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From Components to Systems

IT116Flash Single-Axis Controller

**Programming of the IT116Flash
with the isel-@ protocol**

The information, technical data and dimensional specifications contained in this document correspond to the state of the art at the time of publication. However, any print errors and mistakes cannot be entirely ruled out. We appreciate your assistance with any recommendations for improvement or notification of errors.

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Table of contents

1 Overview of commands

The following commands of the *isel-@* format were implemented for the IT116Flash.

DNC commands

Command	Meaning
`@01`	Initialisation of the axis
`@0a / @0A`	Relative movement
`@0b`	Read port
`@0B`	Write port
`@0d`	Adjust reference speed
`@0D`	Diagnostics (only for commissioning / debugging)
`@0F`	Retract
`@0g`	Adjust acceleration
`@0G`	Change device number (future extension)
`@0h`	Read inputs (only for commissioning / debugging)
`@0H`	Read status (only for commissioning / debugging)
`@0i`	Save CNC program
`@0I`	Initialisation of parameters
`@0j`	Adjust start-stop frequency
`@0k`	Delete CNC program
`@0m / @0M`	Absolute movement
`@0n`	Set zero point
`@0N`	Simulate reference run
`@0P`	Query position
`@0r / @0R`	Reference run
`@0s / @0S`	Start CNC program or movement
`@0T`	Switch test mode on/off
`@0V / @0?`	Version query
`@0Z`	Movement to input port

CNC commands

Command code	Meaning
`0`	Relative movement
`1`	Send synchronisation character
`2`	Wait for synchronisation character
`3`	Loop, branch
`5`	Time delay
`6`	Movement to input port
`7`	Reference run
`9`	CNC program end
`d`	Adjust reference speed
`g`	Adjust acceleration
`j`	Adjust start-stop frequency
`m`	Absolute movement
`n`	Set zero point

N	Simulate reference run
O	Read port and branch
P	Write port
T	Switch test mode on/off

2 DNC mode and its commands

2.1 Structure of DNC commands

The data records or commands transmitted from a control computer are directly evaluated and executed when operating in DNC mode. For this purpose, a so-called initialisation is required at the start of the data communication. It is comprised of the data opening character @, the device number (0=standard), and the number of axes to be travelled. Then the control unit transmits the individual program steps and they are executed directly from there. To check the data transmission or message of occurring errors, corresponding ASCII characters are sent back to the control unit via the interface. This so-called software handshake process is realised as follows:

```
         ┌──────────────────────────┐
         │  Command transmission    │
         └──────────────────────────┘
                      │
                 ◇ Response    no
                  received? ─────┐
                      │ yes
         ┌──────────────────────────┐
         │    Wait for response     │
         └──────────────────────────┘
                      │
                 ◇ Error?     no
                      │ ──────────────►
                      │ yes
         ┌──────────────────────────┐
         │    Error evaluation      │
         └──────────────────────────┘
```
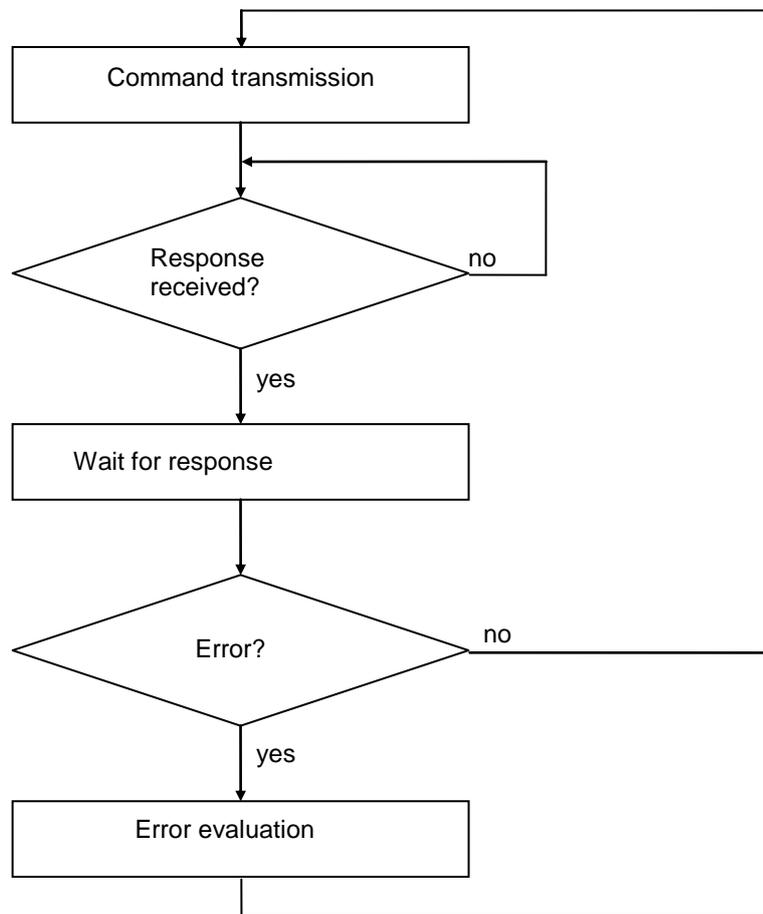
First a command is transmitted to the control unit. The command is decoded and processed by the control unit. Then the control unit generates a corresponding acknowledgement or error symbol.
This response is evaluated by the control computer. If an error occurs, a corresponding error evaluation and rectification must take place. Then the next command can be transmitted to the control unit in the same manner.

