



# Machine capability test

## Cordless Screwdriver

### Angle EXACT 12V-12-400

With 180W Head 0.607.453.620



Torque range 2,5 – 8,0 Nm

Torque max. 9,0 Nm

Rotational speed range 95 – 480 rpm

Rotational speed max. 650 rpm

Machine 1	ANGLE EXACT 12V-12-400	Machine 2	ANGLE EXACT 12V-12-400	Machine 3	ANGLE EXACT 12V-12-400
Bare-Tool No.	3 602 D96 600	Bare-Tool No.	3 602 D96 600	Bare-Tool No.	3 602 D96 600
Serial number	331 000 044	Serial number	331 000 130	Serial number	331 000 145



## Table of Contents

<b>1. Overview of the cm – cmk values .....</b>	<b>4</b>
<b>2. Machine capability analysis .....</b>	<b>5</b>
<b>2.1 Machine capability analysis 331 000 044 (480 rpm) .....</b>	<b>5</b>
2.1.1 Screw joint 30° (hard) Set point 2,5 Nm (0%) .....	5
2.1.1.1 Screw joint 30° (hard) Set point 2,5 Nm (0%) 25/100 .....	6
2.1.1.2 Screw joint 30° (hard) Set point 2,5 Nm (0%) 75/100 .....	7
2.1.2 Screw joint 360° (soft) Set point 2,5 Nm (0%) .....	8
2.1.2.1 Screw joint 360° (soft) Set point 2,5 Nm (0%) 25/100 .....	9
2.1.2.2 Screw joint 360° (soft) Set point 2,5 Nm (0%) 75/100 .....	10
2.1.3 Screw joint 30° (hard) Set point 4,15 Nm (30%) .....	11
2.1.3.1 Screw joint 30° (hard) Set point 4,15 Nm (30%) 25/100 .....	12
2.1.3.2 Screw joint 30° (hard) Set point 4,15 Nm (30%) 75/100 .....	13
2.1.4 Screw joint 360° (soft) Set point 4,15 Nm (30%) .....	14
2.1.4.1 Screw joint 360° (soft) Set point 4,15 Nm (30%) 25/100 .....	15
2.1.4.2 Screw joint 360° (soft) Set point 4,15 Nm (30%) 75/100 .....	16
2.1.5 Screw joint 30° (hard) Set point 6,9 Nm (80%) .....	17
2.1.5.1 Screw joint 30° (hard) Set point 6,9 Nm (80%) 25/100 .....	18
2.1.5.2 Screw joint 30° (hard) Set point 6,9 Nm (80%) 75/100 .....	19
2.1.6 Screw joint 360° (soft) Set point 6,9 Nm (80%) .....	20
2.1.6.1 Screw joint 360° (soft) Set point 6,9 Nm (80%) 25/100 .....	21
2.1.6.2 Screw joint 360° (soft) Set point 6,9 Nm (80%) 75/100 .....	22
2.1.7 Screw joint 30° (hard) Set point 8,00 Nm (100%) .....	23
2.1.7.1 Screw joint 30° (hard) Set point 8,0 Nm (100%) 25/100 .....	24
2.1.7.2 Screw joint 30° (hard) Set point 8,0 Nm (100%) 75/100 .....	25
2.1.8 Screw joint 360° (soft) Set point 8,0 Nm (100%) .....	26
2.1.8.1 Screw joint 360° (soft) Set point 8,0 Nm (100%) 25/100 .....	27
2.1.8.2 Screw joint 360° (soft) Set point 8,0 Nm (100%) 75/100 .....	28
2.1.9 Screw joint 30° (hard) Set point 9,0 Nm (additional) .....	29
2.1.9.1 Screw joint 30° (hard) Set point 9,0 Nm (additional) 25/100 .....	30
2.1.9.2 Screw joint 30° (hard) Set point 9,0 Nm (additional) 75/100 .....	31
2.1.10 Screw joint 360° (soft) Set point 9,0 Nm (additional) .....	32
2.1.10.1 Screw joint 360° (soft) Set point 9,0 Nm (additional) 25/100 .....	33
2.1.10.2 Screw joint 360° (soft) Set point 9,0 Nm (additional) 75/100 .....	34
<b>2.2 Machine capability analysis 331 000 130 (480 rpm) .....</b>	<b>35</b>
2.2.1 Screw joint 30° (hard) Set point 2,5 Nm (0%) .....	35
2.2.1.1 Screw joint 30° (hard) Set point 2,5 Nm (0%) 25/100 .....	36
2.2.1.2 Screw joint 30° (hard) Set point 2,5 Nm (0%) 75/100 .....	37
2.2.2 Screw joint 360° (soft) Set point 2,5 Nm (0%) .....	38
2.2.2.1 Screw joint 360° (soft) Set point 2,5 Nm (0%) 25/100 .....	39
2.2.2.2 Screw joint 360° (soft) Set point 2,5 Nm (0%) 75/100 .....	40
2.2.3 Screw joint 30° (hard) Set point 4,15 Nm (30%) .....	41
2.2.3.1 Screw joint 30° (hard) Set point 4,15 Nm (30%) 25/100 .....	42
2.2.3.2 Screw joint 30° (hard) Set point 4,15 Nm (30%) 75/100 .....	43



2.2.4	Screw joint 360° (soft) Set point 4,15 Nm (30%) .....	44
2.2.4.1	Screw joint 360° (soft) Set point 4,15 Nm (30%) 25/100 .....	45
2.2.4.2	Screw joint 360° (soft) Set point 4,15 Nm (30%) 75/100 .....	46
2.2.5	Screw joint 30° (hard) Set point 6,9 Nm (80%) .....	47
2.2.5.1	Screw joint 30° (hard) Set point 6,9 Nm (80%) 25/100 .....	48
2.2.5.2	Screw joint 30° (hard) Set point 6,9 Nm (80%) 75/100 .....	49
2.2.6	Screw joint 360° (soft) Set point 6,9 Nm (80%) .....	50
2.2.6.1	Screw joint 360° (soft) Set point 6,9 Nm (80%) 25/100 .....	51
2.2.6.2	Screw joint 360° (soft) Set point 6,9 Nm (80%) 75/100 .....	52
2.2.7	Screw joint 30° (hard) Set point 8,0 Nm (100%) .....	53
2.2.7.1	Screw joint 30° (hard) Set point 8,0 Nm (100%) 25/100 .....	54
2.2.7.2	Screw joint 30° (hard) Set point 8,0 Nm (100%) 75/100 .....	55
2.2.8	Screw joint 360° (soft) Set point 8,0 Nm (100%) .....	56
2.2.8.1	Screw joint 360° (soft) Set point 8,0 Nm (100%) 25/100 .....	57
2.2.8.2	Screw joint 360° (soft) Set point 8,0 Nm (100%) 75/100 .....	58
2.2.9	Screw joint 30° (hard) Set point 9,0 Nm (additional) .....	59
2.2.9.1	Screw joint 30° (hard) Set point 9,0 Nm (additional) 25/100 .....	60
2.2.9.2	Screw joint 30° (hard) Set point 9,0 Nm (additional) 75/100 .....	61
2.2.10	Screw joint 360° (soft) Set point 9,0 Nm (additional) .....	62
2.2.10.1	Screw joint 360° (soft) Set point 9,0 Nm (100%) 25/100 .....	63
2.2.10.2	Screw joint 360° (soft) Set point 9,0 Nm (100%) 75/100 .....	64
<b>2.3</b>	<b>Machine capability analysis 331 000 145 (480 rpm) .....</b>	<b>65</b>
2.3.1	Screw joint 30° (hard) Set point 2,5 Nm (0%) .....	65
2.3.1.1	Screw joint 30° (hard) Set point 2,5 Nm (0%) 25/100 .....	66
2.3.1.2	Screw joint 30° (hard) Set point 2,5 Nm (0%) 75/100 .....	67
2.3.2	Screw joint 360° (soft) Set point 2,5 Nm (0%) .....	68
2.3.2.1	Screw joint 360° (soft) Set point 2,5 Nm (0%) 25/100 .....	69
2.3.2.2	Screw joint 360° (soft) Set point 2,5 Nm (0%) 75/100 .....	70
2.3.3	Screw joint 30° (hard) Set point 4,15 Nm (30%) .....	71
2.3.3.1	Screw joint 30° (hard) Set point 4,15 Nm (30%) 25/100 .....	72
2.3.3.2	Screw joint 30° (hard) Set point 4,15 Nm (30%) 75/100 .....	73
2.3.4	Screw joint 360° (soft) Set point 4,15 Nm (30%) .....	74
2.3.4.1	Screw joint 360° (soft) Set point 4,15 Nm (30%) 25/100 .....	75
2.3.4.2	Screw joint 360° (soft) Set point 4,15 Nm (30%) 75/100 .....	76
2.3.5	Screw joint 30° (hard) Set point 6,9 Nm (80%) .....	77
2.3.5.1	Screw joint 30° (hard) Set point 6,9 Nm (80%) 25/100 .....	78
2.3.5.2	Screw joint 30° (hard) Set point 6,9 Nm (80%) 75/100 .....	79
2.3.6	Screw joint 360° (soft) Set point 6,9 Nm (80%) .....	80
2.3.6.1	Screw joint 360° (soft) Set point 6,9 Nm (80%) 25/100 .....	81
2.3.6.2	Screw joint 360° (soft) Set point 6,9 Nm (80%) 75/100 .....	82
2.3.7	Screw joint 30° (hard) Set point 8,0 Nm (100%) .....	83
2.3.7.1	Screw joint 30° (hard) Set point 8,0 Nm (100%) 25/100 .....	84
2.3.7.2	Screw joint 30° (hard) Set point 8,0Nm (100%) 75/100 .....	85
2.3.8	Screw joint 360° (soft) Set point 8,0 Nm (100%) .....	86
2.3.8.1	Screw joint 360° (soft) Set point 8,0 Nm (100%) 25/100 .....	87
2.3.8.2	Screw joint 360° (soft) Set point 8,0 Nm (100%) 75/100 .....	88
2.3.9	Screw joint 30° (hard) Set point 9,0 Nm (additional) .....	89
2.3.9.1	Screw joint 30° (hard) Set point 9,0 Nm (additional) 25/100 .....	90



