective if *Stepper function* is activated.
- ON
When the end of the stepper for the electrode in question has been reached a new sequence with this electrode is not possible.
 - OFF
When the end of the stepper for the electrode in question has been reached further sequences with this electrode can be started.
With automated welding installations it might be wise to report reaching the end of the stepper with a signal in order to continue welding and finish the current piece of work.

**NOTE**

Continuing welding with an electrode that has reached the stepper end can lead to quality problems.

**NOTE**

Stop at end of stepper: The next start is not enabled before the electrode has been replaced and electrode replaced has been confirmed (reset counter). The acknowledgement of the electrode replacement can also be done using the BOS-5000 software.

10

Correction settings allow the operator to make temporary adjustments of the parameters [%I] and [pressure] without changing the basic setup.

The possible regulating range is given:

- [2] maximum positive [%I correction]
[3] maximum negative [%I correction]

**NOTE**

If current monitoring is active the current monitoring value is adjusted automatically.

- [4] maximum positive [pressure correction]
[5] maximum negative [pressure correction]

10.7 Stepper Curves

Ten *stepper curves* can be defined for the *stepper*. The application of the curves is done in the *Stepper* window.

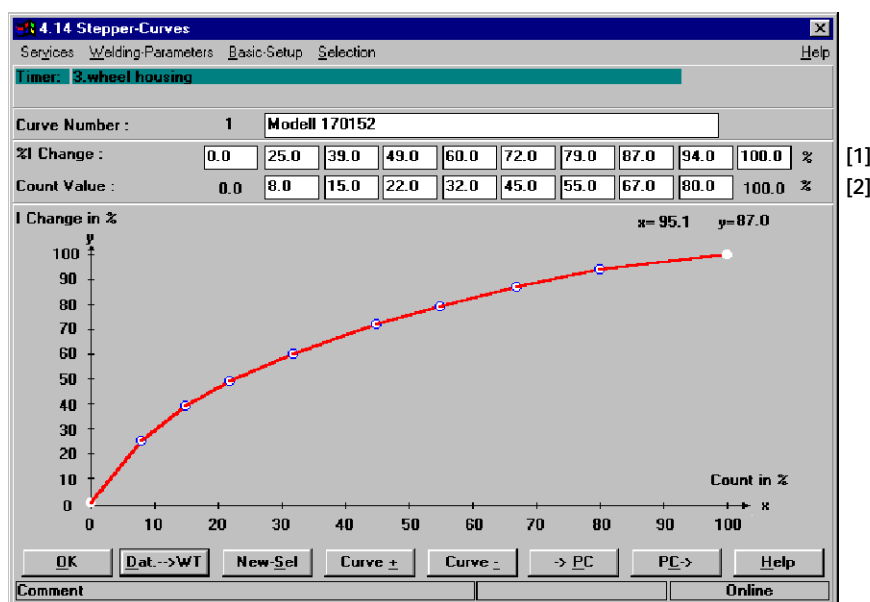
The electrode wear compensation for [%I] and [pressure] is done according to the shape of the curve of this menu item.

The application of a *stepper curve* should compensate changes (wear of the electrode) and is closely connected to the electrode maintenance concept.

As a first approximation, the characteristics of the curve are similar to those of an e-function. But the actual curve is based on practical experience and depends on the electrodes alloy and the welding task.

For *Stepper*, see section 8.10.

D Select *Starting window - Operation - Modify - Programming - Basic-Setup - Stepper-Curves*.



Command buttons:

- <OK>
transmits data to the timer or cancels the transmission, closes the window.
- <Dat. -> WT> transmits data to timer.
- <New Sel> *New Select* corresponds to the *Selection* menu in *Programming*, see chapter 12.
- <Curve +> next curve (current curve number +1).
- <Curve -> previous curve (current curve number -1).
- <->PC> transmits the curve data from the timer to the programming unit.
All parameters are stored in the timer. In order to avoid entering all stepper/tipdress curves individually in each timer, you may transfer your stored curves from a timer to the programming unit <->PC>. When you have selected the next timer, you can transmit the curves from the programming unit to this timer.
- <PC->> transmits the curve data from the programming unit to the timer.



Inputs:

The necessary (desired) %I change is to be entered as a percent change compared to [basic current]. The count value describes the electrode wear [end of stepper].

Wear = 100% corresponds to [end of stepper].

For each curve the current (%I) changes for ten count values are entered. The following count value always has to be equal to or higher than the previous one.

Falling %I changes in percent can also be entered.

The entries have immediate effect on the graphic course of the curve. Entries in the comment field are optional.

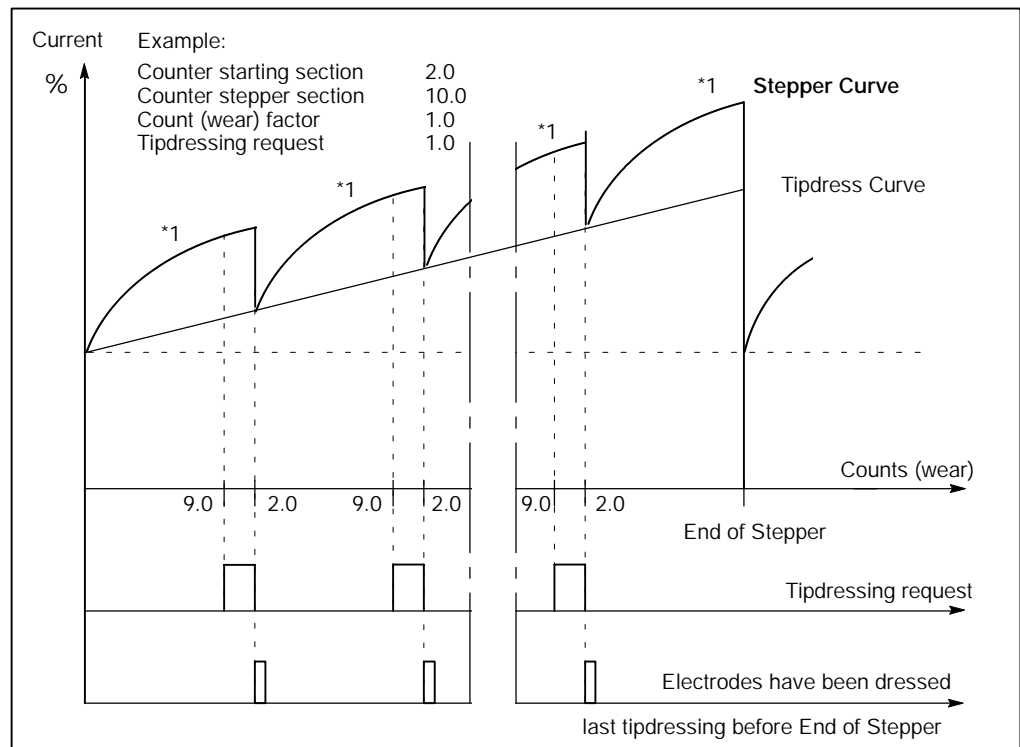
[1] Current (%I) changes in % (definition of the curve shape)

NOTE



The %I change of 100% refers to the change curve, not to the absolute start and end current.

[2] Count values (electrode life) in % (definition of the curve shape)



10.8 Tipdress Curves

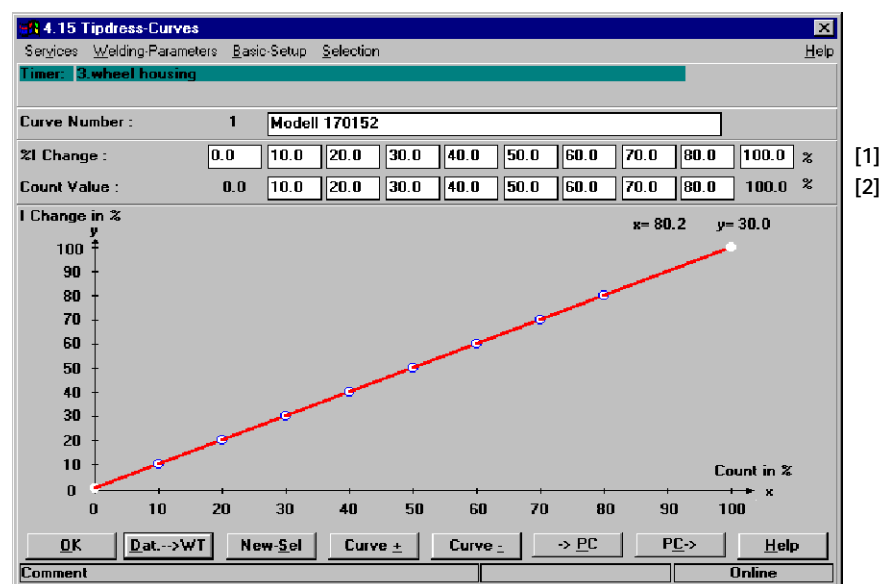
The purpose of a *Tipdress Curve* is to compensate for changes of an electrode after tipdressing through its participation in the *Stepper*. The application is done in the *Stepper* window.

The shape of the curve is based on experience which depends on the electrode maintenance concept. As a first approximation, a straight line can be assumed.

Ten *Tipdress curves* may be programmed.

For tipdressing, see section 8.10.

D Select *Starting window - Operation - Modify - Programming - Basic-Setup - Tipdress curves*.



Command buttons:

- <OK>
transmits data to the timer or cancels the transmission, closes the window.
- <Dat. -> WT> transmits data to the timer.
- <New Sel> *New Select* corresponds to the *Selection* menu in *Programming*, see chapter 12.
- <Curve +> next curve (current curve number +1).
- <Curve -> previous curve (current curve number -1).
- <->PC> transmits the curve data from the timer to the programming unit.
All parameters are stored in the timer. In order to avoid entering all stepper/tipdress curves individually in each timer, you may transfer your stored curves from a timer to the programming unit <->PC>. When you have selected the next timer, you can transmit the curves from the programming unit to this timer.
- <PC->> transmits the curve data from the programming unit to the timer.



Inputs:

The necessary (desired) %I change is to be entered as a percent change compared to [basic current]. The count value describes the electrode wear [end of stepper].

[Wear] = 100% corresponds to [end of stepper] or the maximum wear in one tipdressing interval.

For each curve the %I changes for ten count values are entered. The following count values always has to be equal to or higher than the previous one.

Falling %I changes in percent can also be entered.

The entries have immediate effect on the graphic course of the curve. Entries in the comment field are optional.

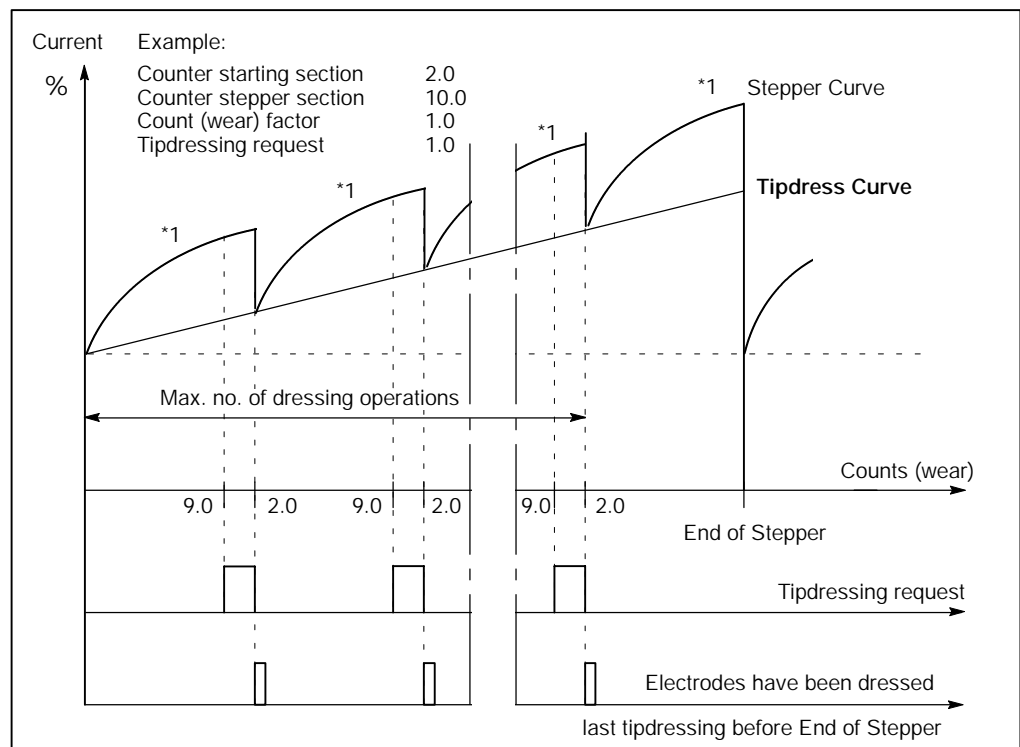
[1] Current (%I) changes in % (definition of the curve shape)

NOTE



The %I change of 100% refers to the change curve, not to the absolute start and end current.

[2] Count values (electrode life) in % (definition of the curve shape)

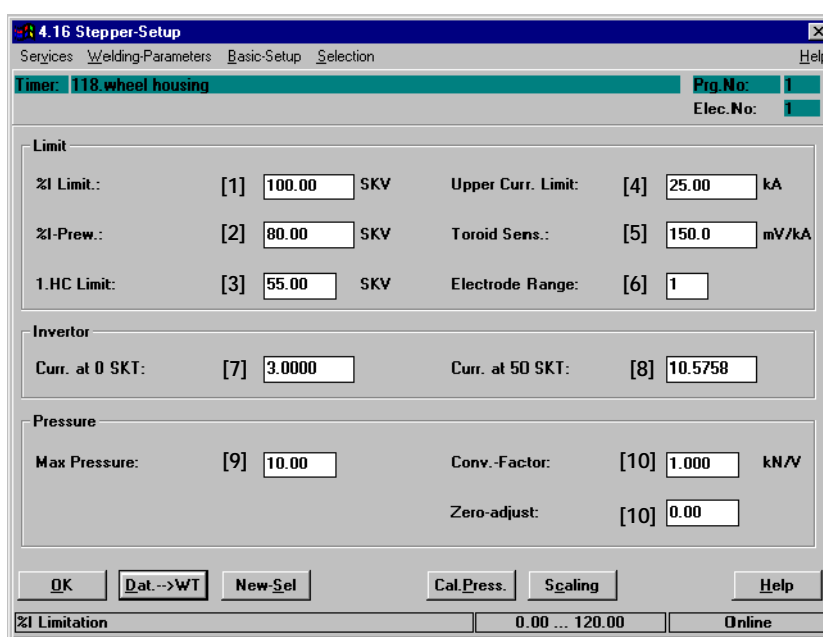


10.9 Stepper-Setup

In this window controller specific values for each electrode are entered individually.

They depend on the weld transformer, the current sensor (toroid sensor), the welding installation and, if applicable, on the thyristor unit. Some parameters can be determined by *Scaling*. After that they must not be altered by other inputs.

D Select *Starting window - Operation - Modify - Programming - Basic-Setup - Electrode (Stepper) Setup*.



Command buttons:

- <OK>
transmits data to the timer or cancels the transmission, closes the window.
- <Dat. -> WT> transmits data to the timer.
- <New Sel> *New Select* corresponds to the *Selection* menu in *Programming*, see chapter 12.
- <Cal. Press.> selects pressure calibration with which the real characteristics of the pressure output voltage in relation to the electrode pressure (kN) are determined, see section 10.11.
- <Scaling> selects scaling with which the real values of the current measurement and control loop are determined, see section 10.12.



Inputs:

Limit

- [1] %I Limit. (%I Limitation)
The controller can reduce the phase angle (electrical degrees) to this value (increase current) at the most. The input is made in scale values, separately for each electrode.
- [2] %I-Prew. (%I Prewarning)
When the controller reaches this value, the message *%I Prewarning* will be displayed (imminent limitation of phase angle).
The input is made in scale values (value < [1]).
In KSR and KUR regulation modes this function serves e.g. to detect cable losses in the secondary circuit.
- [3] 1. HC Limit (Limitation of First Halfcycle)
Limits activation (of the making current) of the first halfcycle of a weld schedule in order to protect the transformer, the thyristor unit and the net, see section 8.16.
The input is made in scale values.
- [4] Upper Curr. Limit (Upper Current Limit)
The purpose of this limit is to protect the devices in the welding installation. During the later programming [reference current values] given in kA can be entered up to this value. The timer includes correction values from the stepping table and the *%I correction*.
Example:
Upper current limit = 16.8 kA
Upper %I stepping = 120 %

10

The parameter kA in the window *Welding-Parameters - Schedule* cannot be higher than 14.00 kA.

[5] Toroid sensitivity

Bosch sensors have a working sensitivity of 150 mV/kA. If you use other sensors enter their sensitivity here.

**NOTE**

The accuracy of your current feedback depends on this value. Use only calibrated precision sensors or use the current scaling feature.

The value input for the toroid sensitivity is changed by current scaling and must not be changed afterwards by an input.

[6] Electrode range (Current measuring range)

A timer with an automatic measuring range setting will show the current range.

If the timer has not automatic measuring range setting, the electrode range must be entered as a function of the toroid sensitivity.

The electrode range must correspond to the relevant working range of the current.

PSS 5000

Curr. meas. range	Toroid sensitivity					
	50 mV / kA	100 mV / kA	150 mV / kA	500 mV / kA	1000 mV / kA	1500 mV / kA
0 (AC)	1,5 - 15,0	0,7 - 7,5	0,5 - 5,0	0,1 - 1,5	0,0 - 0,7	0,0 - 0,5
1 (AC)	7,5 - 75,0	3,7 - 37,0	2,5 - 25,0	0,7 - 7,5	0,5 - 3,7	0,3 - 2,5
2 (AC)	30,0 - 300,0	15,0 - 150,0	10,0 - 100,0	3,0 - 30,0	1,5 - 15,0	1,0 - 10,0
3 (AC)	75,0 - 750,0	37,0 - 375,0	25,0 - 250,0	8,0 - 75,0	3,7 - 37,0	2,5 - 25,0
0 (DC)	2,4 - 24,0	1,2 - 12,0	0,8 - 8,0	0,2 - 2,4	0,0 - 1,2	0,0 - 0,8
1 (DC)	12,0 - 120,0	6,0 - 60,0	4,0 - 40,0	1,2 - 12,0	0,6 - 6,0	0,4 - 4,0
2 (DC)	48,0 - 480,0	24,0 - 240,0	16,0 - 160,0	4,8 - 48,0	2,4 - 24,0	1,6 - 16,0
3 (DC)	120,0 - 999,0	60,0 - 600,0	40,0 - 400,0	12,0 - 120,0	6,0 - 60,0	4,0 - 40,0

PSI/PST 6000

Curr. meas. range	Toroid sensitivity 150 mV / kA
10	0,25 *) - 2,5
11	0,5 *) - 5,0
12	1,0 *) - 10,0
13	2,0 *) - 20,0
14	4,0 *) - 40,0
15	8,0 *) - 80,0
16	16,0 *) - 160,0

*) Lower values are displayed with undefined accuracy.



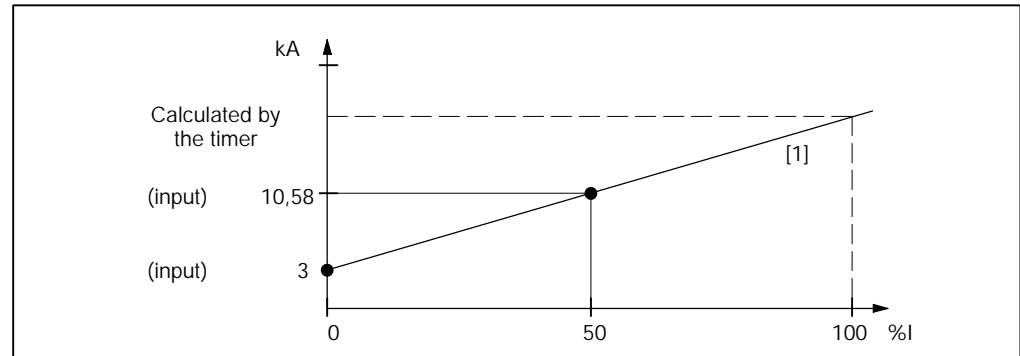
Inverter

Enter two points for inverters that have a linear [1] current response curve:

[7] Current at 0 %I (scale values)

[8] Current at 50 %I (scale values)

- The timer will automatically calculate the inversion values.



NOTE



The values of the inverter's characteristic are altered by current scaling and must not be changed afterwards by an input.

10

Pressure

Determines the characteristic of the pressure output value for activating external pressure regulating valves.

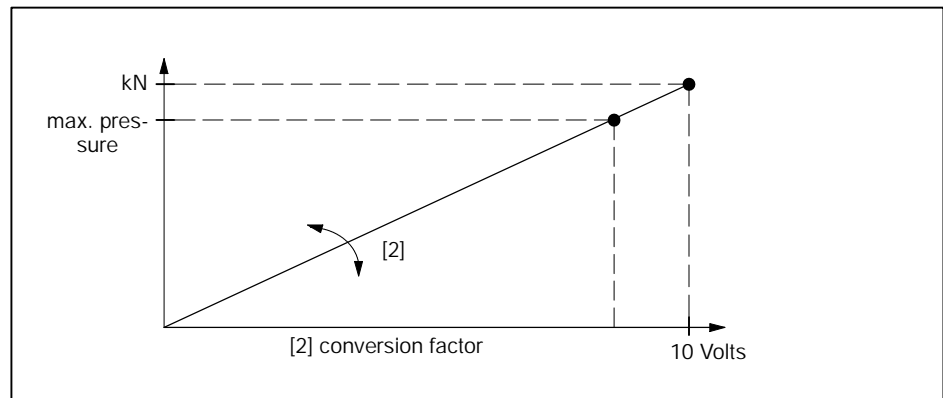
The transmission ratio of the pressure regulating valve, the pressure and the electrode gun defines the resulting electrode pressure.

[9] Max Pressure

The timer's pressure output is limited to this maximum value (mechanical safety function). Calculation also considers *Pressure Correction*, *Pressure Stepping* and *Pressure Profile*.

[10] Conv.-Factor (Conversion factor in kN/Volt)

In order to program the pressure in kN it is necessary to enter the value. The timer will output a voltage calculated with the conversion factor (not available for all types).

**NOTE**

The value of the conversion factor input is changed by pressure calibration and must not be changed afterwards by an input.

[11] Zero adjust in kN/V (not available for all timer types)

The characteristic of the pressure regulating valve and the timer might have a zero shift. This input adjusts the characteristic to the working zero of the pressure regulating valve.

NOTE

The value of the zero adjust input is changed by pressure calibration and must not be changed afterwards by an input.



Your notes:

10.10 *Sequence Setup*

- Basic setup for all programs
 - Setup for a specific program
 - Assigning the electrode to a program
- D Select *Starting window - Operation - Modify - Programming - Basic-Setup - Sequence-Setup*.

[1]

[2]

[3]

[4]

[5]

[6]

[7]

[8]

[10]

[9]

[11]

[15]

[12]

[16]

[13]

[17]

[14]



NOTE

A selection of the objects of a window is shown, depending on the timer used and the selected program functions.

Command buttons:

- **<OK>**
transmits data to the timer or cancels the transmission, closes the window.
- **<Dat. -> WT>** transmits data to the timer.
- **<New Sel>** *New Select* corresponds to the *Selection* menu in *Programming*, see chapter 12.
- **<Prog. +>** next program (current program +1)
- **<Prog. ->** previous program (current program -1)
- **<Act. Val.>** Current actual values as a basis for setting the sequence parameters. See volume 1, section 7.4.7.



Inputs and selections:

[1] Timer and program selected for *sequence setup*.

For all programs:

[2] Start Inhibit (T): T = Timer related sequence inhibition.

- On
The sequences of all programs are inhibited, regardless of the program-specific start (sequence) inhibition (P).
- Off
The sequences of all programs have been enabled. The program-specific start (sequence) inhibition (P) may still act on a program sequence.

