SOFTWARE

KR C...

ArcTechDigital 2.2

for power sources with program number control

Operation

KUKA SystemSoftware (KSS) R5.2, R 5.3, 5.4

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PD Interleaf

Contents

1 General

In the development of a welding robot that is easy and safe to use, top priority was given to the optimized adaptation of the operator interface and the interfacing capability to welding equipment with program number control, as well as uncomplicated handling of the ArcTechDigital technology package.

This is intended to allow the trouble-free operation, parameter and hardware configuration and programming of arc welding applications. The entire range of KRL commands are available to you at the expert level. Configuration requires sufficient knowledge of the KRL programming language.

ArcTechDigital features:

- Menu-guided creation of programs at the user level.
- Simple operation using application-specific softkeys and menus.
- Prepared programs and subroutines.
- Adaptation to the peripheral equipment and configurable options of the digital outputs.
- Simple setting of variables, entries in files and parameter lists.
- Use of the function generators for two-dimensional mechanical weaving as well as the possibility of configuring your own weave patterns.
- Adaptation to various welding controllers with program number control and their different coding systems.
- Various routines used for ignition faults and monitoring of the number of ignition attempts.
- Restart options in case of faults.

This documentation has been created for the user group **User**. It contains the description of the graphic user interface of the KUKA Control Panel and illustrates the operator actions necessary for creating, testing, correcting, altering and optimizing programs of the “ArcTechDigital” technology. Explanatory information on the technology commands and the associated parameters is also included.

The functions that are specific to “ArcTechDigital”, the operator control elements, the menus and the various inline forms of the KUKA Control Panel are described in **Chapter 2 - Graphic user interface of the KUKA Control Panel**.

Chapter 3 - Programming and operation - contains the description of the individual “ArcTechDigital” commands together with various tables and information on programming. The command-specific overviews showing the parameter lists that are assigned to the inline forms, together with a brief description of the parameters and of the frequently required operator control elements can be useful - especially to the less experienced user.

By using the simple examples given in both **Chapter 4 - Program example** - and **Chapter 5 - Altering an existing program** - where the individual steps required for creating and altering programs are illustrated, even less experienced users can quickly familiarize themselves with programming.

As a user, you should have adequate knowledge regarding the creation of motion programs. More detailed information on this can be found in the [Operating Handbook], in the documentation [User Programming].

The documentation [ArcTechDigital - Configuration] contains detailed information for the user group “Expert” on the procedures for assigning parameters and names and for declaring signals.

The meaning of the symbols, icons and particular font styles is explained in the chapter [About this documentation].

It is assumed that the robot system is prepared for production operation and that the technology package is loaded. Information on this can be found in the documentation [Start-up].

1.1 System requirements, Installation

The Software ArcTechDigital can be used with the following KRC-Software:

- **KR C2**
- Software Rel. **5.2, 5.3, 5.4, 5.5**

From system software version 5.1 onwards, technology packages are offered exclusively as ad-on software modules. These are available on CD-ROM.

The installation, uninstallation, reinstallation and update of technology packages are described in detail in the documentation [Installation/Uninstallation/Update of Tech Packages].

1.2 Software settings at a glance

An overview of the important software settings for the configuration of the ArcTechDigital technology package.

Unless otherwise stated, settings and changes to the variable values only become active after the system is restarted. The following procedure is carried out:

- When configuration is complete, save the data on the hard disk.
- Once the data have been saved, shut the system down.
- Restart the system.

1.3 General information

An initialization command and three program commands, which are used to control the welding equipment, are basically available for gas metal-arc welding involving power sources with program number control.

These are:

- **INI**

This initialization command is automatically entered at the beginning of the skeleton program when a new program is created. This sets the basic parameters for the robot and the application program and initializes the welding and motion commands and approximate positioning. The parameters can only be changed by the user group “Expert”.

- **ARC ON**

The command “ARC ON” contains the parameters for moving the welding torch (type of motion, velocity, etc.) from the home position to the start point of the seam, the start delay and the program number for the power source. “ARC ON” ends after ignition has been successfully completed.

- **ARC OFF**

The welding command “ARC OFF” contains the motion parameters (LIN or CIRC), the program number for the power source, the welding velocity and, if applicable, the mechanical weave pattern and the end parameters for the seam, or for the last section of the seam if it is divided into several sections.

“ARC OFF” ends the welding process by filling the crater and – subject to the setting of the external welding controller – burning back excess wire, so that the correct free wire length and wire form are available for the ignition process at the start of the next seam.

- **ARC SWITCH**

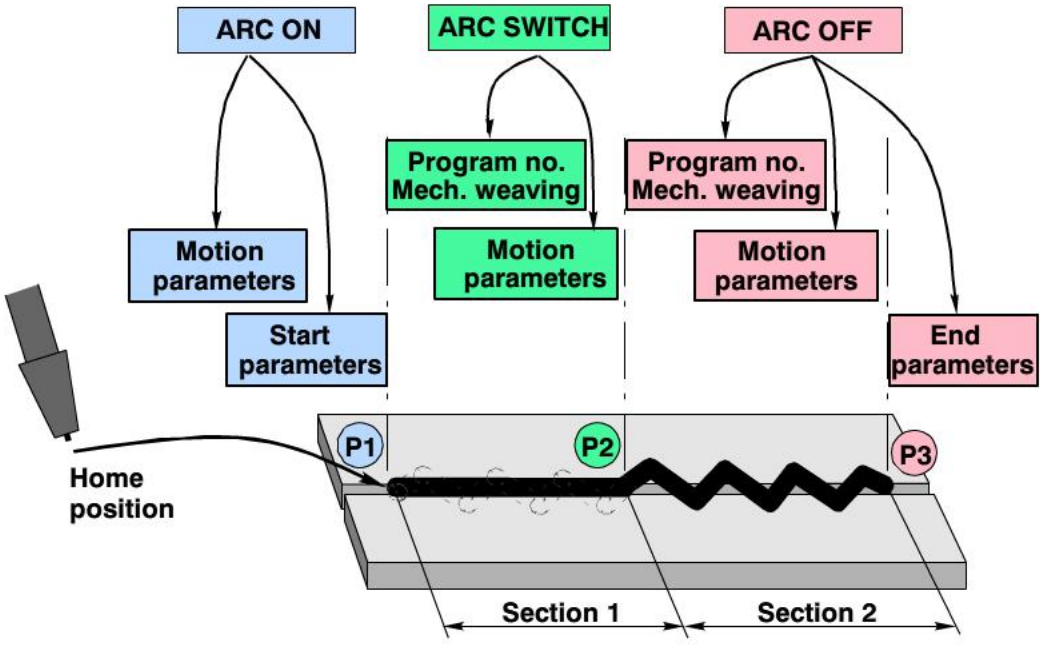
The command “ARC SWITCH” is used where the seam is divided into several sections. It contains the motion parameters (type of motion and welding velocity) and the program number (including mechanical weaving) for the current section of the seam.

A command belonging to the “Motion” group is used for moving the welding torch, e.g. from the end of a seam (ARC OFF) to the home position of a following “ARC ON” command, and for reorientating it.

Detailed information on motion programming can be found in the [Operating Handbook], in the chapter “User Programming”.

1.4 Program structure

The structure of the “ArcTechDigital” – commands is illustrated in the following sketch by means of a simple example. You can see how the motion and welding commands and the start and end parameters are assigned to the individual sections of the seam.



2 The graphic user interface of the KUKA Control Panel (KCP)

This section is intended to familiarize you with the graphic user interface of the KUKA Control Panel (KCP), in particular with the possibilities offered by it in the framework of ARC Tech programming.

A basic description of the graphic user interface can be found in the [Operating Handbook], in the chapter “Operator Control”. The creation and selection of a program that is to be altered is described in the [Operating Handbook], in the chapter “User Programming].

2.1 Function of the menu keys

The configuration menu allows part of both the left status key bar and the softkey bar to be assigned specific arc welding functions by means of the menu item “Status keys”. A graphic user interface optimized for the current application is thus available for the purpose of entering program commands and function calls.

2.1.1 Controlling welding (HOT/COLD) and the “dry run” (DRY)

The two status keys “HOT/COLD” and “DRY” have a toggle function with reciprocal lockout. It is not possible to switch directly from “HOT” (Welding on) to “DRY” and vice versa.

The screenshot on the left shows the status “Welding and DRY switched off”, which is recognizable by the fact that each of the welding torch icons is struck through. In this position, only the motions of a welding program can be executed; **there is no welding**.

The status key “HOT/COLD” must always be switched on (HOT) for welding.

This status key can also be used for manually switching between “HOT” (welding) and “COLD” (robot motion only), so-called “flying” on/off.

When the status key “DRY” is switched on, the robot moves at a higher velocity (in accordance with the default setting in $CONFIG.DAT). In this instance, the welding process, the wire feed and the shielding gas are switched off and any mechanical weaving that has been programmed is not executed.

2.2 Key functions

A range of "softkeys" is available for operating the robot and entering commands. The distinction is made between menu keys, softkeys and status keys. The functions of the ArcTechigital – specific keys are described below.

2.2.1 Function of the menu key "Technology"

After pressing the menu key "Technology", the following menu is displayed:

After selection of the menu item "ARC Tech 20" (ArcTechDigital) a further pulldown menu for selecting the type of motion is opened:

- "PTP", "LIN" or "CIRC" for the welding command "ARC ON",
- "LIN" or "CIRC" for the welding commands "ARC SWITCH" and "ARC OFF".

In the following example "ARC ON, PTP" has been selected.

After pressing the Enter key, an inline form is opened in the programming window:

If the programming window is active (in focus), the input boxes can be selected by means of the cursor keys. The selected box appears in white lettering on a blue background. The functions of the individual boxes are described in Section 3.

The cursor keys have the following functions here:

↑ The cursor moves one *box* to the *left*
↓ The cursor moves one *box* to the *right*
← The cursor moves one *character* to the *left*
→ The cursor moves one *character* to the *right*

The softkey bar has the following assignment:

The function of these softkeys is as follows:

It is possible to abort programming at any time by means of the softkey "Cmd Abort". In this case, none of the data are saved and the inline form is closed.

Pressing this softkey changes the type of motion, PTP, LIN or CIRC.

It is possible to change the selected welding command by means of the softkeys "ARC SWI" and "ARC OFF" in this case.

The current robot coordinates are saved by pressing the softkey "Touch Up".

Save the data and close the form by pressing the softkey "Cmd Ok". The newly created command line appears in the program list.

3 Programming and operation

This section describes how to create new programs and how to program welding and motion commands. It also contains information on everything that has to be taken into account when setting individual parameters.

3.1 General information

To ensure satisfactory operation, the “ArcTechDigital” package must be configured appropriately.

The documentation [ArcTechDigital – Configuration] contains detailed information for the user group “Expert” on the procedures for assigning parameters and names and for declaring signals.

Only alter variables if you have adequate knowledge of the function, and of the possible consequences!

3.2 Start welding (ARC ON)

3.2.1 General information

The command “ARC ON” contains the parameters for moving the welding torch (type of motion, velocity, etc.) from the home position to the start point of the seam, the program number for the power source and the parameters for the start delay.

3.2.2 Types of motion

The robot can be moved from the home position to the start point of the seam using PTP, LIN or CIRC motions. Approximate positioning is not possible; the robot is exactly positioned to each point.

3.2.2.1 Point-to-point (PTP) motions

PTP (point-to-point) motions offer the quickest way of moving the robot to the end position and are thus the most efficient.

The path cannot be predicted exactly for PTP motions. The motion characteristics of the robot near obstacles should therefore be checked in a test run.

3.2.2.2 Motion along a straight line (LIN)

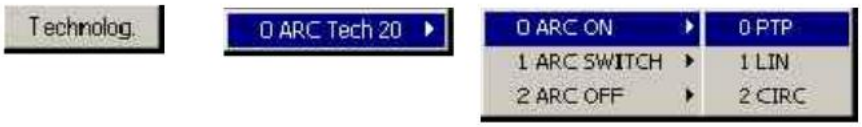
LIN (linear) motions are used whenever the robot has to follow an exact path to the end point (the start of the seam in this case).

3.2.2.3 Motion along a circular path (CIRC)

In the case of CIRC motions, the welding torch is moved along a circular path. This type of motion is useful for the command “ARC ON” if the welding torch cannot be positioned to the end point using a linear motion.

