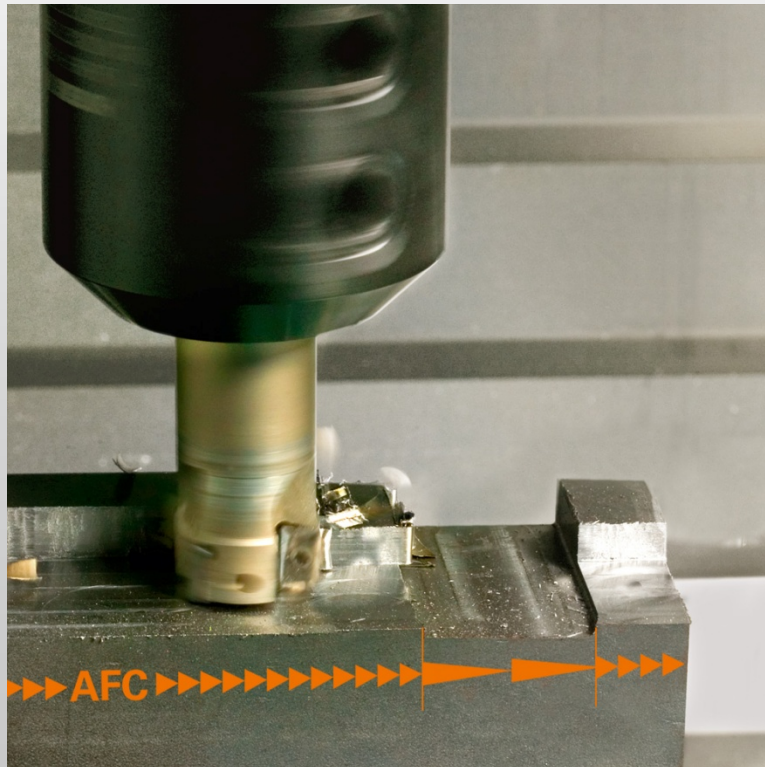




AFC

Adaptive Feed Control (Software Option 45)



HEIDENHAIN

iTNC 530

As of software 340 49x-03

As of software 606 42x-01

TNC 640

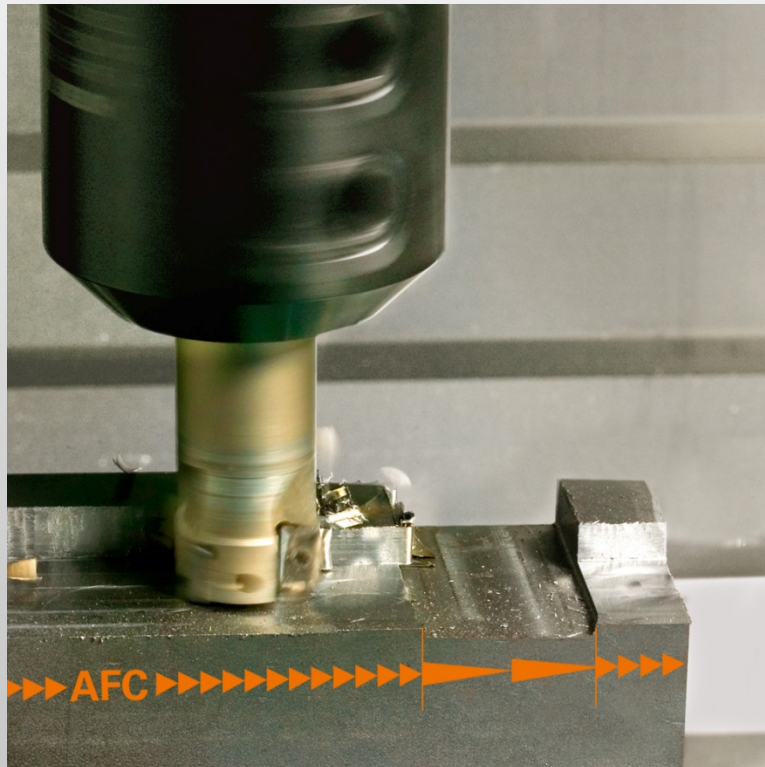
As of software 340 59x-02

dynamic + **efficiency**



HEIDENHAIN

Application





Application

- Extension of tool life
- Optimization of machining time
- Avoidance of tool breakage
- Protection of machine kinematics