2.3.9.2	Screw joint 30° (hard) Set point 9,0 Nm (additional) 75/100 .....	91
2.3.10	Screw joint 360° (soft) Set point 9,0 Nm (additional) .....	92
2.3.10.1	Screw joint 360° (soft) Set point 9,0 Nm (additional) 25/100 .....	93
2.3.10.2	Screw joint 360° (soft) Set point 9,0Nm (additional) 75/100 .....	94
<b>3.</b>	<b><i>Certificates</i>.....</b>	<b>95</b>
<b>3.1</b>	<b>Calibration certificate torque and angle sensor 10 Nm .....</b>	<b>95</b>

## 1. Overview of the cm<sup>1</sup> – cmk<sup>2</sup> values

Torque range		Test data	0%		30%		80%		100%		additional		
2,5 Nm	8,0 Nm		30 °	360 °	30 °	360 °	30 °	360 °	30 °	360°	30 °	360°	
Tool	Serial number	Torque	2,5 Nm		4,15 Nm		6,9 Nm		8,0 Nm		9,0 Nm		
ANGLE EXACT 12V-12-400		Tolerance	±10 %										
		Upper tolerance limit	2,25 Nm		3,735Nm		6,21 Nm		7,2 Nm		8,1 Nm		
		Lower tolerance limit	2,75 Nm		4,565 Nm		7,59 Nm		8,8 Nm		9,9 Nm		
	331000044	Machine 1	Speed 480 rpm										
			cm	3,17	3,42	2,36	3,93	2,54	3,48	2,81	3,78	3,62	3,38
			cmk	2,94	2,98	2,29	3,69	2,47	3,47	2,62	3,35	2,77	3,09
	331000130	Machine 2	Speed 480 rpm										
			cm	2,57	4,14	2,50	3,95	2,53	3,98	2,53	2,57	2,62	3,83
			cmk	2,56	3,87	2,19	3,60	2,31	3,73	2,33	2,42	2,61	3,64
	331000145	Machine 3	Speed 480 rpm										
			cm	2,13	2,20	2,55	3,03	2,69	2,57	2,66	2,89	2,97	4,04
			cmk	2,04	2,01	2,47	2,66	2,67	2,49	2,50	2,74	2,86	4,00
Min cm/cmk		Speed 480 rpm											
		cm	2,13	2,20	2,36	3,03	2,53	2,57	2,53	2,57	2,62	3,38	
		cmk	2,04	2,01	2,19	2,66	2,31	2,49	2,33	2,42	2,61	3,09	
Battery: GBA 12V 6,0 Ah (1 607 A35 06F)	Undervoltage detection: Yes	Weight (w/o; 2,0Ah; 6,0Ah battery) 0,66 kg; 0,83 kg; 1,07 kg			Sound pressure level: < 70 dB(A)		Temperature: 21,2 °C Humidity: 43,7 %			Break between measurements: 3 sec.			

<sup>1</sup> machine capability

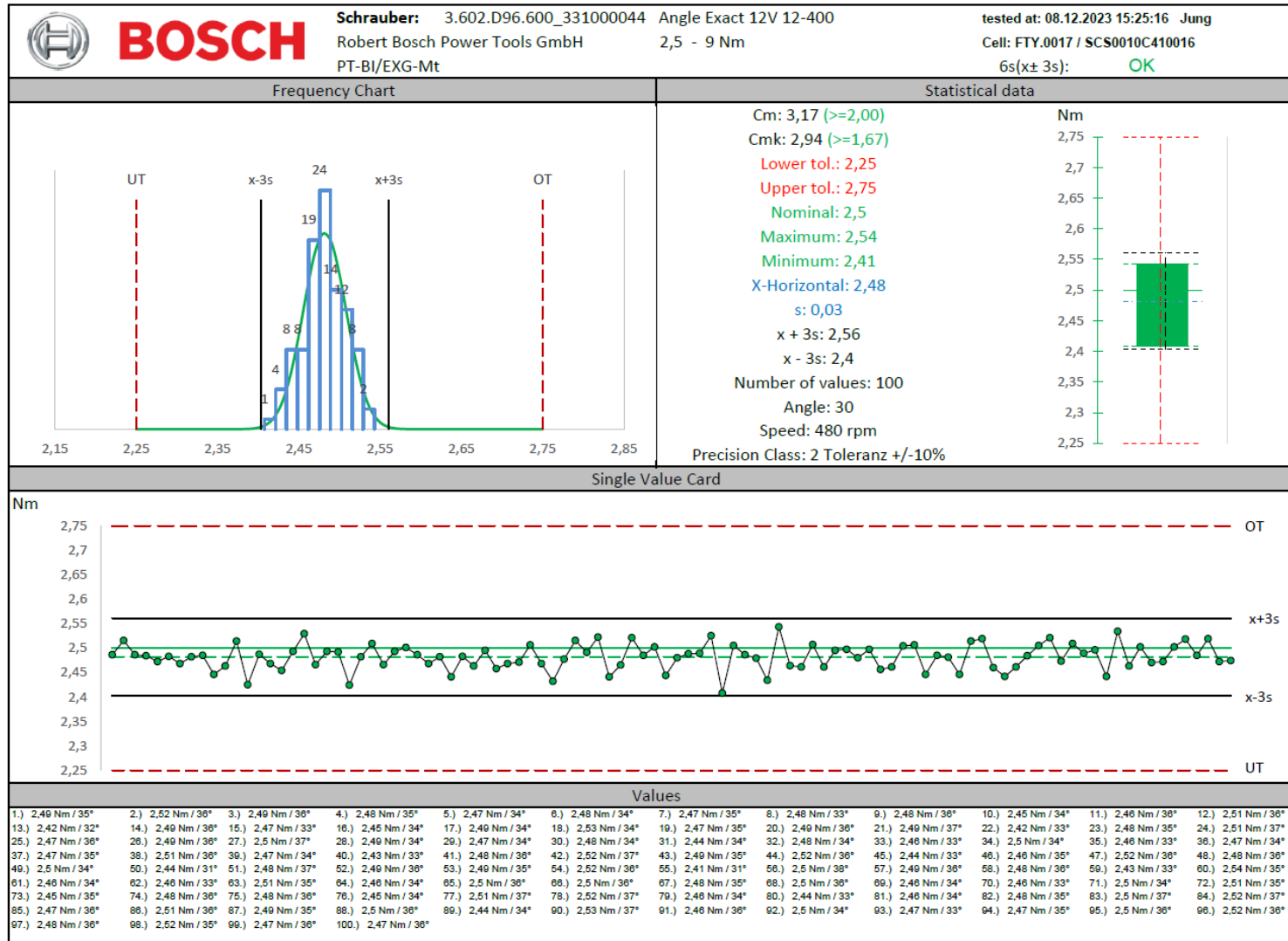
<sup>2</sup> position of machine capability