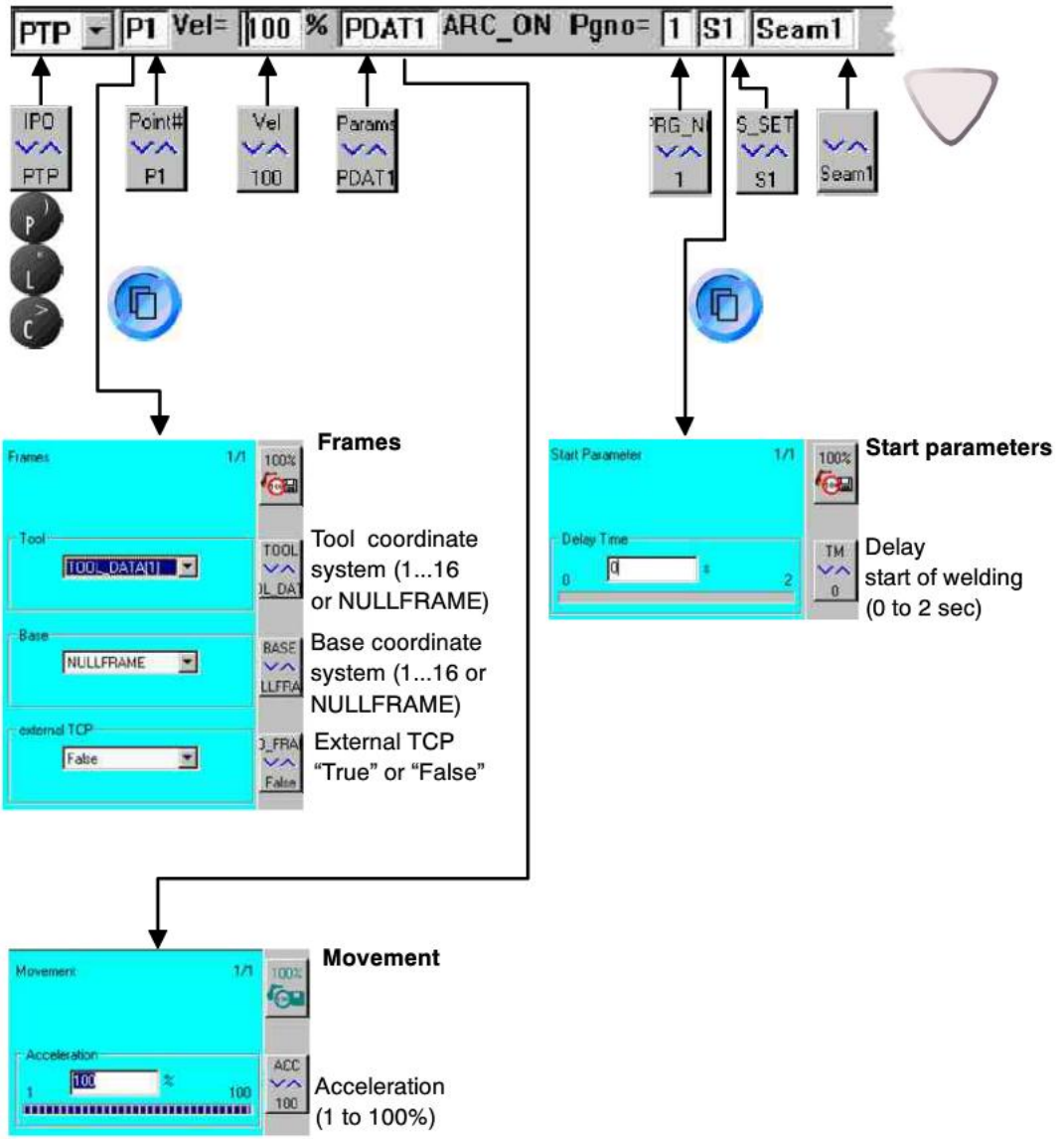
3.2.3 Programming the start of the welding (ARC ON)

3.2.3.1 Menu



After selecting the relevant option by means of the menu key “Technology” (“ARC ON - PTP” in this example), the inline form described in the next section is opened.

3.2.3.2 Inline form and parameter lists for the command “ARC ON”, “PTP”



Cmd Abort	LIN/CIRC	ARC SWI	ARC OFF		Touch Up	Cmd Ok

Softkey bar when the inline form is active

Cmd Abort					Command	Cmd Ok

Softkey bar when a parameter list is active

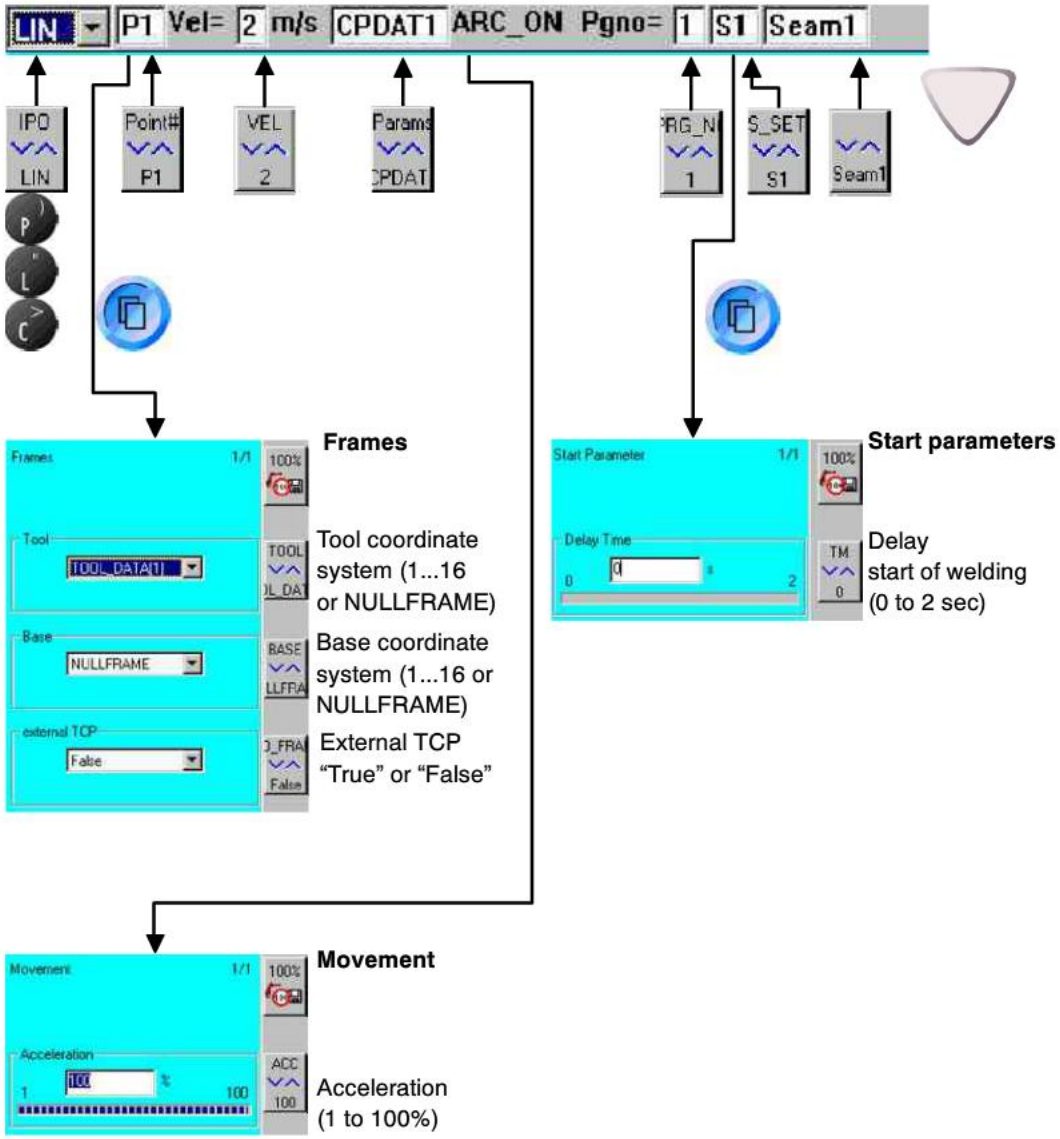
Brief description of the input boxes of the inline form (from left to right), their functions and their range of values where applicable:

Box	Function	Range of values, Comments
PTP	Type of motion	Change using bottom right status key, softkey bar or keypad.
P1	Designation of the end point (teach using softkey “Touch Up”)	Freely selectable.
Vel =100%	Path velocity	1 to 100% of the maximum value (default setting: 100%) Change by entering a value by means of the numeric keypad or the bottom right status key.
PDAT1	Designation of the motion parameters	Freely selectable.
Pgno=1	Program number	Freely selectable.
S1	Designation of the start parameters	Freely selectable.
Seam 1	Comment	Freely selectable.

3.2.3.3 Inline form and parameter lists for the command “ARC ON”, “LIN”

Technology

After selecting the command “ArcTechDigital” – “ARC ON – LIN”, the inline form shown below is opened.



Cmd Abort	CIRC/PTP	ARC SWI	ARC OFF		Touch Up	Cmd Ok

Softkey bar when the inline form is active

Cmd Abort					Command	Cmd Ok

Softkey bar when a parameter list is active

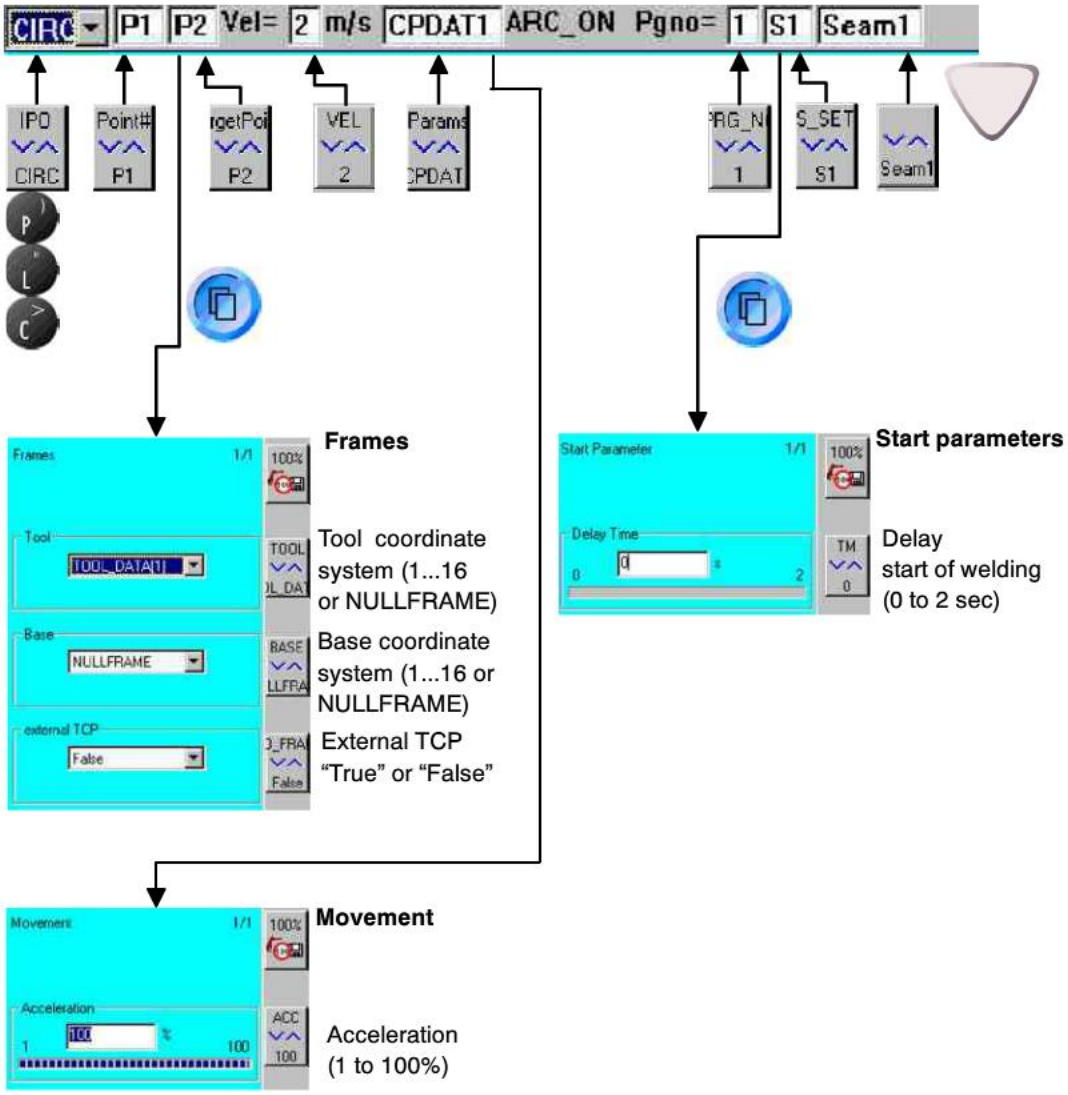
Brief description of the input boxes of the inline form (from left to right), their functions and their range of values where applicable:

Box	Function	Range of values, Comments
LIN	Type of motion	Change using bottom right status key, softkey bar or keypad.
P1	Designation of the end point (teach using softkey “Touch Up”)	Freely selectable. Change the designation P*n* by using the keypad or the bottom right status key.
Vel =2 m/s	Path velocity	0.001 to 2 m/s (default setting: 2 m/s) Change by entering a value by means of the numeric keypad or the bottom right status key.
CPDAT1	Designation of the motion parameters	Freely selectable.
Pgno=1	Program number	Freely selectable.
S1	Designation of the start parameters	Freely selectable.
Seam 1	Comment	Freely selectable.

3.2.3.4 Inline form and parameter lists for the command “ARC ON”, “CIRC”

Technology

After selecting the command “ARC ON – CIRC”, the inline form shown below is opened.



Softkey bar when the inline form is active

Softkey bar when a parameter list is active

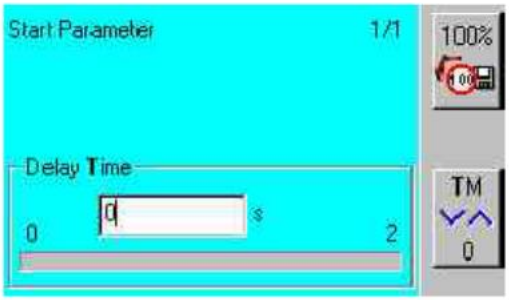
Brief description of the input boxes of the inline form (from left to right), their functions and their range of values where applicable:

Box	Function	Range of values, Comments
CIRC	Type of motion	Change using bottom right status key, softkey bar or keypad.
P1	Designation of the auxiliary point (teach using softkey “Teach Aux”)	Freely selectable. Change the designation by using the keypad or the bottom right status key.
P2	Designation of the end point (teach using softkey “Teach End”)	Freely selectable. Change the designation by using the keypad or the bottom right status key.