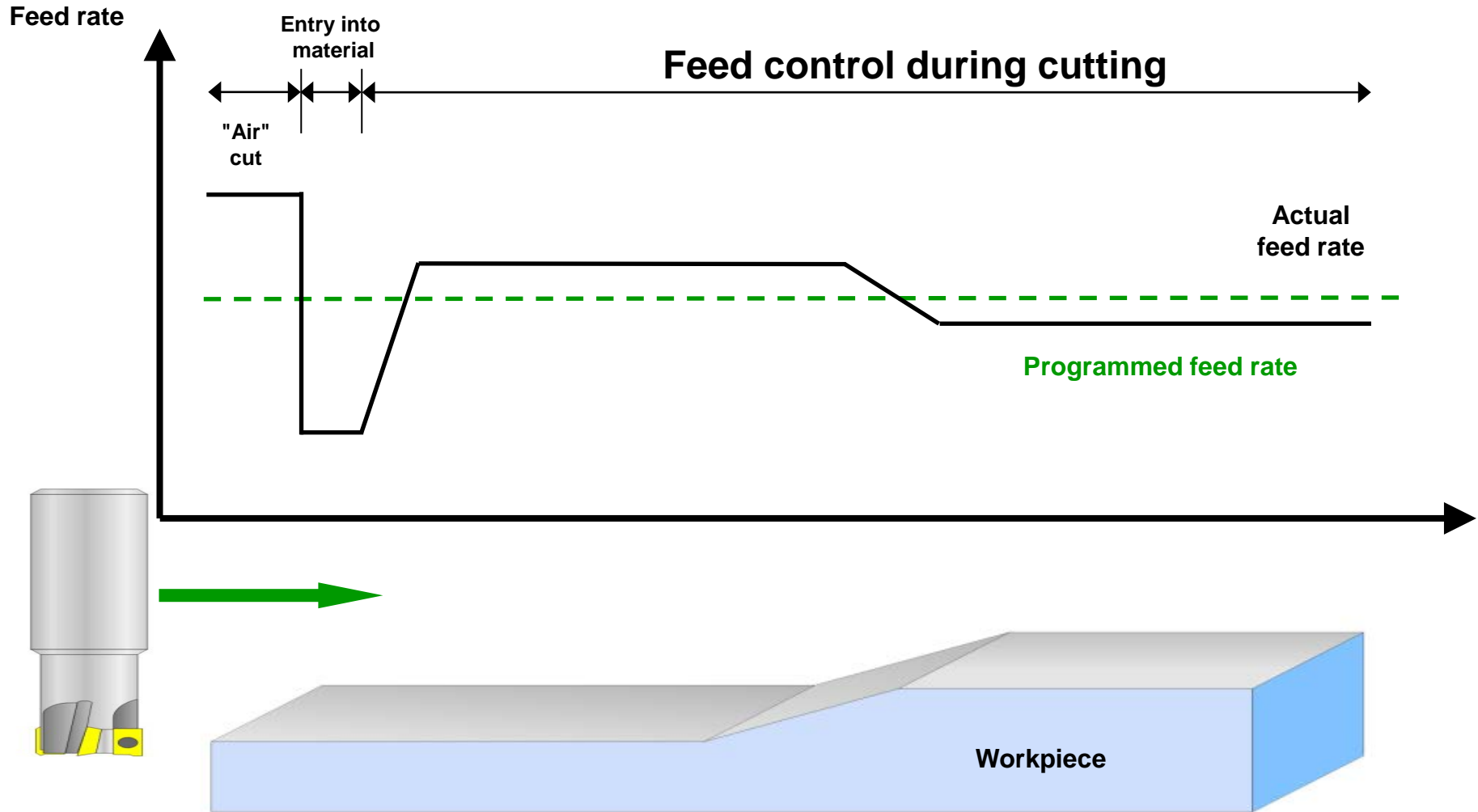
Function

- Trigger overload reaction depending on the reference values
- Transfer the spindle reference load
- Adapt the machining feed rate depending on the spindle current consumption





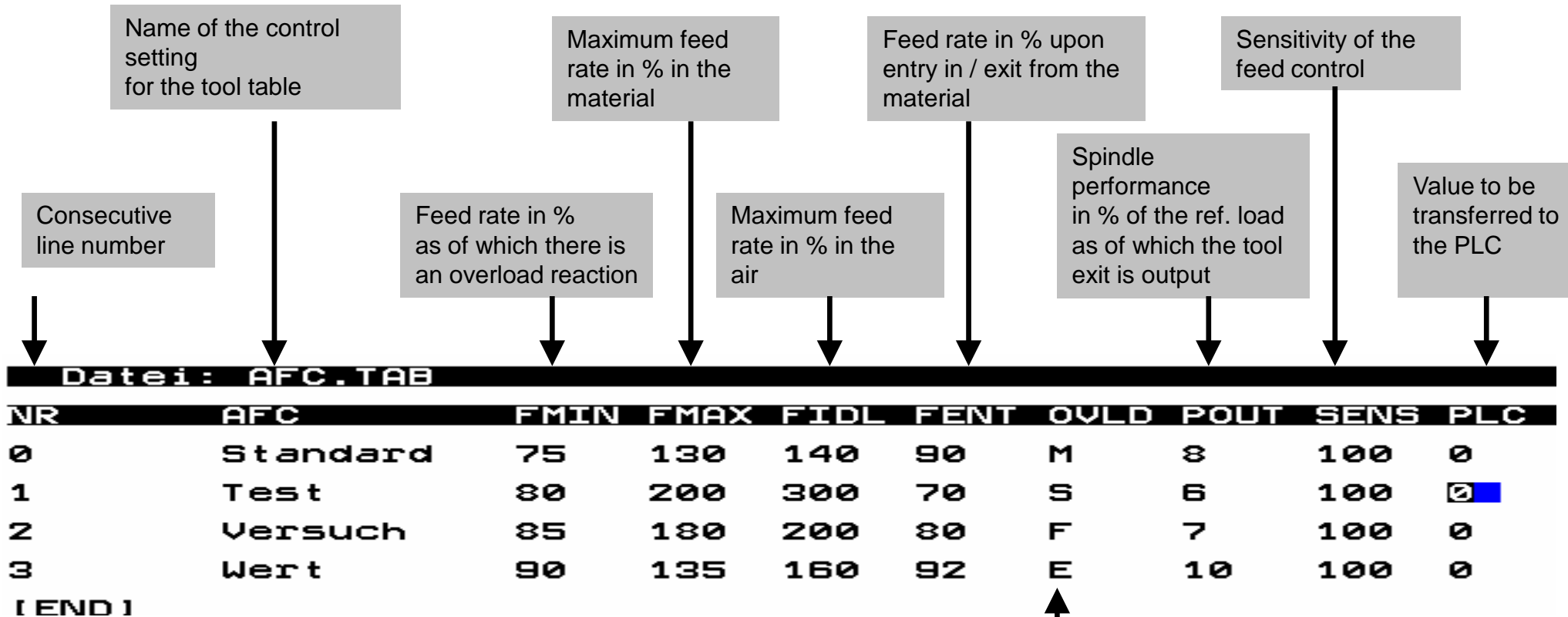
Adaptive Feed Control





Adaptive Feed Control

MW M-TS/ Sep. 2014



Desired reaction of the TNC to overload:

M: Run a special AFC macro.
(defined by the OEM)