**NOTE**

When Start inhibition is active while program start is given, the message "Start Inhibited" will be output.

[3] Control Stopped

- On
The actual values of the sensor are not processed anymore. Programs with KSR/KUR control modes are welded with the last phase angle. An active stepping function will be considered.
- Off
The welding current is controlled. Programs working in KSR/KUR control modes require the actual value message from the sensor.

**NOTE**

*In case of failure of the current sensor (in KSR/KUR mode) turning on Control Stopped activates an emergency operation (depending on the type of the thyristor unit).
Caution: There is no actual current control, check your welding spots.*

[4] Weld/No Weld (T): : Activation signal Thyristor, T = timer related ignition

- On
Activation of the thyristor unit is enabled but still dependent on the external Weld/No weld and/or on the program-related internal Weld/No weld (P).
- Off
Activation of the thyristor unit is disabled independently from the external Weld/No weld (timer input) or the program-related internal Weld/No weld (P).

**NOTE**

Program start with Weld/No weld internal (T) = Off initiates a sequence without welding current, independent from the external weld/no weld setup or the internal weld/no weld (P).

- [5] Monitoring stopped
- On
For the KSR/KUR regulating modes (see section 11.3) monitoring of the actual current in the programmed tolerance band is turned off in all programs.
 - Off
For the KSR/KUR regulating modes (see section 11.3) monitoring of the actual current in the programmed tolerance band is turned on. Monitoring is now dependent on the programmed current and/or time monitoring of the programs.

**NOTE**

*In case of failure of the current sensor (in KSR/KUR mode) turning on Control Stopped activates an emergency operation (depending on the type of the thyristor unit).
Caution: There is no control of the actual current, check your welding spots.*

- [6] Max. Welding Time:
Specification of the maximum duration of the current pulse in the [1st weld time] (1.WLD), [2nd weld time] (2.WLD) and [3rd weld time] (3.WLD) in [sequence] programming. Later *programming* of the [welding times] is limited to this upper limiting value.
- [7] Max. Repeat Welds:
Welding of a welding spot below the tolerance band can be repeated only once. When repeating its current values have to stay within the tolerance band, see section 8.15.
Specification of the maximum admissible number of consecutive rewelds if the actual current value is within the conditional tolerance band.
- Input = 1
As current faults such as *Current too low* or similar are identified, the same spot is repeated with a second program execution. If the current is now within the tolerance band, the timer remains **<Ready>** for further sequences, no message is output. A message (*Fault* or *Warning*) will be issued and the timer is switched to stopped condition if the current is not within the tolerance band after the second sequence.

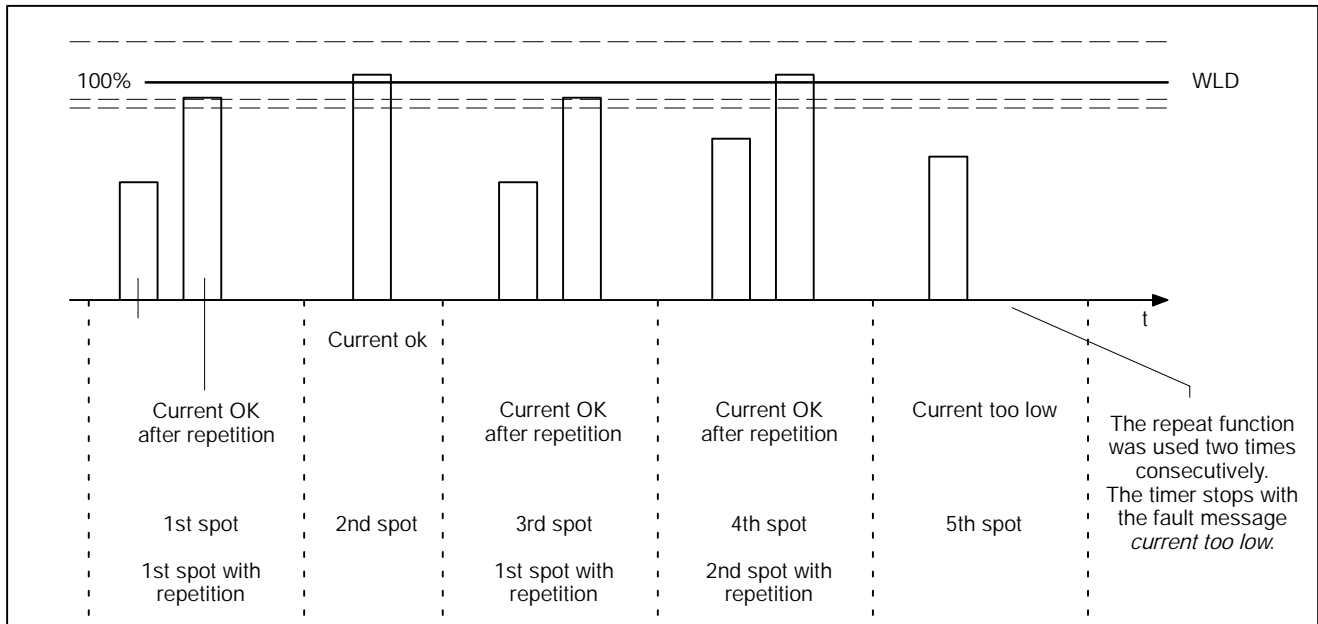
**NOTE**

Current monitoring must be switched on for the Repeat (Reweld) function.

- Input > 1
The input determines the maximum number of automatic repeats of spots with the current value below the tolerance band. The sum of all repeats is counted and compared to the entered value.



Example: maximum rewelds = 2



Current measurement:

- [8]** Fade-out time
 Input of this function is dependent on timer type.
 For current measurement, the current rise time can be suppressed. The fade-out time specifies the duration of time during which no measurement is performed in the beginning of a current pulse, see page 10-39 or section 8.20.3.
- [9]** Trail current
 Input of this function is dependent on timer type.
 For current measurement, the trail current can be suppressed, see page 10-39 or section 8.20.3.
- On : Trail current is incorporated into the measurement result.
 - Off : Trail current is not incorporated into the measurement result.
- [10]** Measurement Circuit Test (Measurement Loop Check)
 Checks the current sensor prior to each weld. Current monitoring needs to be enabled and monitoring stopped disabled.
 Input of this function is dependent on timer type.
- On : Measurement Circuit Test is active, sensor errors are detected.
 - Off : Measurement Circuit Test is inactive, sensor errors are not detected.

10

NOTE



If measurement circuit test (loop check) is switched on and an error occurs, the message "Circuit open" or "Secondary monitoring circuit is shorted" is displayed.

Additionally for this program:**[11]** Start Inhibit (P), P = program-specific start inhibit

- On
The sequences of all programs are inhibited, regardless of the timer-specific start inhibit (T).
- Off
The sequences of all programs have been enabled. The timer-specific start inhibit (T) can still influence the program sequence.

Timer-specific Inhibit	Program-specific Inhibit	Schedule (Sequence)
OFF	OFF	Enabled
OFF	ON	Inhibited
ON	Invalid	Inhibited

**NOTE**

When starting a program whose program-specific start inhibit is switched on, the message "Weld Schedule Stopped" is displayed.

[12] Elec. No. (Electrode No.)

- This parameter determines which electrode number the program should use.

Examples	Progr. no.	1 2 3 4	or	1 2 3 4	or	1 2 3 4
	Electr. no.	1		1 2		1 2 3 4

The maximum number of electrodes available is number 0 to 31 (depending on timer type). Each electrode is assigned different parameters for describing the life and compensation behavior of each electrode (electrode maintenance concept).

In order to guarantee a selective reset it is not allowed to use the electrode number 0.

[13] Weld/No weld (P), P = program-specific weld/no weld

Activation of thyristor unit is enabled or disabled.

- On
Activation of the thyristor unit is enabled for the selected program but still dependent on the external Weld/No weld and/or on the higher-level internal Weld/No weld (T).
- Off
Activation of the thyristor unit is disabled independently from the external Weld/No weld (timer input) or the higher-level internal Weld/No weld (T).

**NOTE**

Program start with internal Weld/No weld (P) = Off initiates a sequence without welding current, independent of the external weld/no weld setting or the internal weld/no weld (T).



Timer-specific Weld/no weld (T) setting internal	Program-specific Weld/no weld (P) setting internal	Weld/no weld setting external	Firing is:
ON	ON	ON	ON
ON	OFF	ON	OFF
ON	ON	OFF	OFF
OFF	Invalid	Invalid	OFF

[14] Schedule – Welding modes, see section 8.3

- Single spot (SINGLE), (for spot welding, projection welding, butt welding ...)
The start signal initiates a sequence and the <Weld Complete> is given at the end of it. Afterwards, Start has to be turned off and then on again to initiate another [sequence].
- Repeat (REPEAT), (for spot welding with manually operated devices)
The start signal initiates several sequences consecutively until the start signal is no longer present.
When Start is active, the solenoid valve will be switched off when the hold time (HOLD) has elapsed, and the electrode gun is opened. Then, an off time (OFF) will be initiated. During this time, the electrode gun can be positioned for the next spot. Then the solenoid valve will be activated again and the electrode gun will be closed.
This sequence is repeated as long as Start is active. The repeat mode is also suited for manual guns.
- Seam, (for seam welding)
The [1. weld time] is operated as programmed. The [2. weld time] is performed as long as the start signal is present. A running [2. weld time] is switched off synchronously (zero crossing) to the mains if the start signal is cleared. After the end of the [weld time] the [hold time] (HLD) still runs out.

10**NOTE**

Seal welds and stitch welds are to be distinguished.

Stitch welds:

When driving the roller electrode over the material that is to be welded the latter gets connected by single welding spots. The time between the welding times of the two spots is the cool time.

Seal welds:

With seal welds the cool time gets very short, down to 0 cycles. Thus, the spots are close to each other or they even overlap.

- [15] Regulation, see page 11-10.
Determines the measuring method of regulation.
- Standard
The same regulation mode (PHA, KSR, KUR) is used for all [weld times] (1. to 3. weld time).
 - Mix
Each [weld time] (1. to 3. weld time) works with an individually selected regulation mode (PHA, KSR, KUR).
- [16] Monitoring
Determines the measuring mode of current monitoring.
- Standard
The actual current values are monitored during the entire [weld] and [cool] times, see also section 8.20.1 and 8.21.1.
 - Mix
The actual current values of each [weld time] are monitored separately using individual reference values (without considering the cool times), see section 8.20.2.
- [17] Spot-Repeat, see section 8.15
With *low current* or *no current* the sequence is repeated if the function is enabled. There is no connection with *Series of welds below lower threshold point*. The function works together with the parameter [7] "max repeat welds".
- On
The function Spot-Repeat (spot repetition) is enabled for the selected program. If the actual current values lie below the tolerance band the spot is repeated.
 - Off
The function Spot-Repeat (spot repetition) is disabled for the selected program.

10.11 Pressure calibration**NOTE**

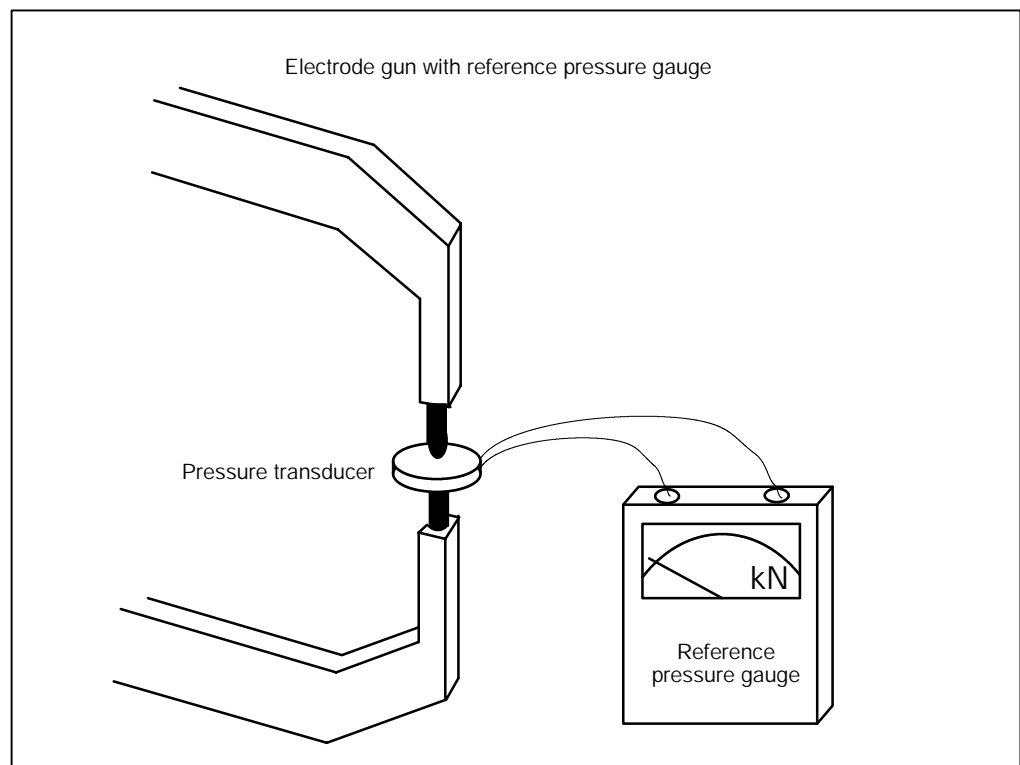
The availability of the pressure calibration function depends on the timer type used.

To ensure a uniform welding quality, a reproducible electrode pressure must be available. A timer with a pressure output and calibration (scaling) function offers the possibility of programming the required electrode pressure directly in kN.

Pressure calibration is used to achieve synchronicity between the command pressure values of the timer and actual pressure values at the electrode gun (measured with a reference pressure gauge). The command value input in kN is adjusted to the display of an external reference pressure measuring unit.

**NOTE**

A calibrated pressure gauge is required as reference pressure gauge for pressure calibration.



During pressure calibration, the command values of two working points are input for the pressure regulation valve as % values. The actual pressure values resulting for the respective working points are input to the timer via the operator interface. From these measurements, the timer calculates factors for the desired synchronicity of command values and actual values.

For pressure calibration, the electrode gun must be closed. The reference pressure gauge is inserted between the electrodes.

Measurement must be performed without welding current (guaranteed if the pressure calibration routine is used).

During calibration, the given pressure values are output as % values. The values measured during calibration with the reference pressure gauge are input at the programming unit. The timer determines the adjustment factors during pressure calibration.

Pressure calibration must be performed for each electrode gun (electrode) connected to the timer and when exchanging a component in the pressure circuit. To do so, the secondary circuit of the timer that is calibrated must be closed (without material).

**NOTE**

Value settings during pressure calibration: Pressure values in % should possibly be adjusted so as to ensure that calibration is performed with the lowest and highest pressure required for the welding task.

Please make sure that the electrode pressure is stable during measurement and can be displayed by the reference pressure gauge.

**NOTE**

The value of the conversion factor input is changed by pressure calibration and must not be changed afterwards by an input.

**NOTE**

The value of the zero adjust input is changed by pressure calibration and must not be changed afterwards by an input.



10.11.1 Pressure calibration - Operation

**CAUTION!**

Make sure that there are no persons in the direct vicinity of the electrode gun. Only input calibration values which the electrode gun can support mechanically, otherwise, there is danger of personal injury and/or damage to the machine. If you do not know the behavior of the electrode gun, use low values in the beginning of calibration and increase these values until the working pressure is reached in additional calibration sequences.

- D Select the command button *Scaling* in the plant layout or select *Operation - Modify - Scaling*.
- D Select the timer and the program.
- D Select *Pressure Scaling*.

The *Calibrate Pressure* window is displayed. The values 30% and 60% of the maximum pressure are displayed as default values. These values can be changed, however, they should correspond to the minimum and maximum working pressure. Now connect the reference pressure gauge and close the electrodes.

**10****NOTE**

In order to perform Pressure Calibration a program must have been selected. This will trigger the pressure output with the base pressure (*Programming - Welding-Parameters - Pressure*) immediately.

Store values:

Store the input values for later scaling tasks.

Command buttons:

First measurement

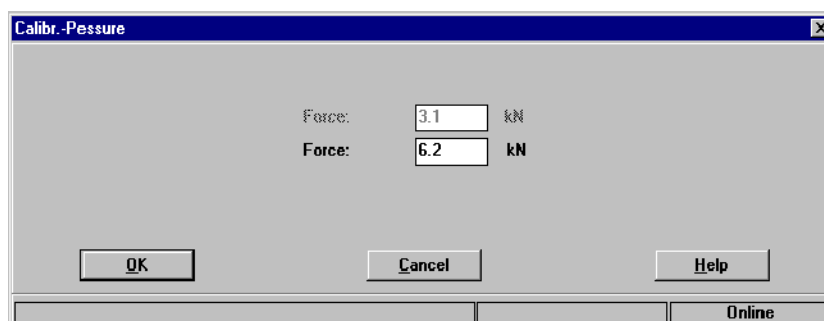
- D Select the command button **<OK>**. The pressure regulating valve is triggered with the entered upper scaling value (percentage of the basic pressure value). Now the electrode gun is to be closed with the on-off valve.

The window for entering the measured value is displayed at the same time as the beginning of the first measurement.

- D Read the actual pressure value from the measuring instrument.
- D Enter the first measured value in the upper input field.
- D Reopen the electrode gun.

Second measurement

- D Select the command button **<OK>**. The proportional valve is triggered with the entered lower scaling value (percentage of the basic pressure value) and the electrode gun is pressed together.
- D Read the actual pressure value from the measuring instrument.
- D Enter the second measured value in the lower input field.
- D Select the command button **<OK>**.



On the basis of the inputs, the timer calculates the conversion factor and the zero shift. Then the message *Scaling done ...* will appear.

<kN Display>

After the successful pressure calibration the pressure values given in [kN] can be set as default parameters. They are displayed in the unit [kN]. With the menu **<kN Display>** this function can be turned on and/or off.

If you modify the welding installation in such way that the scaling values are not exact anymore, you can deactivate the display **<kN Display>**.

The output value for the pressure regulation valve is still dependent on the zero shift and the factor kN/V.

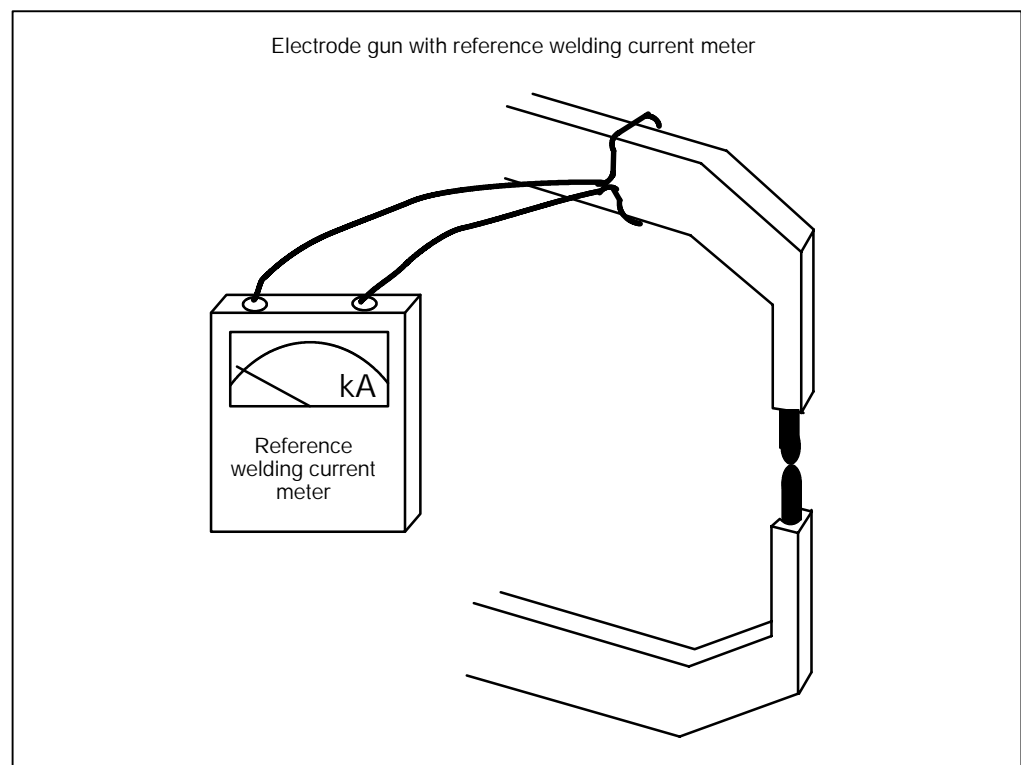
10.12 *Current Scaling*

Reproducible preselectable current values are required to ensure a uniform welding quality in connection with current measurement, current monitoring and current regulation. The entire measuring and control loop consists of individual components with different tolerances. The sum of these individual tolerances may result in current deviations. To avoid the accompanying differences in quality, *current scaling* should be performed.

The timer offers the opportunity of programming welding currents directly in kA and of displaying the actual currents as kA values. In practice, there may be a difference between commanded and actual current values, as well as between the current displayed on the programming unit and measured with welding current meters. To attain synchronicity between the actual value determined by the timer and the actual value displayed on a reference welding current meter, current scaling should be performed.

With the help of current scaling, the entire measuring and control loop is adjusted to the display of an external reference welding current meter.

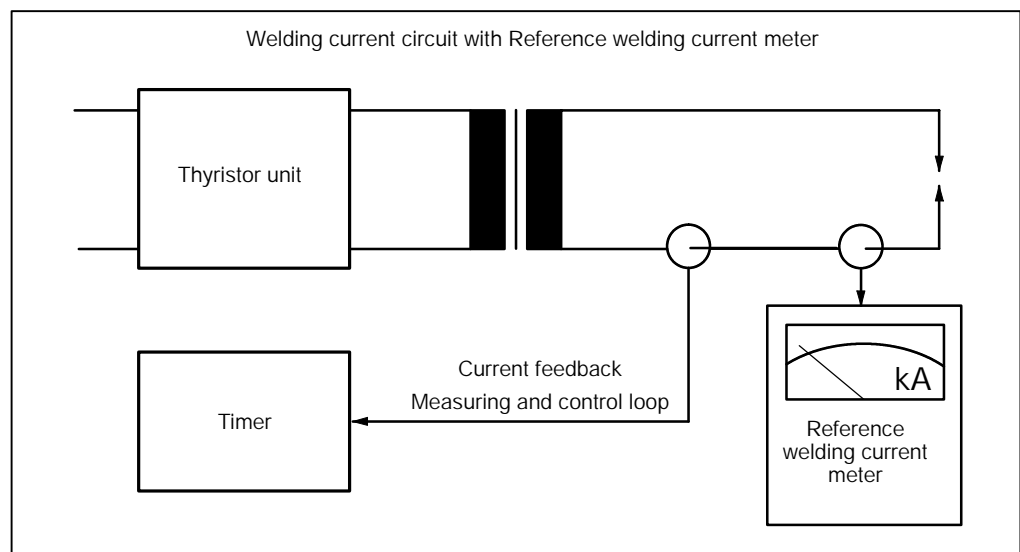
In addition to current feedback for the measuring and control loop, a reference welding current meter with an appropriate current sensor must be installed in the welding circuit for performing the scaling procedure.



During current scaling, the current values of two working points are simultaneously determined via the current measurement input of the timer and the reference welding current meter. The selected working points should be in the actual working range of the welding equipment.

NOTE

A calibrated meter is needed as reference welding current meter for current scaling.