The scope of commands of DNC mode of the IT116Flash controller is described below.

2.2 Commands of IT116FLASH in DNC mode

2.2.1 Initialisation, setting number of axes

Command: Set number of axes

Purpose: The control unit is re-initialised with transmission of the number of axes.

Structure: @<GN>1<CR>

@	= Data opening character
<GN>	= Device number, Standard=0
1	= Axis specification, see below
<CR>	= Carriage Return as command end

Use: @01

Explanation: The control unit is addressed with "@"; the following numerical value contains the axis configuration. Since the IT116Flash is a single-axis control unit, only the value 1 is possible for the axis specification.

2.2.2 Executing a relative movement

Command: Relative movement

Purpose: The control unit generates a relative movement corresponding to the transmitted path of travel and the speed. The travelling movement is executed immediately.

Structure: @<GN>A<S>,<G><CR>

@	= Data opening character
<GN>	= Device number, Standard=0
A or a	= Relative movement command
<S>	= Path
<G>	= Speed
<CR>	= Carriage Return as command end

Use: @0A5000,900

Explanation: The control unit is addressed with '@0'; 'A' or 'a' indicates that a relative movement should take place. The control unit now expects a pair of numbers consisting of a path of travel and speed. The movement takes place in a relative measurement, i.e. based on the last position. The control unit reports after the command has been executed with the handshake character ('0'). The control unit can only process new commands after the command has been executed.

2.2.3 Reading ports

Command: Read port

Purpose: The command enables the current status of logical or physical input ports to be determined via the serial interface.

Structure: @<GN>b<PortNo><CR>

@   = Data opening character
<GN>   = Device number, Standard=0
b   = Read port command
<PortNo>   = Port number, see below
<CR>   = Carriage Return as command end

Use: @0b0

Explanation: The control unit is addressed with '@'. 'b' indicates that the status of an input port should be determined. Then the port number is determined and the command is concluded with carriage return. The control unit answers with the software handshake '0' followed by two characters which specify a hexadecimal value corresponding to the current status of the input port.

Port	Status	Function
0	00 - 0F	User I/O
		Bit0 UserInput1
		Bit1 UserInput2
		Bit2 UserInput3
		Bit3 UserInput4
1	00 - 0F	System I/O
		Bit0 LimitSwitch1
		Bit1 LimitSwitch2
		Bit2 PowerOK
		Bit3 StartButton

2.2.4 Writing ports

Command: Write port

Purpose: The command makes it possible to describe logical or physical output ports with defined values via the serial interface.

Structure: @<GN>B<PortNo>,<Value><CR>

@   = Data opening character
<GN>   = Device number, standard=0
B   = Write port command
<PortNo>   = Port number, see below
<Value>   = New port value

<CR>   = Carriage Return as a command end

Use: @0B0,1

Explanation: The control unit is addressed with '@'. 'B' indicates that the value of an output port should be set. Then the port number and the new port value are transmitted with comma separation and the command is concluded with carriage return. The control unit answers with the software handshake '0' if the execution was successful, or with a command message if the wrong port numbers and/or values were transmitted.

Port	Value	Function
0	0 - 15	User I/O
		Bit0 UserOutput1
		Bit1 UserOutput2
		Bit2 UserOutput3
		Bit3 UserOutput4

2.2.5 Define reference speed

Command: Set reference speed

Purpose: The command defines the speed at which are reference run is executed.

Structure: @<GN>d<G><CR>

@	= Data opening character
<GN>	= Device number, Standard=0
d	=Set reference speed command
<G>	= Reference speed
<CR>	= Carriage Return as command end

Use: @0d2500

Explanation: If no information about the reference speed is transmitted to the control unit, the execution takes place with a default value. A changed value is not saved after switching off.

Limitation: The specified speed must lie within the valid range of values for speeds.
                If a reference value which is too high is selected in combination a large spindle pitch, the reference switch can be damaged due to the inertia. The control unit requires a switching hysteresis of the connected zero position switch. This must be observed for connection of electronic zero sensors!

2.2.6 Retract

Command: Retract a connected axis

Purpose: The control unit moves the axis, starting from the reference switch.

Structure: @<GN>F1<CR>

@	= Data opening character
<GN>	= Device number, Standard=0
F	= Idle run command
1	= Axis specification, see below
<CR>	= Carriage Return as command end

Use: @0F1

Explanation: The control unit is addressed with '@'. 'F' indicates that a connected axis should be retracted from the limit switch. The subsequent numerical value defines the axis which should perform a reference run. Since the IT116Flash is a single-axis control unit, only the value 1 is possible for the axis specification.

