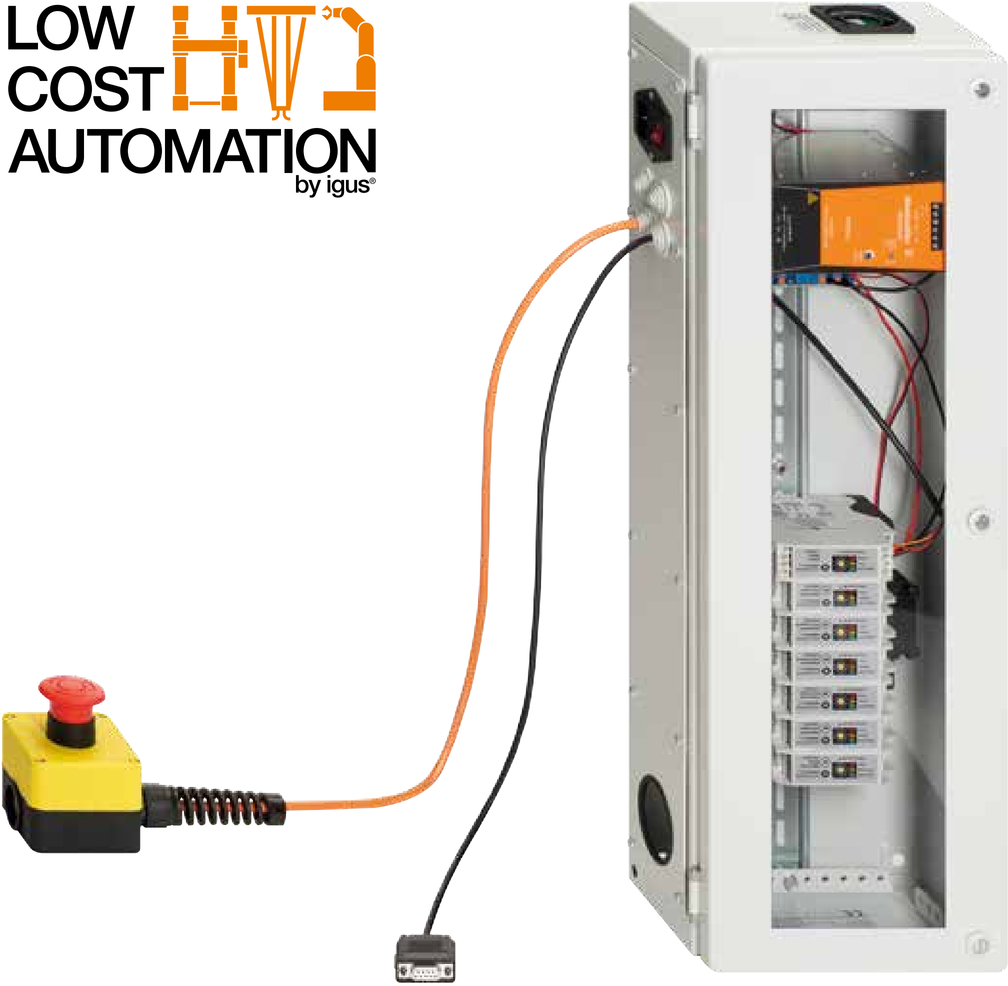
igus®

Robot Control

Command reference

LOW COST AUTOMATION by igus®



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iRC Command Reference

igus® Robot Control – V902-11-005

No.	Command	Functionality	iRC	TinyCtrl
	Motion			
0	**All: Abort Condition**	Motions commands can be interrupted	●	●
0	**All: Smoothing**	Smooth transition between motions	●	●
0	**All: Acceleration**	Defined accelerations for motions	●	●
6.1	**Joint**	Move in joint coordinates	●	●
6.2	**JointByVariable**	As above, target defined by variable	●	●
6.3	**Linear Move**	Linear in cartesian xyzabc position	●	●
6.4	**LinearByVariable**	As above, target defined by variable	●	●
6.5	**RelativeBase**	Relative motion in base coordinates	●	●
6.6	**RelativeTool**	Relative motion in tool coordinates	●	●
6.7	**RelativeJoint**	Relative motion in joint coordinates	●	●
	Input/Output			
7.1	**DigitalOut**	Set a digital output to high or low	●	●
	Gripper	Open or close the gripper	●	●
	Structure			
	Simple conditions	E.g. DIn21	●	●
	Complex conditions	E.g. DIn21 AND DIn24 or targetpos.x > 200	●	●
	Internal Signals	E.g. GSig1 to remember internal states	●	●
8.1	**LoopCounting**	Repeat a defined number of iteration	●	●
8.2	**LoopConditional**	Repeat until a condition is true	●	●
8.3	**If-Then-Else**	Conditional branch	●	●
8.4	**Wait**	Wait a defined time span	●	●
8.5	**WaitConditional**	Wait until a condition is true	●	●
8.6	**Sub**	Call a sub program defined in another .xml file	●	●
	Advance			
9.1	**DefPosVariable**	Defines a Position Variable	●	●
9.2	**DefNumberVariable**	Defines a Number Variable	●	●
	Variable Operations	Add, Subtract, Set values to variables and variable sections	●	●
9.6	**PluginTargetPos**	Get a target position from e.g. a camera	●	partly

2. Names of Programs and Sub-Programs

2.1 Program Names