F: Output NC stop when the tool has been retracted

-: Do not perform overload reaction

S: Immediately perform NC stop

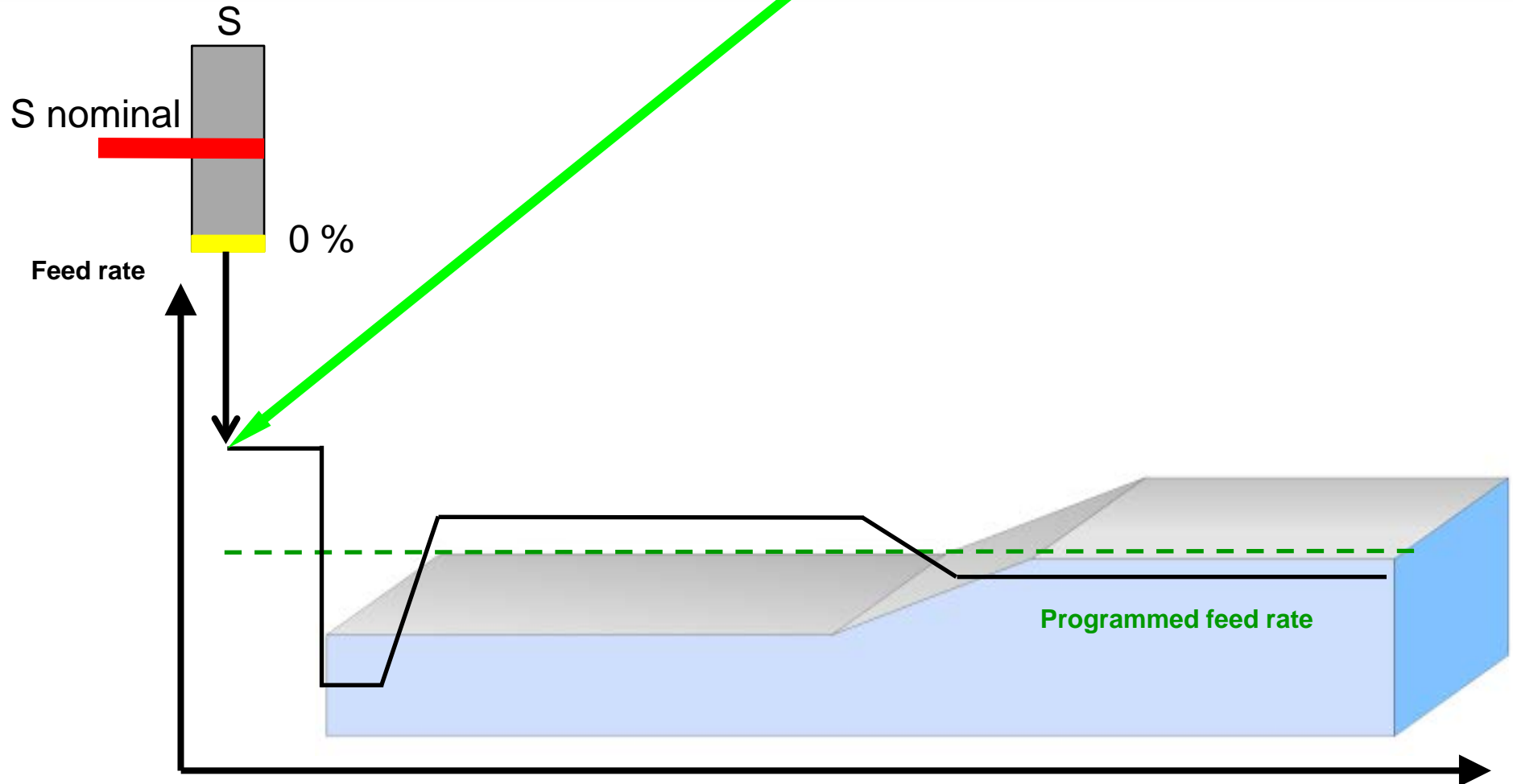
E: Only error message on the screen



Adaptive Feed Control

MW M-TS/ Sep. 2014

Datei: AFC.TAB									
NR	AFC	FMIN	FMAX	FIDL	FENT	OVLD	POUT	SENS	PLC
0	Standard	75	130	140	90	M	8	100	0

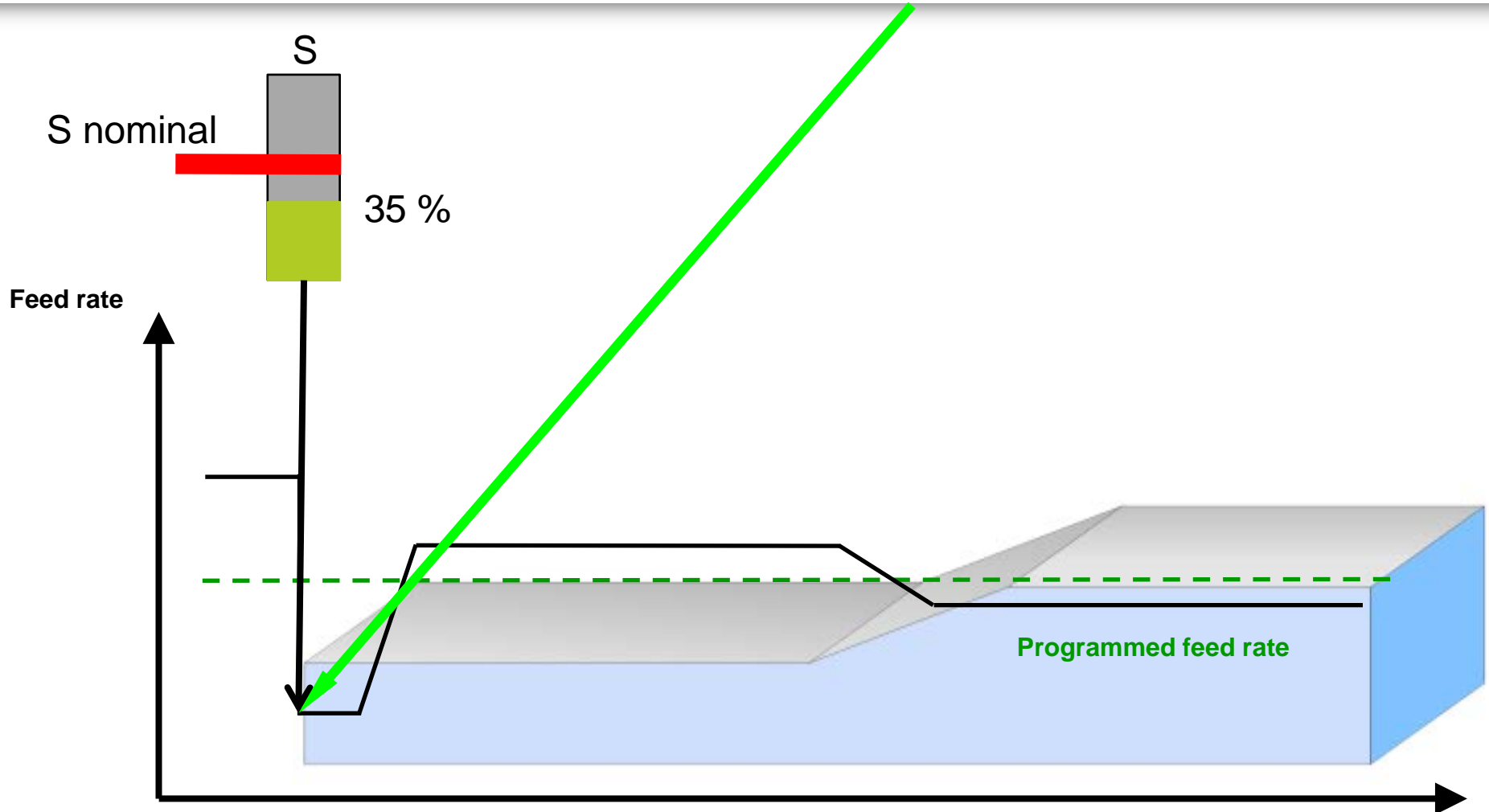




Adaptive Feed Control

MW M-TS/ Sep. 2014