After the movement is completed, the control unit sends its acknowledgement character and awaits the next command. The control unit can only process commands once a reference run has been executed.

2.2.7 Define acceleration

Command: Set acceleration

Purpose: The command defines the acceleration with which the ramps required for the movements are executed.

Structure: @<GN>g<B><CR>

@	= Data opening character
<GN>	= Device number, Standard=0
g	= Set acceleration
<B>	= Acceleration
<CR>	= Carriage Return as command end

Use: @0g100

Explanation: If the control unit does not transfer any information about the acceleration, the execution takes place with a default value. A changed value is not saved after switching off.
The acceleration is specified in Hz/ms, the default value is 100 Hz/ms. Accelerations in a value range between 1Hz/ms and 1000 Hz/ms are provided.

Limitation: The specified acceleration must lie within the valid value range for acceleration.

An acceleration value which is too high can lead to losses of steps in the acceleration or braking phase.

2.2.8 Define start-stop frequency

Command: Set start-stop frequency

Purpose: The command defines the frequency at which the ramps required for the movements begin and end.

Structure: @<GN>j<F><CR>

@   = Data opening character
<GN>   = Device number, Standard=0
j   = Set start-stop frequency
<F>   = Frequency
<CR>   = Carriage Return as command end

Use: @0j300

Explanation: If the control unit does not transfer any information about the acceleration, the execution takes place with a default value. A changed value is not saved after switching off.
The specification of the start-stop frequency takes place in Hz; the default value is 300 Hz. Frequencies in a range of values between 20Hz and 40kHz are provided.

Limitation: The specified start-stop frequency must lie within the valid value range for step frequencies.
A start-stop frequency which is too high can result in step losses in the acceleration or braking phase.

2.2.9 Initialisation of parameters

Command: Initialisation

Purpose: The command defines important parameters for the functionality of the control unit.

Structure: @<GN>I<C><w><CR>

@   = Data opening character
<GN>   = Device number, Standard=0
I   = Initialisation
<C>   = Parameter code
<w>   = Parameter values
<CR>   = Carriage Return as command end

Parametercode	Meaning of the parameter	Parameter values
D	Axis direction	0 - normal 1 - inverse
d	Default reference speed	Default value for reference speed
R	Reference direction	0 - normal 1 - inverse
E	Limit switch	
	Bit 0: Enable LimitSwitch1	0 - disabled 1 - enabled
	Bit 1: Enable LimitSwitch2	0 - disabled 1 - enabled
	Bit 2: Active level LimitSwitch1	0 - low active 1 - high active
	Bit 3: Active level LimitSwitch2	0 - low active 1 - high active
F	Offset at reference	Number of increments for retracting the switch
T	Axis type	0 - linear 1 - Rotary axis
O	IOonly	0 - disabled 1 - enabled
P	Default output assignment	<p>,<n>,<w> <p> - Port number <m> - Mask <w> - Value
L	Load parameters from flash	-
W	Save parameters to flash	-
X	Load default parameters	-

Use: @0IF100
       @0IP0,255,1

Explanation: This command is used for initialisation of parameters. The control unit is addressed with '@'. 'I' indicates that parameters should be initialised. An additional code defines the parameters which should be accessed or which function should be executed (see table).

With the default initialisation of output ports, the port number, a mask, and a value are transmitted as parameters. The transmission of these parameters takes place analogously to the other port commands with decimals. In the process, the mask and the value code the individual bits of the output port, considered as a binary value. If a bit in the mask corresponds to a '1', the corresponding bit in the output port is initialised with the bit from the value. If the bit in the mask corresponds to a '0', the corresponding bit in the output port remains unchanged.

2.2.10 Save CNC data field

Command: Save CNC data field

Purpose: This command is used as an initialisation for the transmission of storable commands and is required at the beginning of CNC mode.

Structure: @<GN>i<CR>

@	= Data opening character
<GN>	= Device number, Standard=0
i	= Save CND data field command
<CR>	= Carriage Return as command end

Use: @0i

Explanation: The control unit is addressed with '@'. 'i' indicates that a CNC data field should be saved. The command is concluded with carriage return. The control unit then only accepts CNC commands until the 'data field end' command or until an error occurs. The command is acknowledged with a corresponding reply. All subsequent storable commands are saved in FlashPROM.

2.2.11 Delete CNC program

Command: Delete CNC program in FlashPROM

Purpose: This command deletes a CNC program saved in FlashPROM.

Structure: @<GN>k<CR>

@	= Data opening character
<GN>	= Device number, Standard=0
k	= Delete FlashPROM command
<CR>	= Carriage Return as command end

Use: @0k

Explanation: The control unit is addressed with '@'. 'k' indicates that the FlashPROM buffer of the control unit should be deleted. The command is concluded with carriage return. The control unit confirms the successful deletion with a reply '0'.