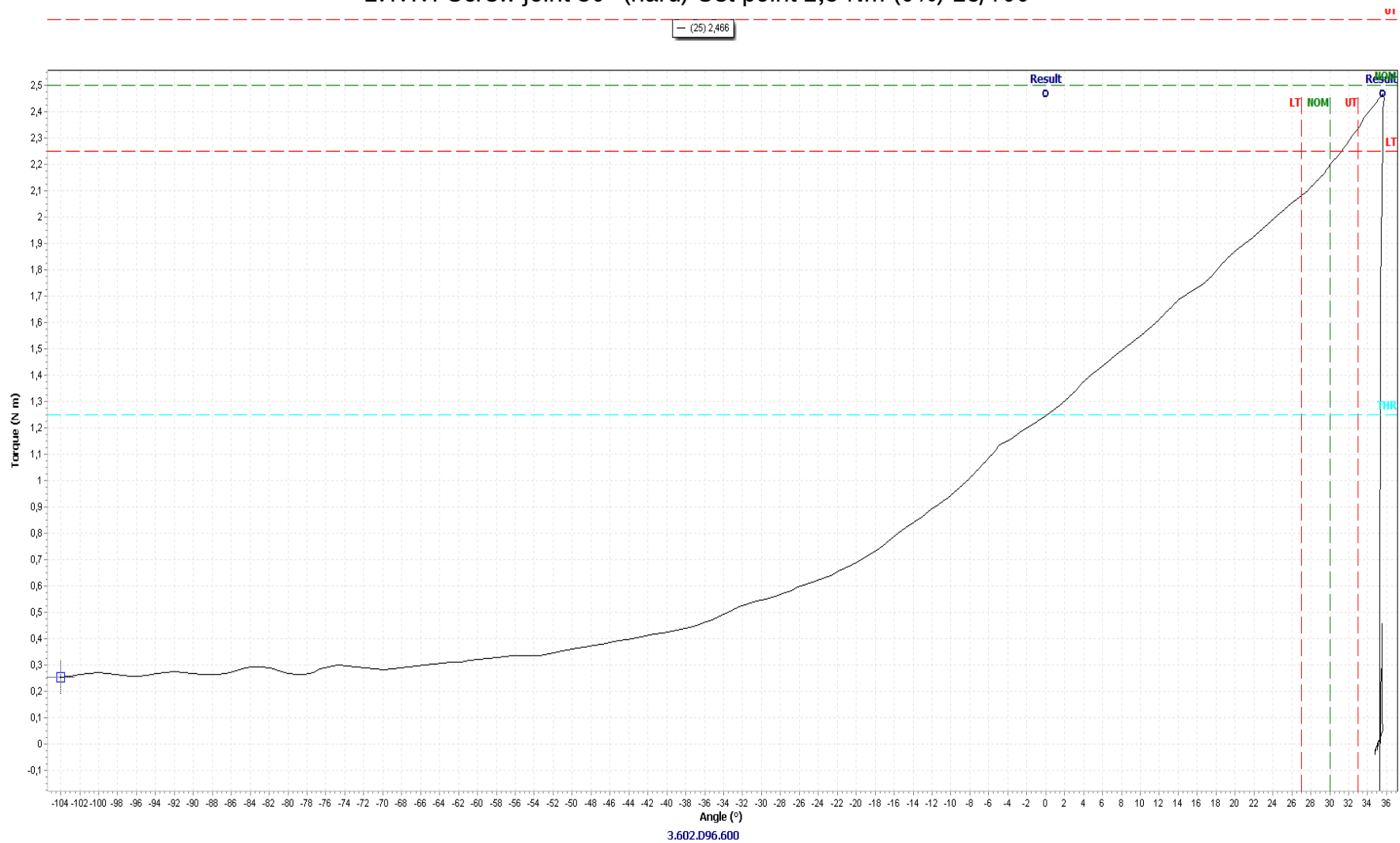
### 2. Machine capability analysis

#### 2.1 Machine capability analysis 331 000 044 (480 rpm)

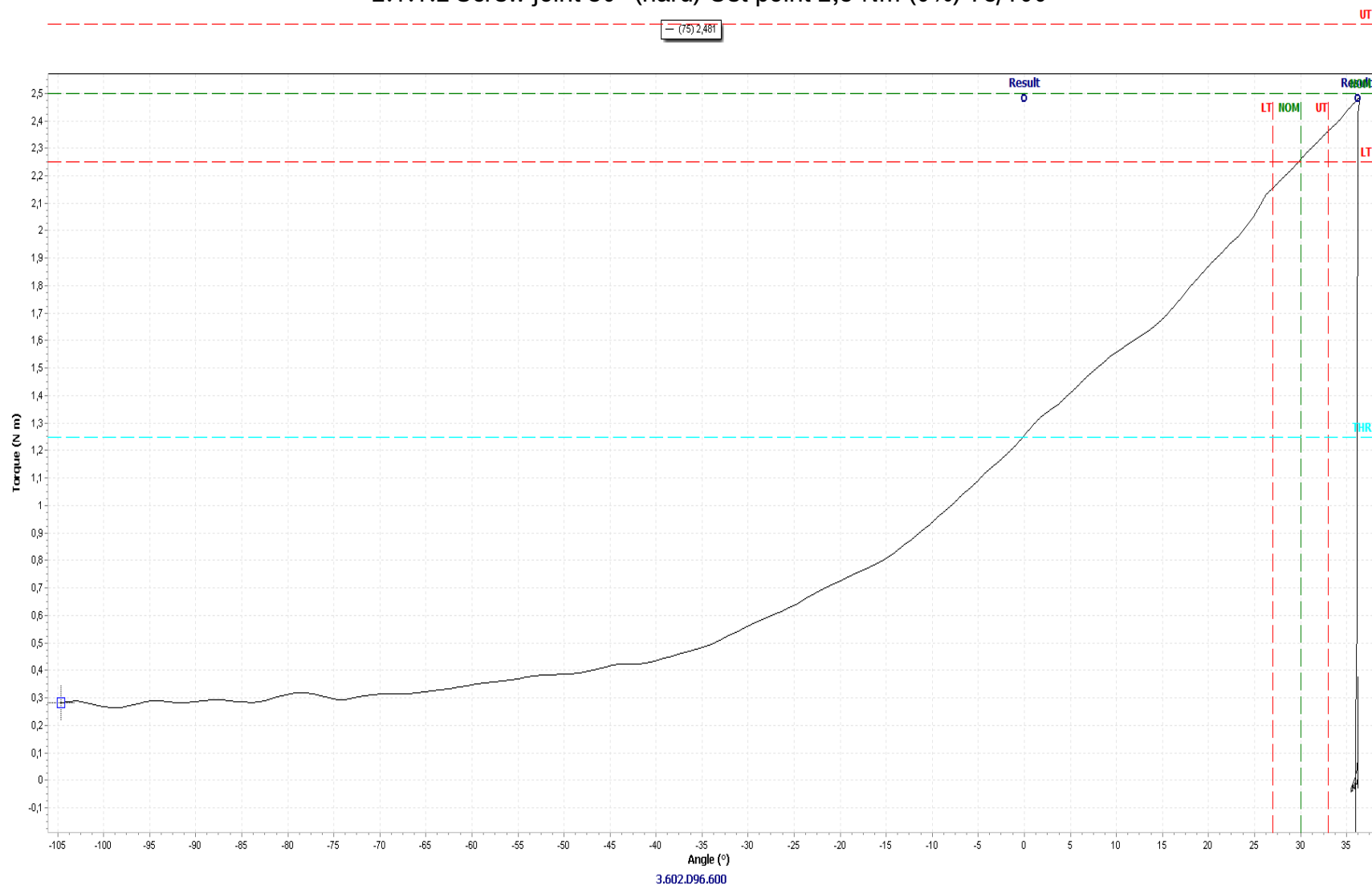
##### 2.1.1 Screw joint 30° (hard) Set point 2,5 Nm (0%)