For information on the other parameters, see Section 3.2.3.3. Detailed information on motion programming can be found in the [Programming Handbook], in the chapter [Motion programming].

3.2.3.5 Parameter list for start parameters

The values for the start time and the parameters for mechanical weaving are defined in the parameter list “Start Parameter”.



Start parameters

Delay start of welding
0 to 2 seconds

3.3 Welding and ending a seam (ARC OFF)

3.3.1 General information

The welding command “ARC OFF” contains the motion parameters (LIN or CIRC), the program number for the power source, the weld velocity and, if applicable, the mechanical weave pattern for

- the seam from after welding has been successfully started (ARC ON) up to the end of the seam, provided that the same motion and weld parameters are used for the entire seam,
- the last section of the seam from an “ARC SWITCH” command up to the end of the seam when the seam is divided into several sections with different movement and/or weld parameters,

and the parameters for crater filling.

3.3.2 Types of motion for the command “ARC OFF”

Two types of motion can be selected for the command “ARC OFF”:

“LIN” – linear motion – and “CIRC” – motion along a circular path. Approximate positioning is not possible; the robot is exactly positioned to each point.

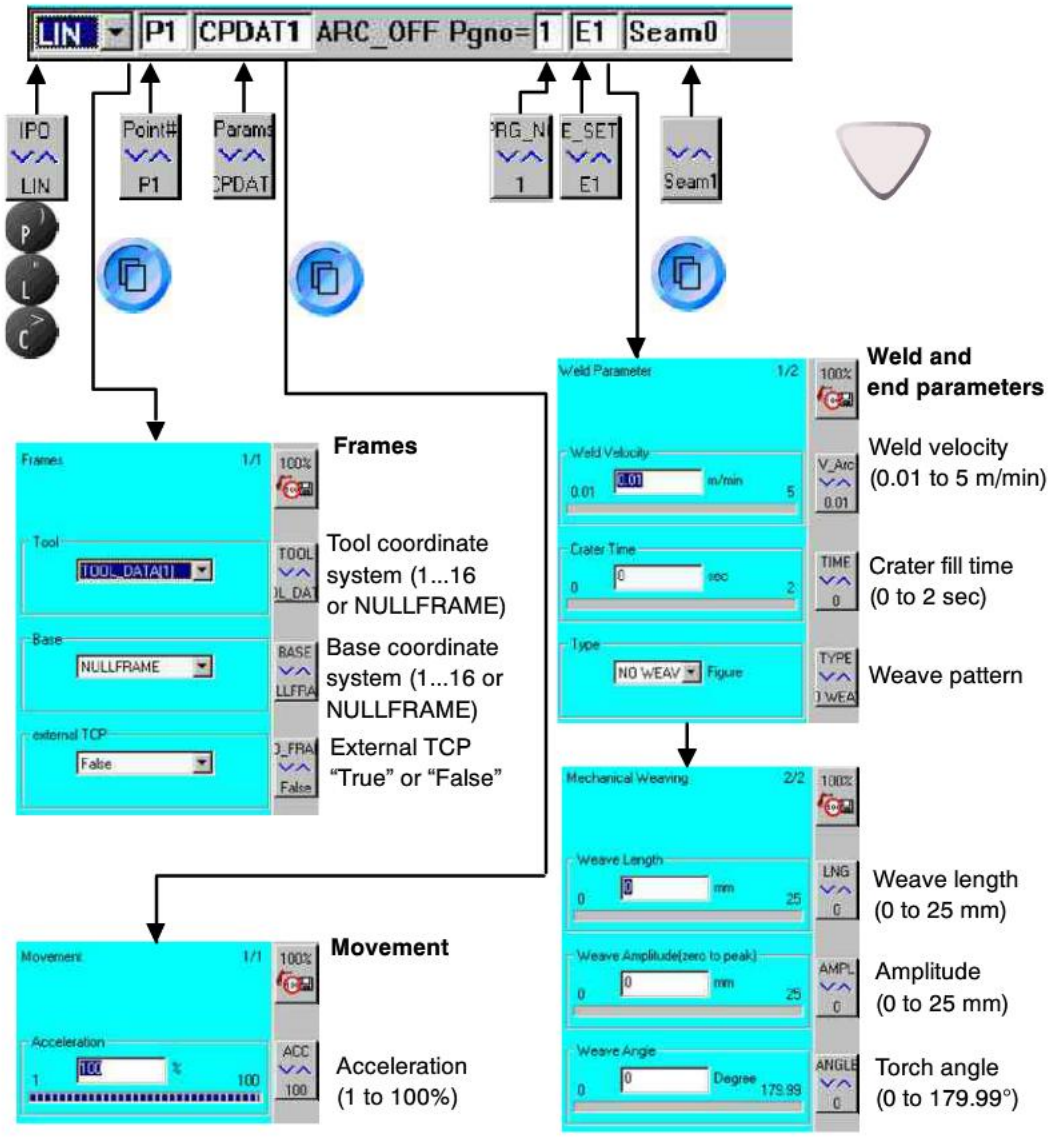
3.3.3 Programming “ARC OFF”

3.3.3.1 Menu

After selecting the relevant option by means of the menu key “Technology” (ArcTechDigital © – ARC OFF – LIN in this example), the inline form described in the next section is opened.

If the status key option “ARC Tech” has been selected in the “Configure” menu, the key “ARC OFF” is available in the softkey bar. Selecting this option also opens the inline form. Please note that in this case the type of motion that is displayed corresponds to the setting for the last command. The desired motion type (“LIN” or “CIRC”) can be selected by means of an additional softkey or in the inline form.

3.3.3.2 Inline form and parameter lists for the command “ARC OFF”, “LIN”



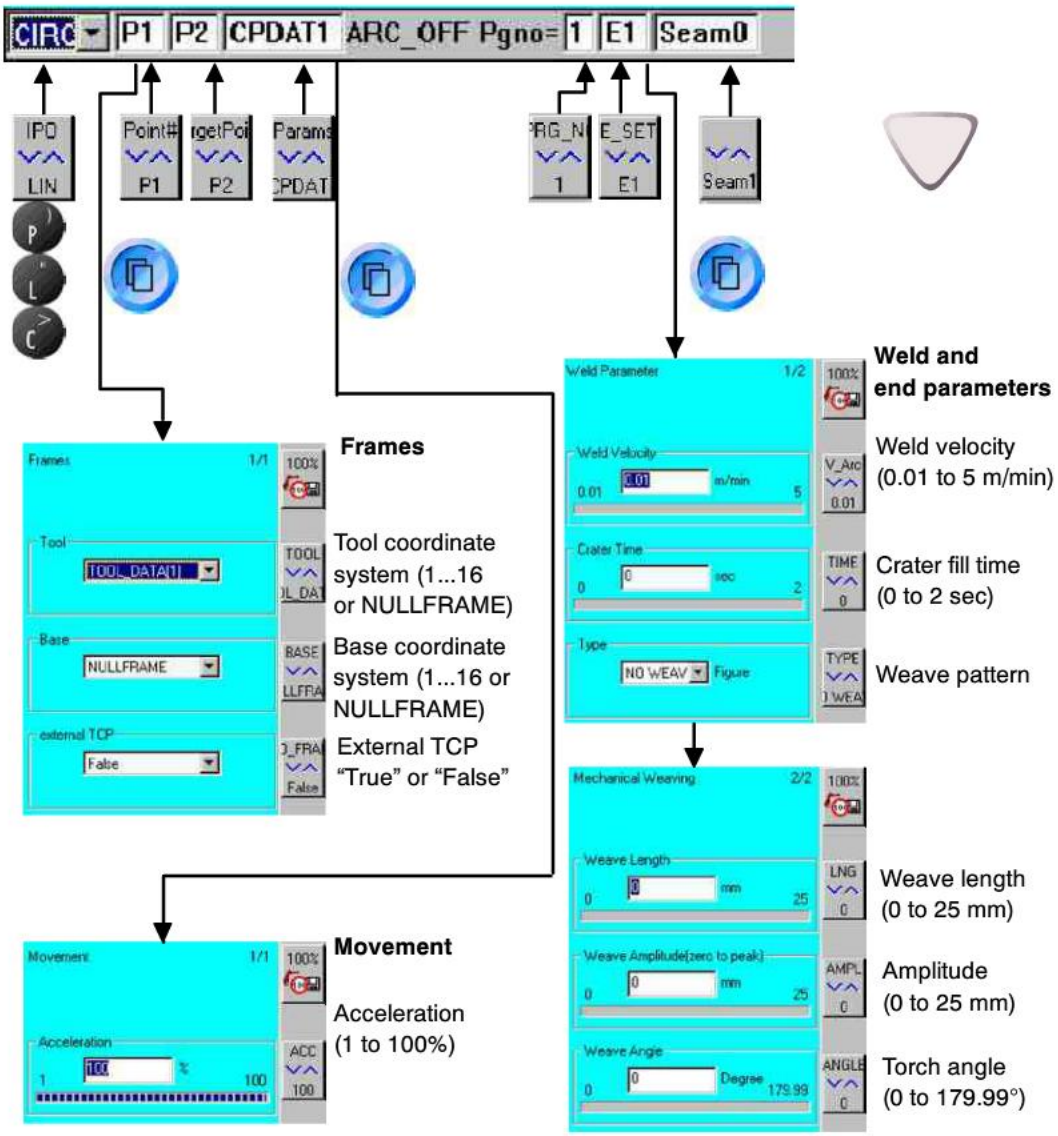
Brief description of the input boxes of the inline form (from left to right), their functions and their range of values where applicable:

Box	Function	Range of values, Comments
LIN	Type of motion	Change using bottom right status key, softkey bar or keypad.
P1	Designation of the end point (teach using softkey “Touch Up”)	Freely selectable. Change the designation by using the keypad or the bottom right status key.
CPDAT1	Designation of the movement parameters	Freely selectable.
Pgno=1	Program number	Freely selectable.
E1	Designation of the end parameters	Freely selectable.
Seam0	Comment	Freely selectable.

3.3.3.3 Inline form and parameter lists for the command “ARC OFF”, “CIRC”

ARC OFF

After selecting the command “ARC OFF - CIRC”, the inline form given below is opened.



Brief description of the input boxes of the inline form (from left to right), their functions and their range of values where applicable:

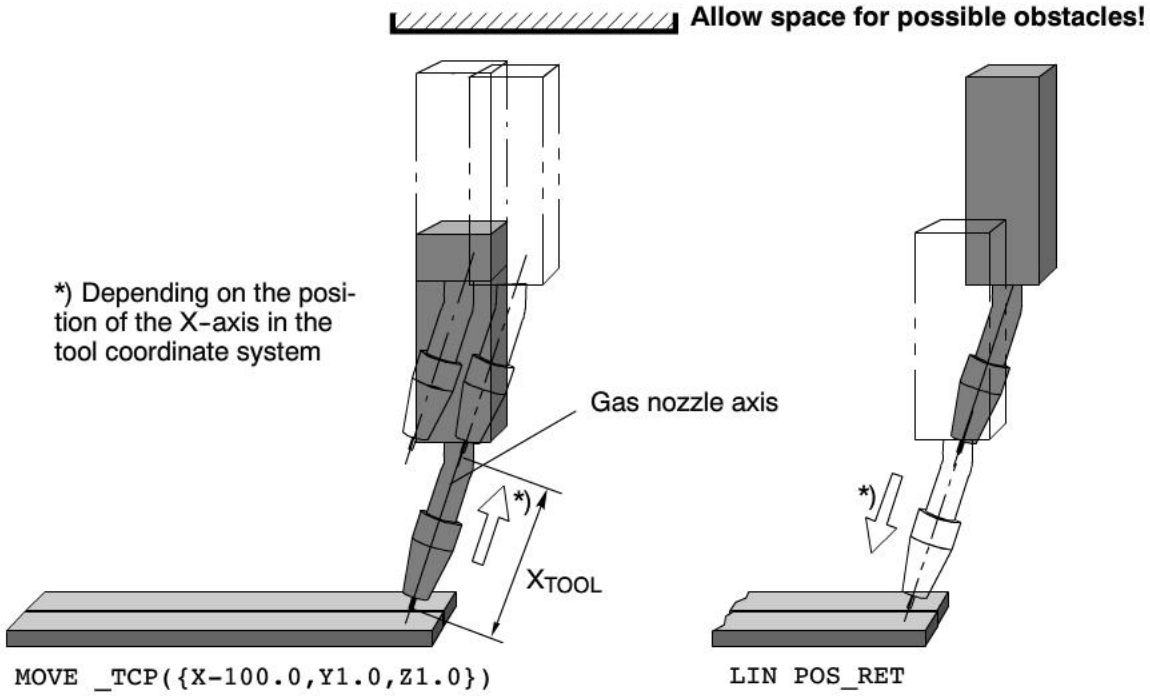
Box	Function	Range of values, Comments
CIRC	Type of motion	Change using bottom right status key, softkey bar or keypad.
P1	Designation of the auxiliary point (teach using softkey “Teach Aux”)	Freely selectable. Change the designation by using the keypad or the bottom right status key.
P2	Designation of the endpoint (teach using softkey “Teach End”)	Freely selectable. Change the designation by using the keypad or the bottom right status key.
CPDAT1	Designation of the movement parameters	Freely selectable.
Pgno=1	Program number	Freely selectable.
E1	Designation of the end parameters	Freely selectable.
Seam0	Comment	Freely selectable.

Detailed information on motion programming can be found in the [Programming Handbook], in the chapter “Motion programming”.