Date: AFC.TAB									
NR	AFC	FMIN	FMAX	FIDL	FENT	OVLD	POUT	SENS	PLC
0	Standard	75	130	140	90	M	8	100	0



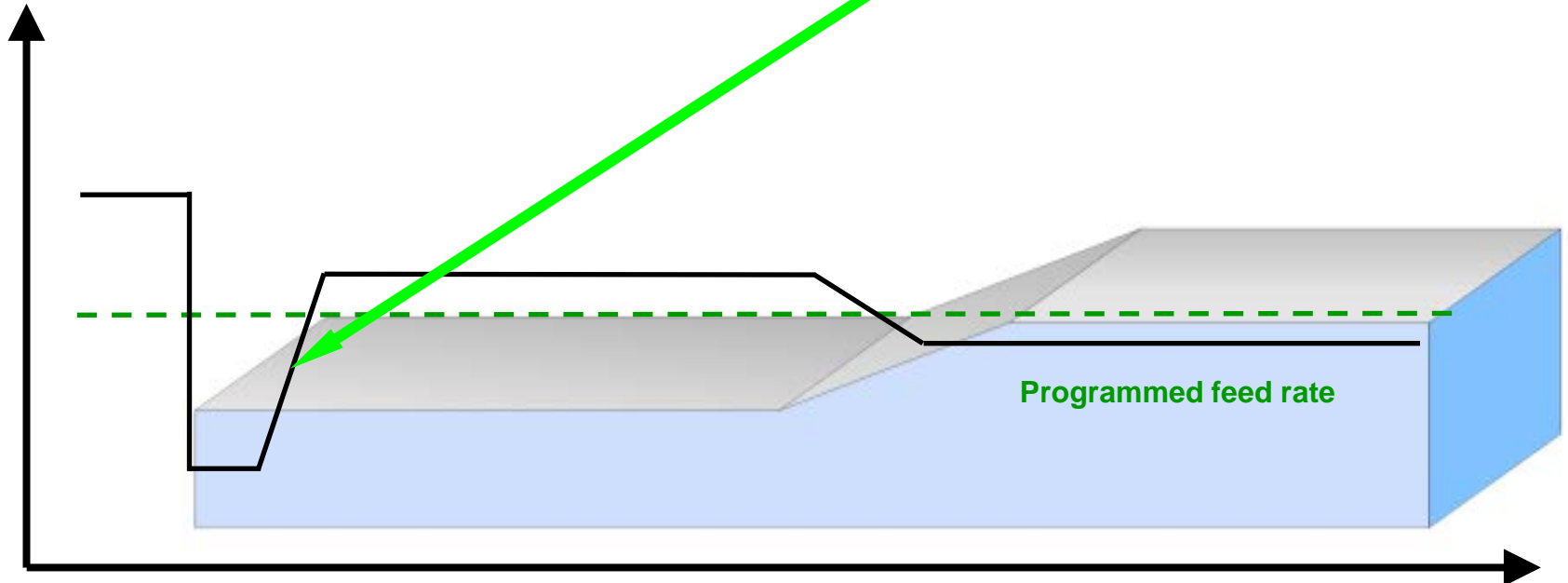


Adaptive Feed Control

MW M-TS/ Sep. 2014

Date: AFC.TAB									
NR	AFC	FMIN	FMAX	FIDL	FENT	OVLD	POUT	SENS	PLC
0	Standard	75	130	140	90	M	8	100	0

Feed rate

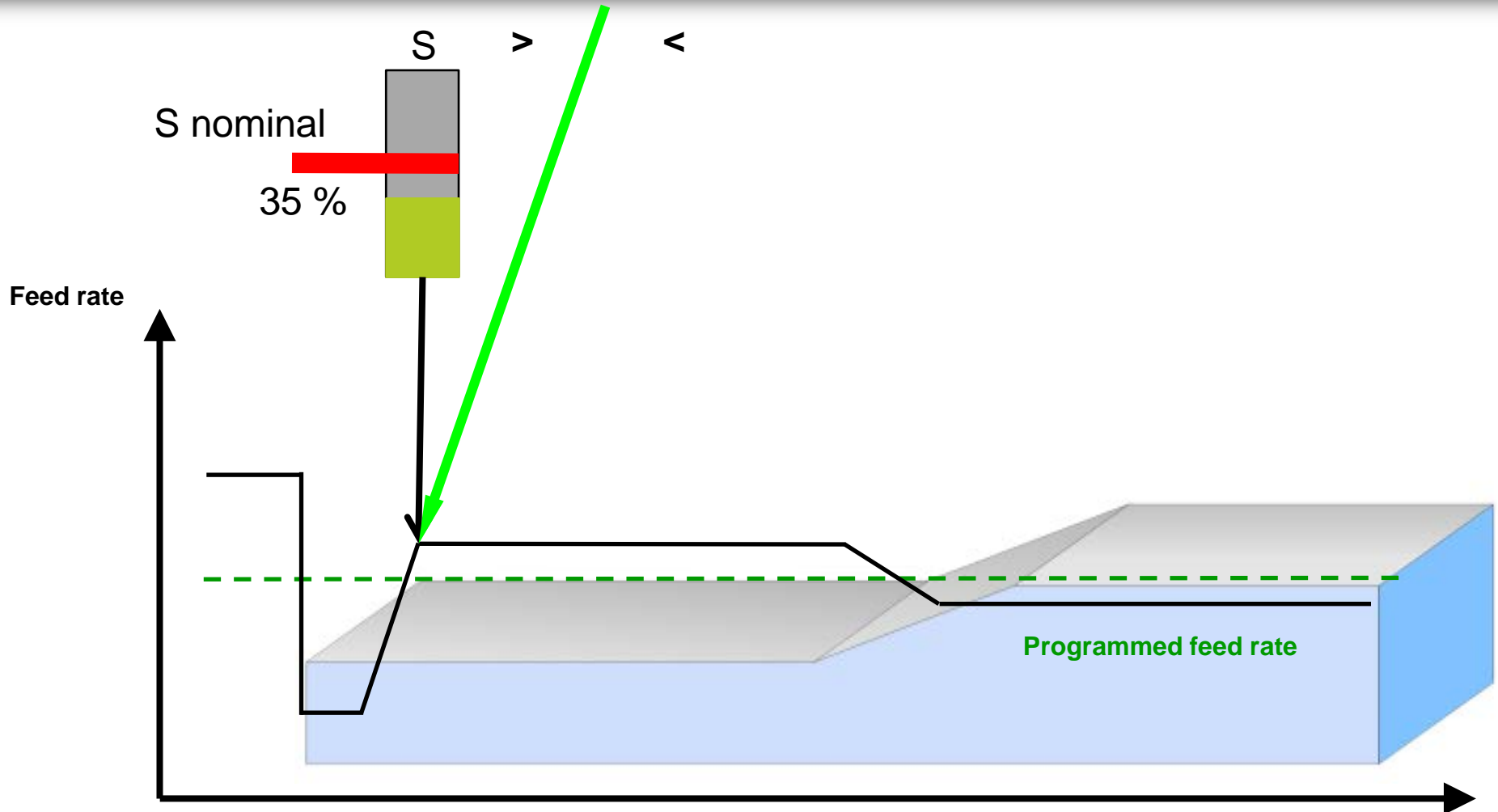




Adaptive Feed Control

MW M-TS/ Sep. 2014

Date: AFC.TAB										
NR	AFC	FMIN	FMAX	FIDL	FENT	OVL	POUT	SENS	PLC	