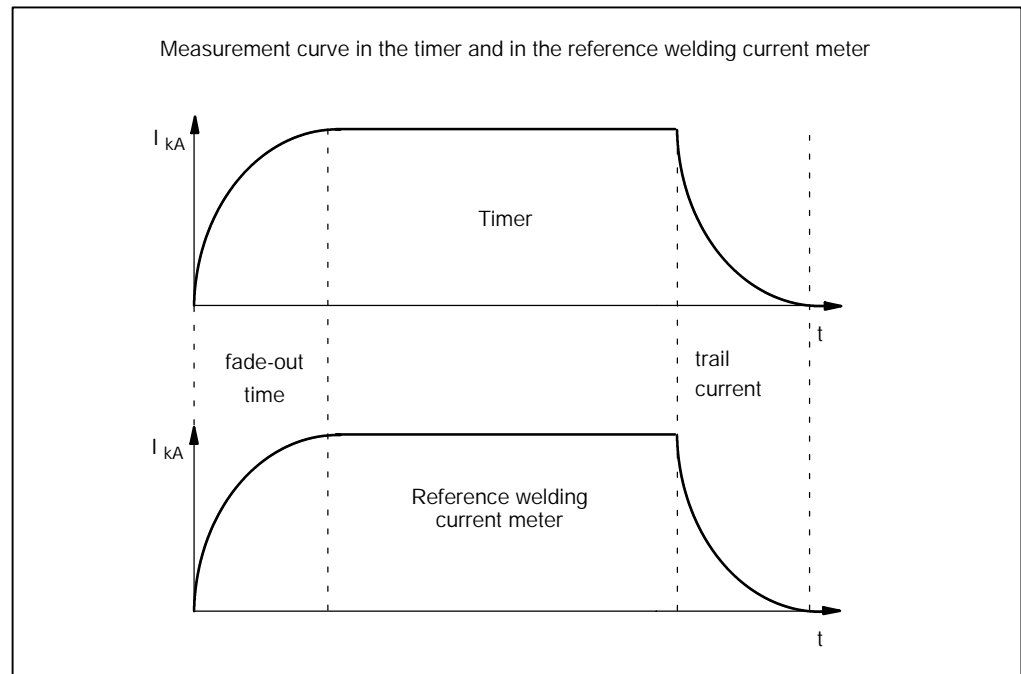


Scaling must be performed for every gun (electrode) connected to the timer. For this purpose, the secondary circuit of the welding equipment to be scaled must be closed (without material, i.e. short-circuited).

Irrespective of the programmed mode, the timer uses the PHA mode with the specified %I values from the scaling window for current scaling. The 2nd weld time (2.WLD, one pulse) programmed in the selected welding program is used as weld time.



During the scaling process, the programmed fade-out time and the trail current are accounted for. The settings of the reference welding current meter must be identical.



The values measured by the reference welding current meter during current scaling must be entered at the programming unit. **10**

The timer determines conversion factors based on current scaling. When the welding sequence is repeated and the corresponding measured values of the reference welding current meter are input, the conversion factors will be averaged. Thus, the danger of reading inaccuracies is reduced.

**NOTE**

Current scaling alters the toroid sensitivity. Afterwards the toroid sensitivity must not be altered by another input.

10.12.1 *Current scaling* - Operation

**CAUTION!**

Make sure that the electrode gun is properly closed. Otherwise, there is danger of welding splashes!

**WARNING!**

During scaling, the welding schedule is performed with special scaling parameters.

**NOTE**

Settings for current scaling: In order to obtain identical settings for all systems, we recommend writing a special welding program for current scaling in all timers. The following values are to be selected in such a way that their conversion in the timer can be done without danger.

Recommendation:

2.WLD: select 10 to 15 cycles. This duration will ensure proper averaging and low dependence on transient recovery processes.

Up/Down slope:

Do not activate up/down slope and specify the most constant conditions possible in order to achieve low dependence on transient recovery processes.

Current values:

should be set so that the same measuring range can be set at the reference welding current meter for both working points during the scaling process.

This helps to avoid sudden changes in the current value measurement.

The fade-out times of the timer and the reference welding current meter must be identical.

Fade-out time = 2 cycles or 40 ms.

Switch trail current measurement off.

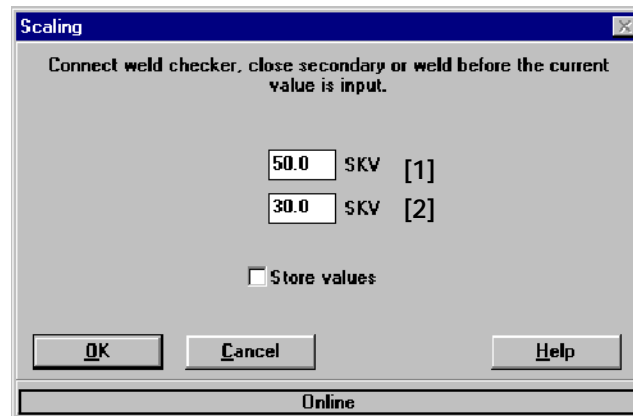
Toroid:

Place measuring belt in defined position and note correct position of sensor ends when using velcro fasteners. Properly close the lock of the measuring belt. Make sure that the lock is outside the secondary window.



- D Select the command button *Scaling* in the plant layout or select the menu items *Operation - Modify - Scaling*.
- D Select the timer and the program.
- D Select *Scaling* (Current *Scaling*).

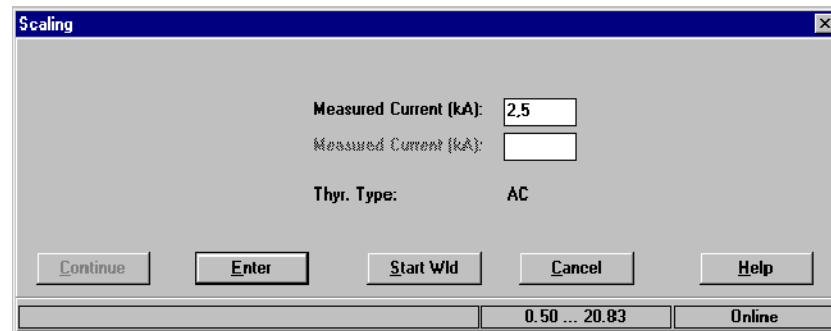
The *Scaling* window will be displayed. The values 50 SKV (scale values) and 30 SKV are shown as default values. These values can be changed, however, they should correspond to the upper and lower limit of the current range. Close the electrode gun without sheets to be welded.



Store values:

Store the entered values for later scalings.

- D Select the command button <OK> and the window *Scaling* will be displayed.



NOTE



With Weld/No weld turned on and after activating the command button <Start Wld> in the Scaling window current starts to flow.

Comply with the safety instructions.

CAUTION!



Prior to entering a current value, a sequence must be performed. The sequence can be started externally or by pressing the command button <Start Wld>.

First Measurement

- D Select the command button **<Start Wld>**. Measurement of the first working point is performed with the entered scaling values **[1]**.
- D Read the actual current value from the reference welding current meter.
- D Enter the measured value in the upper input field.
- D The command button **<Enter>** takes over the entered measured value.

This procedure can be repeated several times for calculating average values by reselecting **<Start Wld>** and **<Enter>**.

- D Select the **<Continue>** command button.

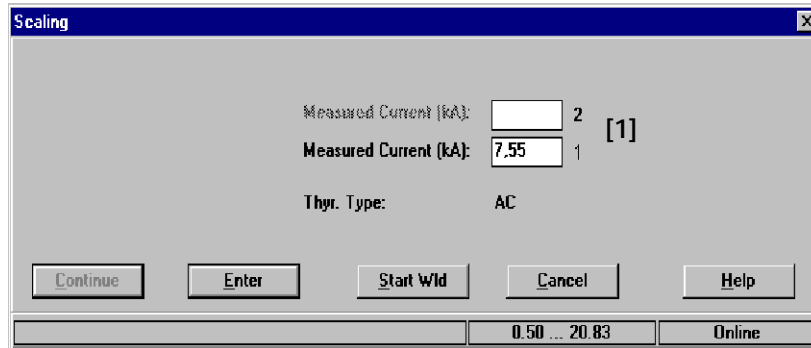
The following actions refer to the second measurement:

Second measurement

- D Select the command button **<Start Wld>**. Measurement of the second working point is performed with the entered scaling values **[2]**.
- D Read the actual current value from the reference welding current meter.
- D Enter the measured value in the lower input field.
- D The command button **<Enter>** takes over the entered measured value.

This procedure can be repeated several times for calculation average values by reselecting **<Start Wld>** and **<Enter>**.

The following figure shows two measurements with value input for the first measuring point. The second measuring point is also determined by two measurements, but the second input still has to be saved by selecting the **<Enter>** command button.

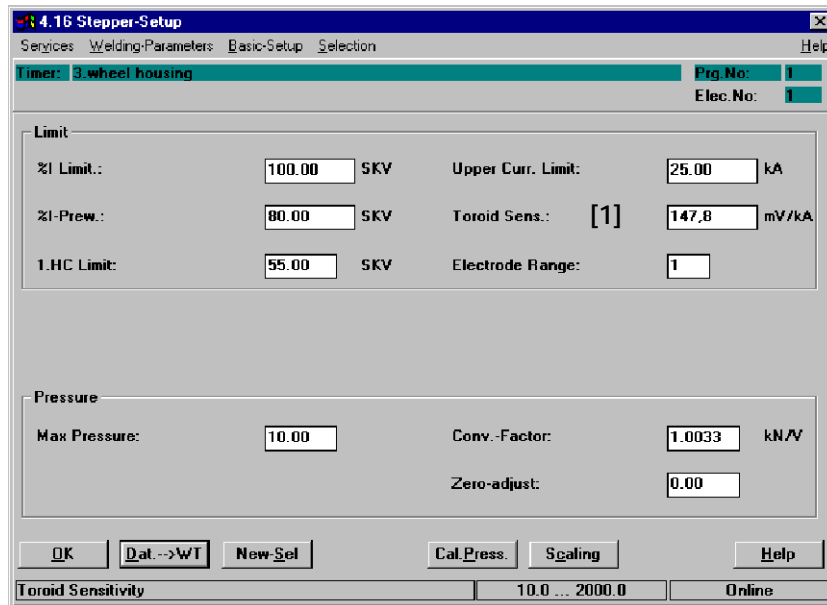


[1] Display showing the number of measurements and mean value calculation inputs. The timer will now determine the toroid sensitivity, toroid correction (turns ratio), current at 0 SKV and current at 50 SKV.

Result of current scaling

Current scaling takes effect on the following input in the window:

- toroid sensitivity [1]



10

NOTE



Subsequent changes done by direct inputs for the toroid sensitivity alter the values calculated through current scaling.

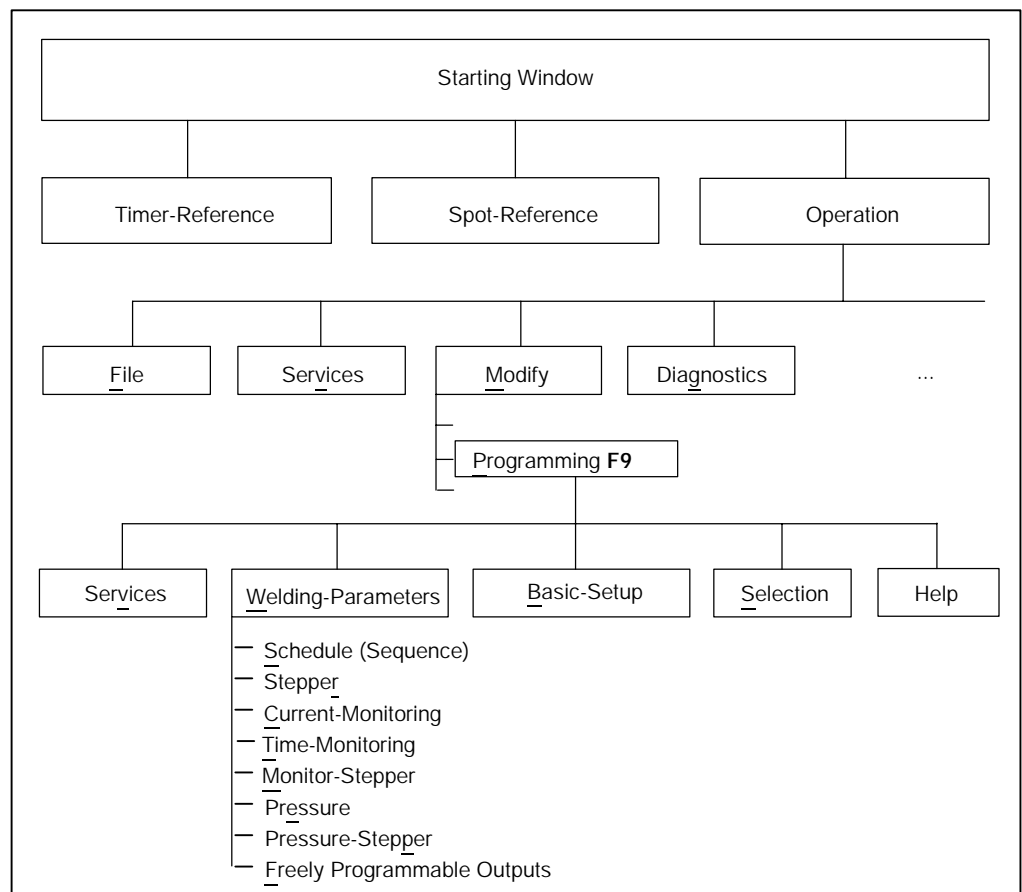
Your notes:



11 Welding parameters

By entering the welding parameters, you assign the timer the specific functions of your welding task. The parameters for the *Schedule (Sequence)* are programmed. For compensating the electrode wear stepper programming is available. The monitoring function serves as quality assurance.

- Parameters used in the welding *Schedule (Sequence)*, such as [Squeeze Times], [Weld Times], [Cool Times] and [Hold Times] and regulation modes
- *Stepper Curves* for [Current] and [Pressure]
- *Monitoring* of Weld Current, [Weld Time] with tolerances
- Specification of *Base Pressure value* and *Pressure profile*
- *Freely Programmable Outputs* for the different phases of the *Schedule (Sequence)*.



11

NOTE



For some timers programming of certain welding parameters is not possible. These parameters are timer-specific.

Operation of *Welding-Parameters*

When clicking on *Programming* the windows *Timer-Select* and *Program-Selection* are opened. If no *timer* or *spot* has been *selected*, an appropriate dialog will be opened.



NOTE

Before you can program welding parameters, you must select a Timer or a Spot.

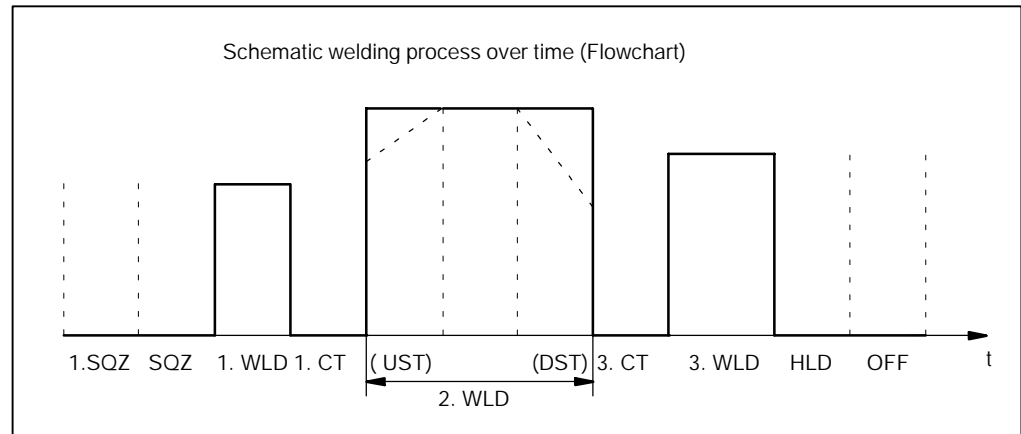


Your notes:

11.1 *Schedule (Sequence)*

A *Schedule* flowchart is a diagram, which displays the welding process as a function over time as the x axis. This time axis is thereby subdivided into different segments, see section 8.9.

They determine the weld and cool times of your *Schedule(s)* (*Sequence(s)*).





11.1.1 Basic-Setup affecting the Schedule

In the *Basic-Setup* menu, parameters which have a direct influence on the welding *Schedule* can be specified for all programs or for a single program only.

Basic-Setup:

D Select *Starting Window - Operation - Modify - Programming (Quick Programming) - Basic-Setup - Electrode Setup (Stepper-Setup) / Sequence-Setup*

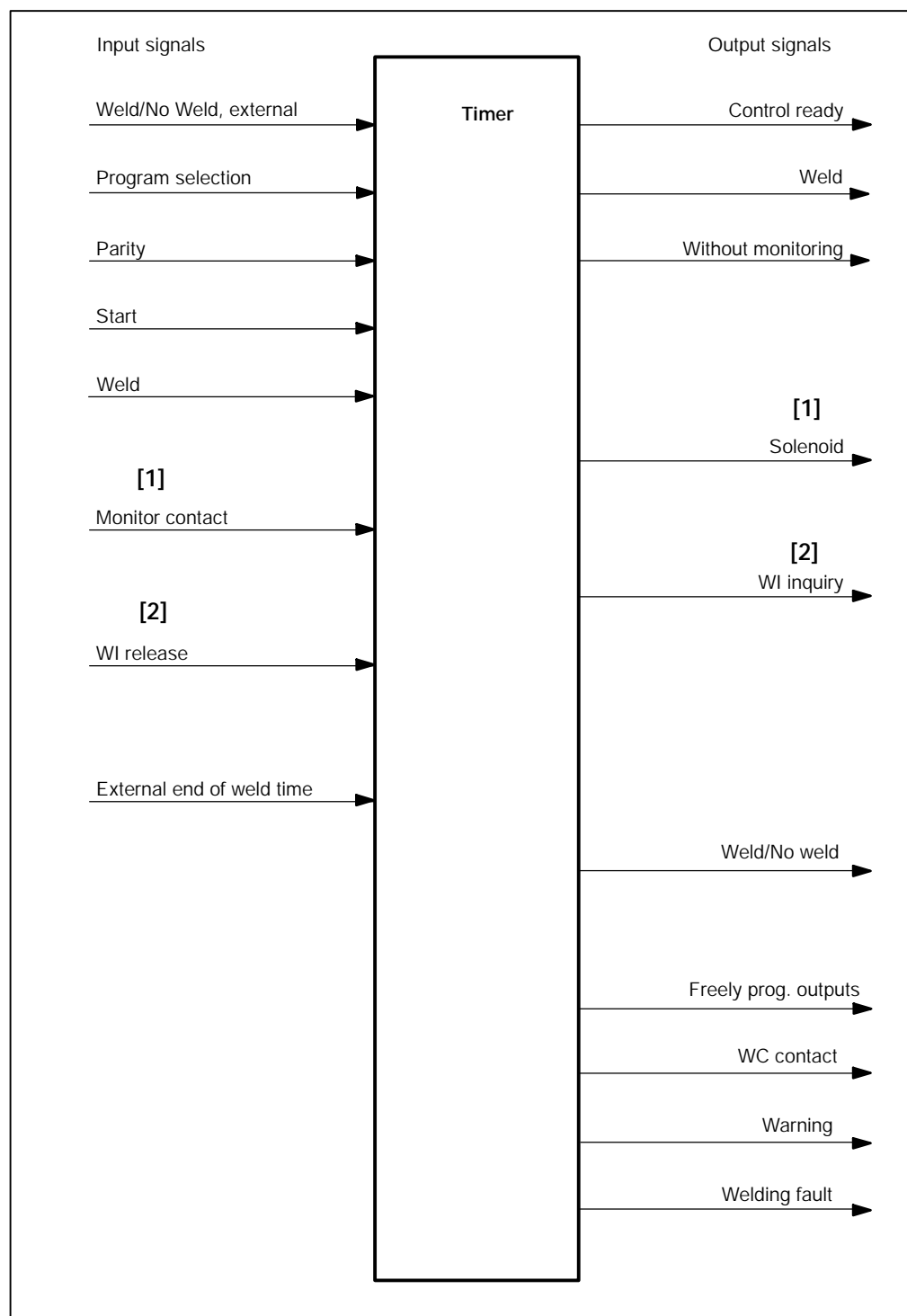
Example: The *Basic-Setup* of the start inhibition is "On" for all programs or for the selected program, which means that any *Schedule (sequence)* is inhibited. If a *schedule (sequence)* is to be tested after programming of the *welding parameters*, then the timer specific and program specific inhibit state must be turned to OFF in the *Basic- Setup*.

Start Inhibit affecting all Programs:			Program sequence is:
	Start Inhibit Programs		
O	Program 1	Off	= released
F	Program 2	On	= inhibited
F	Program 3	Off	= released
	Program 4	On	= inhibited

Start Inhibit effecting all Programs:			Program sequence is:
	Start Inhibit Programs		
O	Program 1	Off	= inhibited
N	Program 2	On	= inhibited
	Program 3	Off	= inhibited
	Program 4	On	= inhibited

11.1.2 Interface Signals which Interact with *Schedule*

The following input and output signals affect the *Schedule* in the welding process:



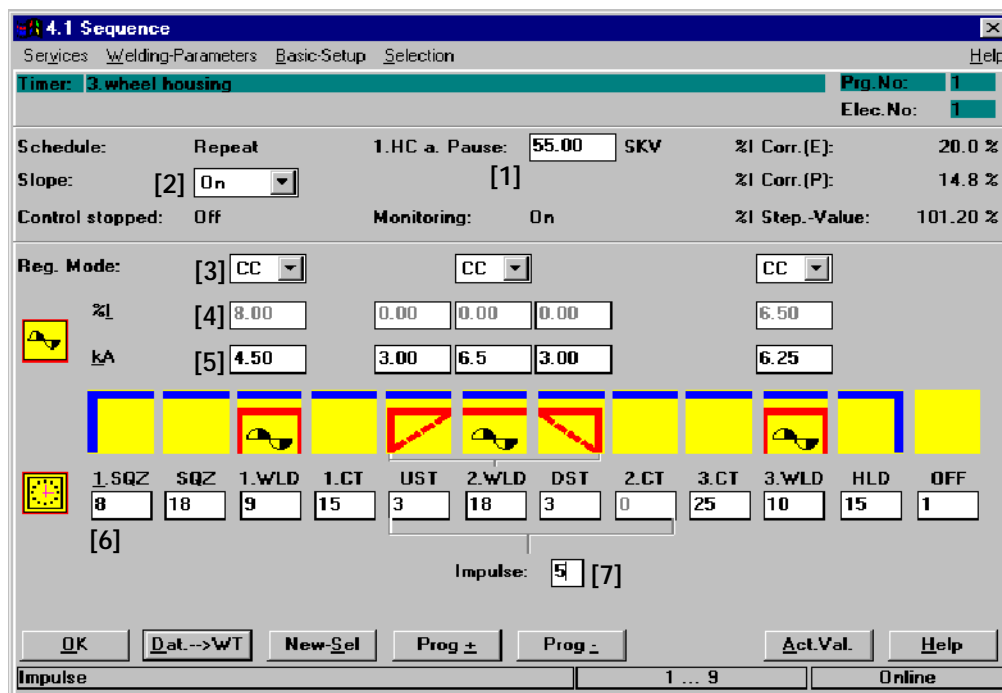
This example corresponds to a timer with discrete I/O-Signals. There are timers with a limited and/or extended I/O-area.



- [1] After issuing the signal <**Solenoid**>, the program waits for the answer with the signal <**Monitor contact**>.
- Monitor contact: Gun is closed or/and
 - Pressure is up or/and
 - other monitoring
- [2] After issuing the signal <**WI Inquiry**> (**Welder Interlock**), the program waits for a response with the signal <**WI release**>.

11.1.3 Starting *Schedule (Sequence)*

- D Select *Starting Window - Operation - Modify - Programming - Welding-Parameters - Schedule (Sequence)*.