#### 2.1.1.1 Screw joint 30° (hard) Set point 2,5 Nm (0%) 25/100

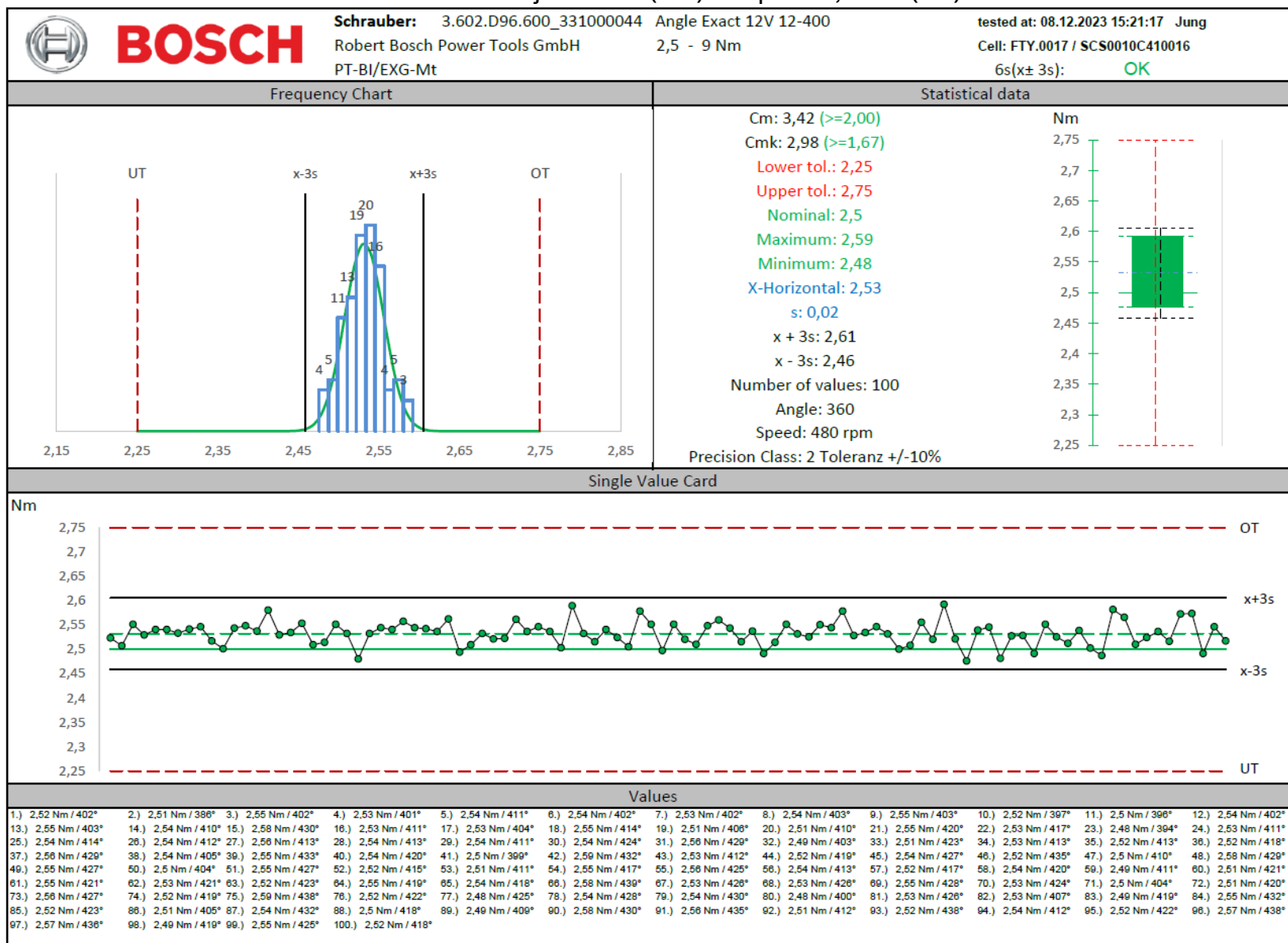


### 2.1.1.2 Screw joint 30° (hard) Set point 2,5 