0	Standard	75	130	140	90	M	8	100	0	

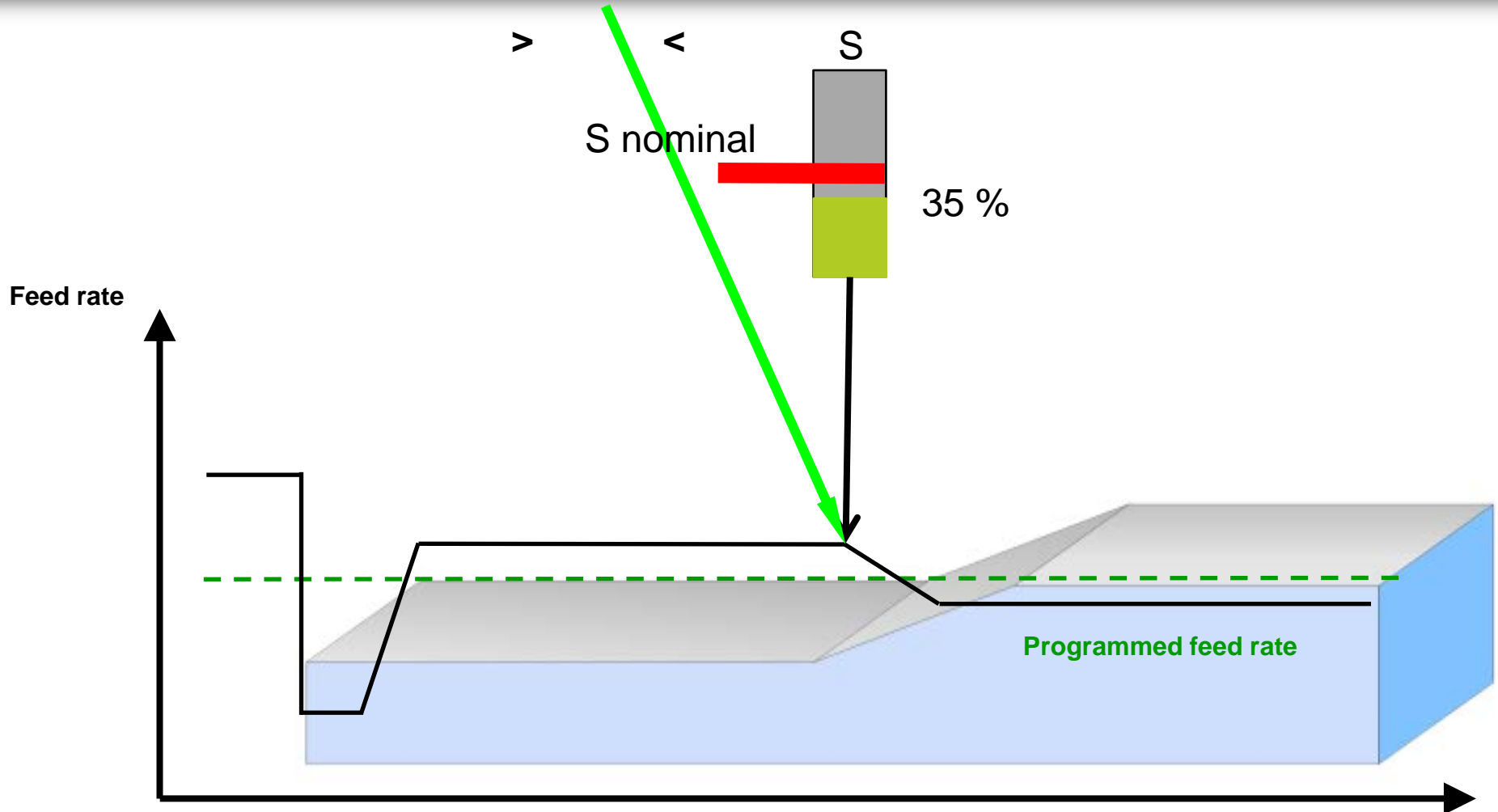




Adaptive Feed Control

MW M-TS/ Sep. 2014

Date: AFC.TAB									
NR	AFC	FMIN	FMAX	FIDL	FENT	OVL	POUT	SENS	PLC
0	Standard	75	130	140	90	M	8	100	0

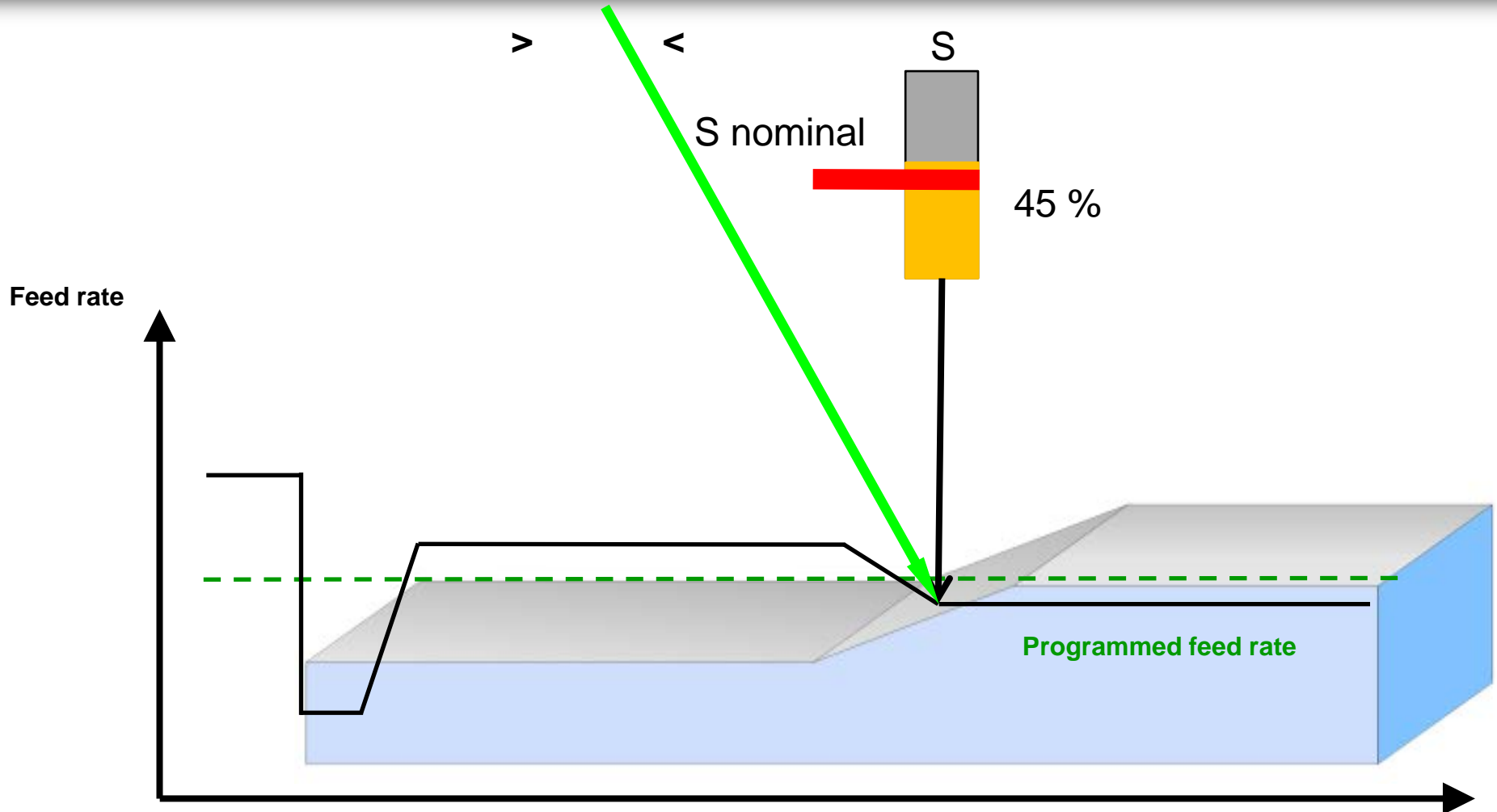




Adaptive Feed Control

MW M-TS/ Sep. 2014

Datei: AFC.TAB									
NR	AFC	FMIN	FMAX	FIDL	FENT	OVL	POUT	SENS	PLC
0	Standard	75	130	140	90	M	8	100	0