The screenshot shows the '4.1 Sequence' window with the following parameters:

Parameter	Value
Timer	3 wheel housing
Prog.No.	1
Elec.No.	1
Schedule	Repeat
1.HC a. Pause	55.00 SKV
%I Corr.(E)	20.0 %
Slope	[2] On
[1]	
%I Corr.(P)	14.8 %
Control stopped	Off
Monitoring	On
%I Step.-Value	101.20 %
Reg. Mode	[3] CC
%I	[4] 8.00
kA	[5] 4.50
1.SQZ	8
SQZ	18
1.WLD	9
1.CT	15
UST	3
2.WLD	18
DST	3
2.CT	0
3.CT	25
3.WLD	10
HLD	15
OFF	1
[6]	
Impulse	5 [7]

Buttons: **OK**, **Dat.-->WT**, **New_Sel**, **Prog +**, **Prog -**, **Act.Val.**, **Help**

Impulse: 1 ... 9 Online

Command buttons:

- **<OK>**
transmits data to the timer or cancels transmission, closes the window.
- **<Dat. -> WT>** transmits data to the timer.
- **<New Sel>** corresponds to the *Selection* menu in *Programming*, see chapter 12.
- **<Prog +>** next program (current program number +1).
- **<Prog ->** previous program (current program number -1).
- **<Act.Val.>** see section 7.4.7.



Inputs, selections and displays

The *Basic-Setup* settings initiate or limit the input range of some of the data and inputs displayed in the *Schedule (Sequence)* window (e.g. the Standard regulation mode in the *Basic-Setup* has the effect that only one regulation mode can be selected for all weld times in *Schedule (Sequence)*).

Programming of the fixed displays in the *Schedule (Sequence)* window is made in:

Schedule (Sequence):

D *Starting Window - Operation - Modify - Programming (Quick Programming) - Basic-Setup - Sequence-Setup*

%I-Corr. (E), %I-Corr. (P), [%I-Correction] (Electrode), [%I-Correction] (program):

D *Starting Window - Operation - Modify - Correction*

Control Stopped:

D *Starting Window - Operation - Modify - Programming - Basic-Setup - Sequence-Setup*

Monitoring:

D *Starting Window - Operation - Modify - Programming (Quick Programming) - Basic-Setup - Sequence-Setup*

D *Starting Window - Operation - Modify - Programming (Quick Programming) - Welding-Parameters - Current Monitoring - Time Monitoring*

11

%I Step.-Value, Stepper value:

D *Starting Window - Operation - Modify - Programming (Quick Programming) - Welding-Parameters - Stepper*

[1] 1. HC a. PAUSE [1. Half-Cycle after Cool Time]], see section 8.16.

The default value is 55 scale values (%I). During the *Schedule (Sequence)* the current of the 1. half-cycle after cool time is limited to this programmed value.

[2] Slope, see section 8.7

ON:

Starting with the [UST] the generated [current] will be gradually increased from a [starting current] to the [commanded current] of the [2nd Current Block] or the [2.WLD]. Starting with the Down Slope Time [DST] the generated [current] again will be gradually decreased to the [final current] at the end of [DST].

The number of line cycles or milliseconds for the [UST] and [DST] and the current values for these times can only be entered, if Slope is enabled.

OFF:

The generated [current] rises at the beginning of the [2.WLD] immediately to the programmed [current] value and drops at the end of the [2.WLD] abruptly to Zero.

[3] Reg.-Mode: Regulation Mode

Regulation principles of the timer:

- Phase angle control PHA, see section 8.17
 - PHA function without regulation without monitoring. This operation is possible without toroid.
 - PHA function without regulation with monitoring. A toroid is needed in the current circuit.
- Constant-current regulation KSR (current regulation), see section 8.18
 - KSR function with regulation without monitoring. Even though regulation takes place during welding the timer remains operative when currents are non-conforming.
 - KSR function with regulation with monitoring. For robot electrode guns (and many other applications) this should be the default setting. Fault messages might occur, e.g. "low current". If the current is too low an automatic spot repetition can be enabled.
 - KSR function without regulation without monitoring. This is an "emergency operation mode" in case of disturbances in the toroid circuit. In this case always check your welding spots.
- Constant-voltage regulation KUR, see section 8.19
 - KUR without monitoring. With KUR the voltage regulation is always active, but the current is not monitored.
 - KUR with monitoring. The current in the welding circuit is monitored with regard to a tolerance band.



In the Standard regulation mode, one regulation mode applies to all [weld times] within a *sequence*. The Mixed regulation mode provides for individual settings of the regulation mode for each [weld time] of the *schedule (sequence)*.

Regulation mode:

D *Starting Window - Operation - Modify - Programming (Quick Programming) - Basic-Setup - Sequence-Setup*

NOTE



If an inverter is used, the PHA regulation mode must be activated prior to current scaling. Once current scaling has been completed, the KSR regulation mode may be selected.

The regulation is completely separate from monitoring. The correlation of the values to the functions is shown in the following overview:

Regulation	Monitoring
Regulation Modes PHA, KSR, KUR	Monitoring ON, OFF
Standard, Mixed regulation	Standard, Mixed Monitoring
Command value %I, kA	Reference current kA
Control stopped ON, OFF	Monitoring stopped ON, OFF
Stepper curve %	Stepper curve %
	Tolerance band %

NOTE



The regulation function works separately from monitoring. It is possible to monitor without regulation, or to regulate without monitoring.

The separation of Regulation and Monitoring provides the following advantages:

- Entering separate values. When entering the commanded values, the independent value in monitoring helps to detect entry errors, by means of a fault message at the next *Schedule (Sequence)* run (and vice versa).
- With password entry, it is possible to assign the entry of commanded values and the entry of monitor values to different user groups. This compensates for any corruption from false external parameters by the operating personnel. The monitor values and thereby the range of good welds results can not be changed by this user group.
- Separation increases transparency. It allows for example for combinations between the regulation mode KUR and *Current Monitoring*.

Because of this separation, the following additional parameters must be entered under *Basic-Setup*.

- Monitoring ON / OFF
- monitored Stepper curve
- Reference current

With the reference current it is possible to accept the actual measured value as the new reference current, see section 11.3.

[4] %I (Scale Units)

The firing angle range in the current half wave is divided up into Scale Units. The firing angle and thereby the [current] can be controlled by programming a %I value.

Input of %I: Regulation modes PHA or KUR must have been selected and transmitted to the timer.

[5] kA: Kilo Amperes

The current entry for the measuring unit Kilo Ampere (kA) is intended for KSR control mode.

Upper current limit:

Starting Window - Operation - Modify - Programming - Basic-Setup - Stepper-Setup .

If the *stepper* is active the *stepper* portion is subtracted from the maximum input value.



[6] 1.SQZ, SQZ, 1. WLD, 1. CT, UST, 2. WLD, DST, 2. CT, 3. CT, 3. WLD, HLD, OFF,
see section 8.9

The unit of measurement for the various programming entries which control time, is the line cycle or milliseconds (ms control). To determine the time, enter the number of line cycles or milliseconds. The entry range is displayed in the bottom window line.

Programming of the [2.CT] is only possible if the [number of pulses] in the last entry field is larger than 1, which indicates current output in a pulsed manner.

[7] **Impulse**, see section 8.8

This parameter is used for the entry of the number of [impulses] for the [2nd Current Block], in case of pulsed current output, with enabled slope including [UST] and [DST].

Your notes:

11.2 Stepper

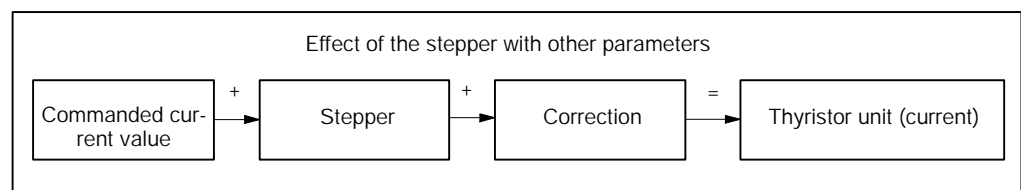
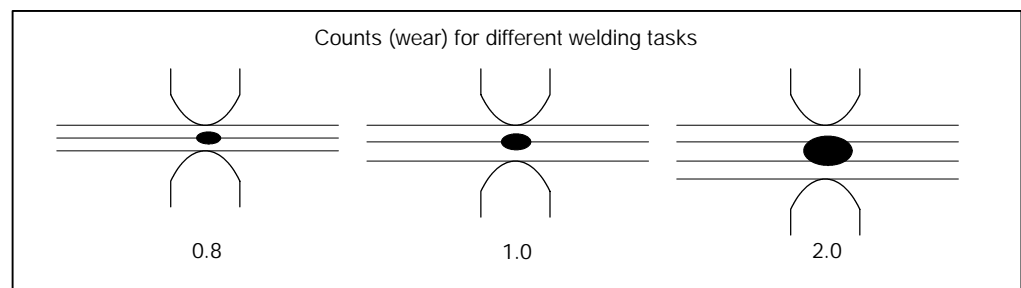
The [%I] (current or phase angle, pressure) is adjusted to compensate for wear of the welding electrodes depending on the counts (wear). Starting with a certain initial output power, the [%I] will be changed for Start, Stepper and Tip Dressing, following a predetermined curve form, see section 8.10.

The *compensation* for Start, Stepper and Tip Dressing can be activated independently from each other.

Regardless from the type of stepper function, a **<Prewarning>** can be programmed. The **<Prewarning>** is a message before the **<End of stepper value>**.

The active *Stepper* function works with linear interpolation. Depending on the wear counter (count value), the compensation value will be calculated individually for each spot from the next coordinate point.

- All settings for electrode maintenance are located in this window.
- Counts (wear) factor (Count value) can be entered for each program.
- Application of a selection from ten *stepper curves* and ten *tipdress curves* for the stepper.



11.2.1 *Basic-Setup* which Affects the *Stepper* Function

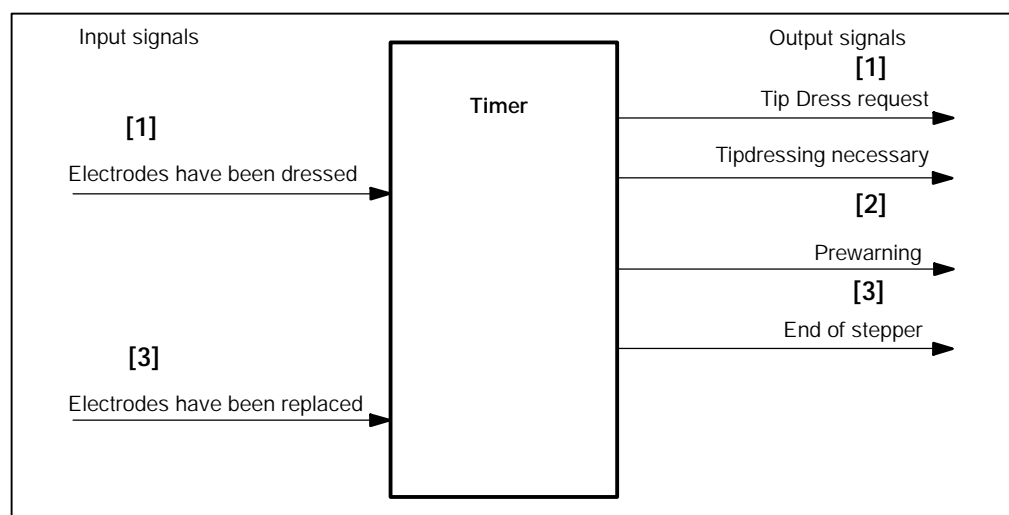
In the *Basic-Setup* menu you may program 10 different curves for the *Stepper* function.

Stepper-Curves:

- *Starting window - Operation - Modify - Programming (Quick Programming) - Basic-Setup - Stepper-Curves*

11.2.2 Interface Signals which Interact with *Stepper*

The following input and output signals affect the *stepper* function in the welding process:



- [1] With active dress function, the **<Tip Dress Request>** (color change in the timer symbol of the plant layout) is generated after reaching the programmed wear. After the dressing of the electrodes the signal **<Electrodes have been dressed>** is expected. If there is no **<Electrodes have been dressed>** signal until the end of stepper the timer sends the message *Tipdressing necessary*. Further [sequences] are not possible.
- [2] The **<Prewarning>** determines the amount of wear before reaching the End of Stepper (maximum wear), at which point the warning signal **<Prewarning>** (color change in the timer symbol of the plant layout) is issued. With some timer types, different wear values (counts) may be entered for the **<Tip Dress Request>** and the **<Prewarning>**.

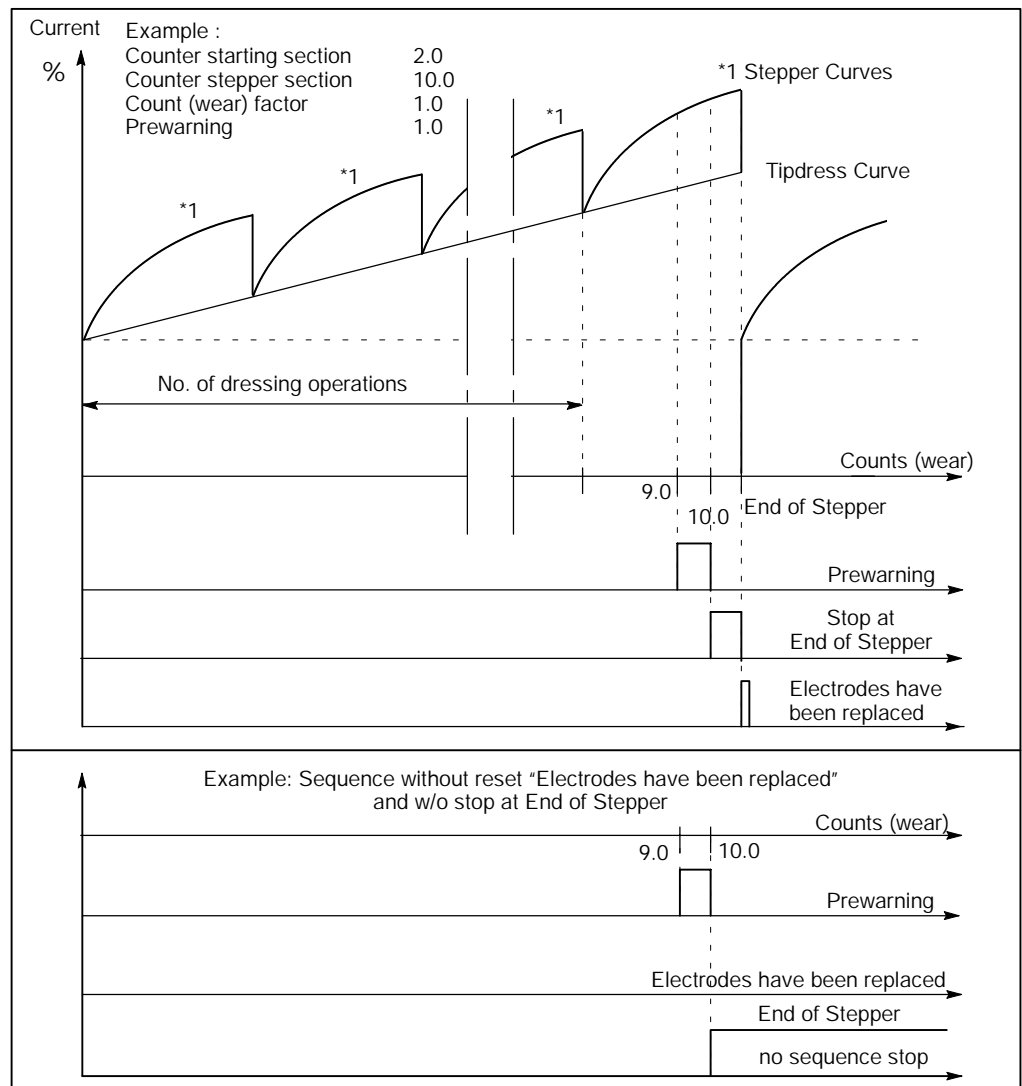


[3] The signal <End of stepper> commands a change of electrodes. The executed change is reported to the weld timer with the signal <Electrodes have been replaced>.

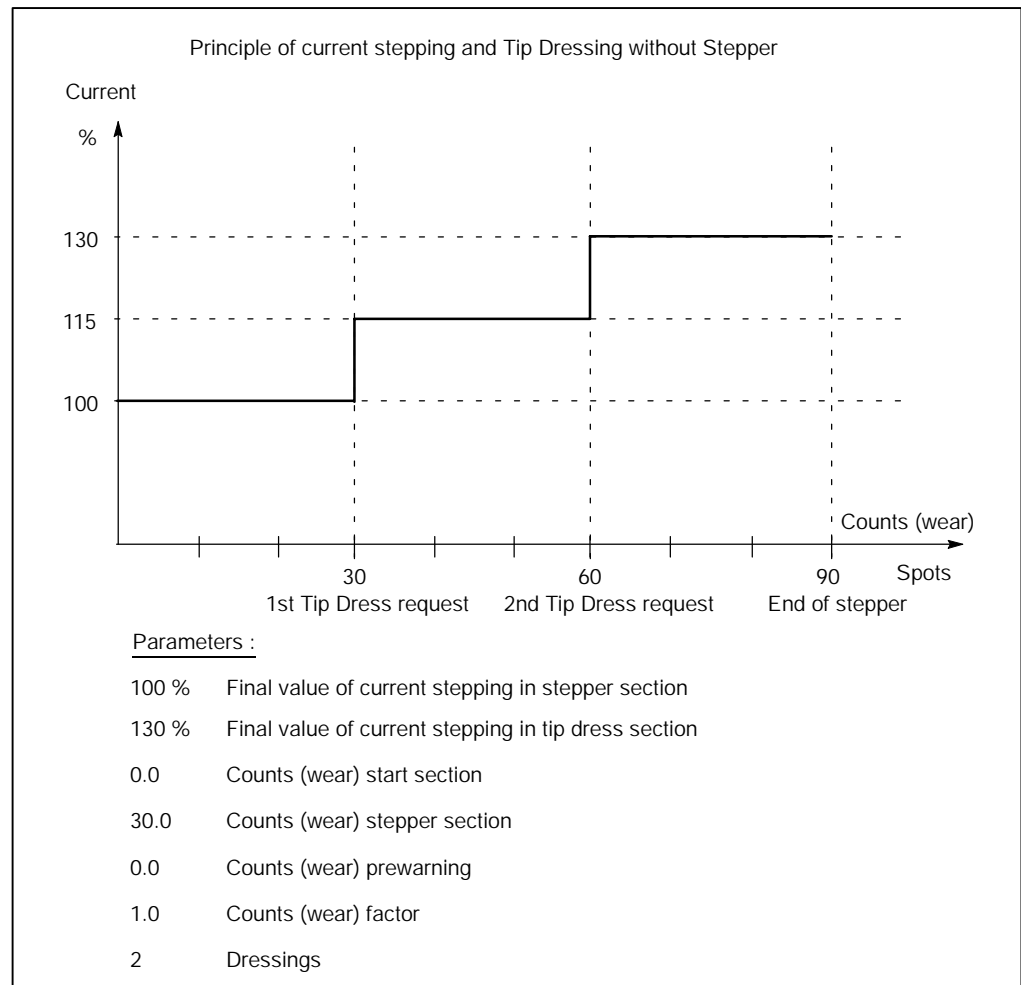
The response of the timer is set to <End of stepper>:

Starting window - Operation - Modify - Programming - Basic-Setup - Global Stepper-Setup

Depending on the settings, further [sequences] are possible / are not possible at the <End of stepper>.



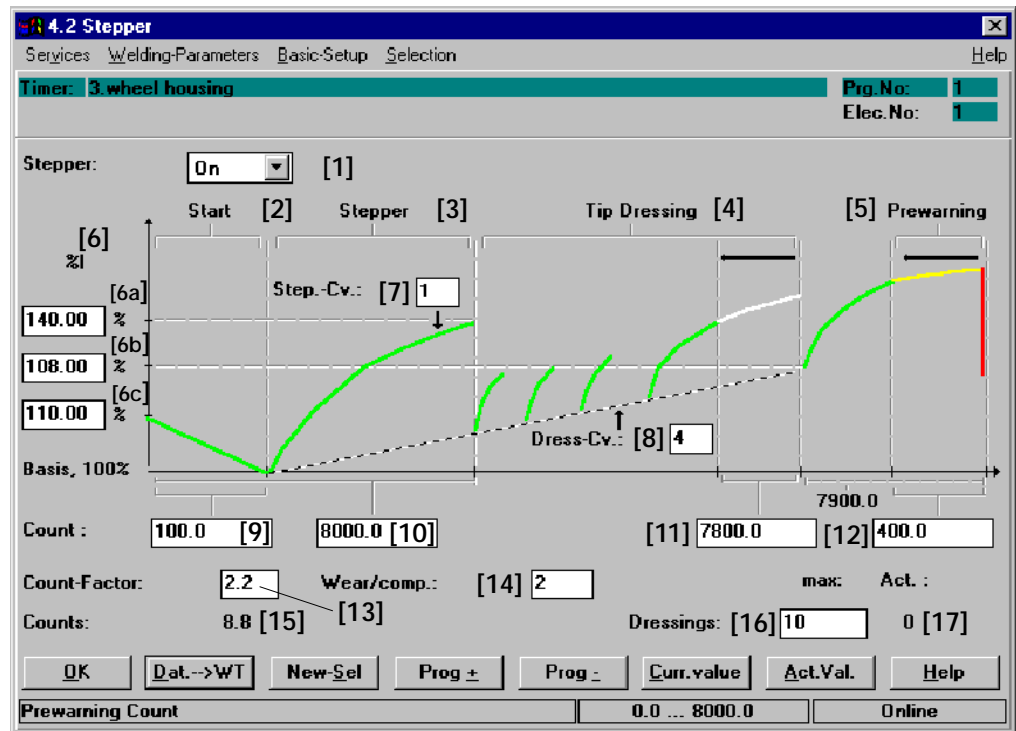
A special case is dressing without stepper with short tip dressing intervals. In this way the [current] is changed with each tip dressing event, but not within the tip dressing interval. A *Stepper* of 100% at the end of the stepper section must be entered in this case.





11.2.3 Starting Stepper

D Select *Starting window - Operation - Modify - Programming - Welding-Parameters - Stepper.*



NOTE



The structure of the window (input fields) depends on the timer type in use.

Command buttons:

- <OK> transmits data to the timer or cancels the transmission, closes the window.
- <Dat. -> WT> transmits data to the timer.
- <New Sel> corresponds to the *Selection* menu, see section 12.
- <Prog +> next program (current program number +1).
- <Prog -> previous program (current program number -1).
- <Curr.value> The *Stepper* percent values are converted into absolute current values and displayed. The inputs for the *Stepper* in percent and the *Current values* can be changed, see section 11.2.4.

NOTE



The current values display can only be called up if *KSR* mode has been preselected.

- <Act.Val.> see section 7.4.7.

**NOTE**

Curve sections displayed in blue color have no effect on the stepping process.

Possible reasons:

- Stepping is disabled.
- No wear has been programmed for these sections.
- Stepping = 100% has been programmed for the stepper section.
- The tip dressing function is disabled.
- No wear value has been programmed for the prewarning.

If the curve section for the start section is shown in blue color ([6c] e.g. wear start section input value = 0), the Stepper function works without a percent change for this section.

A green curve display for the start section ([9] wear start section input value > 0.0) indicates active Stepper for this section. Stepper is performed with the programmed stepping values in percent, depending on the electrode's wear counter.

A blue curve section in the stepper section ([6a], e.g. Stepper input value = 100%) indicates that stepping is performed without a percent change in this section.

The green curve display ([6a], e.g. Stepper input value \neq 100%) in the stepper section indicates that Stepper is performed with the programmed percent stepper values depending on the electrode's wear counter and the stepper curve selected for this section.

A blue curve section for the tip dressing section ([16], e.g. Dressings = 0) means that stepping is performed in this section without a percent change. The tip dressing function is not active.

The green curve display ([16], e.g. Dressings \neq 0) in the tip dressing section indicates that Stepper is active with the programmed stepper values in percent, depending on the number of dressings and the selected tip dressing curve.

If the curve section for the prewarning section is displayed in blue color ([12], e.g. wear prewarning input value = 0.0), no <Prewarning> signal is output.