Nm (0%) 75/100

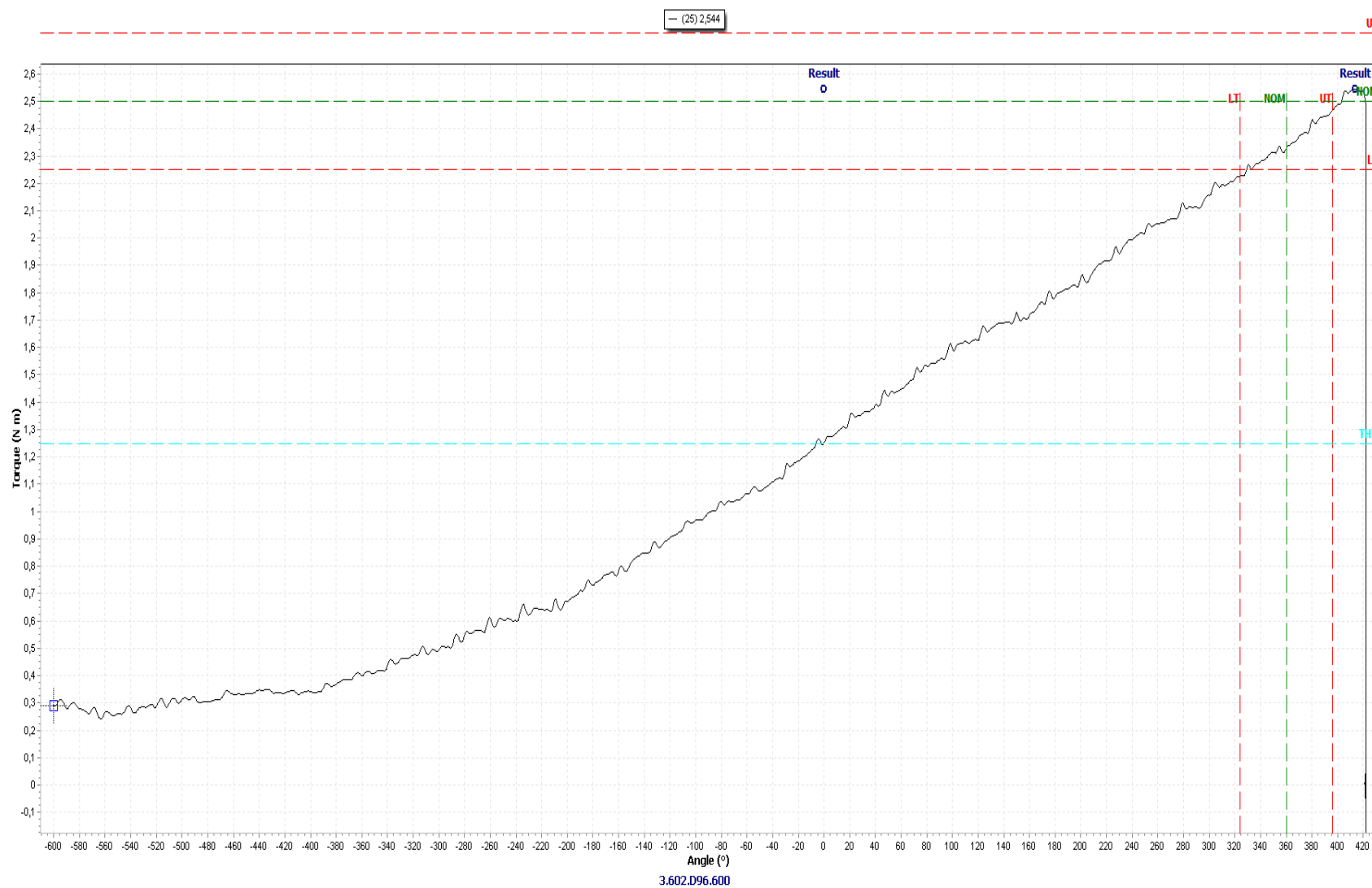




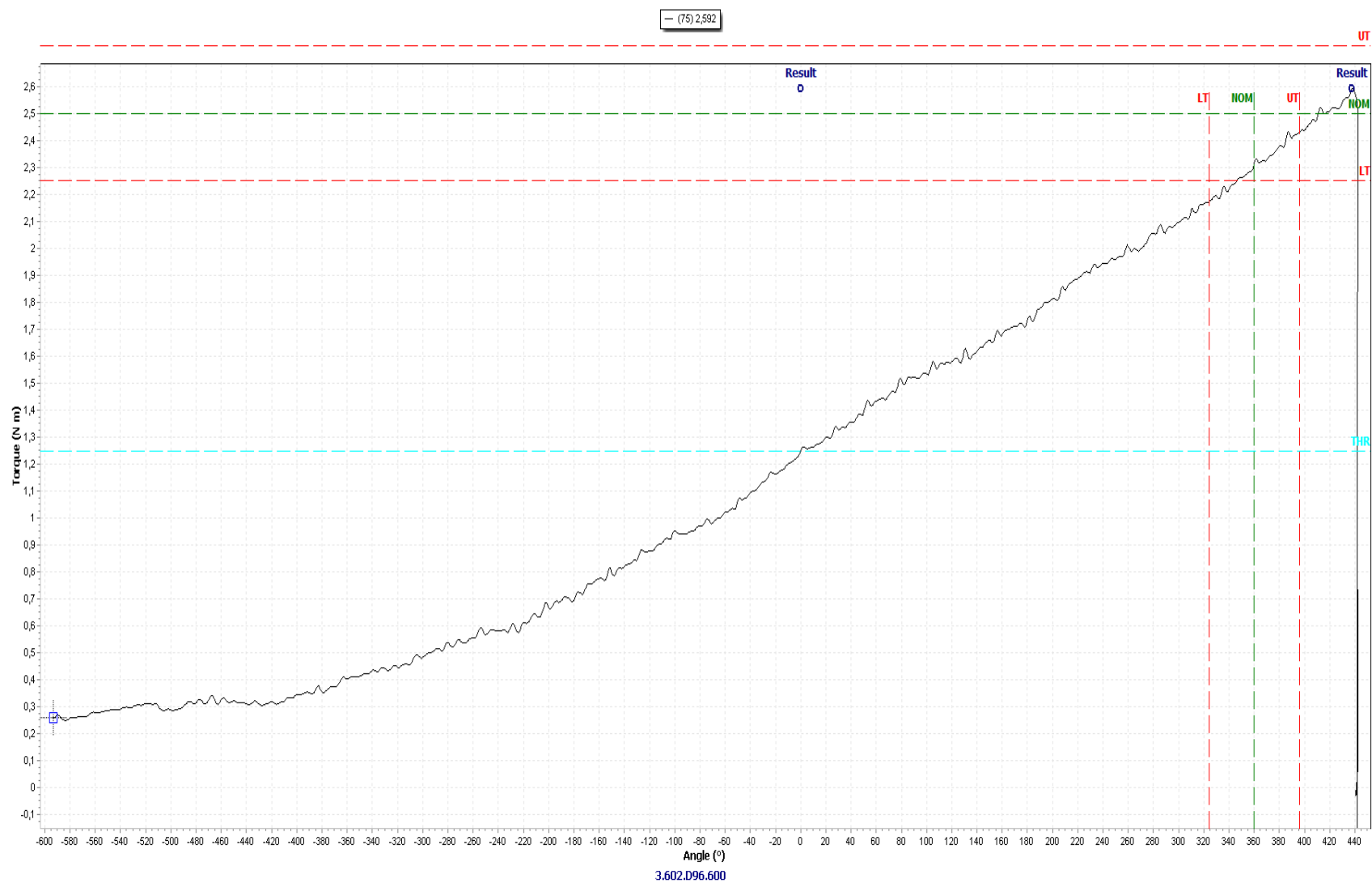
## 2.1.2 Screw joint 360° (soft) Set point 2,5 Nm (0%)