Program names can consist of the standard characters. Only some special characters are allowed.

- Standard characters: a-z A-Z 0-9
- Special characters on Windows: . - _ \
- Special characters on Linux: . - _ /

2.2 Program Location

Robot programs are .xml files in the /Data/Programs/ folder. They can be stored directly in the Programs/folder, or in a subfolder, e.g. Programs/robotStation01/

2.3 Sub-Programs

The main program can call sub-programs, please see section 7.6. The location of the called subprogram is relative to Data/Programs/.

3. Variables and Variable Access

iRC can work with number variables (for both integer and float values) and position variables (Cartesian positions and joint positions). It is also possible to access the elements of the variables.

3.1 User Variables

With the commands "DefPosVariable" and "DefNumberVariable" user variables can be defined. User variable names are case insensitive, they are transformed to lower case.

3.2 System Variables

The following variables are always available:

- #position

The current robot position with Cartesian coordinates in mm for XYZ and degrees for ABC, as well as and joint positions in degrees or mm depending on the type of joint.

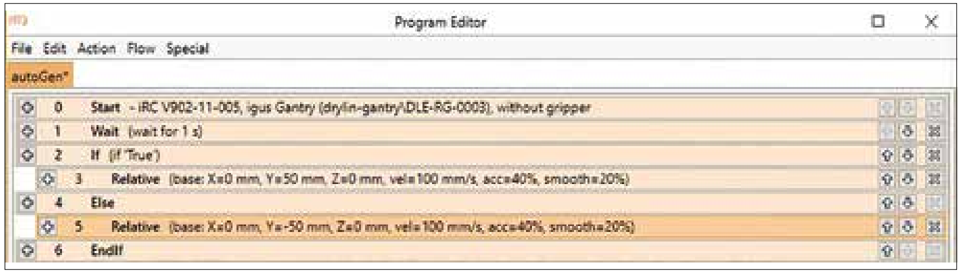
3.3 Element Access

The following elements of the variables can be accessed with the "." Operator:

- Position: X, Y, Z
- Rotation: A, B, C
- Joints: A1, A2, A3, A4, A5, A6

3.4 Example

The following example moves the robot to the left or to the right, depending on the starting position.



```
0  Start  - iRC V902-11-005, igus Gantry (drylin-gantry\DLE-RG-0003), without gripper
1  Wait  (wait for 1 s)
2  If  (if 'True')
    3  Relative  (base: X=0 mm, Y=50 mm, Z=0 mm, vel=100 mm/s, acc=40%, smooth=20%)
4  Else
    5  Relative  (base: X=0 mm, Y=-50 mm, Z=0 mm, vel=100 mm/s, acc=40%, smooth=20%)
6  EndIf
```