If the curve section for the prewarning section is displayed yellow/red ([12], e.g. wear prewarning input value >0.0), the <Prewarning> signal is output.
The stepper values can be changed in the Current values window.



Inputs and displays:

The diagram in the *Stepper* window shows a schematic representation of the curve shape.

The curve shape of the *Stepper* function is programmed in the *Stepper-Curves* or *Tipdress curves* window of the *Basic-Setup*.

Stepper and Tipdress Curves:

D *Starting window - Operation - Modify - Programming - Basic-Setup - Stepper-Curves - Tipdress-Curves.*

[1] Stepper On/Off

The stepper function is turned on or off. If the stepper function is active, the *Pressure-Stepper* function becomes active, too.

[2] Start

The Start section precedes the stepper section for starting up a new electrode. This section as a rule is very small, it includes between 5 to 50 spot welds and is only required in special cases (galvanized sheet metal).

It can work with its own stepping value.



NOTE

A wear [9] of 0.0 must be entered for this section if the Start section in the Stepper function is to be skipped.

11

[3] Stepper

The Stepper section defines the *Stepping* without electrode tip dressing. Beginning with the [base current], the [current] will be changed, according to the programmed curve form to compensate for electrode wear.

It can work with its own stepping value.



NOTE

A percent value for current stepper [6a] = 100% must be entered for this section if a constant current is to be applied in the stepper section.

[4] Tip Dressing

A mechanical treatment of the welding electrodes by dressing or polishing helps to reduce wear and delays the end of stepper. The [current] is being reduced after tip dressing. The new reduced [current] value represents the starting point of the new *stepper curve* for the *tip dressing curve* which is programmed by parameter [6b].

It can work with its own stepping value.

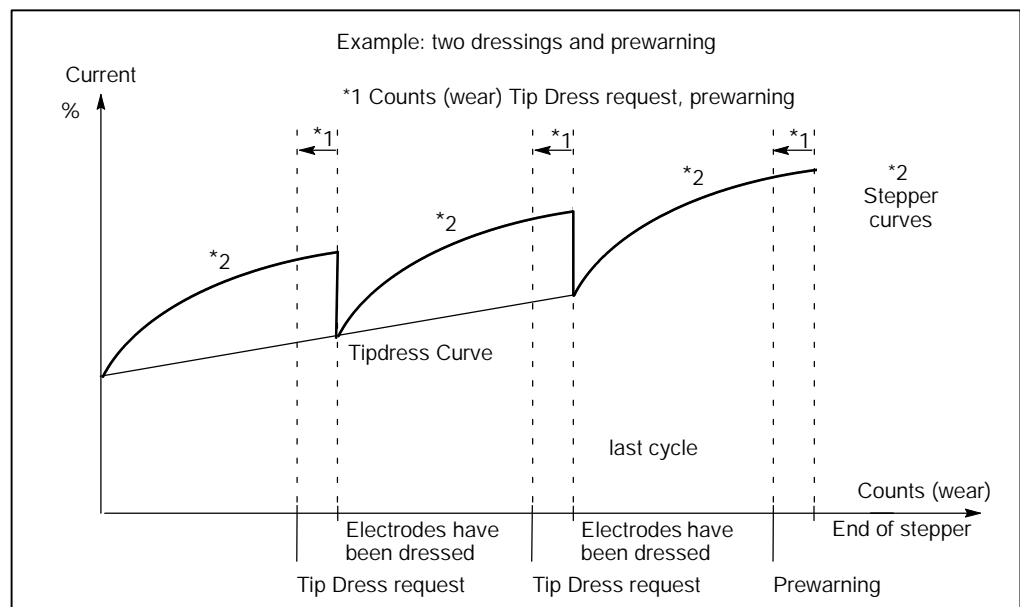
**NOTE**

A number of Dressings = 0 must be entered for this section if the tip dress section is to be skipped.

[5] **Prewarning**, see section 8.10

**NOTE**

A count (wear value) = 0.0 must be entered for this section if the prewarning section is to be skipped.



With the tip dressing function active (Dressings > 0), specifying a wear prewarning serves with some timer types also to output the signal <Tip Dress Request>. Which means that for each tip dressing cycle, along with wear prewarning, the signal <Tip Dress Request> will be output.

With some timer types, different wear values (counts) may be entered for the <Tip Dress Request> and the <Prewarning>.

**[6] Current**

A change in *Stepper* is entered as a percent value, and as such it is independent from the absolute [base current] in the welding program. The *Stepper* percent value may remain unchanged after a change of the [base current] in the welding program.

All entries relate to a [base value] (100%) at the end of the Start section, i.e. the beginning of the Stepper working section.

Three entry fields are available for programming the *Stepper* current:

- **[6a]** The value entered in the top entry field determines the *Stepper* in percent at the end of the stepper section.
- **[6b]** The value entered in the middle entry field determines the *Stepper* in percent at the end of the tip dress section.
- **[6c]** The value entered in the bottom entry field determines the *Stepper* in percent for the start with a new electrode.

**NOTE**

A percent value for Stepper = 100% must be entered for this section if the Stepper section is to be skipped in the Stepper function.

[7] Step.-Cv. (Stepper Curve)

You can program 10 different *stepper curves*. The *stepper curve* determines the current slope within one stepper cycle in the Stepper section for the *Stepper* and the *Pressure-Stepper* functions. The curve characteristics are defined in:

Stepper-Curves:

D *Starting window - Operation - Modify - Programming - Basic-Setup - Stepper-Curves*

[8] Dress.-Cv. (Tipdress Curve)

You can program 10 different *tipdress curves*. The *tipdress curve* determines the current slope within the entire tipdress section and applies from the first to the last stepper cycle. The curve characteristics are defined in:

Tipdress-Curves:

D *Starting window - Operation - Modify - Programming - Basic-Setup - Tipdress-Curves*

[9] Start Counts (Wear), see section 8.11

The electrode is subject to wear with each spot weld. The wear for the Start section is programmed under the X axis of the *Stepper*. It is a component of the wear for the Stepper section.

Computing wear:

$$\text{Wear} = \Sigma (\text{Spot weld} \times \text{Wear factor})$$

**NOTE**

The count value = 0.0 (wear) must be entered if the start section is to be skipped in the Stepper function.

[10] Stepper Counts

The maximum admissible wear until the end of stepper or tip dressing is programmed.

[11] Tipdress Counts

The Tipdress counts value determines the counts that initiate output of the **<Tip Dress Request>** (cf. *Interface signals affecting Stepper* section). For some timer types, no separate counts can be programmed, the prewarning counts are used for outputting the **<Tip Dress Request>**.

**NOTE**

The count value = 0.0 (wear) must be entered if no Tip Dress Request is to be output.

[12] Counts Prewarning

The Counts prewarning value serves to determine the amount of wear which initiates the output of a **<Prewarning>** before the end of stepper (maximum wear).

**NOTE**

The count value = 0.0 (wear) must be entered if no prewarning is to be output.

[13] Count-Factor

The Count-Factor applies to the displayed stepper and represents the wear resulting from welding a spot of a specified welding task.

Example: see section 8.11.

**[14] Wear/comp**

Specification of counts (wear) per part (input not available for all timer types). This parameter indicates the amount of wear units produced on the electrode by each part. With this input the number of remaining parts in the prewarning table is calculated, see volume 1, section 7.6.1.

[15] Counts

The current electrode count (wear) is displayed.

**NOTE**

The actual value of Counts (wear) can be input in the Actual values window. Thus, a used but not yet totally worn electrode may be used, see volume 1, section 7.4.7.

[16] Dressings max.

This input field serves to enter the maximum admissible number of dressings (input ≥ 1 : activate tip dressing function) up to the end of stepper.

**NOTE**

A value of Dressings = 0 must be input if the tip dressing function is to be skipped.

[17] Dressings Act.

The number of completed dressings will be displayed.

11**NOTE**

The actual value of Dressings can be input with Act. Val. - Set counter. Thus, an electrode that has already been tip-dressed can be used again, see volume 1, section 7.4.7.

11.2.4 *Current values*

The percent *Stepper* values are converted into current values and vice versa. The actual currents are displayed in kA.



NOTE

The *Current value* window is only available for selection if *KSR* mode is active.

	[1] %	[2] 1. WLD	[2] 2. WLD	[2] 3. WLD
1. Stepper-Phase:	140.00	6.300	9.100	8.750
last Dressing:	108.00	4.860	7.020	6.750
new Electrode:	110.00	4.950	7.150	6.875
Basis, 100%	100.00	4.50 [3]	6.50 [3]	6.25 [3]
Act. :	109.12	4.910 [4]	7.093 [4]	6.820 [4]

Buttons:

Footer: %I at end of 1. Stepper-Phase | 0.00 ... 300.00 | Online

Command buttons:

D <OK>

Transmits data to the timer or cancels the transmission, closes the window.

Column [1] shows the percent values from the *Stepper* window sections [6] ([6a], [6b], [6c]). From these values and the [base currents] [3], the resulting currents are calculated and displayed in columns [2]. If a percent value [1] or an absolute value [2] is changed, the related other value is re-calculated.

Inputs and displays:

[1] Percent *Stepper*. The values in the framed fields may be changed.

- 1. Stepper-Phase:
Final *Stepper* value in the Stepper section.
- last Dressing:
Final *Stepper* value in the tipdress section.
- new Electrode:
Initial *Stepper* value with new electrode.

[2] Calculated command current on the basis of the *Stepper* and the [base currents].

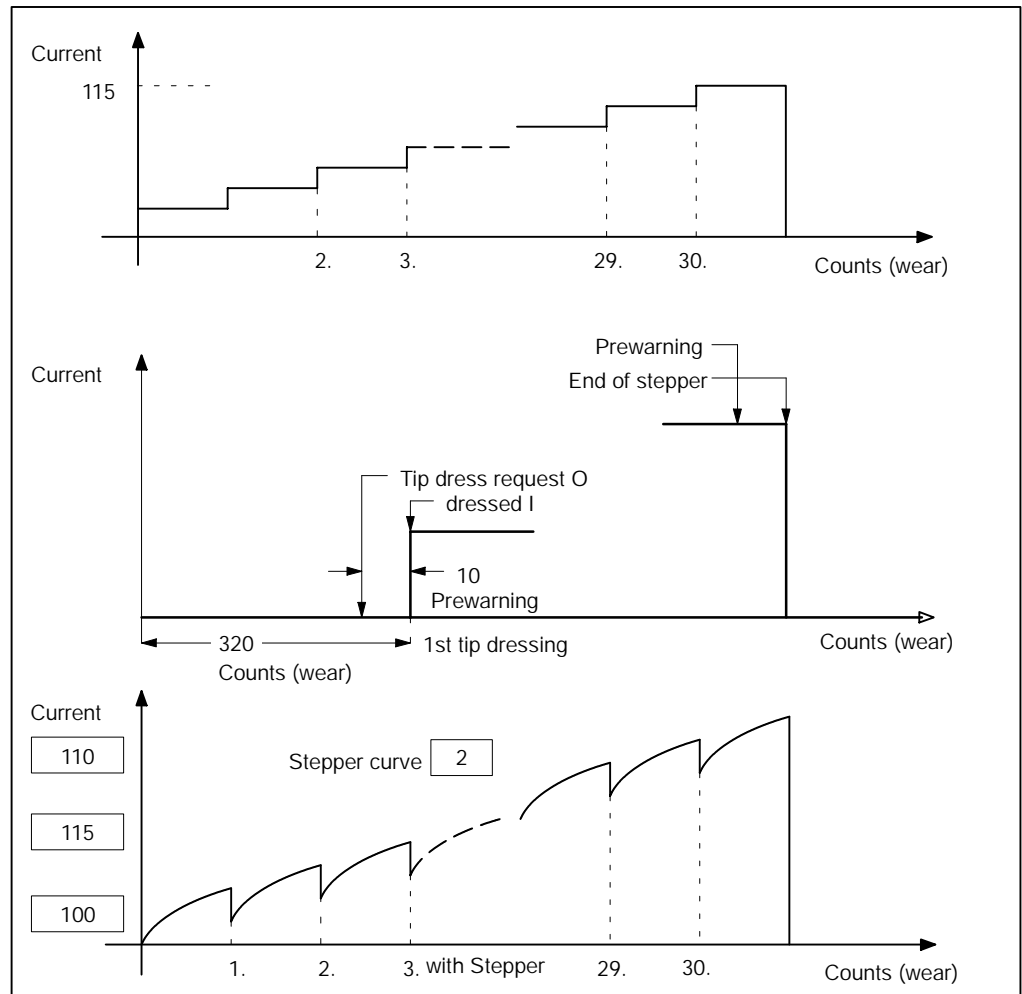
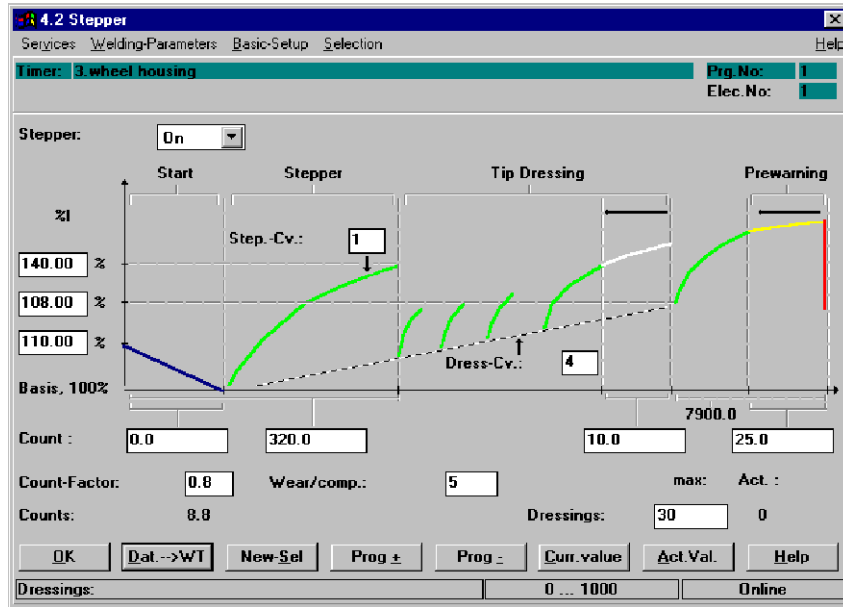
[3] Programmed current values in kA.

[4] Measured actual current values in kA.



Example electrode maintenance

Without start section, but with tipdressing and with prewarning, tipdress curve 2 is linear.



Your notes:



11.3 *Current Monitoring*

- *Current monitoring* and regulation are separate functions.

Current monitoring checks the actual current, which flows during the welding process and compares the feedback value against programmed reference values and upper and lower tolerances. The current thus measured can also be accepted as a new base reference current for the monitoring process.

Any deviation above the tolerance band is reported. The response of the timer is output as **<Welding fault>** or **<Warning>** on the programming unit.

If the measured values are lower than the conditional tolerance band a counter can be incremented, compared and then a spot repeat can be performed.

The timer's response to current values in the conditional tolerance band can be programmed with an adjustable counter.

Current Monitoring must be viewed together with *Weld Time Monitoring*. Both quantities, current and weld time, determine the amount of energy and thereby the quality of the spot weld. If both monitoring functions are conducted with correct reference values, then they contribute considerably to quality assurance.

A transient decay current is still flowing after power turn-off, while welding with DC current, which also goes into the energy equation. Current Monitoring addresses this area as well if desired.

11.3.1 *Basic-Setup Parameters which Affect Current Monitoring*

- Monitoring Std/MIX (Standard and Mixed Monitoring)
- Monitoring Stopped for all programs
- Current measure (fade-out time and trail current, setting depends on the timer type in use)

Monitoring Stopped

D *Starting window - Operation - Modify - Programming - Basic-Setup - Sequence-Setup*

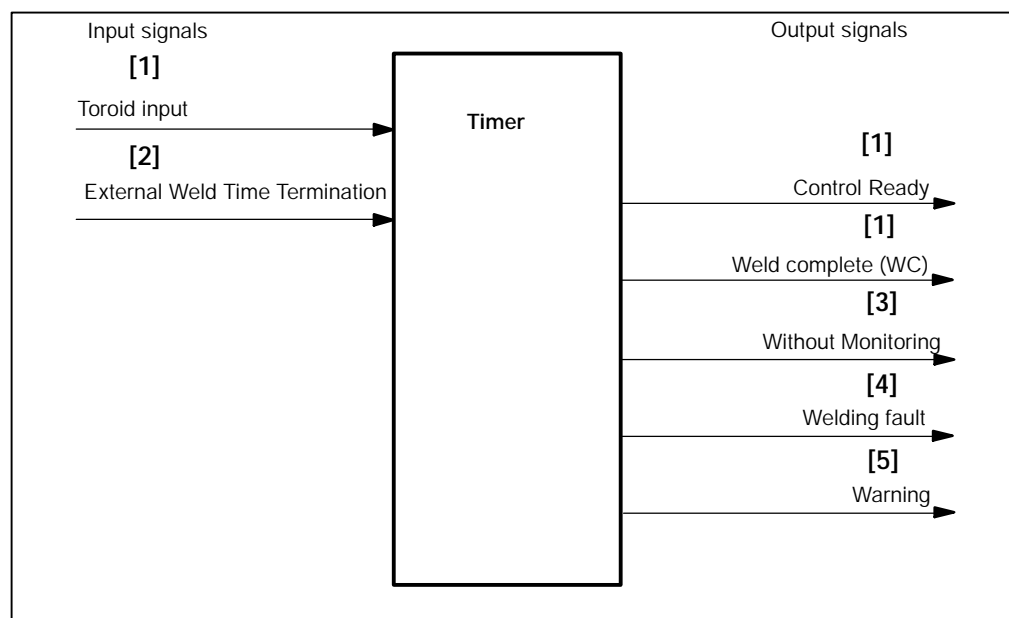
Menu item *Fault-Set-up* allows you to determine the response of the timer (**<Welding fault>** or **<Warning>**) to a deviation of the monitored values.

Fault Allocation:

D *Starting window - Operation - Modify - Programming - Basic-Setup - Fault-Set-up*

11.3.2 Interface Signals which Interact with *Current Monitoring*

The following input and output signals affect *current monitoring* in the welding process:



- [1] The current sensor (toroid) measures the amount of the welding current and returns the value to the toroid input of the welding timer. Based on the parameter settings made in *Current Monitoring*, the welding timer issues **<Weld complete (WC)>** (if welding current is correct) and maintains the signal **<Control ready>** at the end of the [sequence].
The output of **<Weld Complete>** if the welding current is not correct is programmable.
- [2] The **<External weld time termination>** stops the welding process immediately.
- [3] If current monitoring is turned off at the programming unit the signal **<Without Monitoring>** is output.
- [4] When current values fall outside the programmed limits, with monitoring enabled and allocation as fault, the signal **<Control ready>** will be cleared and the signal **<Welding Fault>** will be issued.
- [5] When current values fall outside the programmed limits, with monitoring enabled and allocation as warning, the signal **<Control ready>** will be maintained and the signal **<Warning>** will be issued.



11.3.3 Starting *Current Monitoring*

D Select *Starting window - Operation - Modify - Programming - Welding-Parameters - Current Monitoring*

If in monitoring mode *Standard current monitoring* is active for all weld times, entries are possible in the column *Standard* only. If monitoring mode *Mix* has been selected, inputs in columns *1. Weld-time, 2. Weld-time, 3. Weld-time* are possible.

For *Current Monitoring* in monitoring mode *Mix*, see section 8.20. The organization of the window is dependent on the type of the timer.

[1]

[2]

[2]

[2]

[2]

[3]

[3]

[3]

[3]

[4]

[4]

[4]

[4]

[5]

[5]

[5]

[5]

[6]

[6]

[6]

[6]

[7]

[8]

[7]

[8]

[7]

[8]

[7]

[8]

[9]

[9]

[9]

[9]



NOTE

In the Standard Monitoring mode, Current Monitoring applies to all weld times of a welding program. Use of the Mixed Monitoring mode is recommended for higher quality requirements, since each weld time allows separate monitoring. In such a case the Monitoring Parameters must be entered separately for 1. WLD, 2. WLD and 3. WLD.

Command buttons:

- <OK>
transmits data to the timer or cancels the transmission, closes the window.
- <Dat.-> WT> transmits data to timer.
- <New Sel> corresponds to the *Selection* menu, see chapter 12.
- <Prog +> next program (current program number +1).
- <Prog -> previous program (current program number -1).
- <Act.->Com.> accepts the displayed actual values as command values (reference currents), see section 11.3.4.
- <Act.Val.> see section 7.4.7.

Inputs, selections and displays:



NOTE

A selection of the objects of a window is shown, depending on the timer used and the selected program functions.

[1] Display

- current power correction of the electrode, %I-Corr. (E).
- current power correction of the program, %I-Corr. (P).
- current monitoring value for %I correction **Monitor Step.-Value**.
(For %I Correction see volume 1, sections 7.4.2 and 7.4.3).

[2] Current Monitoring On/Off

Current Monitoring in the Standard monitoring mode is enabled for all weld times, while *Current Monitoring* in the Mixed monitoring mode must be turned on or off separately for each weld time. Any deviation of the monitored values above or below the programmed value generates a message, which may either be a <Welding fault> or a <Warning>, depending on the *Fault Allocation*, (note effect on ready state of the timer).

[3] Upper Tolerance Band (Set)

D Input (Set) of the admissible current deviation in % above the commanded current (reference current) for *Current monitoring*.

A deviation of the actual current above this limit results either in a <Warning>, whereby the timer remains in the ready state, or a <Welding fault> is indicated and the timer is stopped.





[4] Lower Tolerance Band (Set)

D Input (Set) of the admissible current deviation in % above the commanded current (reference current) for *Current monitoring*.

A deviation of the actual current below this limit results either in a <Warning>, whereby the timer remains in the ready state, or a <Welding fault> is indicated and the timer is stopped.

[5] Conditional Lower Tolerance Band (Set)

D Input (Set) of the conditional current tolerance in % of the commanded current (reference current) for downward *Current monitoring*, taking into account the repeat factor, see section 8.15.

If a deviation of the current below the admissible tolerance band occurs, spot repetition can be performed (Max. repeat welds). A spot below the lower tolerance band is repeated only once.

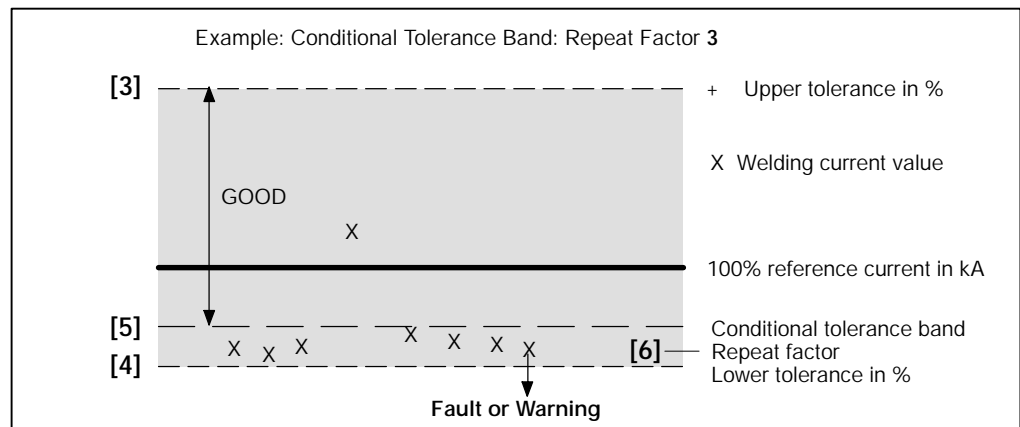
Max. repeat welds:

Select *Starting window - Operation - Modify - Programming - Basic-Setup - Sequence-Setup*

[6] Repeat Factor (Set:/Act.:

D Input (Set:.) and display (Act.:) of the repeat factor of consecutive welds in the conditional tolerance band, see section 8.15.