2.2.12 Execution of an absolute movement

Command: Movement to the absolute position

Purpose: The control unit moves to the specified position at the specified speeds. The travelling movement is executed immediately.

Structure: @<GN>M<S>,<G><CR>

@	= Data opening character
<GN>	= Device number, Standard=0
M	= Absolute movement command
<S>	= Position
<G>	= Speed
<CR>	= Carriage Return as command end

Use: @0M 5000,900

Explanation: The control unit is addressed with '@'. 'M' indicates that an absolute position follows. The control unit replies with the handshake character after successful execution. The control unit can only process new commands after the command has been executed.

2.2.13 Set zero point

Command: Set zero point at the current point

Purpose: The control unit saves the current position as a virtual zero point. The next 'absolute travel' commands consider this virtual zero point as a new reference point.

Structure: @<GN>n1<CR>

@	= Data opening character
<GN>	= Device number, Standard=0
n	= Set zero point command
1	= Axis specification, see below
<CR>	= Carriage Return as command end

Use: @0n1

Explanation: The control unit is addressed with '@'. 'n' indicates that a zero point shift should be carried out. Since the IT116Flash is a single-axis control unit, only the value 1 is possible for the axis specification.

The control unit reports with a reply after successful execution.

2.2.14 Simulate reference run

Command: Set reference point at the current point

Purpose: The control unit simulates a reference run; no axis movement is carried out.

Structure: @<GN>N1<CR>

             @   = Data opening character
             <GN>   = Device number, Standard=0
             N   = Simulate reference run command
             1   = Axis specification, see below
             <CR>   = Carriage Return as command end

Use: @0N1

Explanation: The control unit is addressed with '@'. 'N' indicates that a reference run should be simulated. Since the IT116Flash is a single-axis control unit, only the value 1 is possible for the axis specification.

The control unit reports with a reply after successful execution.

2.2.15 Query of current position

Command: Position query

Purpose: The control unit reports the actual current position of the axis to the superordinate computer.

Structure: @<GN>P<CR>

             @   = Data opening character
             <GN>   = Device number, Standard=0
             P   = Position query command
             <CR>   = Carriage Return as command end

Use: @0P

Explanation: The control unit is addressed with '@'. 'P' indicates that a position query follows. The control unit confirms this with the handshake character with subsequent output in hexadecimal format.

The structure of the reported position is as follows:

Example: 000100

Position = 000100, hexadecimal in the 2nd complement, corresponding to 256 decimal.

2.2.16 Reference run

Command: Reference run

Purpose: The control unit moves the axis to its zero point (reference point). The reference point of the axis is always defined in a logical default arrangement in isel systems.

Structure: @<GN>R1<CR>

@	= Data opening character
<GN>	= Device number, Standard=0
R or r	= Reference run command
1	= Axis specification, see below
<CR>	= Carriage Return as command end

Use: @0R1

Explanation: The control unit is addressed with '@'. 'R' indicates that a reference run should be executed. The subsequent numerical value defines the axis which should perform a reference run. Since the IT116Flash is a single-axis control unit, only the value 1 is possible for the axis specification.

After a successful reference run, the control unit sends its acknowledgement character and awaits the next command. The control unit can only process commands once the reference run has been executed by the mechanical components.

ATTENTION: If a reference switch is not connected, the axis is permanently actuated, whereby the axis can move to the mechanical end stops.

2.2.17 Starting a stopped movement or a CNC program

Command: Start

Purpose: A stopped movement should be resumed or a CNC program should be started.

Structure: @<GN>S<CR>

@	= Data opening character
<GN>	= Device number, Standard=0
S or s	= Start command
<CR>	= Carriage Return as command end

Explanation: The control unit is addressed with '@'. 'S' indicates that a stopped movement should be started and the remainder of the actual movement should be executed. If no movement has been stopped, a stored CNC program is started. The control unit replies with the handshake character ('0') after successful execution or with an error message if there is no remaining movement in the buffer or no CNC program has been saved.

2.2.18 Switch test mode on/off

Command: Switch test mode on/off

Purpose: Test mode can be switched on and off using the command.

Structure: @<GN>T<Status><CR>

@	= Data opening character
<GN>	= Device number, Standard=0
T	= Switch test mode on/off command
<Status>	= 0 --> Switch off, 1 --> Switch on
<CR>	= Carriage Return as command end

Use: @0T1, @0T0

Explanation: The control unit is prepared for a new command with the data opening '@0'. 'T1' switches test mode on; 'T0' switches test mode off. The control unit reports after the command has been executed with the handshake character ('0'). The control unit treats the reference run and the limit switches differently in test mode than in normal operation. If a reference run command is received in test mode, the control unit does not perform a reference run in the actual sense, rather it sets the current point as a reference point. The limit switches can still be monitored, but they can be overrun. This is very useful when an axis is at a limit switch after the system is switched on and must be retracted.