4. Conditions

Conditions are used in if-then-else commands, conditional loops and as abort condition in motion commands. The conditional statements can be combinations of digital inputs, Boolean operators and comparisons. E. g.:

- DIn23 True if digital input 23 is high
- DIn23 AND !DIn27 True if digital input 23 is high and digital input 27 is not high
- modelclass = 31True if variable modelclass is 31
- mempos.x > 350.0 True if the x value of the position variable mempos is higher than 350

EBNF definition:

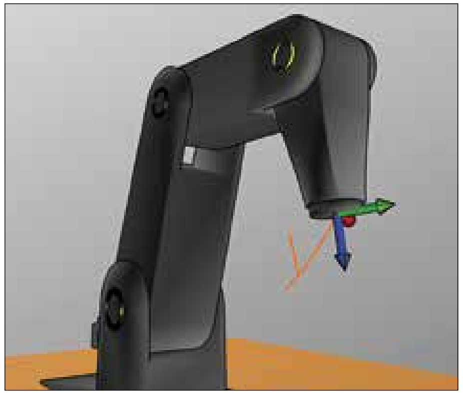
```
Expression:        = [ "!" ] <Boolean> { <BooleanOperator> <Boolean> } ...
Boolean:           = <BooleanConstant> | <Expression> | "(" <Expression> ")" | CompExpression | "(" <CompExpression> ")"

BooleanOperator:   = "And" | "Or"
BooleanConstant:   = "True" | "False"
DigitalInputs:     = "DIn1" | "GSig1"

CompExpression:    = <CompValue> <Comparator> <CompValue>
CompValue:         = <Variable> | <Number>
Variable:          = some variable name
Number:            = Integer or Float number
Comparator:        = "=" | ">" | "<" | ">=" | "<="
```

5. Acceleration and Smoothing

Motion commands are adapted to follow the joint accelerations. This can be done for a single motion command, but also for a combination of up to 10 commands. It is also possible to smooth out corners. This allows the robot to go through the corner with a remaining velocity. If corner smoothing is not active the robot stops at every corner for a short moment. This leads to more abrupt motion.



Parameters:

- Acc: Percentage of the possible acceleration, 0..100
- Smooth: Scope of smoothing in percent, 0..100

Non-motion commands like "Wait" or "DOut" interrupt the smoothing of a motion set.

6. Motion | Detailed Command Reference

6.1 Joint Motion

Moves to a target position in joint coordinates. The joint velocities during the motion are constant. The resulting motion of the TCP is normally not a straight line, but curved.

- A1 to A6: Joint values of the target position in degree
- E1 to E3: Joint values of the external joints, e.g. linear joints
- Vel: Velocity in percent of the max joint velocities
- Acc: Acceleration in % of the max joint acceleration
- Smooth: Interpolation at the edge points
- Condition: Abort condition, if this is true the motion will be aborted
- Description: Free field to comment the line

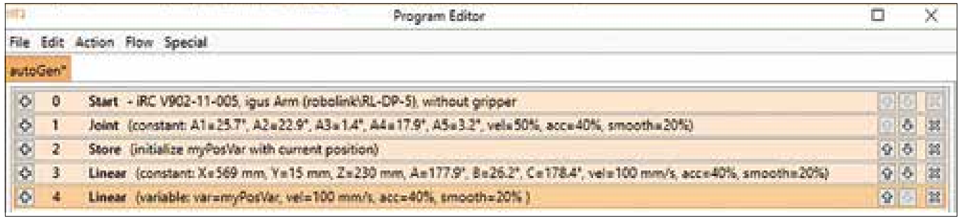
6.2 Linear Motion

A standard linear motion interpolating both position and orientation.