3.4 Mecanical weaving

3.4.1 Tool calibration

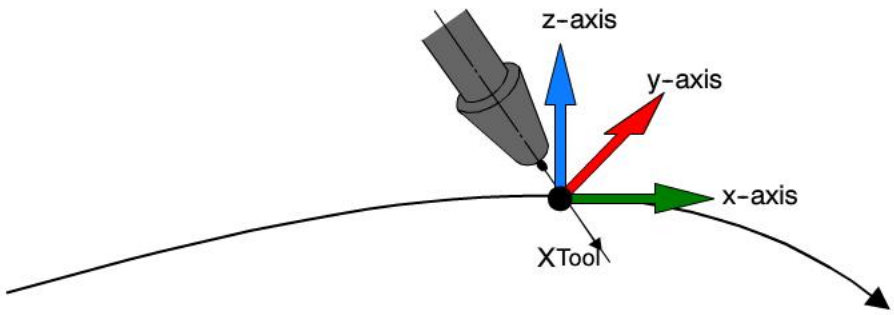
It is recommended that the tool is calibrated 6-dimensionally. The X-axis of the tool coordinate system (TOOL) must be aligned with the direction of the torch. In the case of short torches this means that X_{Tool} is located directly in the gas nozzle.



3.4.2 The coordinate system “TTS” (tool-based technological system)

The tool-based moving frame or TTS (tool-based technological system) is defined as follows:

X-axis	Unit vector in direction of path tangent.
Y-axis	Unit vector in direction of vector product of path tangent and x axis of tool coordinate system.
Z-axis	Unit vector in direction of vector product of path tangent and y axis.

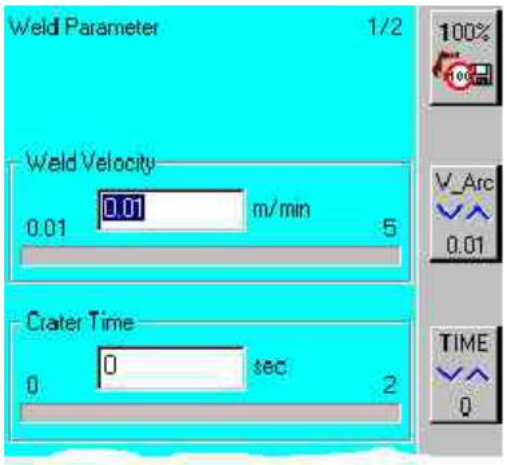


The tool-based moving frame or TTS (toolbased technological system)

The TTS is calculated every time a CP motion is executed. If the X-axis of the tool coordinate system and the path tangent are parallel, the TTS cannot be generated. This triggers dynamic braking and the error message “TTS NOT EXISTING”.

In this case, a corresponding reorientation of the tool is required as well as reprogramming of the motion.

3.4.2.1 Weld velocity, crater time



Weld and end parameters, page 1

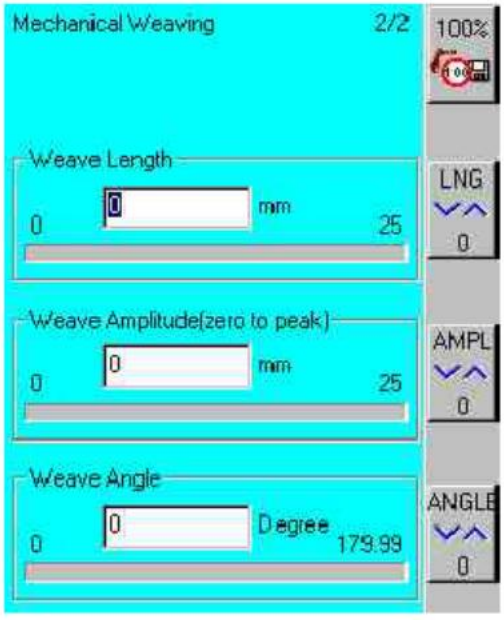
Weld velocity
0.01 to 5 m/min

Crater fill time
0 to 2 sec

Further information on crater filling is contained in the documentation [ArcTechDigital – Configuration].

Weld and end parameters, page 1

Weave pattern
No weaving,
7 patterns as shown in table,
1 freely definable pattern



Weld and end parameters, page 2
(mechanical weaving)

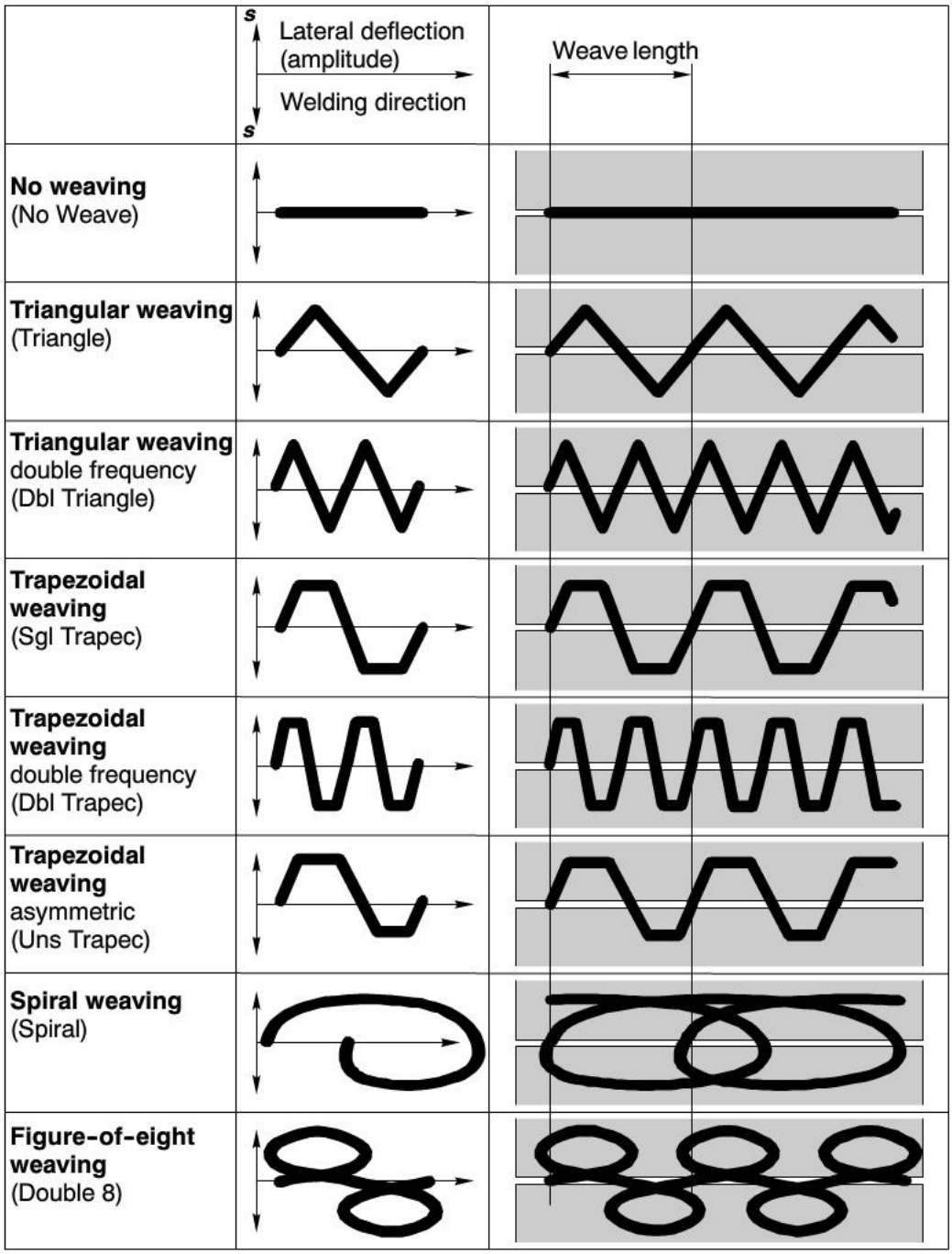
Weave length
0 to 25 mm

Lateral deflection
Half the total weave width, from peak to zero.
0 to 25 mm

Torch angle
0 to 179.99 degrees

Mechanical weaving is used, for example, to compensate for tolerances or to bridge gaps in a seam. The torch moves across the seam in this instance and the weave oscillation is thus superposed on the seam motion. It is also possible to rotate the torch in relation to the plane of the weld (direction of welding).

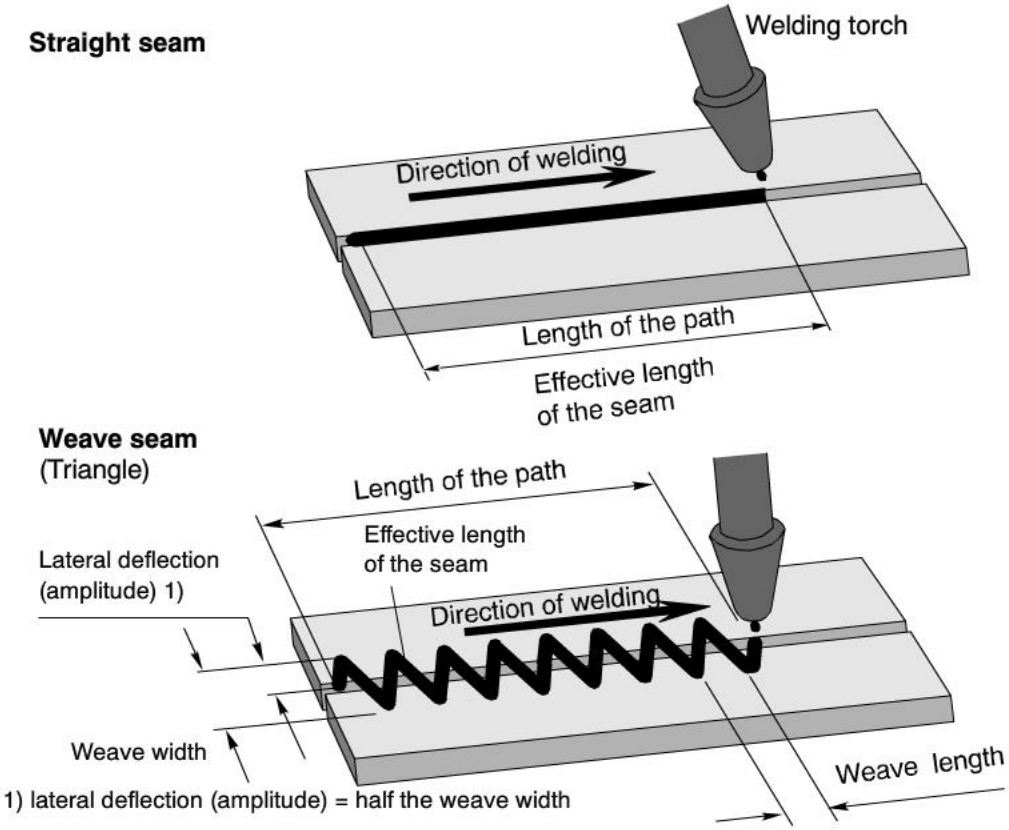
Seven weave patterns are predefined by the manufacturer:



The lateral deflection (amplitude), the weave length (the length over which a pattern is executed) and the angle of the torch to the welding plane can be set for each weave pattern.

In the user group “Expert”, one further weave pattern with the name “Usr_define” can be defined in the file “WEAV DEF.SRC” and existing patterns can be modified. Information on this can be found in the documentation [ArcTechDigital – Configuration].

With mechanical weaving - depending on the weave amplitude and weave length - the effective weld velocity is greater than the travel speed.



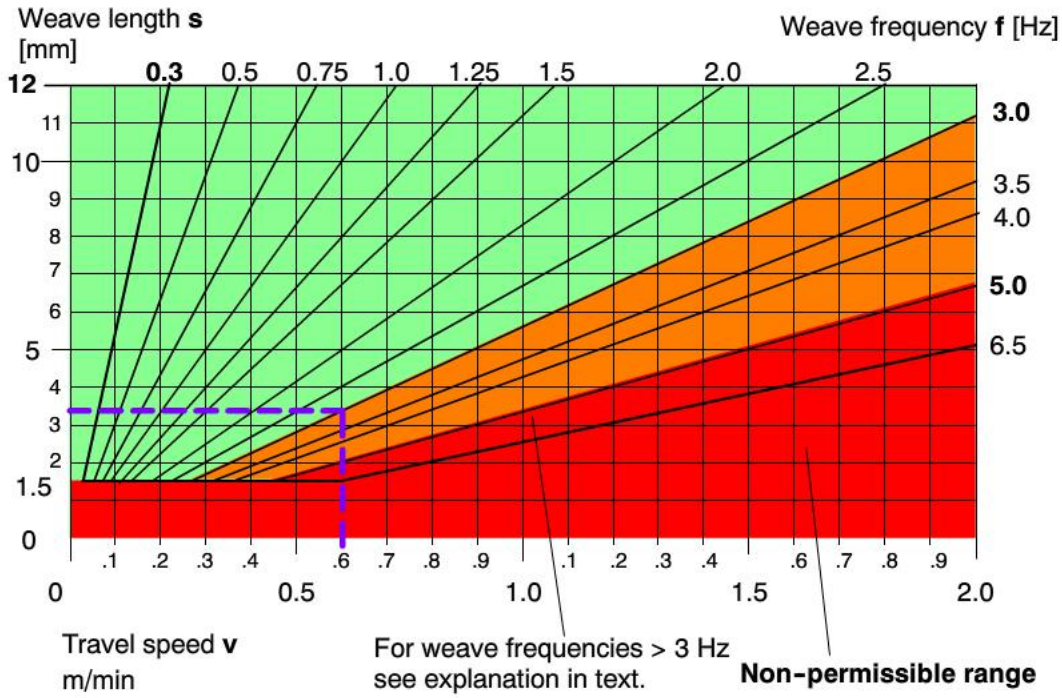
Trapezoidal, spiral and figure-of-eight weave patterns also result in a non-uniform effective weld velocity. This can vary between the set path velocity and a multiple of it during one period, depending on the relation of the lateral deflection (amplitude) to the weave length.