2.2.19 Query of control unit version data

Command: Query version data

Purpose: Query of important control unit version data.

Structure: @<GN>V<CR>   or   @<GN>?<CR>

@	= Data opening character
<GN>	= Device number, Standard=0
V	= Query version data command
<CR>	= Carriage Return as command end

Use: @0V, @0?

Explanation: The control unit is prepared for a new command with the data opening '@0'. 'V' prompts the control unit to send information about the control unit version in plain text format. The control unit answers with the handshake character ('0') at the end of this information. The information is output formatted in lines in ASCII format, such that a terminal window, for instance, can be represented directly on the screen of a control computer.

2.2.20 Executing a movement until port event

Command: Movement until port event

Purpose: Linear relative movement until port event or end of movement

Structure: @<GN>Z<A>,<M>,<W>,<G>,<S><CR>

        @   Data opening character
        <GN> Device number, standard=0
        Z   Movement until port command
        <A>   Port address
        <M>   Mask for bits masking
        <W>   Setpoint as a condition for end of movement
        <G>   Speed
        <S>   Path
        <CR> Carriage Return as command end

Use: @0Z0,8,8,600,3000

Explanation: The control unit is addressed with '@0'; Z indicates that a relative movement should can be ended by a port event should take place. The movement is executed with the specified speed. The movement is ended when the specified path has been travelled or when Bit3 at Input port 0 is set to 1.

2.2.21 Control codes

Control codes enable direct access to the functional sequence of the control unit via the serial interface. In the process, the respective transmitted command is evaluated directly in the receipt routine of the control unit without delay and then executed. Special control codes are available for the following functionalities:

Function: Software stop   char(253)

A positioning movement in DNC mode (relative or absolute), can be stopped with a stop command. A subsequently executed start command ends with the interrupted functional sequence. After a stop command, the currently reached position can also be read with the 'position query' command. This functionality can also be reached by pressing the stop button. If a movement has been successfully stopped, the control unit generates an additional response 'F'.

The function is called with transmission of a cha(523) via the serial RS232 interface.

Function: Software set   char(254)

The control unit immediately interrupts all activities and executes an internal software reset. Then the system must be re-initialised and a reference run must be executed.

The function is called with transmission of a char(254) via the serial RS232 interface.

Function: Software break   char(255)

A positioning movement in DNC mode (relative or absolute) can be ended with a break command. This means that the rest of the movement is forgotten.

The function is called with transmission of a char(255) via the serial RS232 interface.

3 CNC mode and its commands

3.1 Command structure of CNC commands

When operating in CNC mode, the control unit stores all transmitted commands in the internal data buffer. The command 'save CNC data field' must be transmitted for activation after the standard initialisation. Then the data field is transmitted and concluded with the 'data field end' command.
The program can now be activated with an external start command (pressing the start button) without further communication with the control computer.

The storable commands of the IT116Flash controller are listed and briefly explained below. A detailed explanation can be looked up for some commands under the corresponding DNC mode command, because the meaning and number of parameters correspond to those of DNC mode.

If an error occurs during the transmission and storing of a CNC data field, the CNC program saved up to that point is marked as invalid and cannot be processed.

3.2 Commands of IT116Flash in CNC mode

3.2.1 Save CNC data field

Command: Save CNC data field

Purpose: This command is used as an initialisation for the transmission of storable commands and is required at the beginning of CNC mode.

Structure: @<GN>i<CR>

@	= Data opening character
<GN>	= Device number, Standard=0
i	= Save CND data field command
<CR>	= Carriage Return as command end

Use: @0i

Explanation: The control unit is addressed with '@'. 'i' indicates that a CNC data field should be saved. The command is concluded with carriage return. The control unit then only accepts CNC commands until the 'data field end' command or until an error occurs. The command is acknowledged with a corresponding reply. All subsequent storable commands are saved in FlashPROM.

3.2.2 Relative movement in CNC mode

Command: Relative movement

Purpose: The control unit stores a relative movement corresponding to the transmitted path of travel and the speed.

Structure: 0<S>,<G><CR>

0	= Relative movement command code
<S>	= Path
<G>	= Speed
<CR>	= Carriage Return as command end

Use: 05000.900

Explanation: '0' indicates that a relative movement should take place. The control unit now awaits a pair of numbers consisting of the path and speed. The specification of the distance is a relative measurement, which means it is based on the previous position. The control unit responds with the handshake character ('0') after a successful save.

3.2.3 Send synchronisation character

Command: Send synchronisation character

Purpose: The control unit transmits an ASCII character via the serial interface.

Structure: 1<Z><CR>

7	= Reference run command code
<Z>	=ASCII code (decimal between 33 and 126)
<CR>	= Carriage Return as command end

Use: 133

Explanation: '1' indicates that a synchronisation character should be sent. '33' stands for the ASCI character '!'. The control unit responds with the handshake character ('0') after a successful save.