- X, Y, Z: Cartesian position of the target position in mm
- A, B, C: Orientation of the target position in degree, encoding in Euler angles
- E1 to E3: Joint values of the external joints, e.g. linear joints
- Vel: Velocity in mm/s
- Acc: Acceleration in % of the max joint acceleration
- Smooth: Interpolation at the edge points
- Condition: Abort condition, if this is true the motion will be aborted
- Description: Free field to comment the line

6.3 LinearByVariable

A linear motion with the target position defined by a variable



```
0   Start  - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1   Joint  (constant: A1=25.7°, A2=22.9°, A3=1.4°, A4=17.9°, A5=3.2°, vel=50%, acc=40%, smooth=20%)
2   Store  (initialize myPosVar with current position)
3   Linear  (constant: X=569 mm, Y=15 mm, Z=230 mm, A=177.9°, B=26.2°, C=178.4°, vel=100 mm/s, acc=40%, smooth=20%)
4   Linear  (variable: var=myPosVar, vel=100 mm/s, acc=40%, smooth=20% )
```

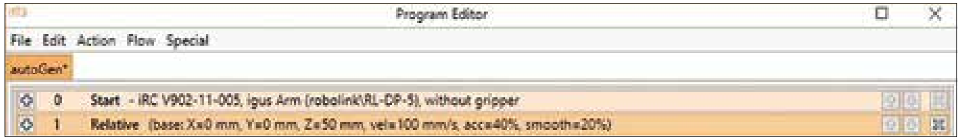
- Field X: Name of the target position variable
- Vel: Velocity in mm/s
- Acc: Acceleration in % of the max joint acceleration
- Smooth: Interpolation at the edge points
- Condition: Abort condition, if this is true the motion will be aborted
- Description: Free field to comment the line

6.4 JointByVariable

A joint motion with the target position defined by a variable. Details are as above.

6.5 Relative Base Motion

A relative linear motion in base coordinates, interpolating the position (without orientation).

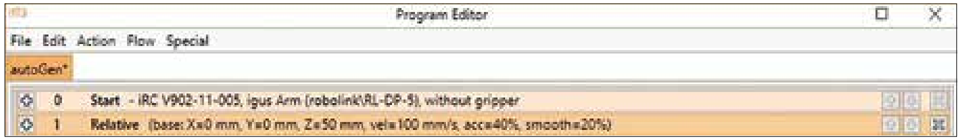


```
0   Start  - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1   Relative  (base: X=0 mm, Y=0 mm, Z=50 mm, vel=100 mm/s, acc=40%, smooth=20%)
```

- X, Y, Z: relative Cartesian motion in mm base coordinate system
- Vel: Velocity in mm/s
- Acc: Acceleration in % of the max joint acceleration
- Smooth: Interpolation at the edge points
- Condition: Abort condition, if this is true the motion will be aborted
- Description: Free field to comment the line

6.6 Relative Tool Motion

A relative linear motion in tool coordinates, interpolating the position (without orientation).

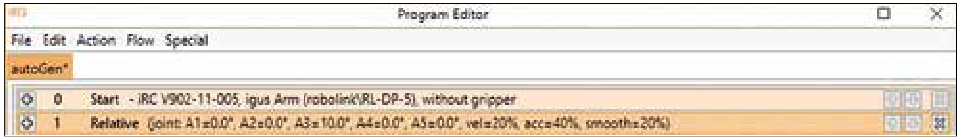


```
0   Start  - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1   Relative  (base: X=0 mm, Y=0 mm, Z=50 mm, vel=100 mm/s, acc=40%, smooth=20%)
```

- X, Y, Z: relative Cartesian motion in mm tool coordinate system
- Vel: Velocity in mm/s
- Acc: Acceleration in % of the max joint acceleration
- Smooth: Interpolation at the edge points
- Condition: Abort condition, if this is true the motion will be aborted
- Description: Free field to comment the line

6.7 Relative Joint Motion

A relative joint motion, interpolating the joint position.