3.4.3 Weave frequency, weave length, path velocity

Of significance for the correct functioning of the robot is the **weave frequency**, which results from the programmed **path velocity** (travel speed) and **weave length**. The following relationships exist between these parameters:

Weave frequency **f**	$= \frac{\text{travel speed [m/min]} \bullet 1000}{\text{weave length [mm]} \bullet 60}$	[Hz]
Weave length **s**	$= \frac{\text{travel speed [m/min]} \bullet 1000}{\text{weave frequency [Hz]} \bullet 60}$	[mm]
Travel speed **v**	$= \frac{\text{weave frequency [Hz]} \bullet \text{weave length [mm]} \bullet 60}{1000}$	[m/min]

These relationships are depicted graphically in the following nomogram.



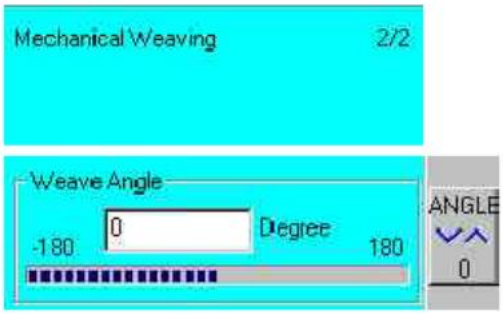
The maximum weave frequency for mechanical weaving is influenced by several factors, depending on the robot type concerned, for example by the resonant frequency of the "robot/tool" unit. Weave frequencies of up to 3 Hz (corresponding, for example, to a weave length of 3.33 mm at a travel speed of 0.6 m/min) are considered safe according to previous experience.

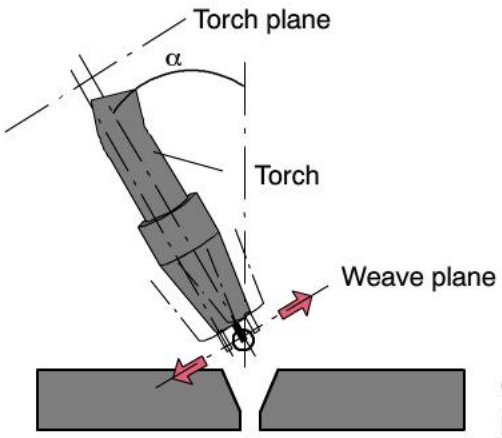
With higher frequencies, undesirable effects are liable to result in certain conditions (depending on the tool design and/or tool orientation). With weave frequencies > 3 Hz, the motion characteristics of the robot should therefore be individually tested in each case.

Further information on mechanical weaving can be found in the documentation [ARC Tech 10 © - Configuration].

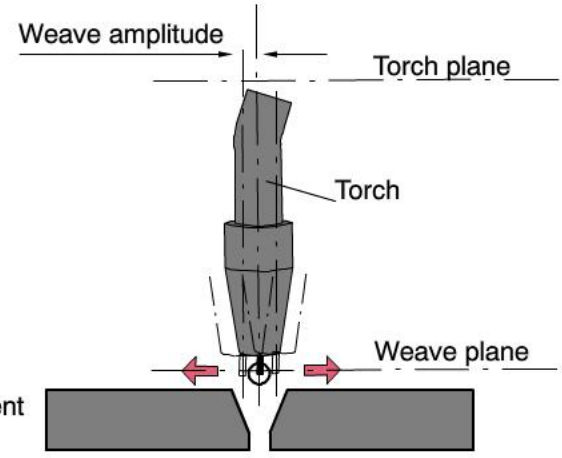
3.4.4 Rotation of the weave plane

In certain applications, it may be necessary to rotate the weave plane. The range of possible settings is -180 to +180 degrees.

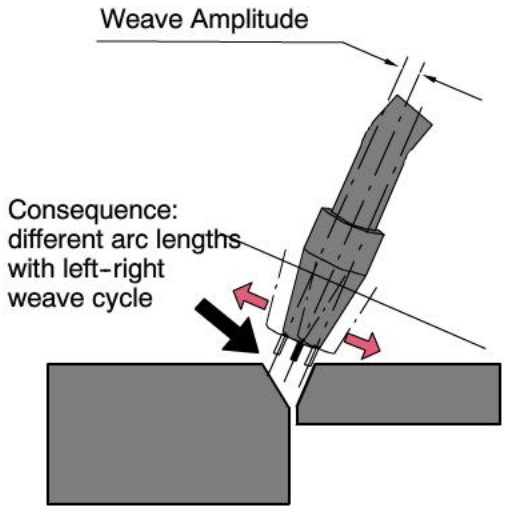




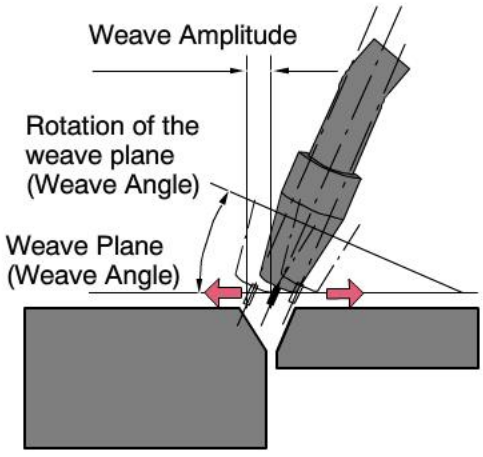
Weave plane α degrees



Weave plane 0 degrees



Weave Plane (Weave Angle) not rotated



Weave Plane (Weave Angle) rotated in component plane

In certain applications, the welding result can be specifically influenced by rotating the weave plane. This requires appropriate tests to be carried out beforehand, however.

3.5 Welding several seam sections - “ARC SWITCH”

3.5.1 General information

The command “ARC SWITCH” is used between the commands “ARC ON” and “ARC OFF” when the seam is divided into several sections with different motion and/or weld parameters.

It contains the motion parameters for the current section of the seam, the program number and parameters for mechanical weaving.

3.5.2 Types of motion for the command “ARC SWITCH”

Two types of motion can be selected for the command “ARC SWITCH”:

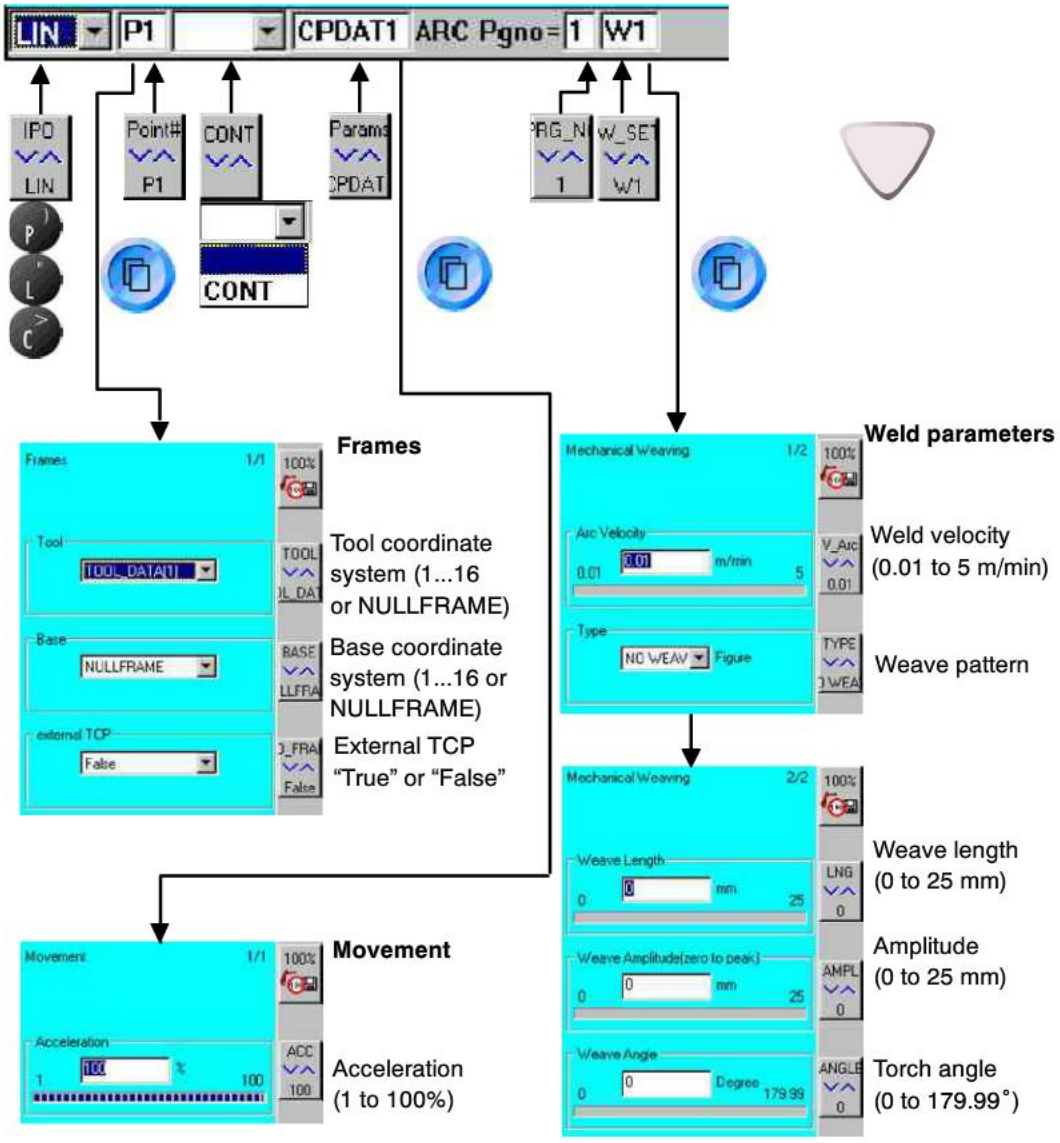
“LIN” - linear motion - and “CIRC” - motion along a circular path. While the robot is always exactly positioned in the case of “ARC ON” and “ARC OFF”, approximate positioning is possible with “ARC SWITCH”.

3.5.3 Programming “ARC SWITCH”

3.5.3.1 Menu

After selecting the relevant option by means of the menu key “Technology” (“ARC Tech 20” - “ARC SWITCH” - “LIN” in this example), the inline form described in the next section is opened.

3.5.3.2 Inline form and parameter lists for the command “ARC SWITCH”, “LIN”



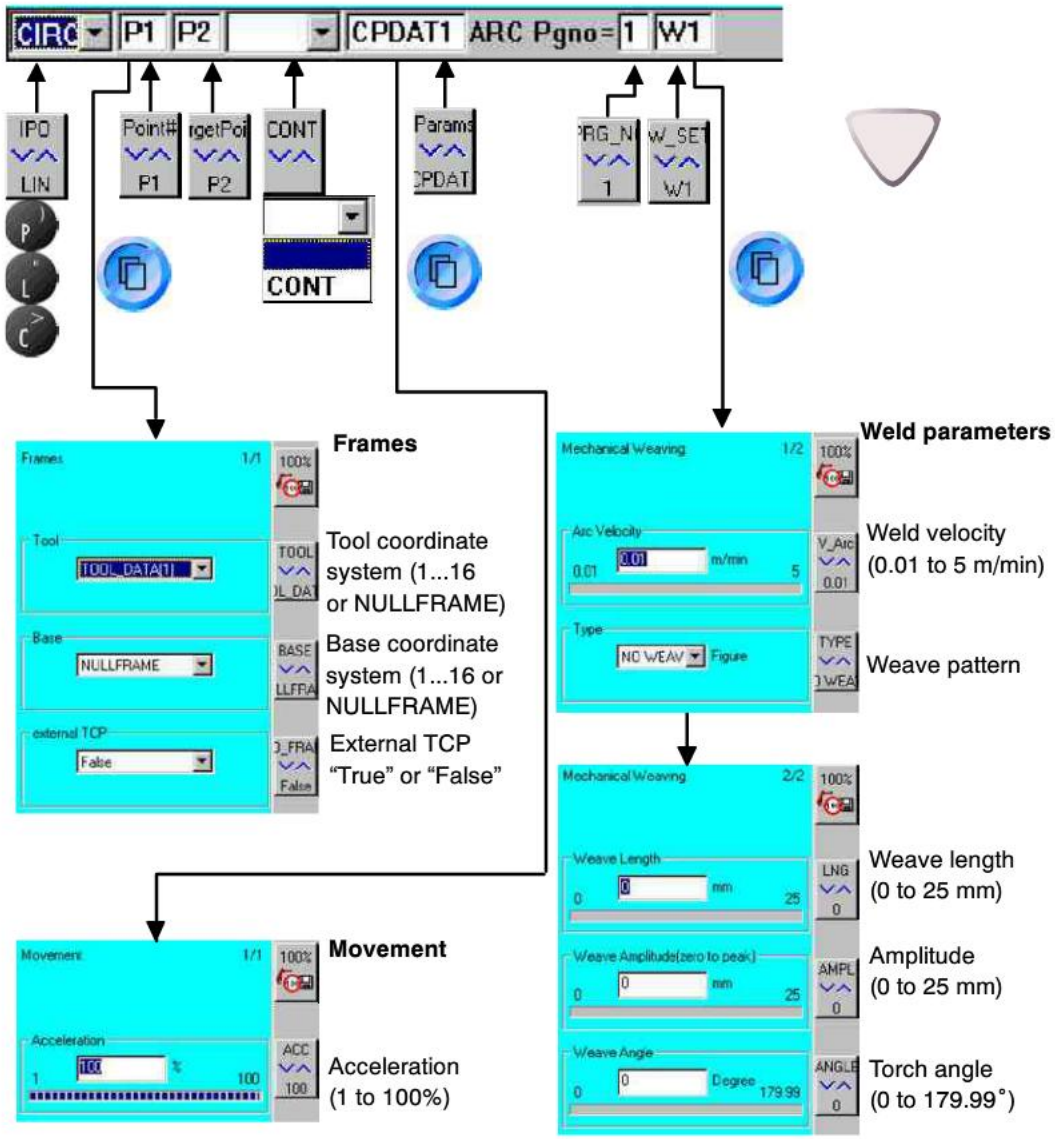
Brief description of the input boxes of the inline form (from left to right), their functions and their range of values where applicable:

Box	Function	Range of values, Comments
LIN	Type of motion	Change using bottom right status key, softkey bar or keypad.
P1	Designation of the end point (teach using softkey “Touch Up”)	Freely selectable. Change the designation by using the keypad or the bottom right status key.
CONT	Approximate positioning	Freely selectable.
CPDAT1	Designation of the motion parameters	Freely selectable.
Pgno=1	Program number	Freely selectable.
W1	Designation for the parameters “Mechanical weaving”	Freely selectable.