### 2.1.2.1 Screw joint 360° (soft) Set point 2,5 Nm (0%) 25/100

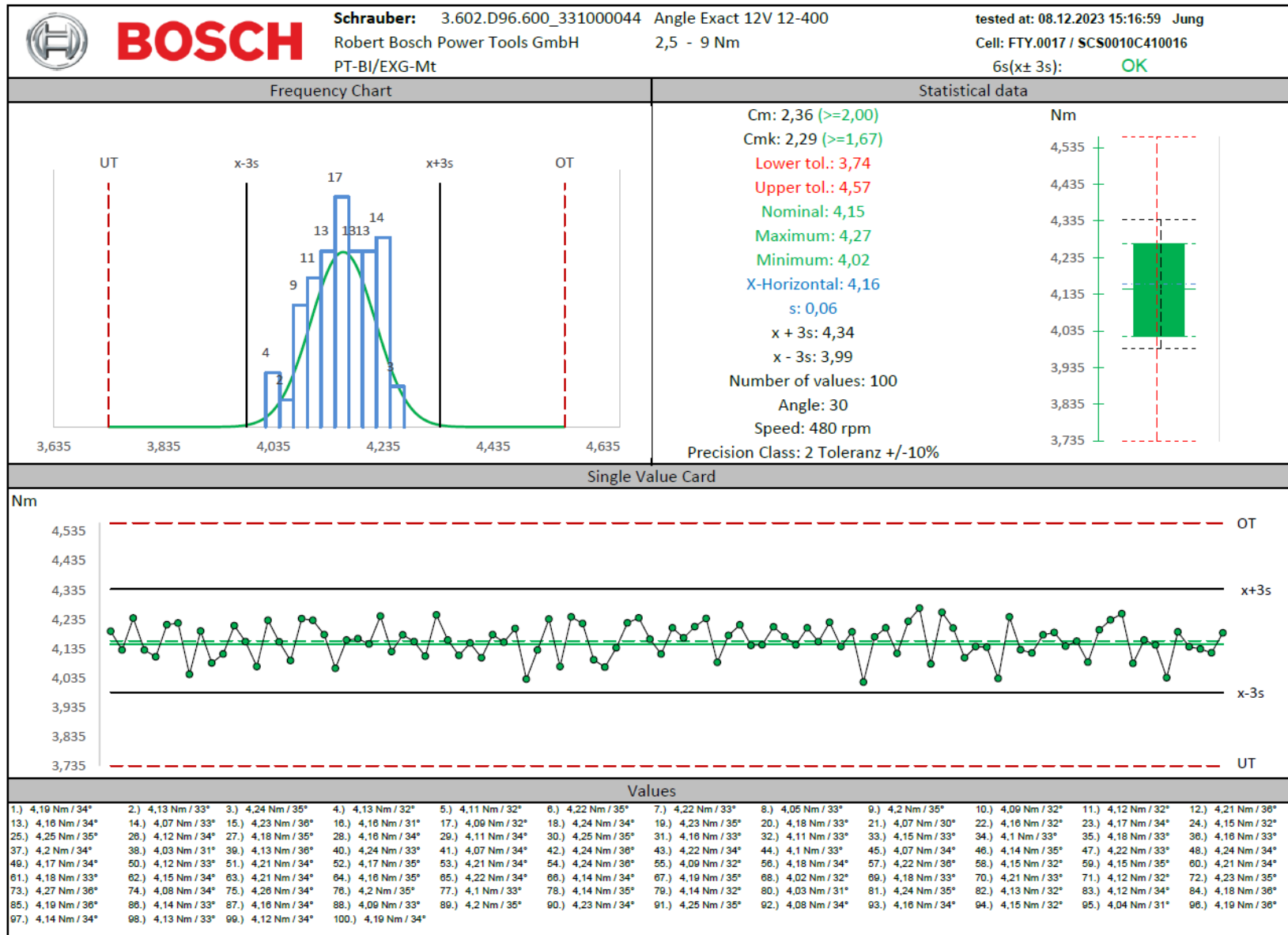


### 2.1.2.2 Screw joint 360° (soft) Set point 2,5 Nm (0%) 75/100



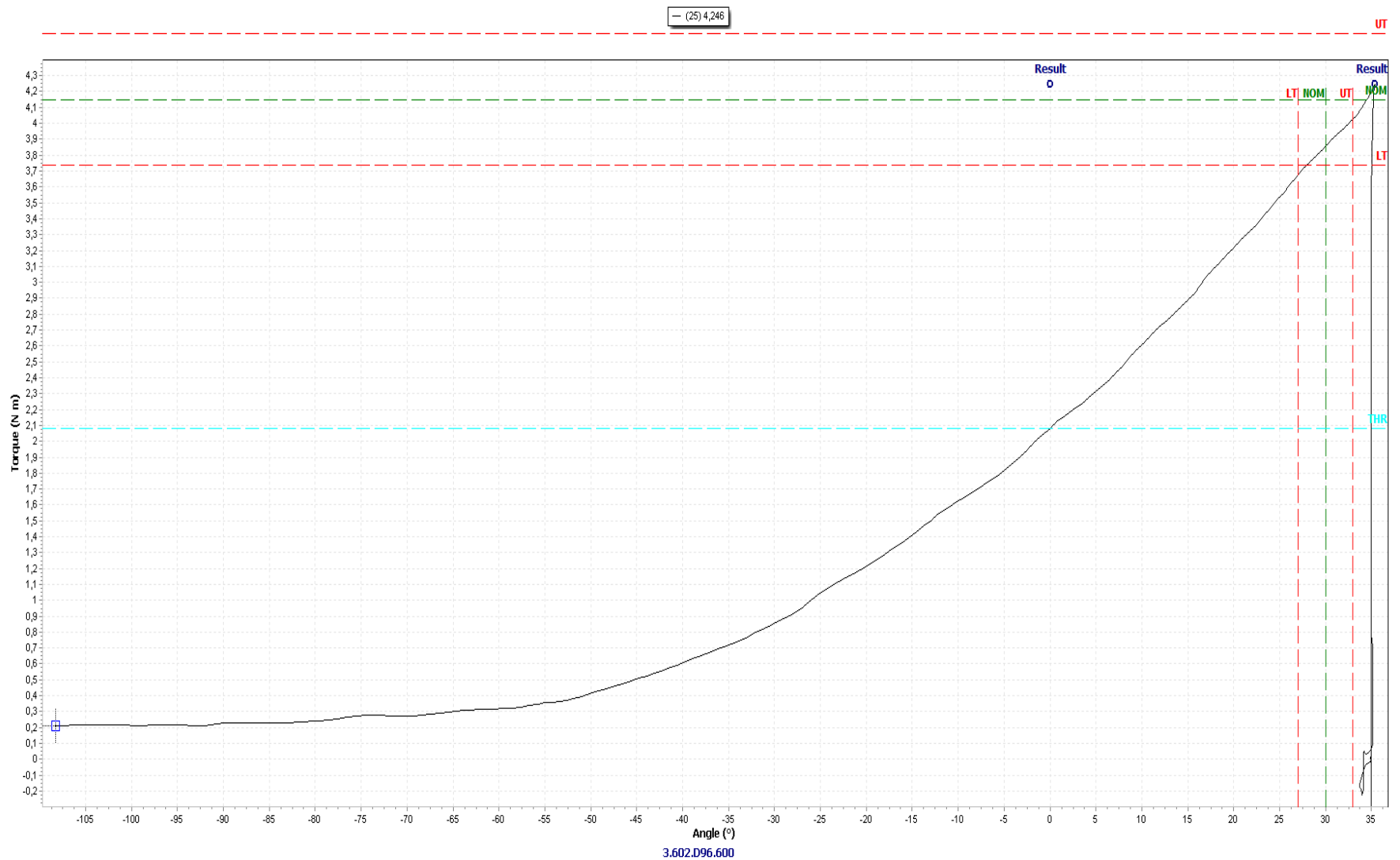


### 2.1.3 Screw joint 30° (hard) Set point 4,15 Nm (30%)