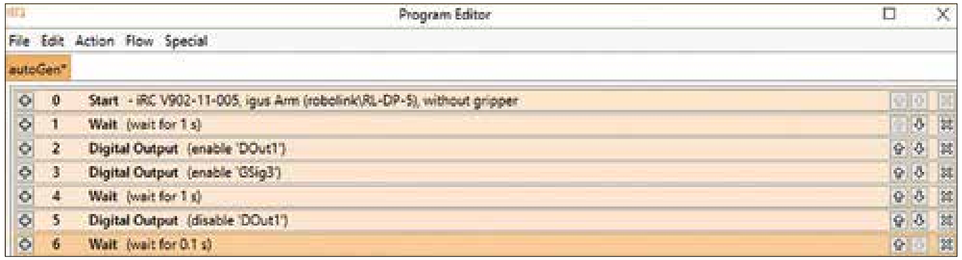
```
0   Start  - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1   Relative  (joint: A1=0.0°, A2=0.0°, A3=10.0°, A4=0.0°, A5=0.0°, vel=20%, acc=40%, smooth=20%)
```

- A1 to A6: relative joint motions in degrees
- E1 to E3: relative external joint motions in degree or mm
- Vel: Velocity in %
- Acc: Acceleration in % of the max joint acceleration
- Smooth: Interpolation at the edge points
- Condition: Abort condition, if this is true the motion will be aborted
- Description: Free field to comment the line

7.1 DigitalOut

This command sets available outputs:.

- Digital outputs, that means real hardware outputs on the robot
- Global signals, that means iRCrog-internal markers to allow synchronization e.g. with conveyors



```
0   Start  - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1   Wait  (wait for 1 s)
2   Digital Output  (enable 'DOut1')
3   Digital Output  (enable 'GSig3')
4   Wait  (wait for 1 s)
5   Digital Output  (disable 'DOut1')
6   Wait  (wait for 0.1 s)
```

Field X: The digital output to set:

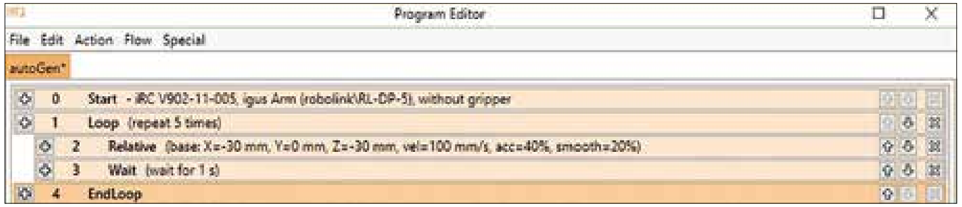
- Hardware outputs: DOut1 to DOut4, or DOut21 to DOut27, DOut 31 to DOut 37 and DOut41 to DOut47 for the digital output modules.
- Internal marker: GSig1 to GSig100

Field Y: The state to set the output to

8. Structure | Detailed Command Reference

8.1 LoopCounting

The commands between the start tag "LoopCounting" and the end tag "LoopEnd" are repeated.



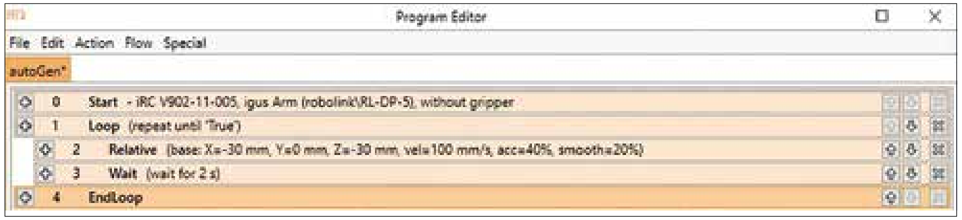
```
0  Start - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1  Loop (repeat 5 times)
    2  Relative (base: X=-30 mm, Y=0 mm, Z=-30 mm, vel=100 mm/s, acc=40%, smooth=20%)
    3  Wait (wait for 1 s)
4  EndLoop
```

Times: Insert the number or repetition times here

Description: Free field to comment the line

8.2 LoopConditional

The LoopConditional command repeats the enclosed commands until the condition in field x is evaluated as true. The condition can be a single digital input, but also a more complex condition as described in section 4.