3.5.3.3 Inline form and parameter lists for the command “ARC SWITCH”, “CIRC”

Technology

After selecting the command “ARC ON – CIRC”, the inline form given below is opened.



Brief description of the input boxes of the inline form (from left to right), their functions and their range of values where applicable:

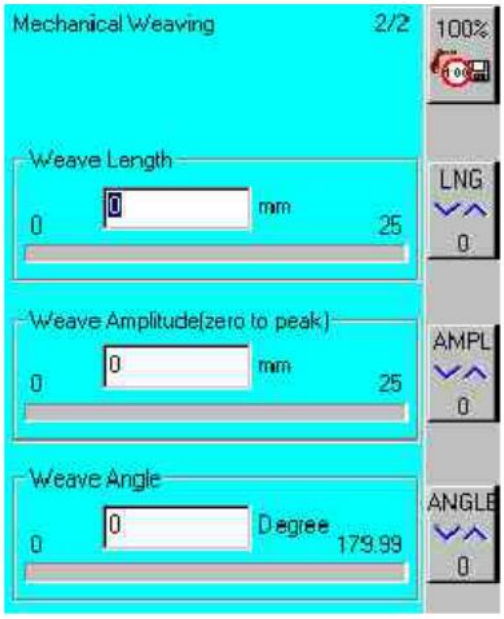
Box	Function	Range of values, Comments
CIRC	Type of motion	Change using bottom right status key, softkey bar or keypad.
P1	Designation of the auxiliary point (teach using softkey “Teach Aux”)	Freely selectable (see Section LEERER MERKER). Change the designation by using the keypad or the bottom right status key.
P2	Designation of the end point (teach using softkey “Teach End”)	Freely selectable (see Section LEERER MERKER). Change the designation by using the keypad or the bottom right status key.
CONT	Approximate positioning	No entry = with exact positioning CONT = with approximate positioning
CPDAT1	Designation of the motion parameters	Freely selectable (see Section LEERER MERKER)
Pgno=1	Program number	Freely selectable (see Section LEERER MERKER)
W1	Designation for the parameters “Mechanical weaving”	Freely selectable (see Section LEERER MERKER)

3.5.3.4 Parameter list for weld parameters (W1)

Weld parameters, page 1

Weld velocity
0.01 to 5 m/min

Weave pattern
No weaving,
7 patterns as shown in table,
1 freely definable pattern



Weld parameters, page 2
(mechanical weaving)

Weave length

0 to 25 mm

Lateral deflection
Half the total weave width, from peak to zero.

0 to 25 mm

Torch angle

0 to 179.99 degrees

Mechanical weaving (W1) is described in Section 3.4.

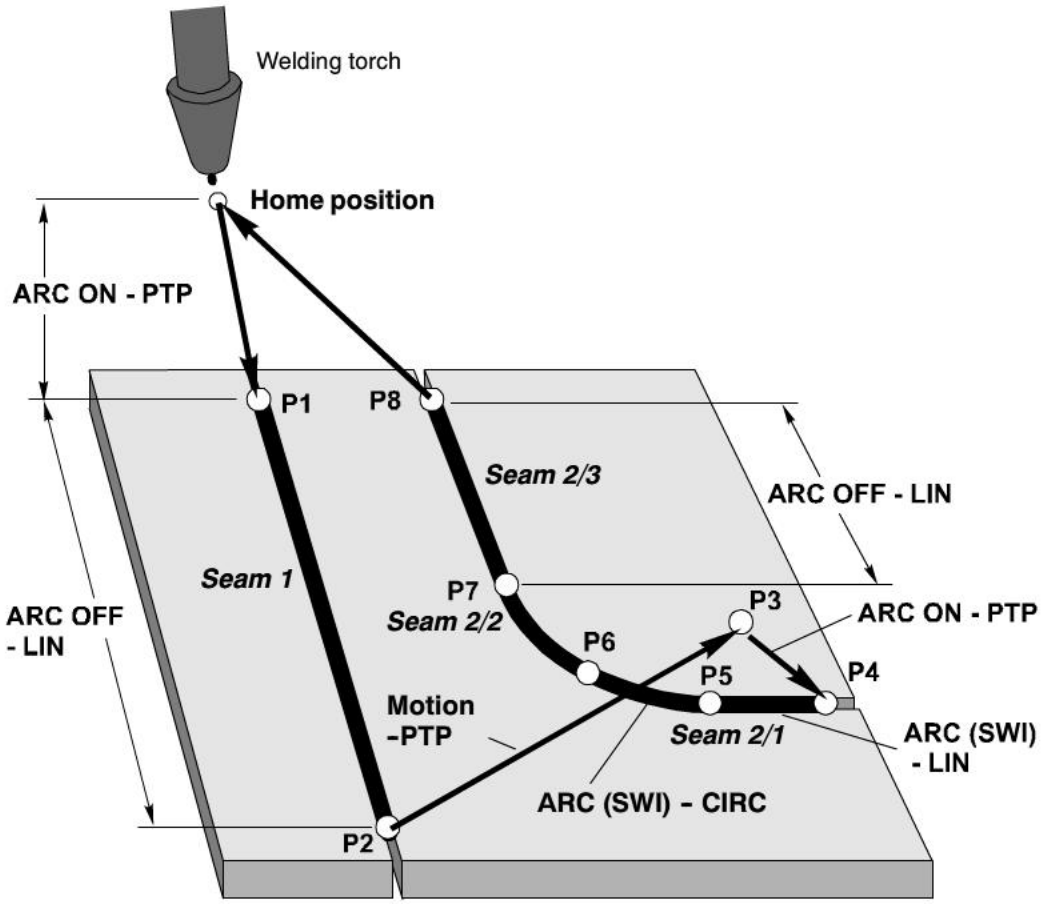
3.6 Motion commands

The command “Motion” from the menu “Commands” is used for moving the welding torch, e.g. from the end of a seam (ARC OFF) to the home position of a subsequent “ARC ON” command, and for reorientating it when necessary.

Detailed information on motion programming can be found in the [Programming Handbook], in the chapter “Motion programming”.

4 Program example

The use of the individual “ArcTechDigital” commands will now be described step by step on the basis of a simple program example. The welded assembly shown below, consisting of three individual parts, is to be fabricated by means of two seams.



4.1 Creating a new program

New

To create a new program, press the softkey “New” and enter a program name (e.g. “Test”) in the input box.

Further information on creating and altering programs can be found in the [Operating Handbook], in the chapter “Program creation”. Details on motion commands can be found in the chapter “Motion programming”, which is also to be found in the [Programming Handbook].

Select

Now press the softkey “Select”. The following skeleton program is displayed in the programming window:

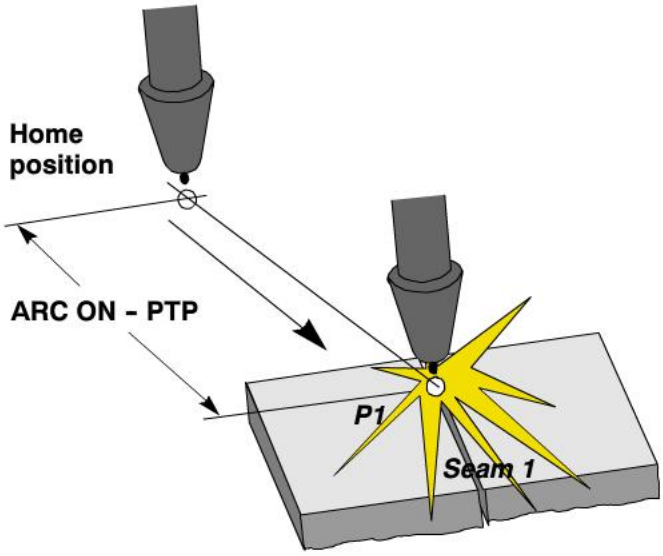
```
1  INI
2  PTP HOME  Vel= 100 % DEFAULT
3
4  PTP HOME  Vel= 100 % DEFAULT
5  END
```

Pay attention to the position of the edit cursor. The following program line created by you will be inserted as a new line after the cursor.

Edit

Alternatively, you can program in offline mode by means of the softkey “Edit”. The syntax will not be checked, however. Further information on this can be found in Section 2.3 (Selecting the edit mode).

4.1.1 Starting welding of seam 1 - “ARC ON”



Technology

Press the menu key “Technology” and select the options shown below (menu items in white lettering on a blue background):

ARC ON

This command can also be entered by means of the softkey “ARC ON” if the status key option “ARC Tech” has been selected.

After selecting the command “ARC ON - PTP”, the inline form for setting the parameters that is shown below is opened on the display.

You can also correct your original selection (ARC command/motion command, type of motion ...) by means of this softkey bar. The inline form changes accordingly when a selection is made. The softkey “Cmd Abort” can be used to abort the command without saving data.

Now enter the motion parameters, the appropriate program number (Pgno) and the start parameters (delay of weld start) into the inline form or the parameter lists. The ignition and welding parameters of the *welding controller* are defined by the program number “Pgno”. These parameters can only be changed via the welding controller.

An overview of both the inline input boxes and the parameter lists can be found in Section 3.2.3.

For the purpose of positioning the welding torch, move it to the position P1 by means of the Space Mouse or the traversing keys. Information on controlling motions of the robot manually can be found in the chapter [Manual traversing of the robot].

Touch Up

You can now press the softkey “Touch Up”. In this case, press the softkey “Yes” to confirm the message in the message window.

Alternatively, press the softkey “Cmd Ok” or the Enter key. The current robot coordinates are automatically saved.

Cmd Ok

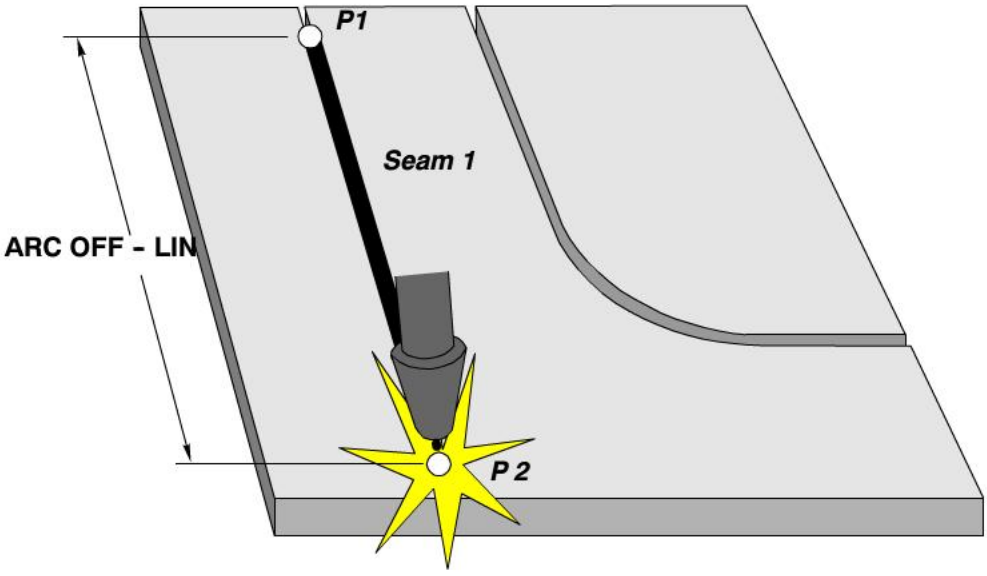
The command is ended by pressing the softkey “Cmd Ok” or the Enter key. If the point P1 has not yet been touched up, the current robot coordinates are now automatically saved. The information message “Point P1 created automatically” is displayed in the message window.

After that the inline form is closed and the generated program line is inserted into the program form. The numbers of the following program lines are automatically updated.

```
1   INI
2   PTP HOME  Vel= 100 % DEFAULT
3
4   PTP P1 Vel= 100 % PDAT1 ARC_ON  Pgno= 1 S1 Seam1
5   PTP HOME  Vel= 100 % DEFAULT
6   END
```

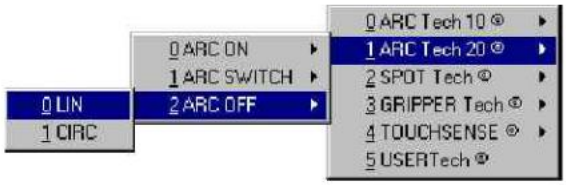
4.1.2 Ending welding of seam 1 - “ARC OFF”

As only a straight seam, with the motion and welding parameters remaining the same, is to be welded in this example, only one “ARC OFF” command is required. This command contains the motion, welding and end parameters for the seam.