Current values in the conditional tolerance band will cause the internal "repeat factor" counter to be incremented. Exceeding the command value of the "repeat factor" counter results either in a <Warning> whereby the timer remains in the ready state, or a <Welding fault> is indicated (message output at the programming unit: "Series of welds below lower threshold point") and the timer is stopped.



[7] Reference Current (Set)

D Input (Set: reference current) for *Current monitoring*. An actual value can be accepted as new command value (reference current) with the **<Act.->Com.>** command button.

In the Standard Monitoring mode, the measuring time includes the beginning of the [1.WLD] up to the end of the [3.WLD] as well as all [cool times], see section 8.20.

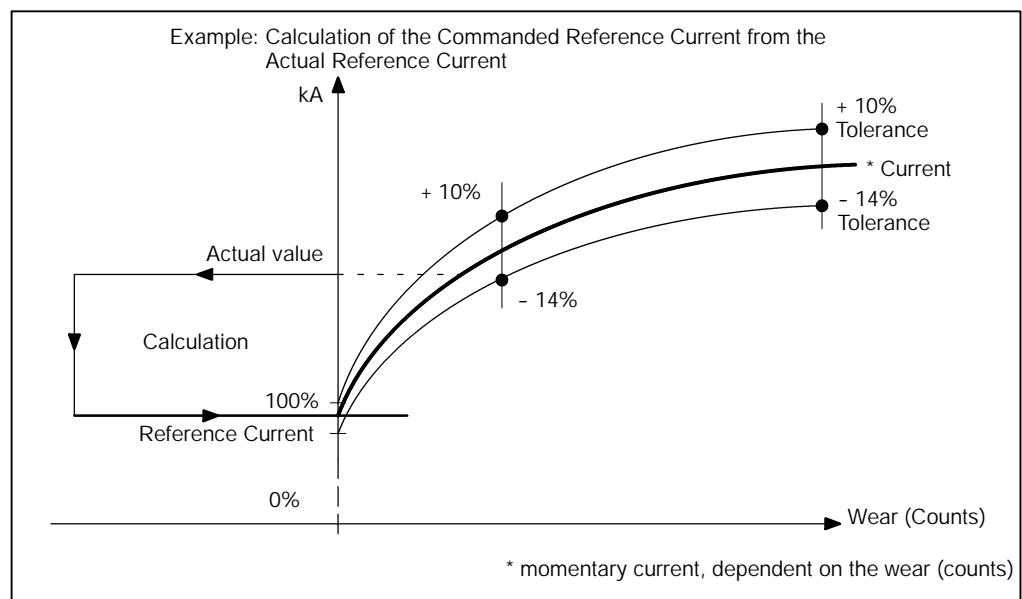
In the Mixed Monitoring mode, the measuring times are restricted to the individual [Weld Times] [1.WLD], [2.WLD] and [3.WLD]. If the [2nd current block] is made up of several [impulses], the measuring time corresponds to the duration of the individual [impulses], see section 8.20.

On this current a deviation of the actual current is monitored.

For example, illustration (2. weld current) in section 11.3.3:

Here 6.43 kA mean "GOOD" current.

In this area, a deviation of +10% (6.43 kA + 10% = 7.07 kA) or -14% (6.43 kA - 14% = 5.53 kA) is admissible. If stepping is activated, then this value always refers to the spot with wear = 0.0 (new electrode), see section 11.2.

**[8] Act. ref. current**

Display of the measured actual current value (rms) of the last welded spot. In monitoring mode Standard with [pulses] in the [2. weld time] and/or [slope] the average value is displayed via the measuring time, see section 8.20.1.

The actual current can be taken over into the command value window of the reference current with the **<Act. -> Com.>** command button.

**[9] Middle PHA (Act.:)**

Display of the actual values of the mean phase angle of the current weld.

The actual values of the resulting mean phase angle are displayed independently from the selected control function.

11.3.4 Accepting Actual Current as Reference Current

		[4]
		[5]
[1]		
[2]	3	
[3]		

- [1] The actual current is accepted as the reference current (Set:) for those programs that work with the displayed electrode [5].
- [2] The actual current is accepted as the reference current (Set:) for the entered program [4].
- [3] The actual current is accepted as the reference current (Set:) for the displayed programs (in the example these are programs 1, 3, 4, 5, 6 and 9).

Your notes:



11.4 Time Monitoring

Time Monitoring controls the actual duration of all weld times and compares the actual value with a programmable reference time and an admissible time tolerance, see section 8.21.

The actual or measured weld time can be accepted as a new command (reference time) value.

The timer reports any deviation beyond the tolerance band. The timer may respond with a **<Welding fault>** or a **<Warning>** and the message is output at the programming unit.

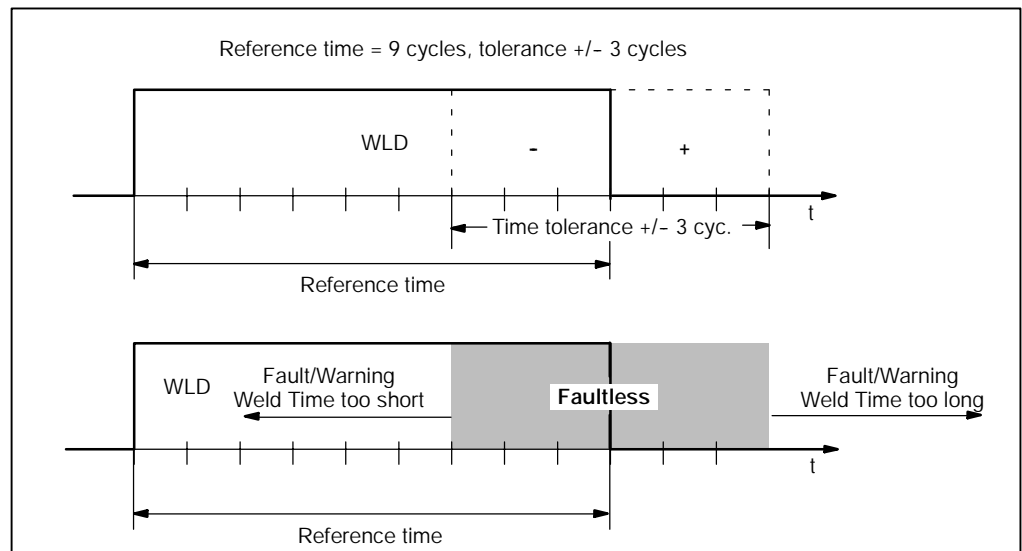
Time Monitoring must be viewed together with *Current Monitoring*. Both quantities, time and current determine the amount of energy and thereby the quality of the spot weld. If both monitoring functions are conducted with correct reference values, then they contribute considerably to quality assurance.

When welding with DC current, larger currents are still flowing after power turn-off, which must also go into the energy equation. *Time Monitoring* also addresses this area.



NOTE

The change of a weld time, with time monitoring enabled, requires also a change in the related reference time. If this is not done, the reference time deviation will eventually be outside the tolerance band specified for monitoring, resulting in a warning or fault message. This helps quality assurance, since it helps to detect careless changes.



11.4.1 *Basic-Setup* Parameters which Affect *Time Monitoring*

- Monitoring Stopped

Monitoring Stopped:

- D *Starting window - Operation - Modify - Programming - Basic-Setup - Sequence-Setup*

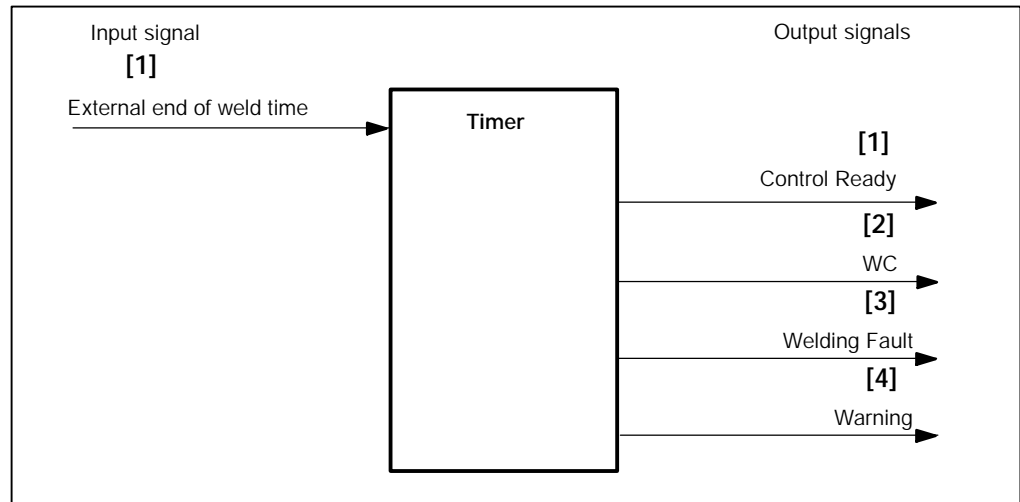
The menu item *Fault-Set-up* serves to determine the response of the timer (<**Welding fault**> or <**Warning**>) to a deviation above or below the monitored time values.

Fault Allocation:

- D *Starting window - Operation - Modify - Programming - Basic-Setup - Fault-Set-up*

11.4.2 Interface Signals which Interact with *Time Monitoring*

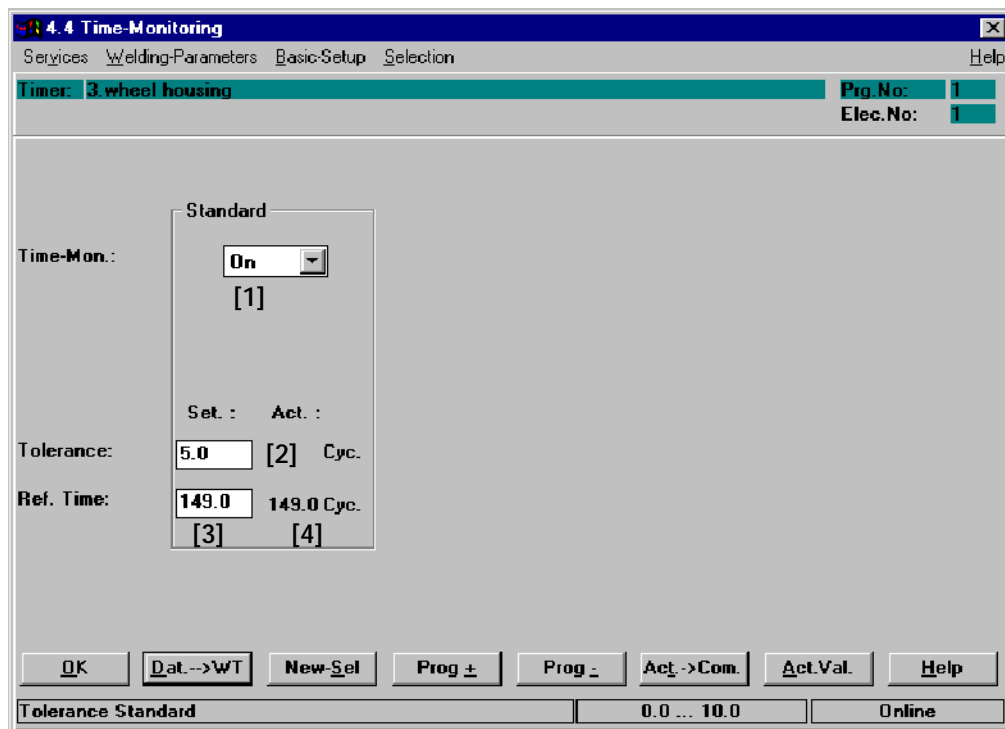
The following input and output signals affect the *Time Monitoring* in the welding process:



- [1] The signal <External end of weld time> ends the welding process directly. The signal <Control ready> is cleared.
- [2] The signal <External end of weld time> does not prevent output of the <WC> signal.
- [3] When weld time values fall outside the programmed limits, with monitoring enabled and allocation as fault, the signal <Control ready> will be cleared and the signal <Welding fault> will be issued.
- [4] When weld time values fall outside the programmed limits, with monitoring enabled and allocation as warning, the signal <Control ready> will be maintained and the signal <Warning> will be issued.

11.4.3 Starting *Time Monitoring*

- D Select *Starting window - Operation - Modify - Programming - Welding-Parameters - Time Monitoring*



Command buttons:

- <OK>
transmits data to the timer or cancels the transmission, closes the window.
- <Dat.-> WT> transmits data to timer.
- <New Sel> corresponds to the *Selection* menu, see chapter 12.
- <Prog +> next program (current program number +1).
- <Prog -> previous program (current program number -1).
- <Act.->Com.> accepts the displayed actual values as command values (reference time), see section 11.4.4.
- <Act.Val.> see section 7.4.7.



Inputs, selections and displays:

[1] Time Mon. On/Off (time monitoring)

Time Monitoring is turned on or off for all weld times.

[2] Tolerance (Set:) (admissible time deviation, set value)

D Input (Set:) of the admissible time deviation (cycles or milliseconds) from the reference time for *Time monitoring*.

Any deviation from the tolerance band causes either a **<Warning>** message and the timer remains in the ready state or a **<Welding fault>** message and the timer is stopped.

[3] Ref. Time (Set:) (reference time set value)

D Input (Set:) of the reference time in cycles or milliseconds (ms-timer) for *Time monitoring*.

The reference time is the entered command time (Set:).

[4] Ref. Time (Act:) (reference time actual value)

The measured actual reference time is displayed in cycles or milliseconds (ms timer).

The measured actual reference time (cycles or milliseconds) can be accepted as the new command value (set reference time) via the command button **<Act.->Com>**.

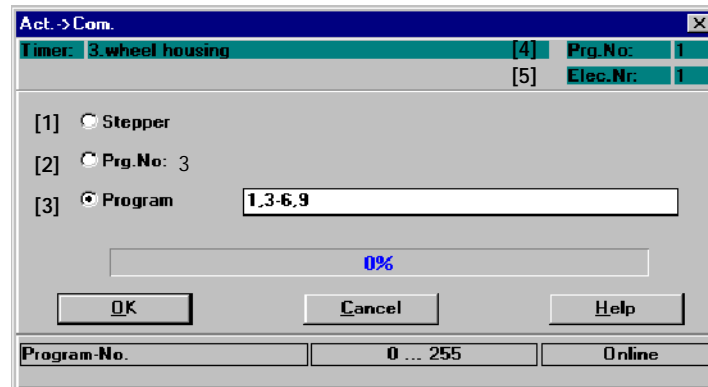
The deviation of the actual time is monitored with regard to this time.

See example illustration in section 11.4.3:

Here 10.0 SKV (scale units) means "Good" Time.

In this area a deviation of +1 SKV (10.0 SKV + 1.0 SKV = 11.0 SKV) or -1 SKV (10.0 SKV - 1.0 SKV = 9.0 SKV) is admissible.

11.4.4 Accepting Actual Time (Act. :) as Command Time (Set. :)



- [1] The actual time is accepted as a reference time (Set. :) for those programs that work with the displayed electrode [5].
- [2] The actual time is accepted as the reference time (Set. :) for the program displayed under [4]: Prg. No.
- [3] The actual time is accepted as the reference time (Set. :) for the displayed programs.



11.5 *Monitor Stepper*

- Monitoring and Regulation are separate functions.

When using the *Stepper* function the [current] (phase angle) is changed in order to compensate the electrode's wear according to the *stepper curves*. Starting with a certain initial current, the outgoing electrical [current] (%I) is stepped in the sections Start, Stepper and Tipdressing, following a predetermined curve shape, see section 11.2.

When a command value for a welding program has been programmed and *Stepper* is active, the current may change from one spot to the next. In this case, the *Monitor Stepper* function provides the possibility to program separate stepping values in percent if, at the same time, a certain current is to be monitored.

The characteristic of the curve and the end of stepper (wear) of the electrodes are the same in the display of the *Stepper* and *Monitor Stepper*, but the percent value of the *Monitor Stepper* may be different.

**NOTE**

A current sensor (toroid) is required for the Monitor Stepper function.

11.5.1 *Basic-Setup* Parameters which Affect the *Monitor Stepper* Function

In the items *Stepper-Curves* and *Tipdress-Curves* of the *Basic-Setup* menu, 10 different curves for *Stepper / Monitor Stepper* can be programmed.

11

Using the menu items *Stepper-Curves/Tipdress-Curves*, you may program the following parameters:

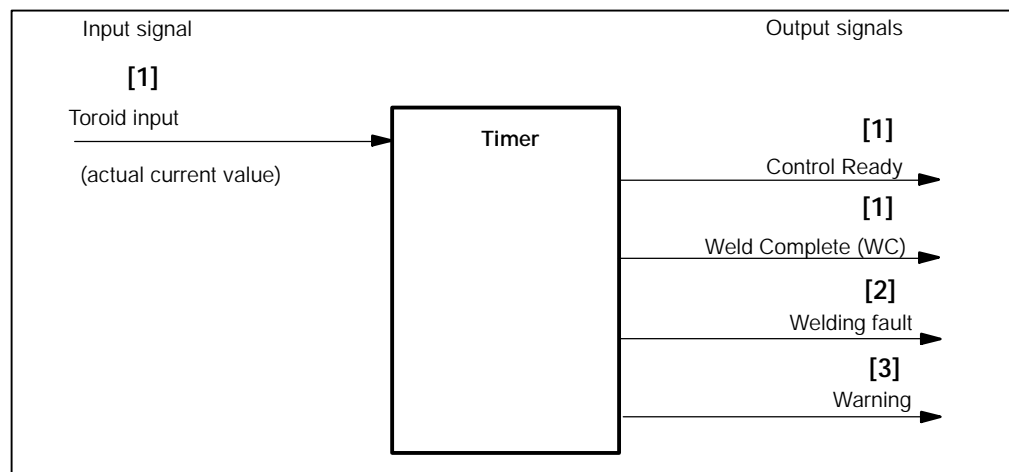
- curve shape
- current changes (%I Change)
- wear counter values (Count Values)

Stepper Curves and *Tipdress-Curves*

D *Starting window - Operation - Modify - Programming - Basic-Setup - Stepper-Curves / Tipdress-Curves*

11.5.2 Interface Signals which Interact with *Monitor Stepper*

The following input and output signals affect the *Monitor Stepper* in the welding process:

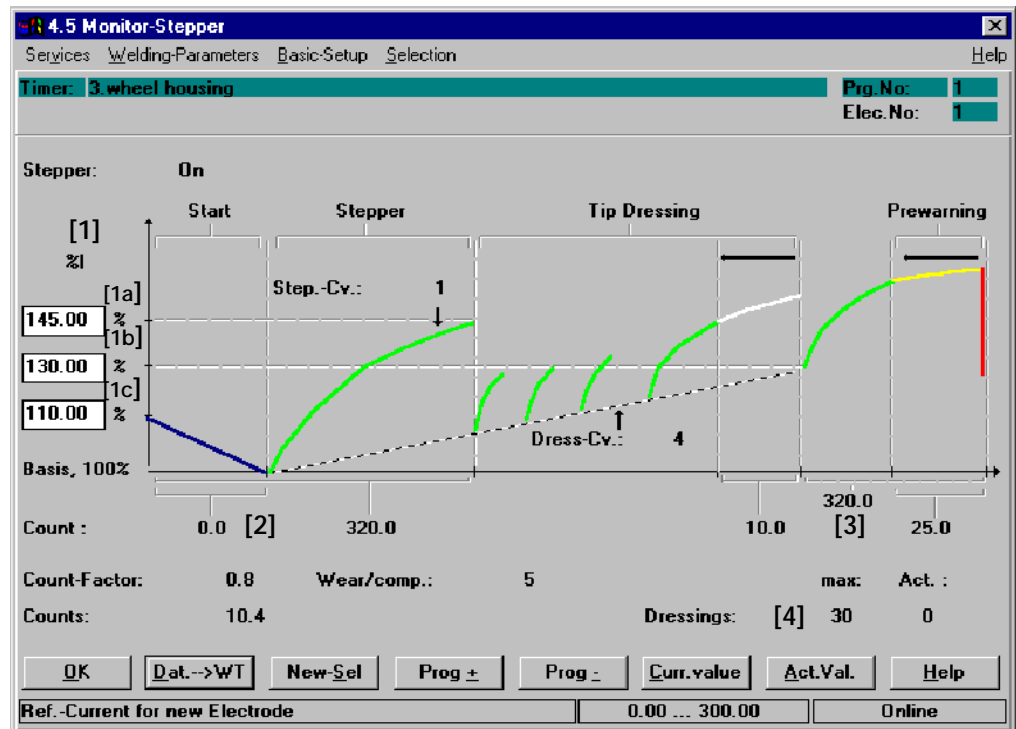


- [1] The current sensor (toroid) measures the welding current and sends the value to the toroid input of the timer. As long as the actual current value is within the programmed tolerances, the welding timer issues <WC> (if welding current is correct) and maintains the signal <Control ready>. The output of the signal <Weld Complete> with a faulty weld current can be programmed.
- [2] When current values fall outside the programmed limits, <Control ready> will be cleared and the signal <Welding fault> will be issued (assuming that current values outside the programmed limits are defined as a fault in *Basic-Setup - Fault Setup*). The operating status of the welding timer will be changed to Stop.
- [3] When current values fall outside the programmed limits, <Warning> will be issued (assuming that current values outside programmed limits are defined as a warning in the *Basic-Setup - Fault-Setup*). The operating status of the welding timer remains in <Control ready>.



11.5.3 Starting Monitor Stepper

D Select *Starting window - Operation - Modify - Programming - Welding-Parameters - Monitor-Stepper.*



NOTE



The organization of the window (input fields) is dependent on the type of timer used.

Command buttons:

- <OK> transmits data to the timer or cancels the transmission, closes the window.
- <Dat.-> WT> transmits data to timer.
- <New Sel> corresponds to the *Selection* menu, see chapter 12.
- <Prog +> next program (current program number +1).
- <Prog -> previous program (current program number -1).
- <Curr.value> The *Stepper* values given in percent are converted into absolute current values and displayed. The inputs for the *Stepper* in percent and the current values can be changed, see section 11.2.4.

NOTE



The current values display can only be called up if KSR mode has been preselected.

- <Act.Val.> see section 7.4.7.

**NOTE**

Curve sections displayed in blue work without monitor stepper.

Possible reasons:

- *Stepping is disabled.*
- *No wear has been programmed for these sections.*
- *Stepping = 100% has been programmed for the stepper section.*
- *The tip dressing function is disabled.*
- *No wear has been programmed for prewarning.*

If the curve for the start section ([1c] input value, stepper, wear, start-section = 0.0) is displayed in blue it works without the monitor stepper function.

A green curve for the start section ([2] input value, stepper, wear, start-section > 0.0) shows that monitoring for this area is active. Stepping is monitored with the programmed monitoring value in percent.

If the curve in the stepper section ([1a] input value, monitor, stepper = 100%) is displayed in blue it works without monitor stepper.

A green curve in the stepper section ([1a] input value, monitor, stepper = 100%) shows that monitoring for this area is active. Stepping is monitored with the programmed monitoring value in percent.

If the curve in the tipdressing section ([4] Stepper, Dressings = 0) is displayed in blue, it works without monitor stepper. The tipdressing function is not active.

A green curve in the tipdressing section ([4] Stepper, Dressings = 0) shows that monitoring in this area is active. Stepping is monitored with the programmed monitoring value in percent.

If the curve in the prewarning section ([3] Stepper, input value, wear, prewarning = 0.0) is displayed in blue, prewarning is not programmed.

If the curve in the prewarning section ([3] Stepper, input value, wear, prewarning > 0.0) is displayed in yellow/red, the stepper works with prewarning. The stepper can be changed in the Stepper window.



Inputs and Displays:

**NOTE**

All unchangeable values displayed in this window correspond to those in the Stepper illustration, see section 11.2.3.

[1] Current (%I)

The monitoring value of the *stepper* is given in percent and is thus independent from the absolute values of a welding program. If the [current] of a welding program is altered, the monitoring value can be taken over.

All entries refer to a basic value (100%) at the end of the start section, i.e. at the beginning of the stepper section.