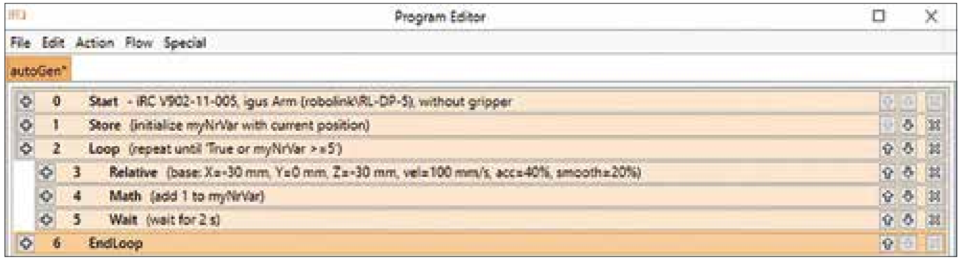
```
0  Start - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1  Loop (repeat until 'True')
    2  Relative (base: X=-30 mm, Y=0 mm, Z=-30 mm, vel=100 mm/s, acc=40%, smooth=20%)
    3  Wait (wait for 2 s)
4  EndLoop
```

Field X: condition, the loop stops if this is evaluated true

- Simple example: DIn4 - waiting for digital input 4 being high
- More complex example: DIn4 OR varCnt >= 5

Description: Free field to comment the line

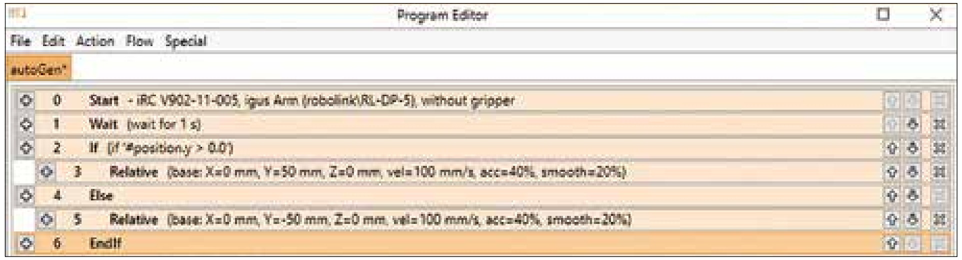
The more complex example is shown below. The RelativeBase motion is repeated until DIn4 is high, or until the variable varcnt is equal (or higher) than 5. So max 5 iterations are done.



```
0  Start - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1  Store (initialize myNrVar with current position)
2  Loop (repeat until 'True or myNrVar >=5')
    3  Relative (base: X=-30 mm, Y=0 mm, Z=-30 mm, vel=100 mm/s, acc=40%, smooth=20%)
    4  Math (add 1 to myNrVar)
    5  Wait (wait for 2 s)
6  EndLoop
```

8.3 If-then-else

This command evaluates a condition. Depending on the result different command blocks are executed.

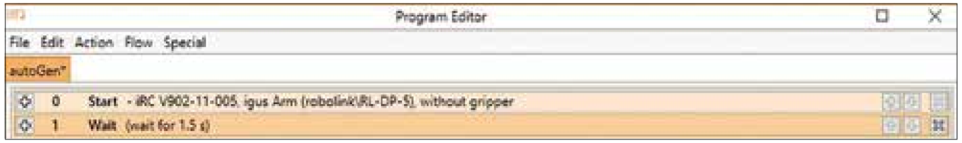


```
0  Start - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1  Wait (wait for 1 s)
2  If (if '#position.y > 0.0')
    3  Relative (base: X=0 mm, Y=50 mm, Z=0 mm, vel=100 mm/s, acc=40%, smooth=20%)
4  Else
    5  Relative (base: X=0 mm, Y=-50 mm, Z=0 mm, vel=100 mm/s, acc=40%, smooth=20%)
6  EndIf
```

Condition: The condition in the X field is described in section 4.