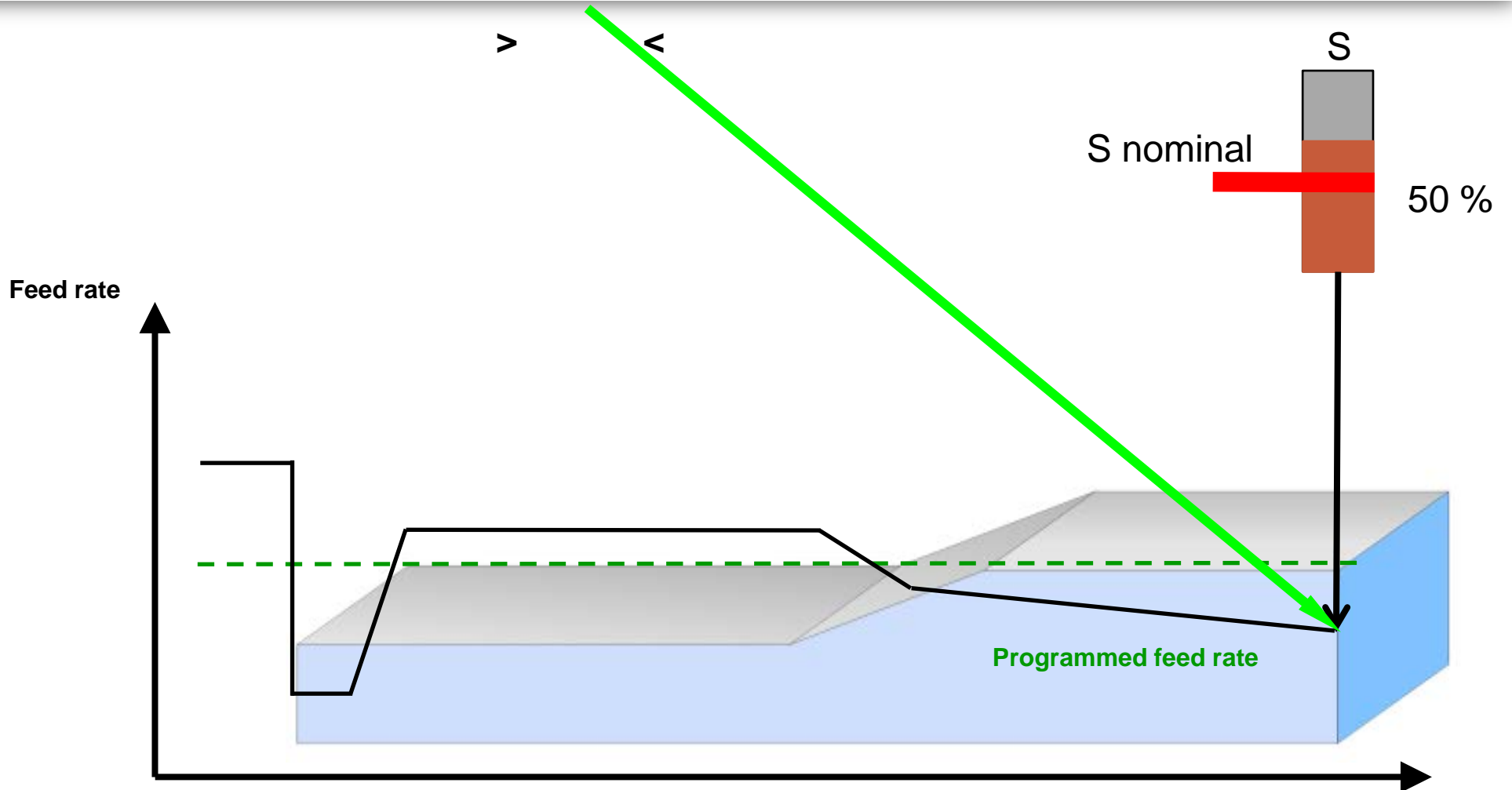




Adaptive Feed Control

MW M-TS/ Sep. 2014

Date: AFC.TAB										
NR	AFC	FMIN	FMAX	FIDL	FENT	OVLD	POUT	SENS	PLC	
0	Standard	75	130	140	90	M	8	100	0	





HEIDENHAIN

Programming





Programming

MW M-TS/ Sep. 2014

Preparation:

- **AFC table** (AFC.TAB in the TNC directory)
 - Name of the control strategy
 - FMIN, FMAX, FIDL, etc.
- **TOOL.T**
 - Entry of AFC strategy

```
File: AFC.tab
NR      AFC      FMIN  FMAX  FIDL
0       Standard  70    125   100
[END]
```

Tool table editing
Feedback-control strategy

Programming and editing

NR	RANGE	PLATE	NAME	RZTOL	LAST USE	Acc	OURTIME
1	+0	+0	Standard	0	2013.10.18 12:23	0	0
2	+0	+0	Standard	0	2013.10.18 12:23	0	0
3	+0	+0	Standard	0	2013.10.18 12:23	0	0
4	+0	+0	Standard	0	2013.10.18 12:23	0	0
5	+0	+0	Standard	0	2013.10.18 12:23	0	0
6	+0	+0	Standard	0	2013.10.18 12:23	0	0
7	+0	+0	Standard	0	2013.10.18 12:23	0	0
8	+0	+0	Standard	0	2013.10.18 12:23	0	0
9	+0	+0	Standard	0	2013.10.18 12:23	0	0
10	+0	+0	Standard	0	2013.10.18 12:23	0	0
11	+0	+0	Standard	0	2013.10.18 12:23	0	0
12	+0	+0	Standard	0	2013.10.18 12:23	0	0
13	+0	+0	Standard	0	2013.10.18 12:23	0	0
14	+0	+0	Standard	0	2013.10.18 12:23	0	0
15	+0	+0	Standard	0	2013.10.18 12:23	0	0
16	+0	+0	Standard	0	2013.10.18 12:23	0	0
17	+0	+0	Standard	0	2013.10.18 12:23	0	0

0% S-IST
0% SCNm] LIMIT 1 09:33

X	+0.000	Y	+0.000	Z	+500.000
*B	+0.000	*C	+0.000		

S1 0.000

ACTL. 0 T Z S 500 F 0 M 5 / 9

POCKET # DISPLAY HIDE	TOOLS DISPLAY HIDE	ASSIGN TOOL TYPE	ASSIGN CUTTING MATERIAL	ASSIGN CUTTING DATA TABLE	ASSIGN KINEMATICS	FIND CURRENT TOOL NAME	COPY LINE
-----------------------------	--------------------------	------------------------	-------------------------------	---------------------------------	----------------------	------------------------------	--------------

S100% OFF ON
F100% OFF ON



AFC operating statuses:

■ During teach-in:

The maximum spindle load during machining is determined.