Input fields for programming the monitoring value:

- **[1a]** The input field at the top determines the monitoring value at the end of the stepper section.
- **[1b]** The input field in the middle determines the monitoring value at the end of the tipdressing section.
- **[1c]** The input field at the bottom determines the monitoring value when starting with a new electrode.

Your notes:

11.6 Pressure

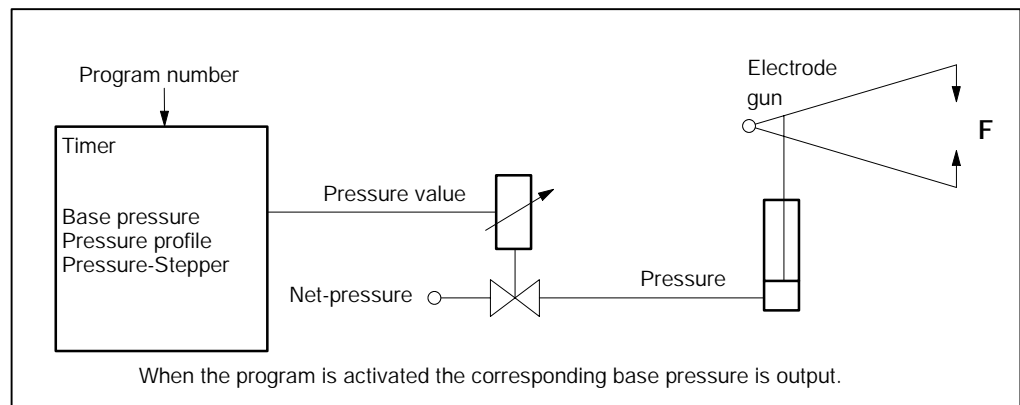


NOTE

The Pressure function is not available in all timer types. Depending on the type of the timer used, activation of the pressure regulating valve is analog or digital. It is set in the window Basic-Setup - I/O-Parameters.

The value for activating a pressure regulating valve is given via an output. The pressure value determines the electrode pressure and is composed of four components:

- [Base-Pressure]
- [Press.-Prof.] (Pressure Profile)
- *Pressure-Stepper*
- Pressure correction

**11**

[Base pressure]

The [Base Pressure] is a pressure value that is available from the beginning of the program selection at the pressure output and can be modulated by a [pressure profile]. The [Base Pressure] is a programmable welding parameter. Each welding program can be given an individual [Base Pressure]. The [Base Pressure] is influenced by the *Pressure Stepper*, the [Pressure Profile], and the pressure correction.

[Press.-Prof.] (Pressure Profile)

A [Pressure Profile] can be employed during the welding process in addition to the [Base pressure], in order to modulate the [Base pressure]. The [Pressure Profile] can be programmed via 10 steps with the pressure value and the pressure time. It starts with the squeeze time [SQZ] and ends with the hold time [HLD]. If the sum of all pressure times exceeds the total length of the welding program from the squeeze time [SQZ] up to the end of the hold time [HLD], then the [Pressure Profile] will be cut short at the end of the hold time [HLD]. Only [Base pressure] is active after this.

**NOTE**

After exchanging a component (e.g. the electrode gun) pressure scaling has to be re-done.

**CAUTION!**

Pressure values that are too high can cause damages to the welding installation.

11.6.1 *Basic-Setup* which Affects the *Pressure* Function

The following parameters can be programmed in the *Basic-Setup* menu:

- Max Pressure (Maximum Pressure)
- Conv.-Factor (Conversion Factor)
- Zero adjust (Zero Adjustment)

**NOTE**

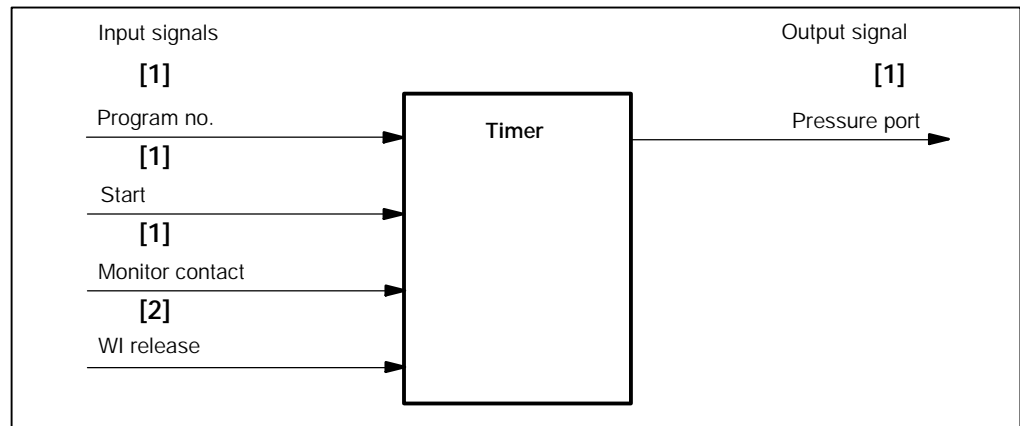
The conversion factor and a possible zero adjustment should better be calculated with Pressure Scaling.

Pressure parameterization:

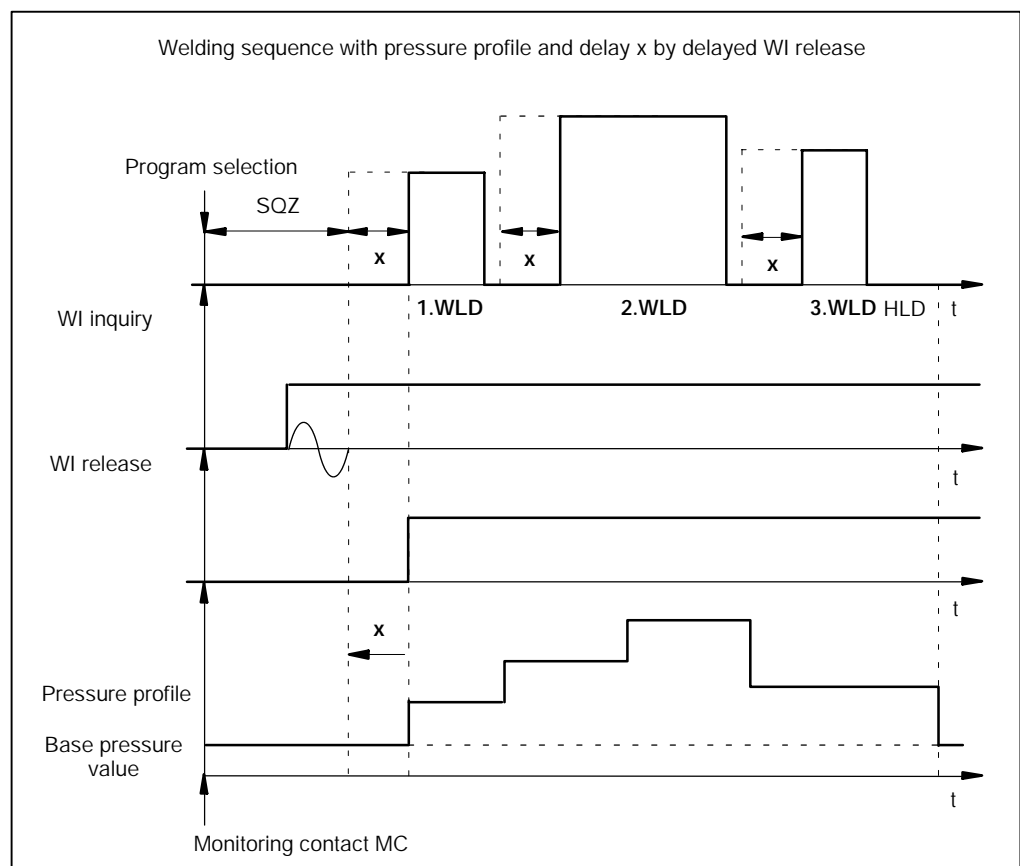
- D *Starting window - Operation - Modify - Programming - Basic-Setup - Electrode Setup (Stepper Setup).*

11.6.2 Interface Signals which Interact with the *Pressure* Function

The following input and output signals affect the *pressure* in the welding process:

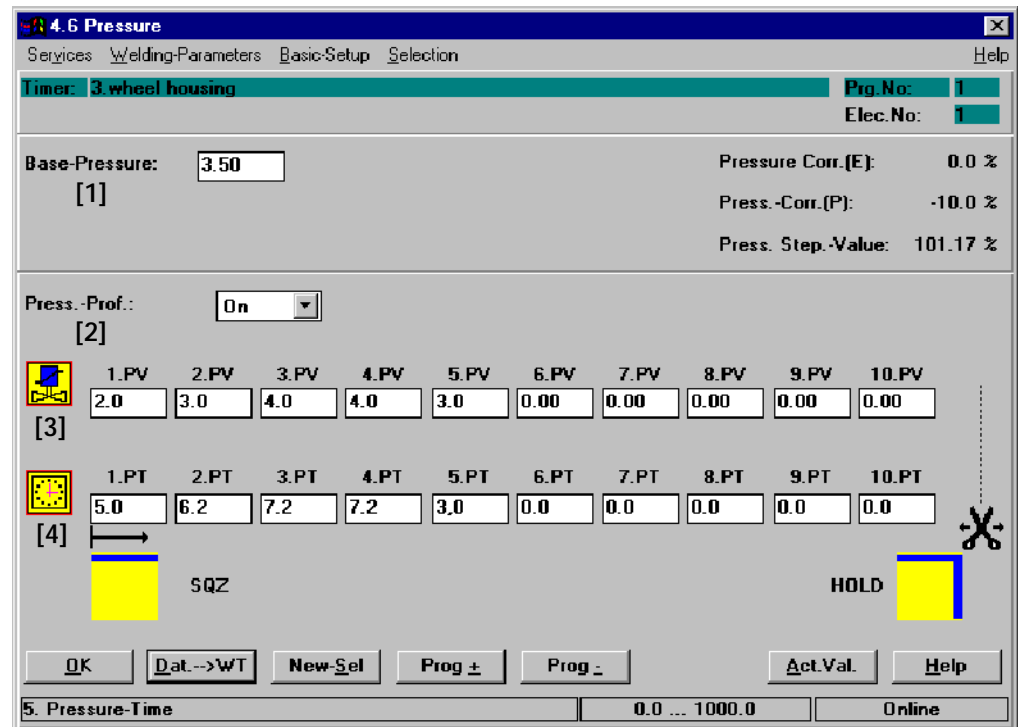


- [1] Program selection generates the programmed [Base pressure value] for driving the pressure solenoid valve. The control awaits a response by the signal <Monitor Contact> in order to start the [sequence].
- [2] Absence of the <WI release> or <Monitor Contact> MC signals delays the execution or the output of the programmed [pressure profile].



11.6.3 Starting *Pressure*

- D Select *Starting window - Operation - Modify - Programming - Welding-Parameters - Pressure.*



Command buttons:

- <OK>
transmits data to the timer or cancels the transmission, closes the window.
- <Dat.-> WT> transmits data to timer.
- <New Sel> corresponds to the *Selection* menu, see chapter 12.
- <Prog +> next program (current program number +1).
- <Prog -> previous program (current program number -1).
- <Act.Val.> see section 7.4.7.

Inputs and selections:

[1] Base pressure

The [base pressure] becomes active at the pressure output upon program selection.

It is affected by the following parameters:

- [Press.-Prof.] (Pressure Profile)
- *Pressure-Stepper*
- Pressure Correction

**[2] [Press.-Prof.] On/Off (Pressure Profile On/Off)**

Used to toggle modulation of [Base pressure] by the [Pressure Profile] On/Off. The [Pressure Profile] is determined by the pressure value and pressure time.

[3] Pressure Value

The max. 10 pressure values for the pressure profile can be entered in kN.

[4] Pressure time

A maximum of 10 pressure times of the pressure profile can be entered in scale units, or in milliseconds.

**NOTE**

If the sum of all pressure times exceeds the total length of the welding program from the squeeze time [SQZ] up to the end of the hold time [HLD], then the [Pressure Profile] will be cut short at the end of the hold time [HLD]. Only [Base Pressure] is active after this.

Your notes:



11.7 *Pressure Stepper*

In order to compensate the wear of the welding electrodes, the [Base Pressure] value is changed by the *Pressure Stepper* function. In order to activate the pressure regulating valve the [Base-Pressure] value is changed for the Start, Stepper, and Tip-Dressing sections according to a preselected curve, starting from an initial value.

The *Pressure Stepper* works with linear interpolation, i.e., depending on the wear counter, the mean value of the stepping value is taken from the following coordinates.

11.7.1 *Basic-Setup* which Affects the *Pressure Stepper* Function

The following parameters can be programmed in the *Basic-Setup* menu:

- Maximum *Pressure* [Max Pressure]
- Conversion factor [Conv.-Factor]
- Zero adjustment [Zero-adjust]

**NOTE**

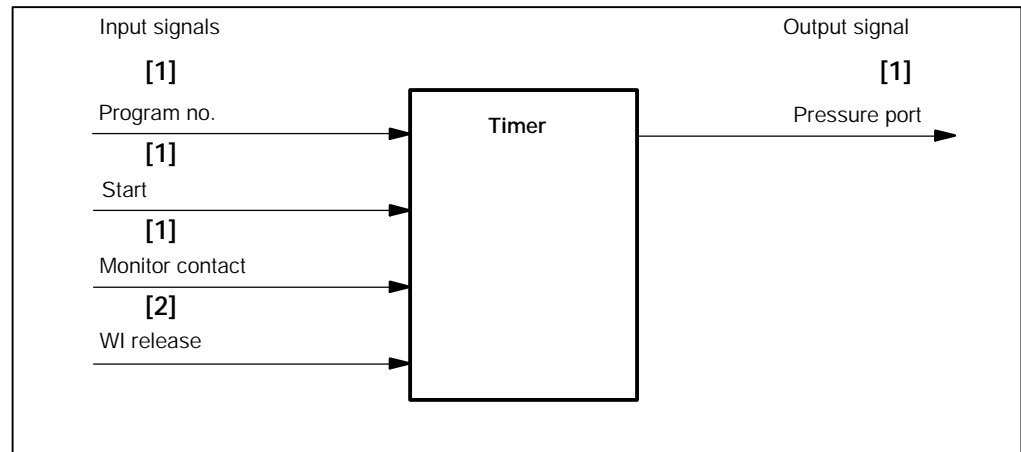
The conversion factor and a possible zero adjustment should better be calculated with Pressure Scaling.

Pressure parameterization:

- D *Starting window - Operation - Modify - Programming - Basic-Setup - Electrode-Setup (Stepper-Setup).*

11.7.2 Interface Signals which Interact with *Pressure Stepper* Function

The following input and output signals affect the *Pressure Stepper* in the welding process:



- [1] Selecting the program generates the output of the programmed [Base Pressure] value for activating the pressure valve. If *pressure stepper* is active the activation changes with each new start.
The signal <Monitor Contact> is the feedback signal for the start of the [sequence].
- [2] Absence of the signal <WI release> delays the [Schedule (sequence)] and/or the output of the programmed [pressure profile] by always the same duration.



11.7.3 Starting *Pressure Stepper*

- D Select *Starting window - Operation - Modify - Programming - Welding-Parameters - Pressure-Stepper*.

[1]

[1a]

[1b]

[1c]

[2]

[3]

[4]

11

Command buttons:

- **<OK>**
transmits data to the timer or cancels the transmission, closes the window.
- **<Dat.-> WT>** transmits data to timer.
- **<New Sel>** corresponds to the *Selection* menu, see chapter 12.
- **<Prog +>** next program (current program number +1).
- **<Prog ->** previous program (current program number -1).
- **<Act.Val.>** see section 7.4.7.

NOTE

Curve sections displayed in blue work without pressure stepper.

Possible reasons:

- *Stepping is disabled.*
- *No wear has been programmed for these sections.*
- *Stepping = 100% has been programmed for the stepper section.*
- *The tip dressing function is disabled.*
- *A wear factor for prewarning has not been programmed.*

If the curve section for the start section is shown in blue color ([1c] Stepper wear start section input value = 0.0), the Pressure Stepper function works without a percent change for this section.

A green curve display for the start section ([2] Stepper wear start section input value > 0.0) indicates active Pressure Stepper for this section. Pressure Stepper is performed with the programmed stepping values in percent, depending of the electrode's wear counter.

A blue curve section in the stepper section ([1a], Monitor Stepper input value = 100%) indicates that Pressure Stepper is performed without a percent change in this section.

A green curve display ([1a], Pressure Stepper input value \neq 100%) in the stepper section indicates that Pressure Stepper is performed with the programmed percent stepper values depending on the electrode's wear counter and the stepper curve selected for this section.

A blue curve section for the tip dressing section ([4], Stepper Dressings = 0) means that Pressure Stepper is performed in this section without a percent change. The tip dressing function is not active.

A green curve display ([4], Stepper Dressings \neq 0) in the tip dressing section indicates that Pressure Stepper is active with the programmed stepper values in percent, depending on the number of dressings and the selected tip dressing curve.

If the curve section for the prewarning section is displayed in blue color ([3], Stepper wear prewarning input value = 0.0), no prewarning section has been defined.

A yellow/red curve display of the prewarning section ([3], Stepper wear prewarning input value > 0.0) means that a prewarning section has been defined.



Inputs and Displays:

**NOTE**

All unchangeable values displayed in this window correspond to those in the Stepper illustration, see section 11.2.3.

[1] Pressure

A percent value is entered for pressure change, which makes it independent from the absolute values of the welding program. The *Pressure Stepper* percent values can remain unchanged, if the *pressure* of a welding program is changed.

All entries relate to a base value (100%) at the end of the Start section i.e. the beginning of the Stepper section.

Three input fields are available for programming *Pressure Stepper*:

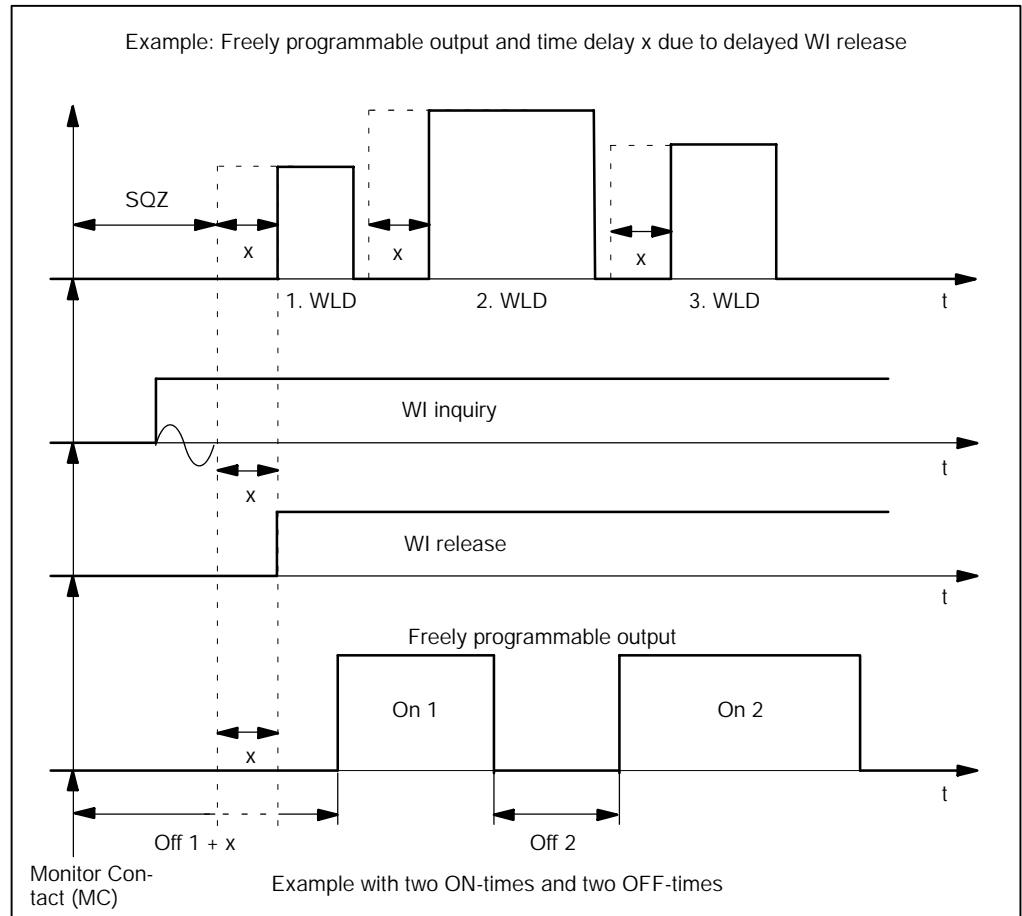
- D **[1a]** The value in the top input field determines the *Pressure Stepper* in percent at the end of the Stepper section. An input value higher or lower than 100% is characterized by a color change of the *Stepper-Curve*, thus indicating changes in the *Pressure Stepper*.
- D **[1b]** The value in the middle input field determines the *Pressure Stepper* in percent at the end of the tipdressing section. An input value higher or lower than 100% results in changes of the *Pressure Stepper* in the tipdressing section.
- D **[1c]** The value in the bottom input field determines the *Pressure Stepper* in percent of a new electrode. An input value higher or lower than 100% results in changes in the *Pressure Stepper* in the starting section.

Your notes:



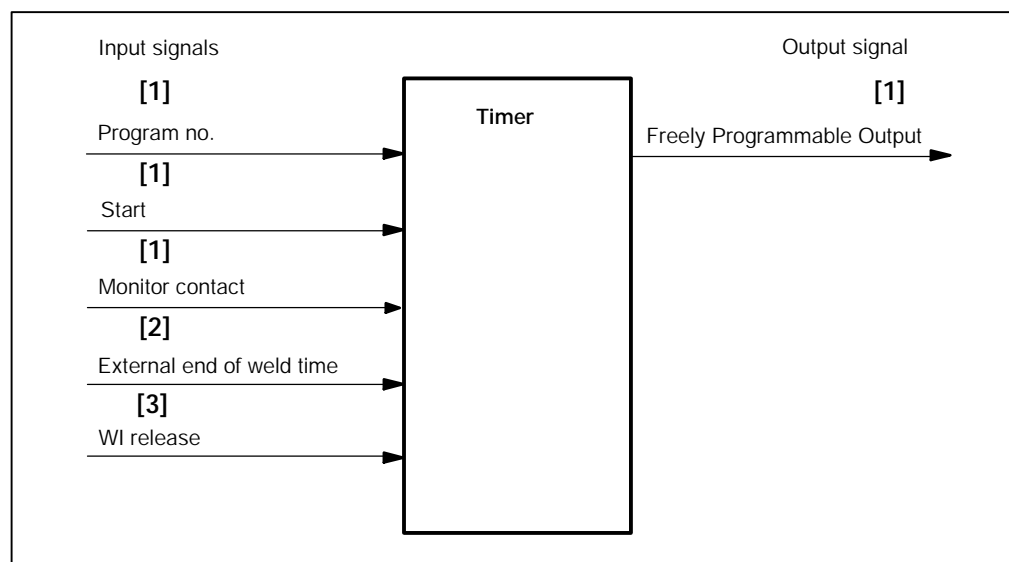
11.8 *Freely Programmable Output*

Each welding program can drive a freely programmable output (timer-specific) of the timer. This output may have up to three programmable On and Off Times during the [Schedule (Sequence)]. It can be used to drive an additional solenoid valve or another peripheral device.