3.2.4 Wait for synchronisation character

Command: Wait for synchronisation symbol

Purpose: The control unit waits to receive an ASCII character.

Structure: 2<Z>,<Offset><CR>

7	= Reference run command code

<Z>   =ASCII code (decimal between 33 and 126)
<Offset>   =Offset, jump target on receipt of the correct character
<CR>   = Carriage Return as command end

Use: 133,-10

Explanation: '1' indicates that a synchronisation character should be awaited. '33' stands for the ASCI character '!'. The control unit interrupts the command execution until a character has been received. If the received character matches the specified synchronisation character (in this case '!'), branching with an offset takes place (-10 command in this case), otherwise the command processing continues with the next command in the CNC program. The control unit responds with the handshake character ('0') after a successful save.

3.2.5 Looping, branching in CNC mode

Command: Loop, branch

Purpose: Saving of loops and branches. Looping is used for summarising equivalent movement processes. For this purpose, the available storage space of the control unit is better utilised. A jump to a specific set within the program can take place after a logical decision.

Structure: 3<Number>,<Offset><CR>

3   = Loop, branching command code
<Number>   = Loop number
             Loop: 0 < Loop number
             Branching: always 0
<Offset>   = Jump target
             Loop: -1 >= Jump target
             Branching: -Offset <= Jump target <= +Offset
<CR>   = Carriage Return as command end

Use: 3 25,-1   Repeat last command 25 times
             3 0,-5   Always branch 5 steps back
             3 0,5   Jump over the next 4 commands
             3 6,-5   Repeat the last 5 commands 6 times

Explanation: If the control unit encounters the 'loop/branching' command in the CNC program sequence, a check of the loop number is used to determine whether it is a loop or branching command. If it is a loop command, a loop counter is set up and pre-set and the command counter is corrected according to the specified offset. The commands up to the loop counter are now repeated and the loop counter is decremented until it reaches zero. Then the execution is resumed with the first command after the loop. Loops can be nested within one another with a nesting depth of 15. The necessary counters are then managed on a corresponding loop stack.

With branching, the offset is understood as a relative jump target within the CNC program and the command counter is corrected by the offset.

Branching may not take place before the start or after the end of the data set. Forward loops are not permitted. A loop must always repeat the last n commands. At least one command must always be repeated. Loops may be nested with a maximum nesting depth of 8. A loop may not be exited by branching.

3.2.6 Time delays in CNC mode

Command: Time delay

Purpose: Saving of time delays.

Structure: 5<Time><CR>

5	= Time delay command code
<Time>	= Time in 1/10 sec
<CR>	= Carriage Return as command end

Use: 350   5 second delay

Explanation: If the control unit encounters the 'time delay' command within the CNC program sequence, the execution of the next command in the CNC command takes place after the laps of the time delay. The time is specified in 1/10 seconds.

3.2.7 Movement until port event in CNC mode.

Command: Definition of port condition for movement until port event

Purpose: The control unit stores the condition for a movement until port event. This condition is applied to the subsequent movement.

Structure: 6<PortNo>,<BitNo>,<Value><CR>

6	= Port condition command code
<PortNo>	= Port number
<BitNo>	= Bit number, 1 - 8 --> bit-by-bit, 128 --> byte-by-byte
<Value>	= Comparison value
<CR>	= Carriage Return as command end

Use: 60,128,1   Subsequent movement is ended, if Port 0 == 1
        60,1,0   Subsequent movement is ended, if Port0, Bit1 == 0

Explanation: '6' indicates that the condition for a movement until a port event should be defined. This condition is applied to the subsequent movement command. The corresponding port is queried during the subsequent movement and

logically compared bit-by-bit or byte-byte with the specified value. If the logical comparison is true, the movement is ended.

Port	Bit	Status	Function
0	0 - 7	00 - FF	User I/O (also possible with 65531)
1	0 - 4	00 - 0F	Function keys F1 – F4

3.2.8 Reference run in CNC mode

Command: Reference run

Purpose: The control unit stores a movement of the axes at their zero point (reference point).

Structure: 71<CR>

> 7   = Reference run command code
> 1   = Axis specification, see below
> <CR>   = Carriage Return as command end

Use: 71

Explanation: '7' indicates that a reference run should be executed. Since the IT116Flash is a single-axis control unit, only the value 1 is possible for the axis specification.

3.2.9 Data field end in CNC mode

Command: Data field end

Purpose: The command identifies the end of a CNC data field and is used for conclusion of the data transmission and saving of storable commands.

Structure: 9<CR>

> 9   = Data field end command code
> <CR>   = Carriage Return as command end

Use: 9

Explanation: '9' indicates that the end of the transmitted CNC data field has been reached. The command is concluded with carriage return. The control unit replies with the software handshake '0', if the save was successful, or with an error message. In addition to the identification of the data field as a valid CNC program, status information (e.g. the current reference speed) is stored in FlashProm. Then the control unit switches returns to DNC mode and accepts the corresponding commands.