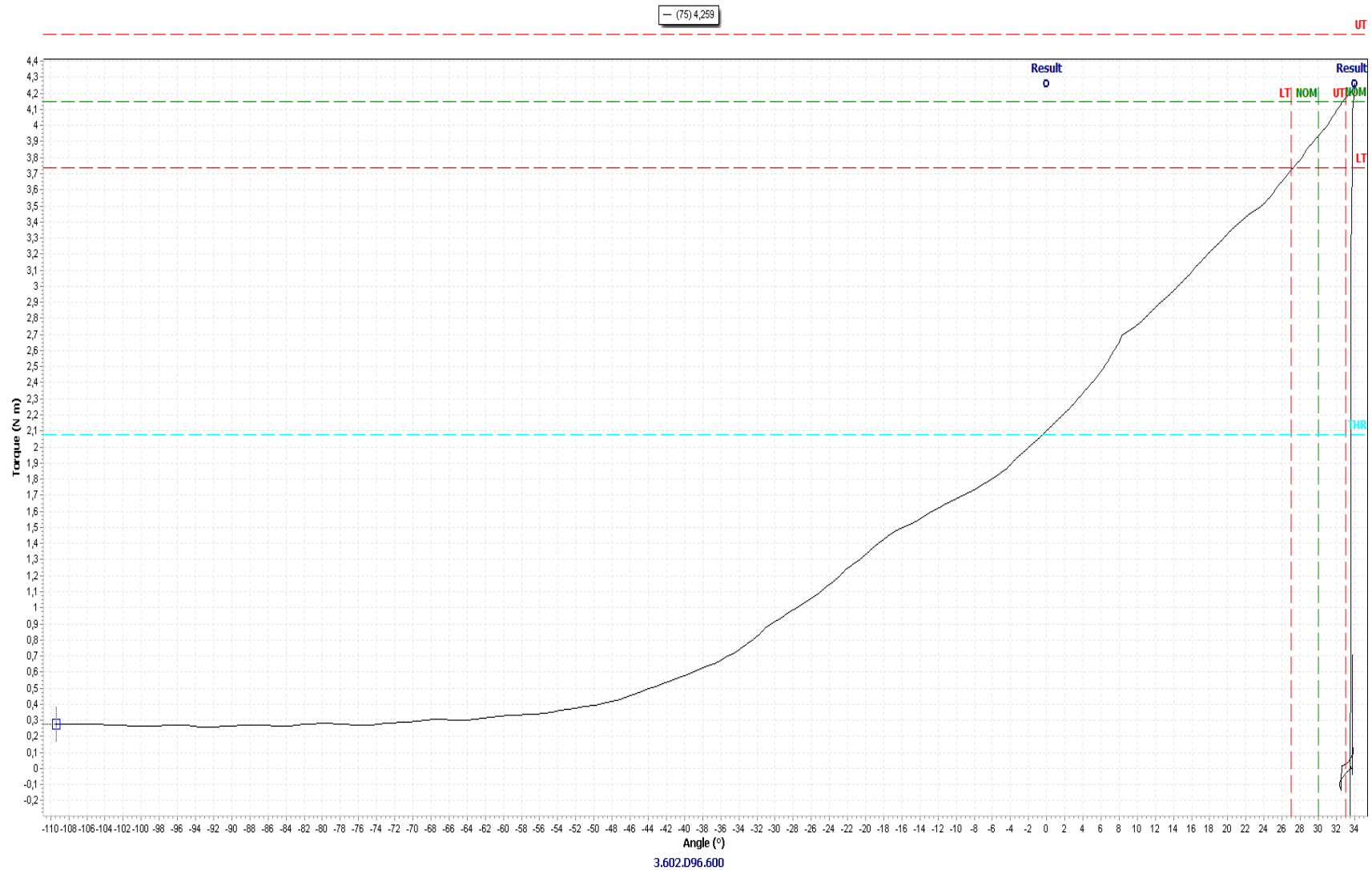


### 2.1.3.1 Screw joint 30° (hard) Set point 4,15 Nm (30%) 25/100



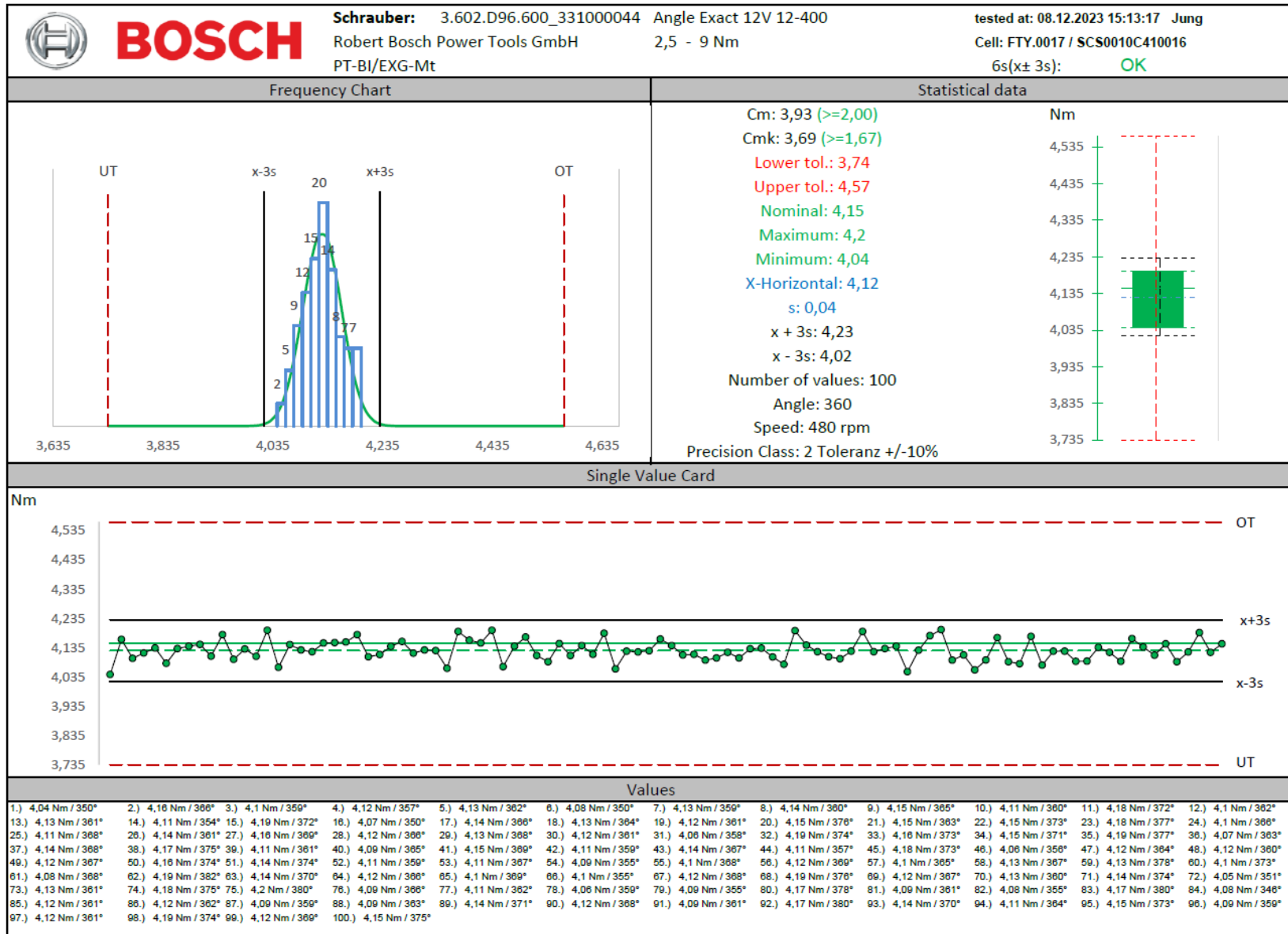


### 2.1.3.2 Screw joint 30° (hard) Set point 4,15 Nm (30%) 75/100



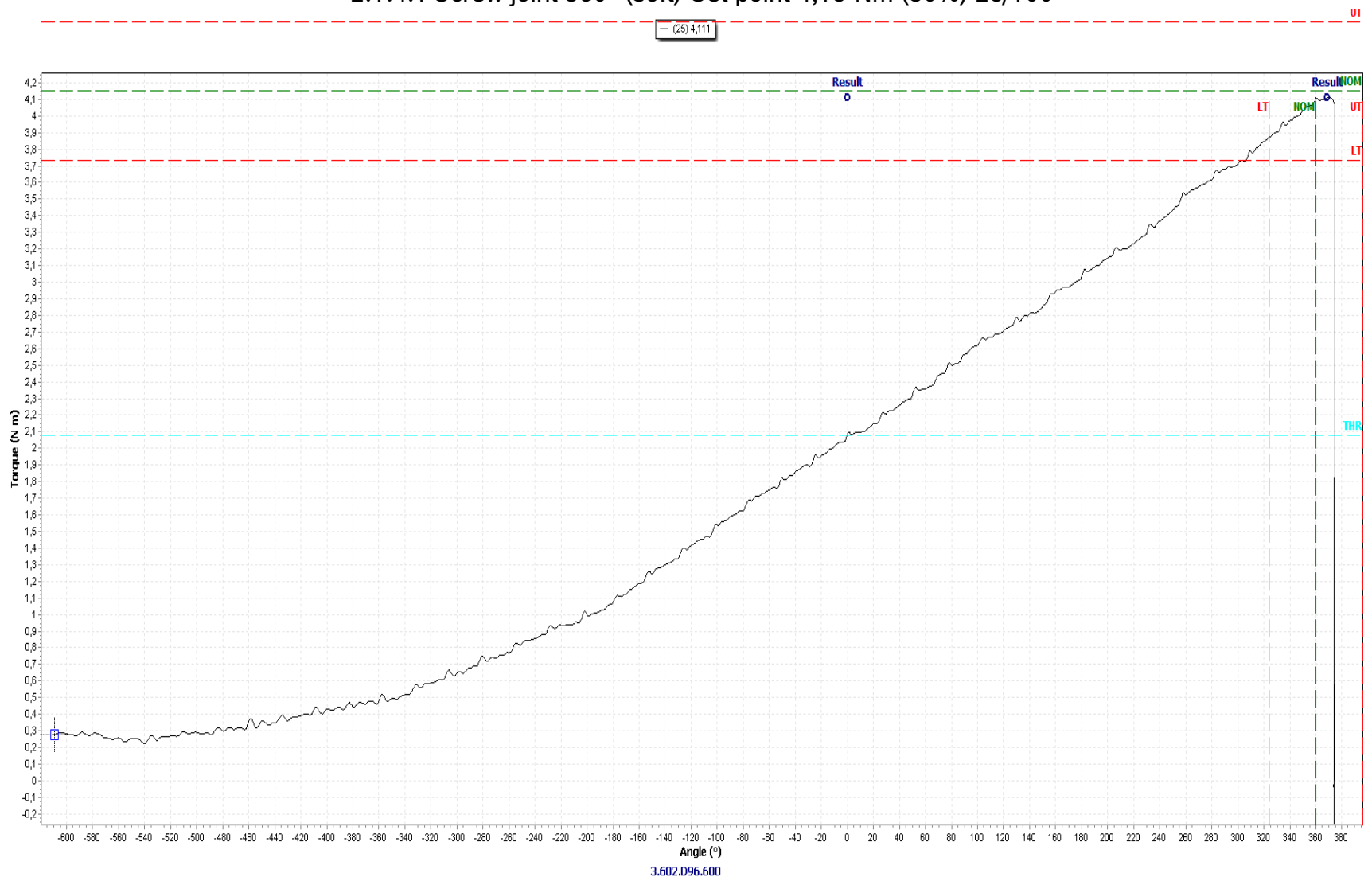