The teach-in phase can extend over the entire machining operation or be terminated manually after the maximum spindle load has been reached.

■ During controlling:

As soon as the control or the operator switches to controlling, the AFC controls the feed rate so that the learned spindle load is maintained.

For this purpose, AFC varies the feed rate between **FMIN** and **FMAX**. If no spindle load is detected (<2%), AFC switches to **FIDL**.





Preparation:

- **NC program**
 - Tool change
 - Spindle ON
 - AFC ON via
 - HEIDENHAIN function
 - M function (OEM)
 - Cycle (OEM)
- Machining
- AFC OFF
 - HEIDENHAIN function
 - M function (OEM)
 - Cycle (OEM)

Manual operation	Programming and editing
	<pre>2 BLK FORM 0.2 X+100 Y+200 Z+0 3 WMAT "st 37-2" 4 L Z+100 FMAX M5 5 L X+0 Y-20 FMAX 6 TOOL CALL 2 Z S2000 F4000 7 L Z+30 M3 8 FUNCTION AFC CUT BEGIN LOAD57 9 CALL LBL 2 10 FUNCTION AFC CUT END 11 M5 12 TOOL CALL 1 Z S1000 F2000 13 L Z+20 M3 14 FUNCTION AFC CUT BEGIN LOAD0 15 CALL LBL 2 16 FUNCTION AFC CUT END 17 M5 18 TOOL CALL 4 S1500 F3000 19 L Z+10 M4 20 FUNCTION AFC CUT BEGIN TIME3 21 CALL LBL 2 22 FUNCTION AFC CUT END 23 M5 24 STOP M2 25 ;Konturunterprogramm 26 LBL 2 27 L X+0 28 L Y+170 29 FUNCTION AFC CTRL 30 L X+0 Y-20 31 L Z+100 FMAX 32 LBL 0 33 END PGM AFCDEMO3 MM</pre>
	<p>BEGIN PGM AFCDEMO3 MM END PGM AFCDEMO3 MM</p>
	<p>M </p> <p>S </p> <p>T </p> <p>S100% OFF ON</p> <p>F100% OFF ON</p>
	<p>FUNCTION AFC CUT BEGIN FUNCTION AFC CUT END FUNCTION AFC CUT CTRL</p>



AFC ON/OFF

FUNCTION AFC CUT

- **SPEC FCT** key
- **PROGRAM FUNCTIONS** soft key
- **AFC FUNCTIONS** soft key

- **FUNCTION AFC CUT BEGIN:** Start teach-in cut (teach-in can be stopped manually)
- **FUNCTION AFC CUT BEGIN TIME10:** Start teach-in cut
Teach-in for 10 seconds, then switchover to controlling

→ Available as of **606 42x – 04 (iTNC 530)**

→ Available as of **340 59x – 04 (TNC 640)**

Manual operation | Programming and editing

```
2 BLK FORM 0.2 X+100 Y+200 Z+0
3 WMAT "st 37-2"
4 L Z+100 FMAX M5
5 L X+0 Y-20 FMAX
6 TOOL CALL 2 Z S2000 F4000
7 L Z+30 M3
8 FUNCTION AFC CUT BEGIN LOAD57
9 CALL LBL 2
10 FUNCTION AFC CUT END
11 M5
12 TOOL CALL 1 Z S1000 F2000
13 L Z+20 M3
14 FUNCTION AFC CUT BEGIN LOAD0
15 CALL LBL 2
16 FUNCTION AFC CUT END
17 M5
18 TOOL CALL 4 S1500 F3000
19 L Z+10 M4
20 FUNCTION AFC CUT BEGIN TIME3
21 CALL LBL 2
22 FUNCTION AFC CUT END
23 M5
24 STOP M2
25 ;Konturunterprogramm
26 LBL 2
27 L X+0
28 L Y+170
29 FUNCTION AFC CTRL
30 L X+0 Y-20
31 L Z+100 FMAX
32 LBL 0
33 END PGM AFCDEMO3 MM
```

BEGIN PGM AFCDEMO3 MM
END PGM AFCDEMO3 MM

M

S

T

S100%
OFF ON

F100%
OFF ON

FUNCTION AFC CUT BEGIN | FUNCTION AFC CUT END | FUNCTION AFC CUT CTRL



AFC ON/OFF

- **FUNCTION AFC CUT BEGIN DIST100:**
Start teach-in cut
Teach-in over 100 mm, then switchover to controlling
- **FUNCTION AFC CUT BEGIN LOAD45:** Start controlling with spindle reference load of 45 %
- **FUNCTION AFC CTRL:**
Switchover from teach-in to controlling
- **FUNCTION AFC CUT END:**
AFC OFF, end cut

→ Available as of **606 42x – 04 (iTNC 530)**

→ Available as of **340 59x – 04 (TNC 640)**

The screenshot displays the CNC control interface with the following elements:

- Manual operation** (left tab)
- Programming and editing** (right tab)
- G-code:**

```
2 BLK FORM 0.2 X+100 Y+200 Z+0
3 WMAT "st 37-2"
4 L Z+100 FMAX M5
5 L X+0 Y-20 FMAX
6 TOOL CALL 2 Z S2000 F4000
7 L Z+30 M3
8 FUNCTION AFC CUT BEGIN LOAD57
9 CALL LBL 2
10 FUNCTION AFC CUT END
11 M5
12 TOOL CALL 1 Z S1000 F2000
13 L Z+20 M3
14 FUNCTION AFC CUT BEGIN LOAD0
15 CALL LBL 2
16 FUNCTION AFC CUT END
17 M5
18 TOOL CALL 4 S1500 F3000
19 L Z+10 M4
20 FUNCTION AFC CUT BEGIN TIMES
21 CALL LBL 2
22 FUNCTION AFC CUT END
23 M5
24 STOP M2
25 ;Konturunterprogramm
26 LBL 2
27 L X+80
28 L Y+170
29 FUNCTION AFC CTRL
30 L X+0 Y-20
31 L Z+100 FMAX
32 LBL 0
33 END PGM AFCDEMOS MM
```
- Function Calls:**
 - BEGIN PGM AFCDEMOS MM
 - END PGM AFCDEMOS MM
- Right Panel:**
 - M: Machine status icon
 - S: Spindle status icon
 - T: Tool status icon
 - S100%: Spindle speed control (OFF/ON)
 - F100%: Feed rate control (OFF/ON)
- Bottom Panel:**
 - FUNCTION AFC CUT BEGIN
 - FUNCTION AFC CUT END
 - FUNCTION AFC CUT CTRL