A CNC data field must be concluded with the data field end command; otherwise the stored CNC program is not valid and cannot be processed.

3.2.10 Define reference run in CNC mode.

Purpose: The command defines the speed at which are reference run is executed.

Structure: d<G><CR>

        d   =Set reference speed command
        <G>   = Reference speed
        <CR>   = Carriage Return as command end

Use: d2500

Explanation: If no information about the reference speed is transmitted to the control unit, the execution takes place with a default value. A changed value is not saved after switching off.

Limitation: The specified speed must lie within the valid range of values for speeds.
               If a reference value which is too high is selected in combination a large spindle pitch, the reference switch can be damaged due to the inertia. The control unit requires a switching hysteresis of the connected zero position switch. This must be observed for connection of electronic zero sensors!

3.2.11 Define acceleration in CNC mode

Command: Set acceleration

Purpose: The command defines the acceleration with which the ramps necessary for the movements are executed.

Structure: g<B><CR>

        g   = Set acceleration
        <B>   = Acceleration
        <CR>   = Carriage Return as command end

Use: g100

Explanation: If the control unit does not transfer any information about the acceleration, the execution takes place with a default value. A changed value is not saved after switching off.
               The acceleration is specified in Hz/ms, the default value is 100 Hz/ms. Accelerations between 1Hz/ms and 1000 HZ/ms are provided as a value range.

Limitation: The specified acceleration must lie within the valid value range for acceleration.
An acceleration value which is too high can lead to losses of steps in the acceleration or braking phase.

3.2.12 Define start-stop sequence in CNC mode

Command: Set start-stop frequency

Purpose: The command defines the frequency at which the ramps required for the movements begin and end.

Structure: j<F><CR>

j = Set start-stop frequency
<F> = Frequency
<CR> = Carriage Return as command end

Use: j300

Explanation: If the control unit does not transfer any information about the acceleration, the execution takes place with a default value. A changed value is not saved after switching off.
The specification of the start-stop frequency takes place in Hz; the default value is 300 Hz. Frequencies in a range of values between 20Hz and 40kHz are provided.

Limitation: The specified start-stop frequency must lie within the valid value range for step frequencies.
A start-stop frequency which is too high can result in step losses in the acceleration or braking phase.

3.2.13 Absolute movement in CNC mode

Command: Movement to the absolute position

Purpose: The control unit saves an absolute movement according to the specified speeds and positions.

Structure: m<P>,<G><CR>

m = Absolute movement command code
<P> = Position
<G> = Speed
<CR> = Carriage Return as command end

Use: m5000,900

Explanation: 'm' indicates that an absolute position follows. The control unit now awaits a pair of numbers consisting of position and speed. The specification of the distance is an absolute measurement, which means it is in relation to the current zero point. The control unit replies with the handshake character after a successful save.

3.2.14 Set zero point in CNC mode

Command: Set zero point at the current point.

Purpose: The control unit saves a command in order to set the current position during the execution of the CNC program as a virtual zero point for the specified axis(axes). The subsequent 'absolute travel' commands are then relative to this virtual zero point.

Structure: n1<CR>

n   = Set zero point command code
1   = Axis specification, see below
<CR>   = Carriage Return as command end

Use: n1

Explanation: 'n' indicates that a zero point shift should be carried out. Since the IT116Flash is a single-axis control unit, only the value 1 is possible for the axis specification.

The control unit reports with a response after a successful save.

3.2.15 Simulate reference run in CNC mode

Command: Simulate reference run

Purpose: The control unit saves a command in order to set the current position during the execution of the CNC program as a reference point.

Structure: N1<CR>

N   = Set zero point command code
1   = Axis specification, see below
<CR>   = Carriage Return as command end

Use: N1

Explanation: 'N' indicates that a reference run should be simulated. Since the IT116Flash is a single-axis control unit, only the value 1 is possible for the axis specification.

The control unit reports with a response after a successful save.

3.2.16 Read port and branch in CNC mode

Command: Read input port and branch

Purpose: Read input port and branch in program sequence. With the branching, a jump can take place after a logical comparison with a specific set within the program.

Structure: o<PortNo>,<BitNo>,<Value>,<Offset><CR>

          o   = Set port command code
          <PortNo>   = Port number
          <BitNo>   = Bit number, 0 - 7 --> bit-by-bit, 128 --> byte-by-byte
          <Value>   = Comparison value
          <Offset>   = Jump target
          <CR>   = Carriage Return as command end

Use: o0,128,1,-1   wait until Port 0 <> 1
        o0,1,1,-1   wait until Port0, Bit1 = 0
        o0,1,1,3   if Port0, Bit1 == 1, command counter += 3

Explanation: '0' indicates that the value of an input port should be read and the program sequence should be adjusted according to the value. Then the port number, bit number, comparison value, and the command offset are transmitted separated by command and the command is concluded with carriage return. The control unit answers with the software handshake '0', if the save was successful, or with an error message, if the incorrect port numbers and/or values were transmitted. The appropriate port is queried during the program sequence and logically compared bit-by-bit or byte-by-byte with the specified value. If the logical comparison is true, branching takes place with the offset, otherwise the next command in the program sequence is executed.