8.4 Wait

The Wait command tells the robot to wait for a specified time span without motion.



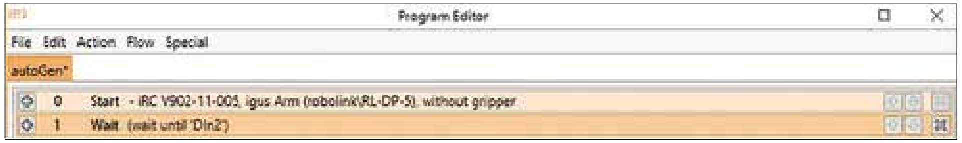
```
0  Start - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1  Wait (wait for 1.5 s)
```

Field X: Time span in seconds

Description: for your comments

8.5 WaitConditional

This command waits until a condition is met, e.g. a digital input is high.



```
0  Start - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1  Wait (wait until 'DIn2')
```

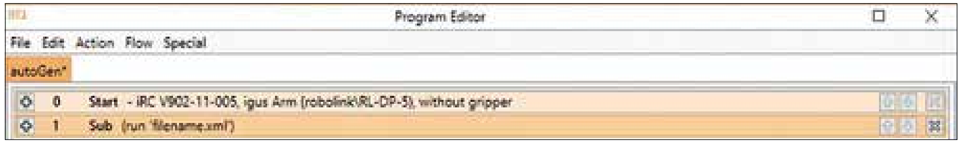
Field X: Condition as shown in section 0

Description: for your comments

8.6 Sub

Call of a sub program.

The filename is relative to the location of the calling program.

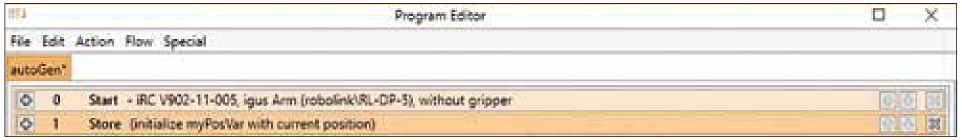


```
0  Start - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1  Sub (run 'filename.xml')
```

9. Advanced | Detailed Command Reference

9.1 DefPosVariable

Defines a position variable. Regarding the naming, only the characters are relevant. Upper or lower case is not differentiated.

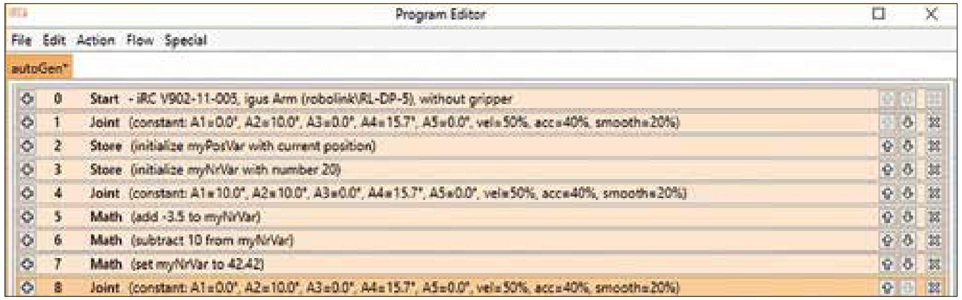


```
0   Start  - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1   Store  (initialize myPosVar with current position)
```

Incomplete implementation: Currently there are two possibilities for initialization:

- Single word in field Y: The variable is initialized with the current position
- Six float values in field Y: The float values are used as xyzabc values
- It is currently not possible to define a variable based on another variable