Assigning several teach-in steps to a tool

- Call the tool
- M3

- AFC ON
- Machining 1
- AFC OFF

- AFC ON
- Machining 2
- AFC OFF

→ Thus you can save several reference spindle loads for a tool (e.g. for half-cut, trochoidal milling, full cut)

Manual operation Programming and editing

```
2 BLK FORM 0.2 X+100 Y+200 Z+0      BEGIN PGM AFCDEMO3 MM
3 WMAT "st 37-2"                      END PGM AFCDEMO3 MM
4 L Z+100 FMAX M5
5 L X+0 Y-20 FMAX
6 TOOL CALL 2 Z S2000 F4000
7 L Z+30 M3
8 FUNCTION AFC CUT BEGIN LOADS7
9 CALL LBL 2
10 FUNCTION AFC CUT END
11 M5
12 TOOL CALL 1 Z S1000 F2000
13 L Z+20 M3
14 FUNCTION AFC CUT BEGIN LOAD0
15 CALL LBL 2
16 FUNCTION AFC CUT END
17 M5
18 TOOL CALL 4 S1500 F3000
19 L Z+10 M4
20 FUNCTION AFC CUT BEGIN TIME3
21 CALL LBL 2
22 FUNCTION AFC CUT END
23 M5
24 STOP M2
25 ;Konturunterprogramm
26 LBL 2
27 L X+0
28 L Y+170
29 FUNCTION AFC CTRL
30 L X+0 Y-20
31 L Z+100 FMAX
32 LBL 0
33 END PGM AFCDEMO3 MM
```

M

S

T

S100% OFF ON

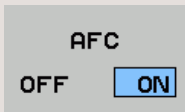
F100% OFF ON

FUNCTION AFC CUT BEGIN FUNCTION AFC CUT END FUNCTION AFC CUT CTRL



Possibility of intervention in controlling

- **Deactivate** or **activate** via soft key



- **Deactivate** if the value set for the potentiometer is changed manually **by more than 10 % in minus** direction.
- If the value of the **potentiometer is smaller than 50 %** and the AFC soft key is set to ON, **AFC is ineffective**. If the potentiometer setting is increased above 50 %, AFC automatically becomes active.





AFC settings memory file

- **<Program name>.h.AFC.DEP**
Storage location for the individual settings and reference spindle loads
- **<Program name>.h.AFC2.DEP**
AFC evaluation

ITNC530
Programmlauf Satzfolge

26 LBL 2
27 L X+00
28 L Y+170
29 FUNCTION AFC CTRL
30 L X+0 Y-20
31 L Z+100 FMAX
32 LBL 0
33 END PGM AFCDEM03 MM

POS	HR	TOOL	TT	TRANS	GS1	GS2	AFC
Modus Regeln							
T	4						DS
DOC: Tool 4							
Schnittnummer 3							
Istfaktor Override	125%						
Istlast Spindel	47%						
Referenzlast Spindel	58.2						
Istdrehzahl Spindel	1500						
Abweichung Drehzahl	0.0%						
00:00:53							

100% S-IST
0% SINM | LIMIT 1 09:50

X	+0.768	Y	-18.176	Z	-190.000
*B	+0.000	*C	+0.000		

S1
REF * 0 T 4 Z S 1500 F 3500 M 4 / 9

F MAX AFC EINSTEL-LUNGEN AFC AUS EIN WERKZEUG TABELLE



Table for the evaluation of AFC

NR	IDX	SNOM	SDIFF	LTIME	CTIME	TDIFF	PMAX	PREF	OULD	BLOCK
0	0	3000	0.0	00:00:07	00:00:07	0.0	59.8	51.1	-	4
1	0	3000	0.0	00:00:07	00:00:07	0.0	59.8	51.1	-	9
2		TOTAL		00:00:14	00:00:14	0.0				

[[Date]: 123.H.AFC2.DEP

[END]



Tasks of feedback control

- Detect entry into material
- Calculation of the optimal feed rate
- Monitoring for overload (switch-off reaction, if necessary)
- Saving the maximum value of the spindle power (for the evaluation)
- Detect exit from material
- Switchover to feed rate in air
- **AFC inactive during machining with FMAX**



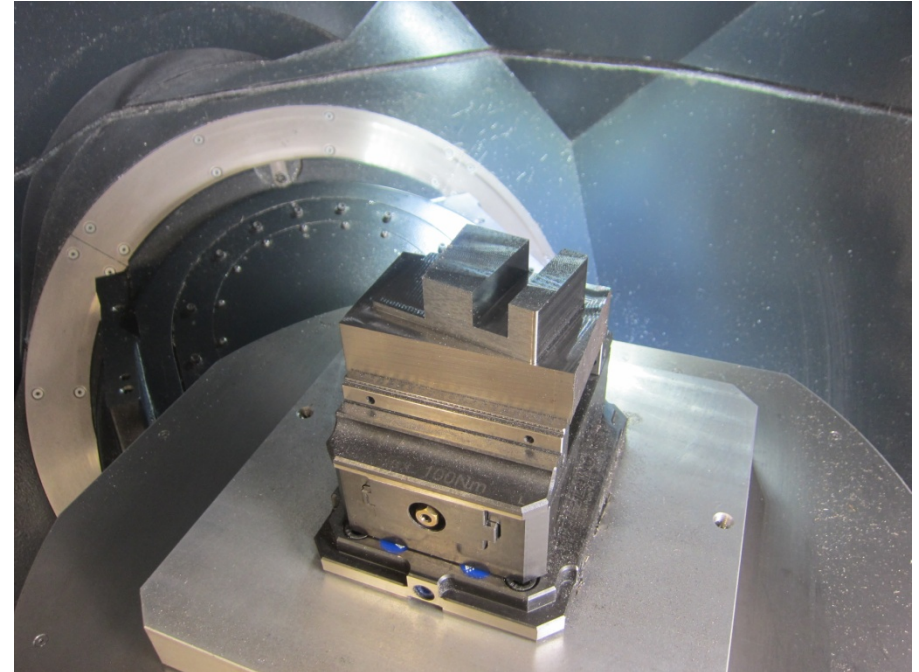
Machining example

HEIDENHAIN



Example

- Face milling (without AFC)
- Rectangular stud milling (at 10 ° angle, with AFC)
 - T D16
 - ae 4 mm (cutting width)
 - ap 30 mm (cutting depth)
 - Fz 0.2
- Shoulder milling (with AFC)
 - T D16
 - ae 4 mm
 - ap 25 mm
 - Fz 0.15





Example

- Trochoidal milling (with AFC)
 - T D12
 - Ae 2 mm
 - ap 20 mm
 - Fz 0.2

Program run time:

Without AFC 05:20 min

With AFC 04:15 min

→ Time saving of 21 %