Port	Bit	Status	Function
0	1 - 4	00 - 0F	User I/O (also possible with 65531)
1	1 - 4	00 - 0F	System I/O

The querying of port inputs is executed within the control unit according to the program sequence. Therefore, a query of inputs while a command is being processed, i.e. a positioning movement, is not possible.

3.2.17 Set port in CNC mode

Command: Set output port

Purpose: Defined switching on/off of existing output ports.

Structure: p<PortNo>,<BitNo>,<Value><CR>

p	= Set port command code	
\<PortNo\>	= Port number	
\<BitNo\>	= Bit number, 0 - 7 --\> bit-by-bit, 128 --\> byte-by-byte	
\<Value\>	= New value	
\<CR\>	= Carriage Return as command end	

Use: p0,128,1   Port 0, set to 1 byte-by-byte
             p0,1,1   Port 0 , set Bit 1 to 1

Explanation: 'p' indicates that the value of an output port should be set. Then the port number, bit number, and the new port value are transmitted separated by command and the command is concluded with carriage return. The control unit answers with the software handshake '0', if the save was successful, or with an error message, if the incorrect port numbers and/or values were transmitted.

Port	Bit	Value	Function
0	1 - 4	0 - 15	User I/O (also possible with 65529)

The port outputs are set within the control unit according to the program sequence. Therefore, setting and/or deleting outputs during command processing, e.g. a positioning movement, is not possible.

3.2.18 Switch test mode on/off in CNC mode

Command: Switch test mode on/off

Purpose: Test mode can be switched on and off using the command.

Structure: T\<Status\>\<CR\>

T	= Switch test mode on/off command
\<Status\>	= 0 --\> Switch off, 1 --\> Switch on
\<CR\>	= Carriage Return as command end

Use: T1, T0

Explanation: 'T1' switches test mode on; 'T0' switches test mode off. The control unit reports after the command has been executed with the handshake character ('0'). The control unit treats the reference run and the limit switches differently in test mode than in normal operation. If a reference run command is received in test mode, the control unit does not perform a reference run in the actual sense, rather it sets the current point as a reference point. The limit switches can still be monitored, but they can be overrun. This is very useful when an axis is at a limit switch after the system is switched on and must be retracted.

4 Error messages of IT116Flash

After each transmitted command, the control unit replies with a corresponding response. This code is transmitted as ASCII characters, making it easy to evaluate. Sources and causes of errors can be recognised based on the transmitted characters. The individual error codes are described below.

Code	Description
0	Handshake character - No error, the command was successfully executed. - The next command can be transmitted.
1	Error in the transmitted number - The control unit received a number specification which could not be correctly interpreted. - The transmitted number value is outside the permissible range or the transmitted number value contains impermissible characters.
2	Limit switch error - A limit switch was triggered by a travel movement. The current movement was interrupted. - The reference run of an axis was not correctly executed or not executed. **ATTENTION:** The control unit must be re-initialised after limit switch error and a reference run must be executed.
3	Impermissible axis specification - The control unit received an axis specification for command to be executed in which an undefined axis is contained. - Only use axis specifications containing combinations of axes which are initialised in the commands.
4	No axes defined - Before movements or general commands which have a number of parameters depending on the number of axes are transmitted to the control unit, the 'set number of axes' command must be transmitted in order to correctly set the internal axis parameters.
5	Syntax error - An command was incorrectly transmitted. - The command which was used does not exist or cannot be executed by this control unit. - Check whether all transmitted commands are correct.
6	Buffer end - An attempt was made to transmit more commands in CNC mode than can be stored in the control unit.
7	Impermissible number of parameters - The control unit has received more or fewer parameters for the command than required. - Check whether the number of parameters for the command in combination with the number of axes is correct.
8	Command to be saved incorrect - A command was transmitted to the control unit which is not available as a CNC command.
9	System error

	- The voltage supply of the system has not been switched on. - The safety circuit of the system is not active. - The limit stages and/or safety circuit could not be switched on, because the hood is still open. - An Emergency STOP situation has occurred. **ATTENTION:** The control unit must be re-initialised after an Emergency STOP situation and a reference run must be executed.
A	Not used by this control unit
B	Not used by this control unit
C	Not used by this control unit
D	Impermissible speed - The permissible limits for speed specifications have not been observed. - Check whether all speed specifications are correct.
E	Not used by this control unit
F	User stop - The user has actuated the stop button on the control unit and the current movement has been stopped. The command execution can be resumed with the start button or the start command '@0s'.
G	Invalid data field - The control unit was sent a start command, although there is movement remaining in the buffer, which means no stop function was executed beforehand. - An attempt was made to transmit a CNC program, although there is still a program or part of a program in the buffer.
H	Not used by this control unit
=	Not used by this control unit