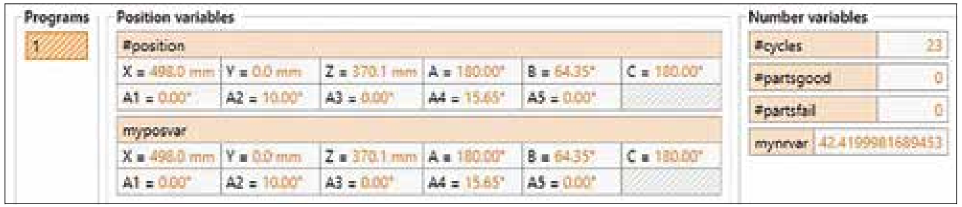
An example for the usage of variables and operations is shown below:



```
0   Start  - iRC V902-11-005, igus Arm (robolink\RL-DP-5), without gripper
1   Joint  (constant: A1=0.0°, A2=10.0°, A3=0.0°, A4=15.7°, A5=0.0°, vel=50%, acc=40%, smooth=20%)
2   Store  (initialize myPosVar with current position)
3   Store  (initialize myNrVar with number 20)
4   Joint  (constant: A1=10.0°, A2=10.0°, A3=0.0°, A4=15.7°, A5=0.0°, vel=50%, acc=40%, smooth=20%)
5   Math  (add -3.5 to myNrVar)
6   Math  (subtract 10 from myNrVar)
7   Math  (set myNrVar to 42.42)
8   Joint  (constant: A1=0.0°, A2=10.0°, A3=0.0°, A4=15.7°, A5=0.0°, vel=50%, acc=40%, smooth=20%)
```

The current values of the variables are shown in the "Variable" tab at the bottom of iRCprog. Please pay attention to the A value of 42.42 degrees, and the value of mynrvar: 20 – 3.5 = 16.5

9.2 DefNumberVariable



Position variables

#position					
X = 498.0 mm	Y = 0.0 mm	Z = 370.1 mm	A = 180.00°	B = 64.35°	C = 180.00°
A1 = 0.00°	A2 = 10.00°	A3 = 0.00°	A4 = 15.65°	A5 = 0.00°	

myposvar					
X = 498.0 mm	Y = 0.0 mm	Z = 370.1 mm	A = 180.00°	B = 64.35°	C = 180.00°
A1 = 0.00°	A2 = 10.00°	A3 = 0.00°	A4 = 15.65°	A5 = 0.00°	

Number variables

#cycles	23
#partsgood	0
#partsfail	0
mynrvar	42.4199981689453

A number variable contains a floating point value. It can be used in conditions, e.g. to stop a loop. It is initialized with the value in the field Y. See the example above for usage.

9.3 VariableAdd

This command adds two values:

First value in field X:

- A position variable with the selected element, e.g. targetpos.x
- A number variable

Second value in field Y:

- An integer or floating point value, e.g. -32.6
- A position variable with the selected element, e.g. targetpos.x
- A number variable

The result will be stored into the variable or variable element that is specified in the field X. See the above example for the usage.

9.4 VariableSubtract

This command subtracts two values:

First value in field X:

- A position variable with selected element, e.g. targetpos.x
- A number variable

Second value in field Y:

- An integer or floating point value, e.g. -32.6
- A position variable with selected element, e.g. targetpos.x
- A number variable

The result will be stored into the variable or variable element that is specified in the field X. See the above example for the usage.

9. Advanced | Detailed Command Reference

9.5 VariableSet

This command sets a variable to a value:

First value in field X:
- A position variable with selected element, e.g. targetpos.x
- A number variable

Second value in field Y:
- An integer or floating point value, e.g. -32.6
- A position variable with selected element, e.g. targetpos.x
- A number variable

See the above example for the usage.

9.6 PluginTargetPos

This command receives a target position from a plugin module. It is intended e.g. to forward gripping positions found by a camera system to the iRC program.

Before calling the plugin command the necessary variables must be defined:
- A position variable. The plugin writes the target position into it. Depending on the plugin the old values may be completely replaced, the new value is added.
- A number variable: Used to e.g. provide a result like the type of object found. Plugin specific semantics.

Afterwards a linear motion to the target position can be performed. For TinyCtrl a camera can be included with the same syntax. A library interface is currently not implemented.

My sketches

/9001:2015
/16949:2016

igus® is certified in accordance with ISO 9001:2015 and ITAF 16949:2016 in the field of energy supply systems, cables and harnessing, as well as plastic bearings.

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