After pressing the menu key “Technology”, select the options shown below:

Technology



After selecting the command “ARC OFF - LIN”, the inline form for setting the parameters that is given below is opened on the display.

Now enter the motion parameters, if necessary the program number (Pgno) and, in the parameter list “E1”, the welding velocity (Arc Velocity) and end crater parameters (Crater Time).

Overviews of both the inline input boxes and the parameter lists for the command “ARC OFF” can be found in Section 3.3.3 of this chapter.

To position the welding torch, move it to the position P2 by means of the Space Mouse or the traversing keys.

You can now save the coordinates for this point by means of the softkey “Touch Up” or you can automatically save them by pressing the softkey “Cmd Ok” or the Enter key.

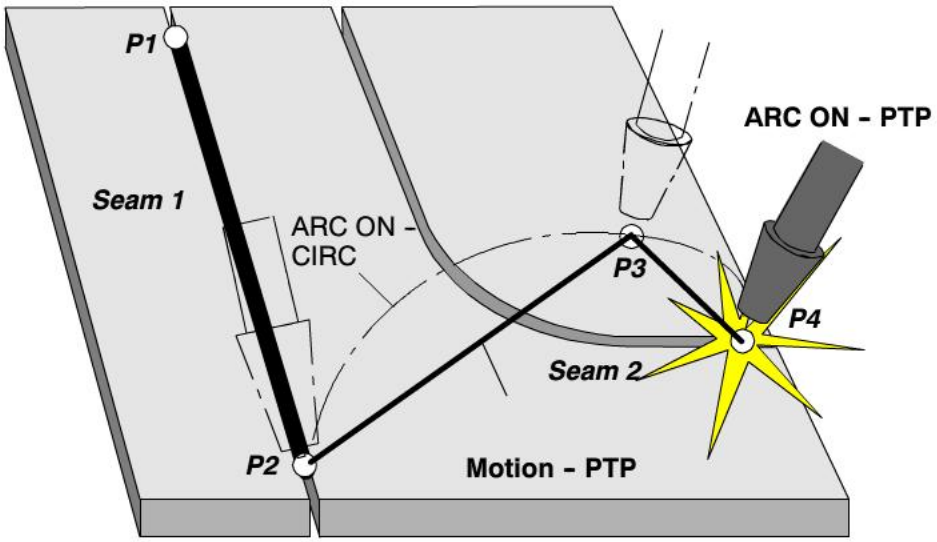
Pressing “Cmd Ok” or the Enter key closes the inline form and the created program line is inserted into the program form. The numbers of the following program lines are automatically updated.

```
1   INI
2   PTP HOME  Vel= 100 % DEFAULT
3
4   PTP P1 Vel= 100 % PDAT1 ARC_ON  Pgno= 1 S1 Seam1
5   LIN P2 CPDAT1 ARC_OFF  Pgno= 1 E1 Seam1
6   PTP HOME  Vel= 100 % DEFAULT
7   END
```

4.1.3 Moving to seam 2 (PTP) and starting welding - “ARC ON”

In order to move from the end point of seam 1 (P2) to the start point of seam 2 (P4) via the auxiliary point (P3), you can, for example, enter the command “ARC ON - CIRC”. Positioning the welding torch directly by means of a PTP motion might involve the risk of it colliding with the workpiece.

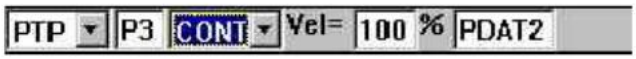
In this example, the path is covered by means of two PTP motions, as this type of motion is normally the quickest. A motion command (PTP with approximate positioning) is used for the path P2 - P3 and the path P3 - P4 is covered by means of the command “ARC ON - PTP”.



4.1.3.1 Moving to the point in space P3

Press the softkey “Motion”. The displayed (default) type of motion must be changed to “PTP” in the inline form, if necessary.

After selecting the command “Motion – PTP”, the inline form for setting the parameters given below is opened on the screen:



Position the welding torch to the point in space P3. You can define this point in any way you like but it should ensure an optimal path. During this motion, also orientate the torch in accordance with the opposite direction of welding used for the second seam. If desired, the robot coordinates can be saved by means of the softkey “Touch Up”.

Finally, press the softkey “Cmd Ok”. If the robot coordinates have not yet been saved, this is done automatically and the program form is updated accordingly.

4.1.3.2 Starting welding of seam 2 – “ARC ON”

Select the command “ARC ON” – ”PTP”. The following new inline form is opened:

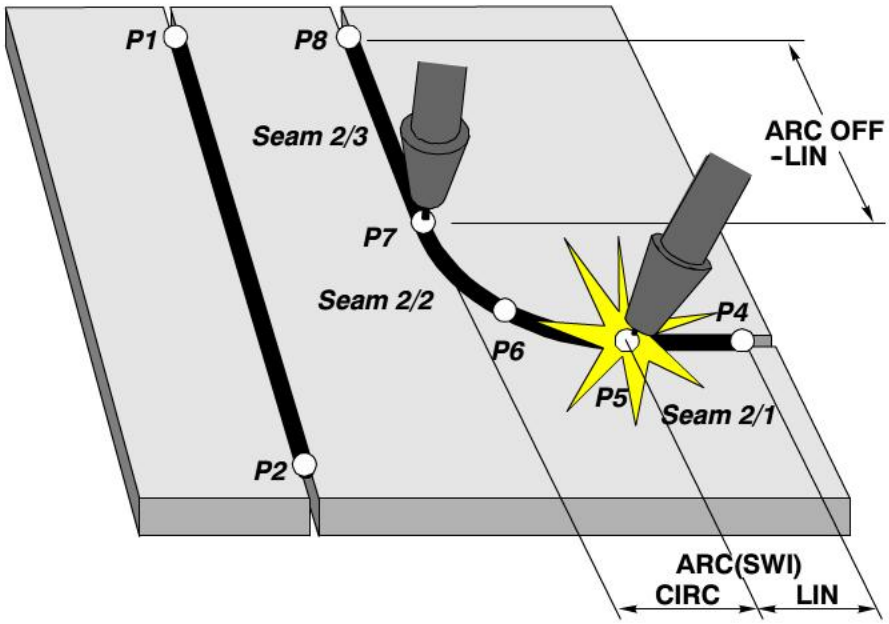
The new designations of the motion parameters (PDAT3), the start parameters (S2) and the numbering for the comment (Seam2) have automatically been generated. The welding parameters are the same as those for the previous section of the seam; the program number (Pgno) therefore remains the same.

Use the procedure described in Section 4.1.3. After all of the commands have been entered, the program form contains the motion command (to point P3) in line 6 and the welding command “ARC ON” – “PTP” (to point P4) in line 7.

```
1   INI
2   PTP HOME  Vel= 100 % DEFAULT
3
4   PTP P1 Vel= 100 % PDAT1 ARC_ON  Pgno= 1 S1 Seam1
5   LIN P2 CPDAT1 ARC_OFF  Pgno= 1 E1 Seam1
6   PTP P3 CONT Vel= 100 % PDAT2
7   PTP P4 Vel= 100 % PDAT3 ARC_ON  Pgno= 1 S2 Seam2
8   PTP HOME  Vel= 100 % DEFAULT
9   END
```

4.1.4 Welding seam 2 (up to P8)

Seam 2 contains a straight section (from P4, where welding starts, to point P5), followed by a circular section (to point P7 via point P6) and finally a straight section (to the end of the seam P8).

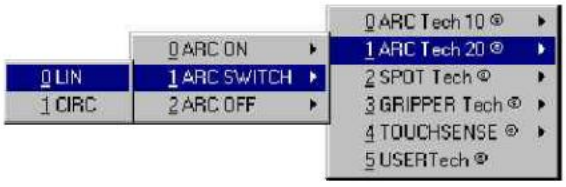


The first section of the seam is programmed as “ARC SWITCH” with the motion type “LIN” and the second section as “ARC SWITCH” with the motion type “CIRC”. The command “ARC OFF” with the motion type “LIN” ends the seam.

4.1.4.1 Section P4 ... P5 – “ARC SWITCH” – “LIN”

After pressing the menu key “Technology”, select the options shown below:
“ARC Tech 20” – “ARC SWITCH” – “LIN”.

Technology



ARC SWI

Alternatively, you can also press the softkey “ARC ON” or “ARC OFF” and – after the inline form has been opened – the new softkey “ARC SWI”. To do so, the status key option “ARC Tech” must have been selected in the “Configure” menu.

Again, please remember that the type of motion that is displayed corresponds to the setting for the last command. The desired motion type (“LIN” or “CIRC”) can be selected by means of an additional softkey or in the inline form.

The following inline form appears in the programming window:

Cmd Ok

After entering the motion parameters and the welding velocity in the parameter list “W1” and after moving the welding torch to the point P5, press the softkey “Cmd Ok” or the Enter key. The program form is updated accordingly.

4.1.4.2 Section P5 ... P6 ... P7 – "ARC SWITCH" – "CIRC"

The following section of the seam also requires the command "ARC SWITCH". As the seam does not run in a straight line, however, but is circular, the motion type "CIRC" must be selected.

Select the command "ARC Tech 20" – "ARC SWITCH" – "CIRC" using the menu key "Technology" or the appropriate softkeys. The following inline form appears on the screen:

This form, with which you will already be familiar from the "LIN" command, contains the auxiliary point P6 which is required for the *CIRC* motion. The additional softkey "Teach Aux" can also be seen in the softkey bar.

Unlike seams along a straight line, whose end point coordinates are automatically saved when the command is ended, the auxiliary point coordinates must be saved by means of "Teach Aux" for a CIRC motion.

For this purpose, position the welding torch to the auxiliary point P6 (pay attention to the orientation during this motion) and press the softkey "Teach Aux". Use the softkey "Yes" to respond to the query "Touchup really?".

Then move the torch to the end point P7 of this seam section, again paying attention to the orientation. You can save the current robot coordinates straight away by means of the softkey "Teach End" or by pressing the softkey "Cmd Ok" or the Enter key.

4.1.4.3 Ending welding of seam 2 – "ARC OFF"

The welding command "ARC OFF" is used for the last section. Use the procedure described in Section 4.1.2.

The three commands that were entered last are shown in lines 8, 9 and 10 of the following screenshot.

```
 1   INI
 2   PTP HOME  Vel= 100 % DEFAULT
 3
 4   PTP P1 Vel= 100 % PDAT1 ARC_ON  Pgno= 1 S1 Seam1
 5   LIN P2 CPDAT1 ARC_OFF  Pgno= 1 E1 Seam1
 6   PTP P3 CONT Vel= 100 % PDAT2
 7   PTP P4 Vel= 100 % PDAT3 ARC_ON  Pgno= 1 S2 Seam2
 8   LIN P5 CONT CPDAT2 ARC  Pgno= 1 W1
 9   CIRC P6 P7 CONT CPDAT3 ARC  Pgno= 1 W2
10   LIN P8 CPDAT4 ARC_OFF  Pgno= 1 E2 Seam2
11   PTP HOME  Vel= 100 % DEFAULT
12   END
```

The motion command "PTP HOME" in the tenth line (automatically generated as part of the program) returns the welding torch to its home position. This concludes programming for this program example.

4.2 Saving a program

To avoid losing data (as a result of a power failure, for instance), you are advised to save programs, especially large ones, at regular intervals during their creation.

Press the softkey “FILE”. The program directory is opened. The program created by you will be selected.

Now press the softkey “Save”. A corresponding dialog is displayed in the message window. Confirm this with the softkey “Yes”, or press the softkey “No” if you do not wish to save the data.

After pressing the softkey “PROGRAM”, the directory is closed again.

A detailed description of how to back up data can be found in the [Operating Handbook], in the chapter “Program creation”.

5 Altering existing programs

It is possible to alter commands and/or parameters and to delete command lines in an existing program at any time. Two examples are given below.

5.1 Altering command lines

The procedure for altering command lines is demonstrated below by using a different type of motion from the end of the first seam (P2) to the point in space P3 from that used in the program example given above.

The type of motion is to be changed from “PTP” to “LIN”.

```
 5   LIN P2 CPDAT1 ARC_OFF   Pgno= 1 E1 Seam1
 6   PTP P3 CONT Vel= 100 % PDAT2
 7   PTP P4 Vel= 100 % PDAT3 ARC_ON   Pgno= 1 S2 Seam2
```

Move the edit cursor to line 6 by means of the arrow keys.

Change

Press the softkey “Change”. The inline form for this command line is opened.

LIN/CIRC

Press the softkey “LIN/CIRC”. Alternatively, the motion type “LIN” can also be selected by means of the bottom right status key if the first box on the left (type of motion “PTP”) is active. The inline form changes accordingly.

Cmd Ok

Enter the new parameters and then press the softkey “Cmd Ok” or the Enter key. The inline form is closed and the program form is updated accordingly.

```
 5   LIN P2 CPDAT1 ARC_OFF   Pgno= 1 E1 Seam1
 6   LIN P3 CONT Vel= 2 m/s CPDAT5
 7   PTP P4 Vel= 100 % PDAT3 ARC_ON   Pgno= 1 S2 Seam2
```

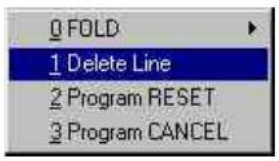
5.2 Deleting program lines

In the following example, a “SPOT TECH” command, which now appears as line 10 in the program form, has been entered by mistake.

```
 9   LIN P8 CPDAT4 ARC OFF PS W4 E2 Seam4
10   PTP P9 PDAT4 SPOT Gun= 1 RETR OPN SDAT1
11   PTP HOME  Vel= 100 % DEFAULT
```

This command line is to be deleted. To do so, move the edit cursor to line 10 and press the menu key “Program”.