11.8.1 Interface Signals which Interact with the *Freely Programmable Output*

The following input and output signals affect the *freely programmable output* in the welding process:

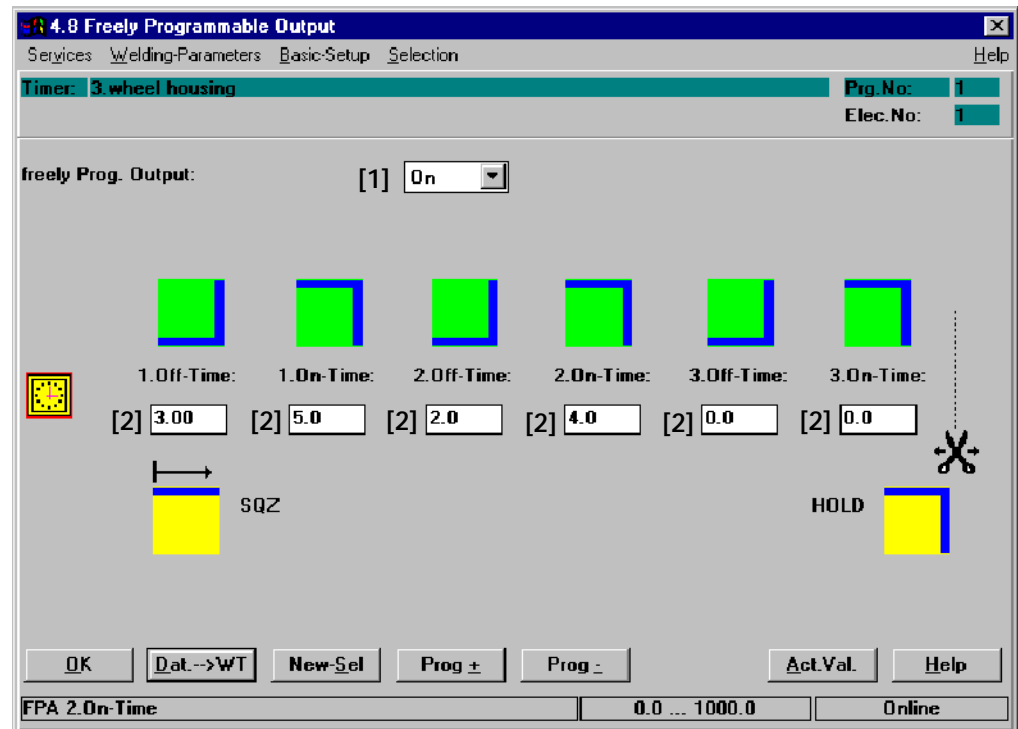


- [1] The time cycle of the *Freely Programmable Output* starts with the beginning of the squeeze time [SQZ]. The conditions for the start of the [squeeze time] [SQZ] are <Program Number>, the <Start> signal, the end of the [pre-squeeze time] [1. SQZ] and the acknowledgement with the signal <Monitor Contact>.
- [2] The signal <External End of Weld Time> resets the *Freely Programmable Output*.
- [3] Absence of the <WI release> or <Monitor Contact> MC signals delays the [sequence] and the timing of the *Freely Programmable Output*.



11.8.2 Starting *Freely Programmable Output*

- D Select *Starting window - Operation - Modify - Programming - Welding-Parameters - Freely Programmable Output*



Command buttons:

- <OK>
transmits data to the timer or cancels the transmission, closes the window.
- <Dat. -> WT> transmits data to timer.
- <New Sel> corresponds to the *Selection* menu, see chapter 12.
- <Prog +> next program (current program number +1).
- <Prog -> previous program (current program number -1).
- <Act.Val.> see section 7.4.7.

Inputs and selection:

[1] *Freely Programmable Output: On/Off.*

Used to enable and disable the *Freely Programmable Output* function and the entry of the On and Off times.

[2] *On-Times / Off-Times*

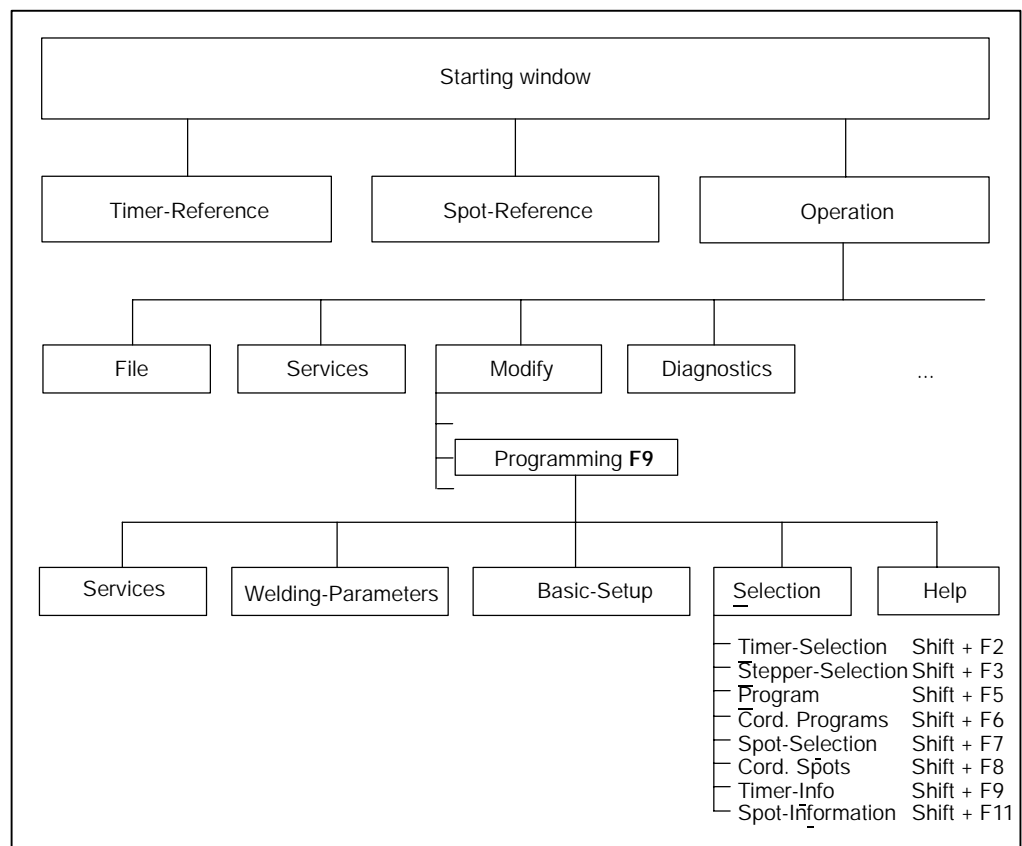
Entry of up to three ON- and three OFF-Times in the section from the beginning of the [squeeze time] [SQZ] up to the end of the [hold time] [HLD]. If the sum of all programmed times exceeds the total length from start of the [squeeze time] [SQZ] up to the end of the [hold time] [HLD], then the remaining ON- and Off-Times will be cut off and have no effect on the output.

The measuring units for programming are cycle or milliseconds.



12 Selection

- Selection of a timer, program, or spot for *Programming*
- Selection of a program using a specific electrode (*Selection - Stepper*)
- Display of programs using the same electrode (Corresponding Programs)
- Display of spots using the same program of the timer (corresponding Spots)
- Information concerning timers and spots.



12

NOTE

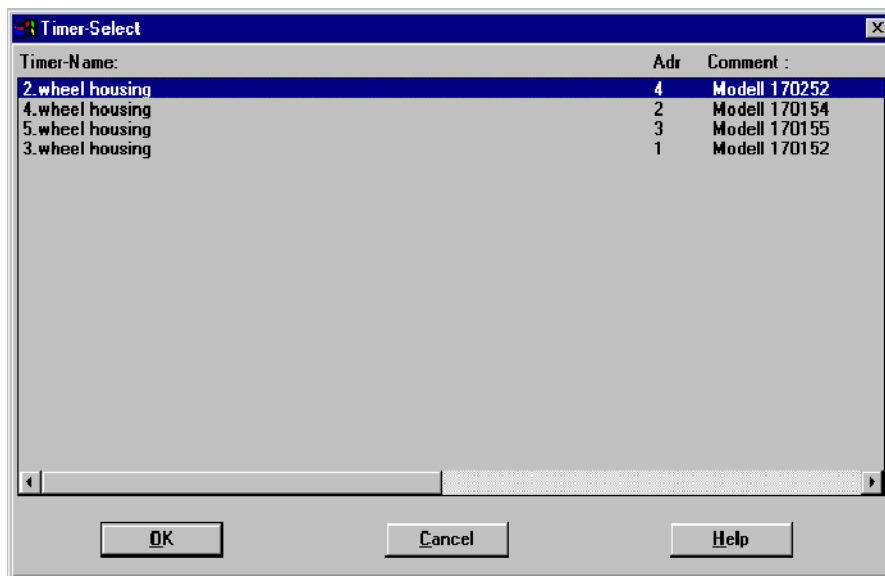


The *Timer-Selection* and *Spot-Selection* menu items function like switches. The check mark in front of the menu item indicates that it is "enabled".
 If a menu item is marked for selection (enabled), the other menu item is automatically disabled for selection.

12.1 *Timer-Selection*

A list is displayed of allocated timers for making a *Selection* of the timer. After *Timer-Selection*, then make a *Program-Selection*.

D Select *Starting window - Operation - Modify - Programming - Selection - Timer-Selection*

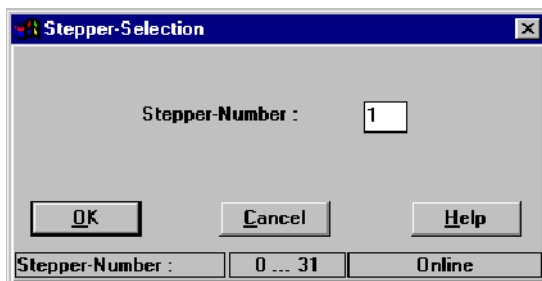


The *Program-Selection* window is opened immediately after *Timer-Selection*. Enter the program number and confirm it by clicking on <OK> (see section 12.3).

12.2 *Stepper Selection*

Select one of 32 electrodes for use with the previously selected timer (the number of selectable electrodes depends on the timer type used). Then select a program that uses this electrode.

D Select *Starting window - Operation - Modify - Programming - Selection - Stepper*

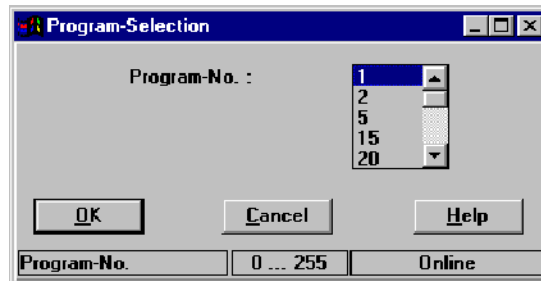


D **Stepper-Number:** entry 0 to n (n = number of electrodes depends on the timer type).

The *Program-Selection* window is shown immediately after *Stepper-Selection*.



In contrast to the *Program-Selection* window from the *Selection* window, you cannot enter a program number. Instead, all welding programs which use the selected stepper are displayed for *Selection*.

**NOTE**

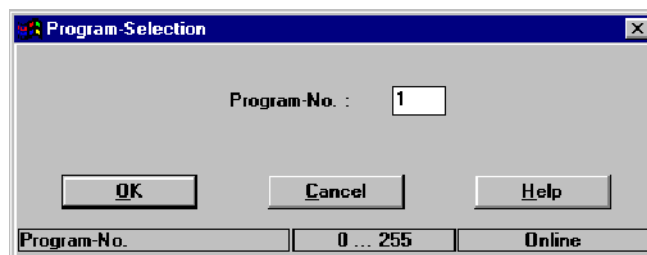
Every welding program uses only one electrode. Several welding programs can use the same electrode.

To effect the allocation: program <-> electrode, use the menu item *Sequence Setup* in the *Basic-Setup* menu, see section 10.10.

12.3 Program Selection

Select a welding program of the previously selected timer.

- D Select *Starting window - Operation - Modify - Programming - Selection - Program (Selection)*

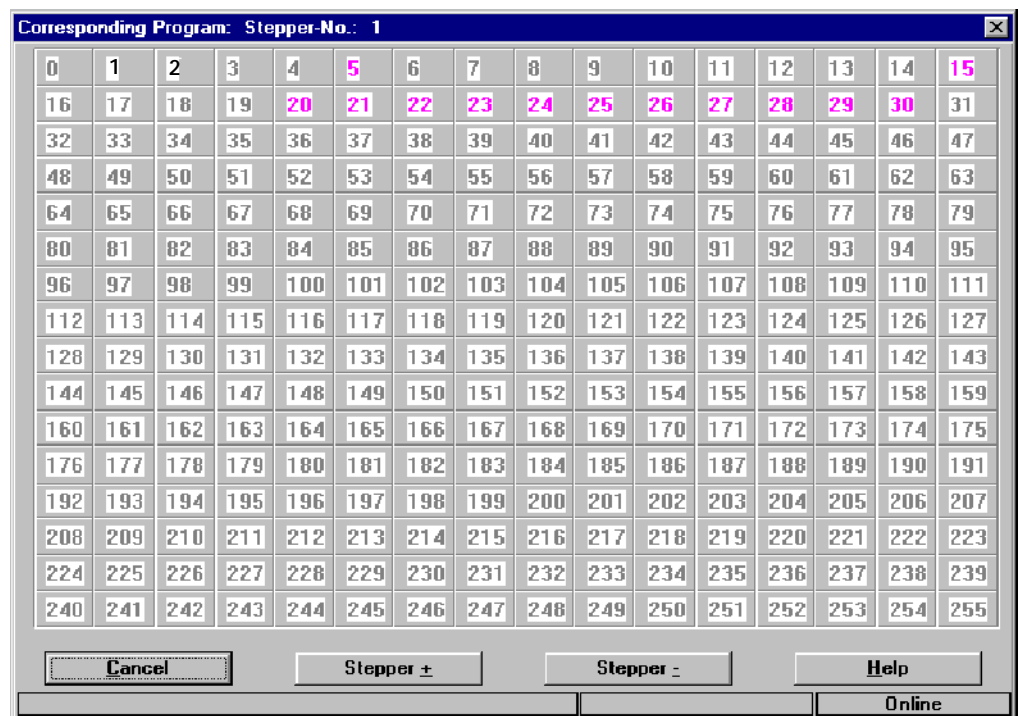
**12**

- D **Program-No. :** Entry 0 to n (n = number of programs depends on the timer type).

12.4 Selection of Cord. Programs

Using this menu item, the programs 0 to 255 (type-specific) are displayed in a table. The corresponding programs of the selected timer (programs using the same electrode) are highlighted in the table by a different color.

D Select *Starting window - Operation - Modify - Programming - Selection - Cord. Programs*



0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

Example: Programs 1 and 2 use electrode 1, i.e. they are *corresponding programs*.

Command buttons:

- <Cancel>: closes window
- <Stepper +>: next stepper (stepper (electrode) number +1).
- <Stepper ->: previous stepper (stepper number -1).



12.5 *Spot-Selection*

Please refer to volume 1, section 7.7.2.

12.6 *Cord. Spots Selection*

This menu item displays a list of all *Corresponding Spots* relating to the previously selected spot in a window.

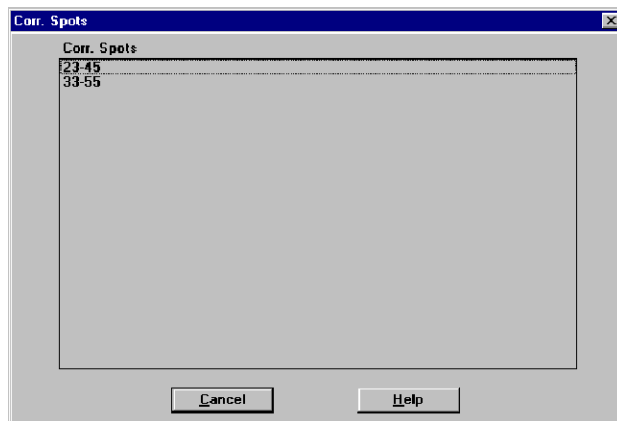
NOTE



The Spot-Selection must be active.

Corresponding Spots use the same program of the same timer.

D Select *Starting window - Operation - Modify - Programming - Selection - Cord. Spots*



NOTE



Changes made to the program parameters of a corresponding spot will also affect the other corresponding spots.

12.7 *Selection - Timer-Info*

Please refer to volume 1, section 7.7.4.

12.8 *Spot Info*

Please refer to volume 1, section 7.7.5.

Your notes:



13 Messages

13.1 Fault and Status Messages

Messages

- **Warnings** : The ready status of the timer remains, further [sequences] are not inhibited.
- **Faults** : The timer is no longer ready, further [sequences] are inhibited.



NOTE

Internally the timer works with coded numbers. All messages are output on the programming unit in text format.

13.2 Ranges of Messages

- [A] Messages concerning the connection WT → Programming terminal are displayed (communication messages)
- [B] Messages concerning the stepper (electrode) status are displayed (*Prewarning, End of Stepper reached*, etc.).
- [C] Messages concerning the timer status are displayed (*battery low*, no +24V etc.).
- [D] Messages from active monitoring (*Weld-time exceeded*).

13.2.1 [A] - Communication Messages

Code	Explanation
-93	
-94	
-95	
-96	<i>Communication with weld timer cannot be established</i>
-97	<i>Communication with weld timer was disconnected</i>
-98	<i>Upload or Download active in Timer</i>
-99	<i>Objects are not accessible</i>
-100	<i>Incorrect timer type (wrong timer in Ref. Table)</i>
-146	<i>Fatal error layer 8</i>
	Error when starting the status message (possibly not enough RAM memory. Close other applications).

-193	<i>Error during checking of parameters</i>
-194	<i>Timer name is unknown</i>
-195	<i>Timer is unknown</i>
-196	<i>Driver is not installed</i>
-197	<i>Station does not exist or driver is not loaded</i>
-198	<i>Object does not exist</i>
-199	<i>Service is unknown</i>
-200	<i>Error of calling parameters</i>

**13.2.2 [B] - Electrode (Stepper) Messages**

Code	Explanation	Additional code
31*	<i>End of Stepper</i>	Electrode no.
32*	<i>Prewarning</i>	Electrode no.
33*	<i>Tip dress request</i>	Electrode no.
34*	<i>Tip dress necessary</i>	Electrode no.
40*	<i>%I (Current) Prewarning</i>	Electrode no.
41*	<i>Maximum current</i>	Electrode no.

13.2.3 [C] - Messages Concerning the Timer Status

Code	Explanation	Additional code
80	<i>Stop Open circuit / no +24V</i>	-
81	<i>Weld without command</i>	-
83	<i>Thyristor unit not ready</i>	-
84	<i>Battery low</i>	-
85	<i>Memory deleted == RAM checksum error</i>	-
86	<i>Data Restore active</i>	-
87	<i>No weld program == invalid parameter</i>	Program no.
88	<i>Hardware fault</i>	H/W fault bitcode
89	<i>I/O-bus fault (only for WT with serial I/O bus)</i>	-
90		-
91	<i>Main switch tripped</i>	-
93	<i>Synchronization fault</i>	-
94	<i>Sequence inhibited</i>	Program no.
95	<i>Parity error</i>	Program no.
96		-
97		-
98		-
99	<i>Welding process, cf. [D]</i>	Monitoring code
100	<i>Supply voltage fault</i>	-
102	<i>No weld external</i>	-
103	<i>No weld internal</i>	-

13.2.4 [D] - Messages for Current and Weld Time Monitoring

Code	Explanation
1001	<i>Current measurement loop open</i>
1002	<i>Current measurement loop shorted</i>
1003	<i>No voltage 1. HW</i>
1004	<i>Primary voltage measurement fault</i>
1010	<i>No current (standard mode)</i>
1011	<i>No current 1. WLD (mixed mode)</i>
1012	<i>No current 2. WLD (mixed mode)</i>
1013	<i>No current 3. WLD (mixed mode)</i>
1020	<i>Current too low (standard mode)</i>
1021	<i>Current too low 1. WLD (mixed mode)</i>
1022	<i>Current too low 2. WLD (mixed mode)</i>
1023	<i>Current too low 3. WLD (mixed mode)</i>
1030	<i>Current too high (standard mode)</i>
1031	<i>Current too high 1. WLD (mixed mode)</i>
1032	<i>Current too high 2. WLD (mixed mode)</i>
1033	<i>Current too high 3. WLD (mixed mode)</i>
1040	<i>Series of welds below lower threshold (standard mode)</i>
1041	<i>Series of welds below lower threshold 1. WLD (mixed mode)</i>
1042	<i>Series of welds below lower threshold 2. WLD (mixed mode)</i>
1043	<i>Series of welds below lower threshold 3. WLD (mixed mode)</i>
1050	<i>Current measuring range exceeded (standard mode)</i>
1051	<i>Current measuring range exceeded 1. WLD (mixed mode)</i>
1052	<i>Current measuring range exceeded 2. WLD (mixed mode)</i>
1053	<i>Current measuring range exceeded 3. WLD (mixed mode)</i>
1060	<i>Weld time too short</i>
1070	<i>Weld time too long</i>

**A Annex****A.1 Abbreviations, Terms**

1. SOZ	1st Squeeze Time or Pre-Squeeze Time: starts after the start signal in the operating modes single, repeat and seam.
1. WLD	1st Weld Time: current is generated for the first time to pre-heat the part being welded
1. CT	1st Cool Time between 1. WLD and 2. WLD
2. WLD	2nd Weld Time: main weld time
2. CT	2nd Cool Time during operation of the 2nd Weld Time with impulses, distance between the [Impulses]
3. CT	3rd Cool Time between 2. WLD and 3. WLD
3. WLD	3rd Weld Time: last current output for post-heating the welding material; improves the structure of the welded material.
CT COOL	Cool time: time between the current pulses/blocks (1., 2., 3. COOL (CT))
Current	Current measured in %I (scale units) or kA (same as HEAT).
DST	Down Slope Time: until the end of 2. WT current is reduced gradually.
EA (EO)	Electronic output: in this case +24V through transistor
EOS	End-of-Sequence contact: signal is output when the spot has been completed
Ext	External, e.g. +24V: voltages for signal transmitters (switches) and actuators (valves) external to the timer
Firing (Ignition)	Weld on/Weld off: enabling and disabling of the firing (ignition) impulses for activating the power unit.
HEAT	Heat in %Ht or kA (same as current)
HLD HOLD	Hold time: last time of the welding schedule; time following the last weld time, during which the parts just welded are allowed to cool down
HSA	Main switch trip
IMP	Number of pulses forming the 2.WLD
LT	Power Unit (thyristor or inverter)
NBS	Mains load limitation control: for monitoring and influencing the mains load
OFF	Off time: time between 2 spot welds during which the solenoid valve is not activated. Available only in REPEAT mode.
PG	Programming unit/welding computer
Post-Heating Time	Also called 3. WLD.
Pressure Contact	Monitor Contact: e.g. monitoring of the pressure in the cylinder that closes the electrodes, or monitoring of the electrode position; gun closed.
PSG	Transformer rectifier unit for the PSU inverter
PSI	Medium-frequency power unit
PSL	PS power unit
PSP	PS programming module
PSS	PS timer
PST	Thyristor power unit
PSU	Weld current inverter (medium frequency)

RA (RO)	Relay output, +24V are output via a contact
REPEAT	Repeat mode: for manually operated systems only
SING	Single spot mode for automatic welding machines and manual systems
Slope	Current increase (or decrease) from an initial to a final current.
Solenoid valve	Activates the cylinders to close the electrodes.
SOZ	Squeeze time: time that elapses before the weld time. The electrodes squeeze the parts to be welded together.
Stepper	Current (heat) stepping for compensating for electrode wear
Temp	Temperature
UST	Upslope Time; time during which the Current (HEAT) stops after beginning of 2.WLD
WC	Weld Complete contact: signal is output when the spot has been completed
WLD	Weld time: entire weld time including cool times
WT	Weld timer, also called resistance weld timer

A.2 Regulation terms

%Ht	Specification of heat in %Ht: represents the electrical phase angle (same as %I)
%I	Specification of current in %I: represents the electrical phase angle (same as %Ht)
kA	kilo Amperes
KSR	Constant current regulation: the current in the secondary circuit is maintained constant by regulation
KUR	Constant voltage regulation: compensation for mains voltage fluctuations
PHA	Phase angle (shift) regulation
SKT (SKV)	Scale Units; correspond to an electrical phase angle.

**A.3 Index****Symbols**

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