Program

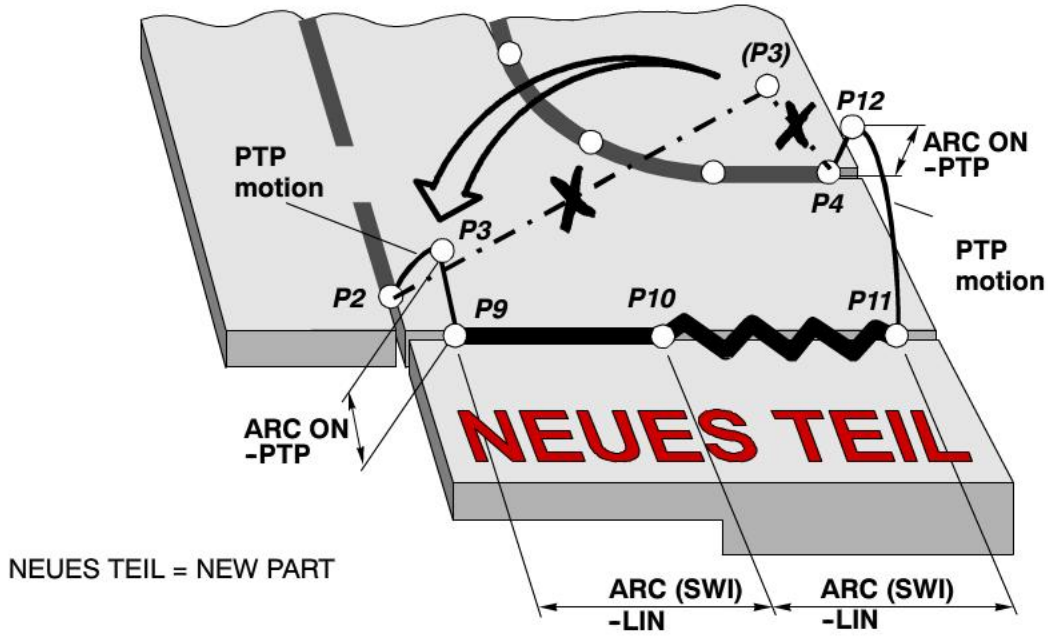


Select “Delete Line” by using the cursor key or press the key “1” on the numeric keypad (do not press Enter). If you press “Yes” to respond to the request for confirmation “Delete line really?” that is displayed in the message window, the selected line is deleted and the program form is updated accordingly.

Alterations and deletions cannot be undone. The program that is saved on the hard disk can, however, be reloaded using the directory “Drives”. In this case, however, all of the alterations that have been made to the program since the data were last saved will be lost.

5.3 Adding commands to an existing program

The procedure for adding commands to an existing program is given below. A further part is added to the welded assembly described in Section 4.



NEUES TEIL = NEW PART

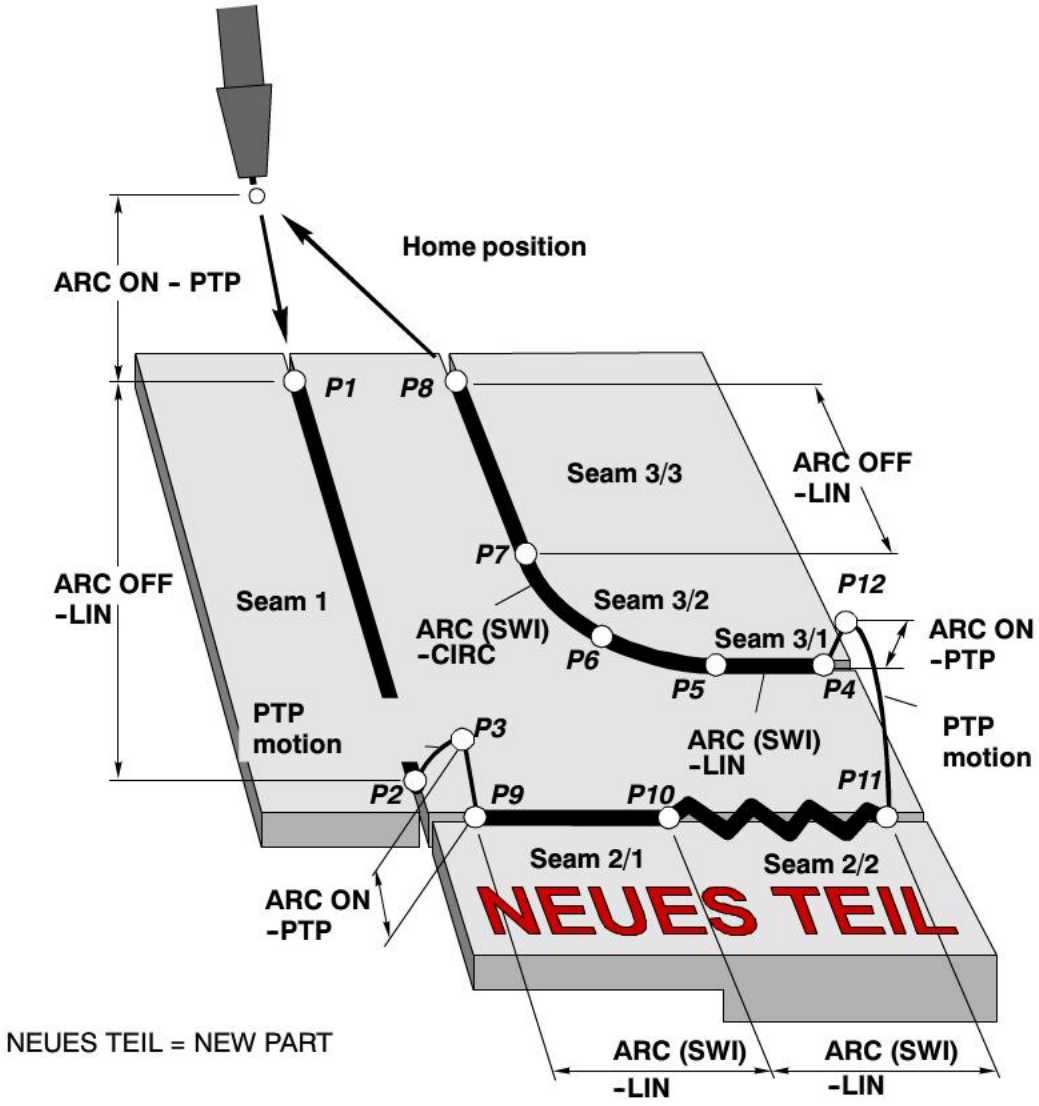
For design reasons, this seam for the new part must be welded using different parameters: it is to be welded as a normal straight seam in the first section and mechanical triangular weaving is to be used in the second.

There are several ways of achieving this, e.g. the new seam could be welded last. However, this would not be an efficient procedure for the entire sequence. To optimize execution and the time taken to perform the operation, it is better to execute the welding process for this new part immediately after seam 1 has been welded.

The following changes, therefore, have to be made to the program:

- Alter the command “Motion” (P3)
- Insert the command “ARC ON” (P9)
- Insert the command “ARC SWITCH” (P10)
- Insert the command “ARC OFF” (P11)
- Insert the command “Motion” (P12)

The modified welded assembly is illustrated in the following diagram.



5.3.1 Description of the alteration

Select

To alter the program, open the program form from the previous section.

```
1   INI
2   PTP HOME  Vel= 100 % DEFAULT
3
4   PTP P1 Vel= 100 % PDAT1 ARC_ON  Pgno= 1 S1 Seam1
5   LIN P2 CPDAT1 ARC_OFF  Pgno= 1 E1 Seam1
6   PTP P3 CONT Vel= 100 % PDAT2
7   PTP P4 Vel= 100 % PDAT3 ARC_ON  Pgno= 1 S2 Seam2
8   LIN P5 CONT CPDAT2 ARC  Pgno= 1 W1
```

5.3.1.1 Altering the command “Motion” (to P3)

Move the edit cursor (the blinking vertical line) to line 6 (P3).

Touch Up

Move the welding torch to the new position of the point in space P3 and press the softkey “Touch Up”. Press “Yes” to respond to the query “Touchup really?”.

5.3.1.2 Inserting the start of welding for the new seam – "ARC ON"

Before opening the menu, ensure that the edit cursor (the blinking vertical line) is positioned in line 6 ("PTP P3..."). Insert the command "ARC ON – PTP" for the new point P9. Use the procedure described in Section 3.2.

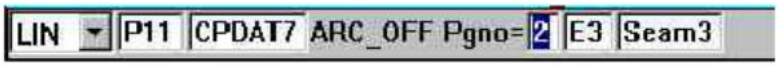
5.3.1.3 Inserting the first section of the new seam – "ARC SWITCH"

Select the command "ARC SWITCH" – "LIN" from the menu "Motion" as the option for the first section (from P9 to P10) of the new seam.

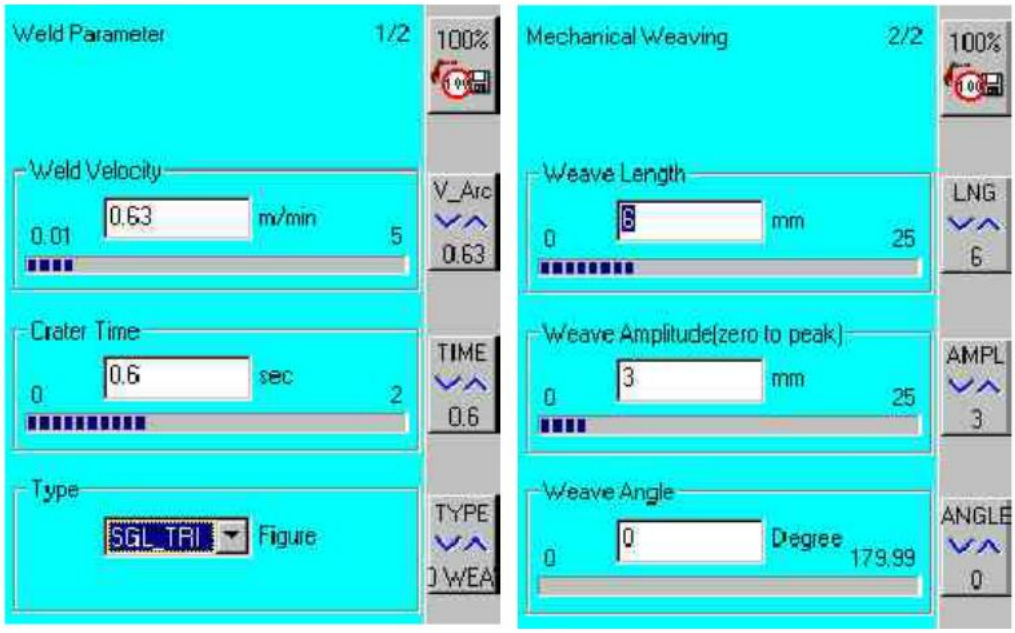
After entering the motion parameters and welding velocity for the current seam section, press the softkey "Cmd Ok" or the Enter key. The program form is updated accordingly.

5.3.1.4 Inserting the second section of the new seam – "ARC OFF"

For this "ARC OFF" command (from P10 to P11) we assume that other welding parameters are required for the welding controller on account of the greater materal thickness. Therefore enter a new program number ("Pgno=2" in this example) according to the specification of the welding controller.



Move the edit cursor to the input box "E3". This causes the following parameter lists for the welding and end parameters and for mechanical weaving to be displayed in the status window.



Enter the welding velocity (Weld Velocity) and the crater filling time (Crater Time).

Select the desired weave pattern ("Triangular weaving" – "SGL_TRI" in our example) in the "Type" box of the parameter list "Weld Parameter 1/2" by means of the bottom right status key. To do so, the input box "Figure" must be active.

Then enter the values for the weave length, the lateral deflection (Weave Amplitude) and the angle of the torch (Weave Angle) in the "Mechanical Weaving" parameter list.

Detailed information on mechanical weaving can be found in Section 3.4.

Cmd Ok

After entering all of the parameters, press the softkey “Cmd Ok” or the Enter key. The program form is updated accordingly.

5.3.1.5 Inserting a point in space - “Motion”

Finally, the motion from the end point of the new seam (P11) to the start of the next seam (P4) must be programmed. A further point in space (P12) is required between P11 and P4 for this purpose.

Insert this command following the description given in Section 4.1.3.1. After ending this command, alteration of the program is completed. The new commands appear in lines 7 to 10 of the program form.

```
 1   INI
 2   PTP HOME  Vel= 100 % DEFAULT
 3
 4   PTP P1 Vel= 100 % PDAT1 ARC ON  Pgno= 1 S1 Seam1
 5   LIN P2 CPDAT1 ARC OFF  Pgno= 1 E1 Seam1
 6   PTP P3 CONT Vel= 100 % PDAT4
 7   PTP P9 Vel= 100 % PDAT5 ARC ON  Pgno= 1 S3 Seam3
 8   LIN P10 CONT CPDAT6 ARC  Pgno= 1 W3
 9   LIN P11 CPDAT7 ARC OFF  Pgno= 2 E3 Seam3
10   PTP P12 CONT Vel= 100 % PDAT6
11   PTP P4 Vel= 100 % PDAT3 ARC ON  Pgno= 1 S2 Seam2
12   LIN P5 CONT CPDAT2 ARC  Pgno= 1 W1
13   CIRC P6 P7 CONT CPDAT3 ARC  Pgno= 1 W2
14   LIN P8 CPDAT4 ARC OFF  Pgno= 1 E2 Seam2
15   PTP HOME  Vel= 100 % DEFAULT
16   END
```