### 2.1.4 Screw joint 360° (soft) Set point 4,15 Nm (30%)



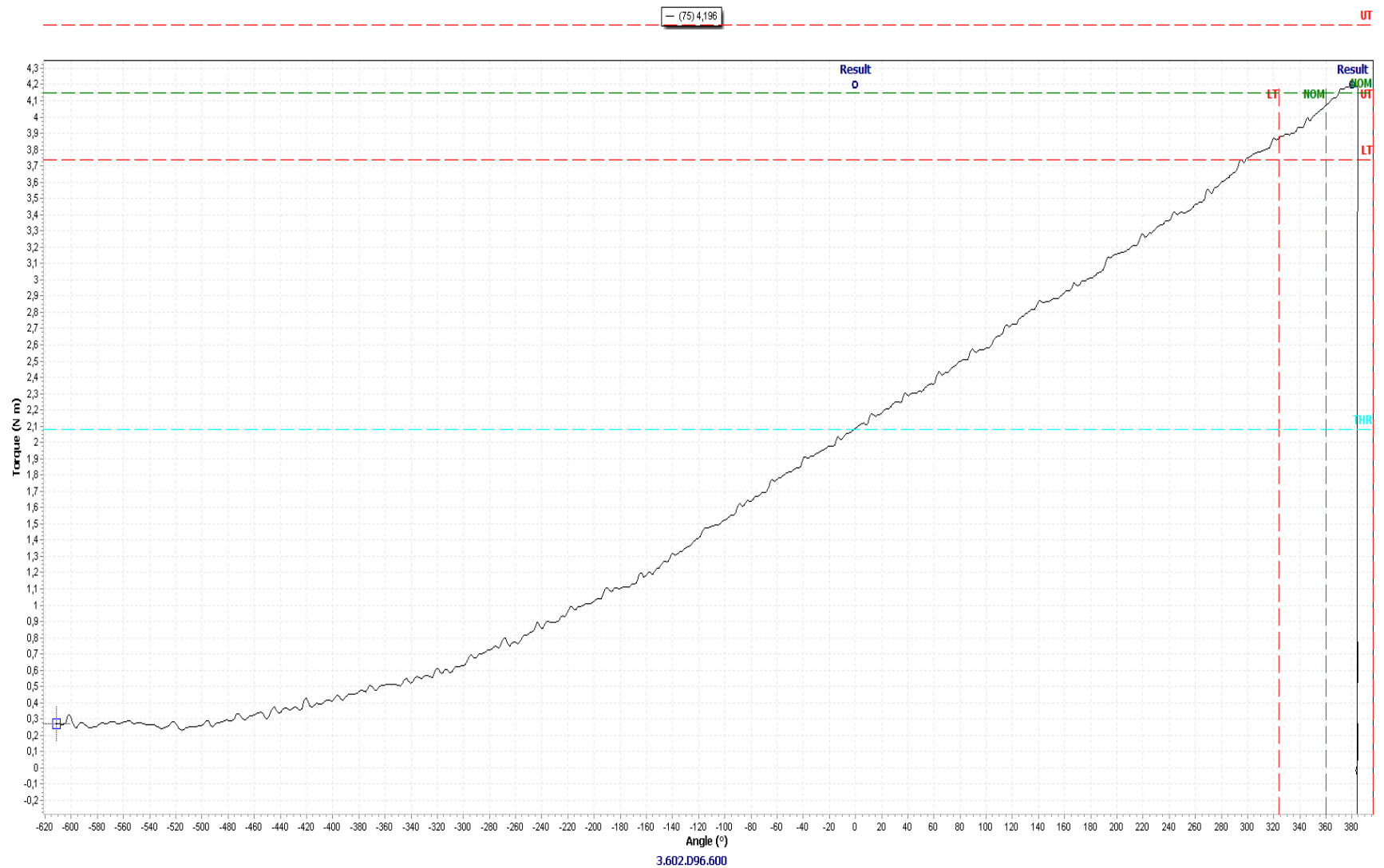


### 2.1.4.1 Screw joint 360° (soft) Set point 4,15 Nm (30%) 25/100



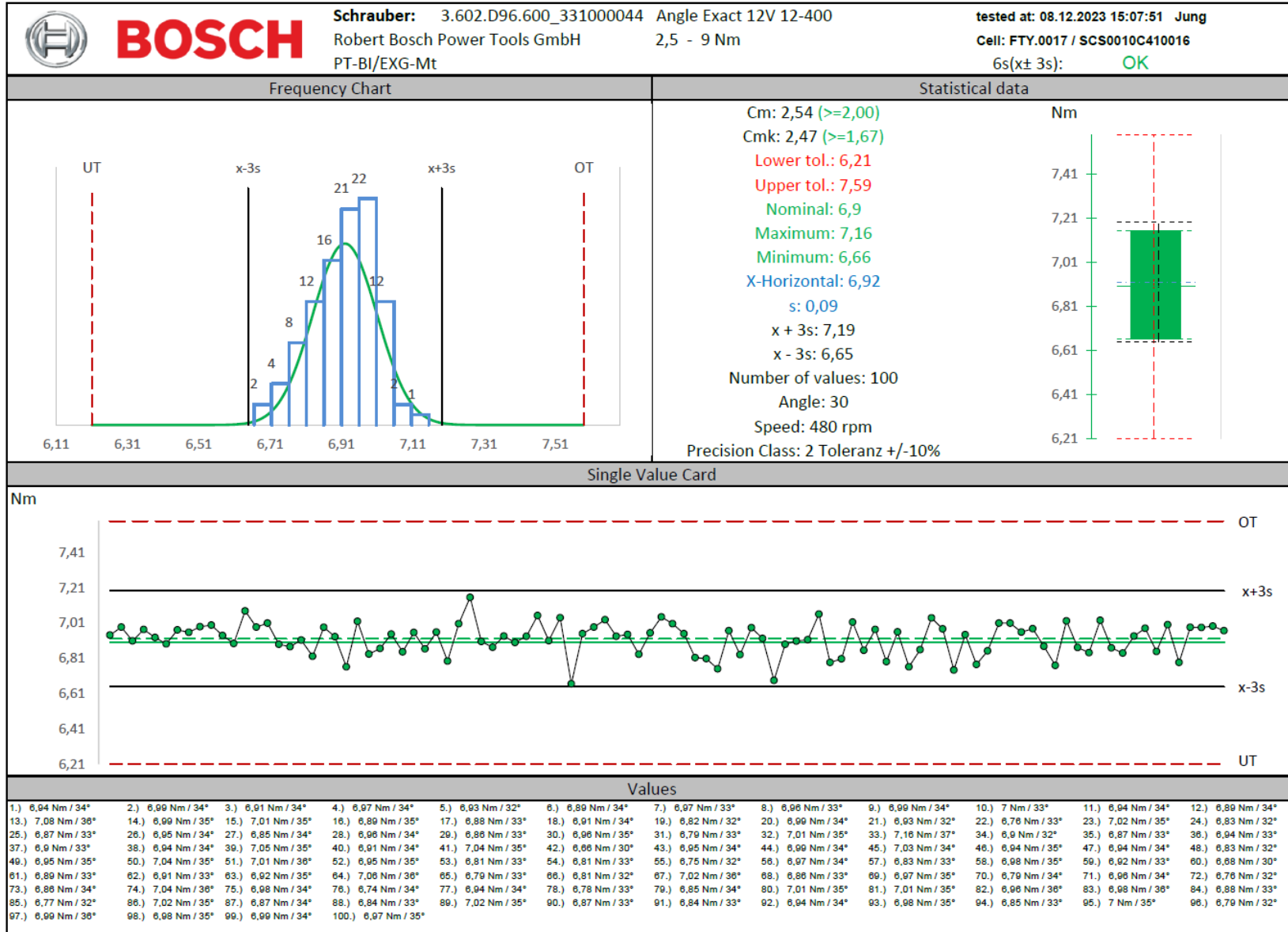


### 2.1.4.2 Screw joint 360° (soft) Set point 4,15 Nm (30%) 75/100

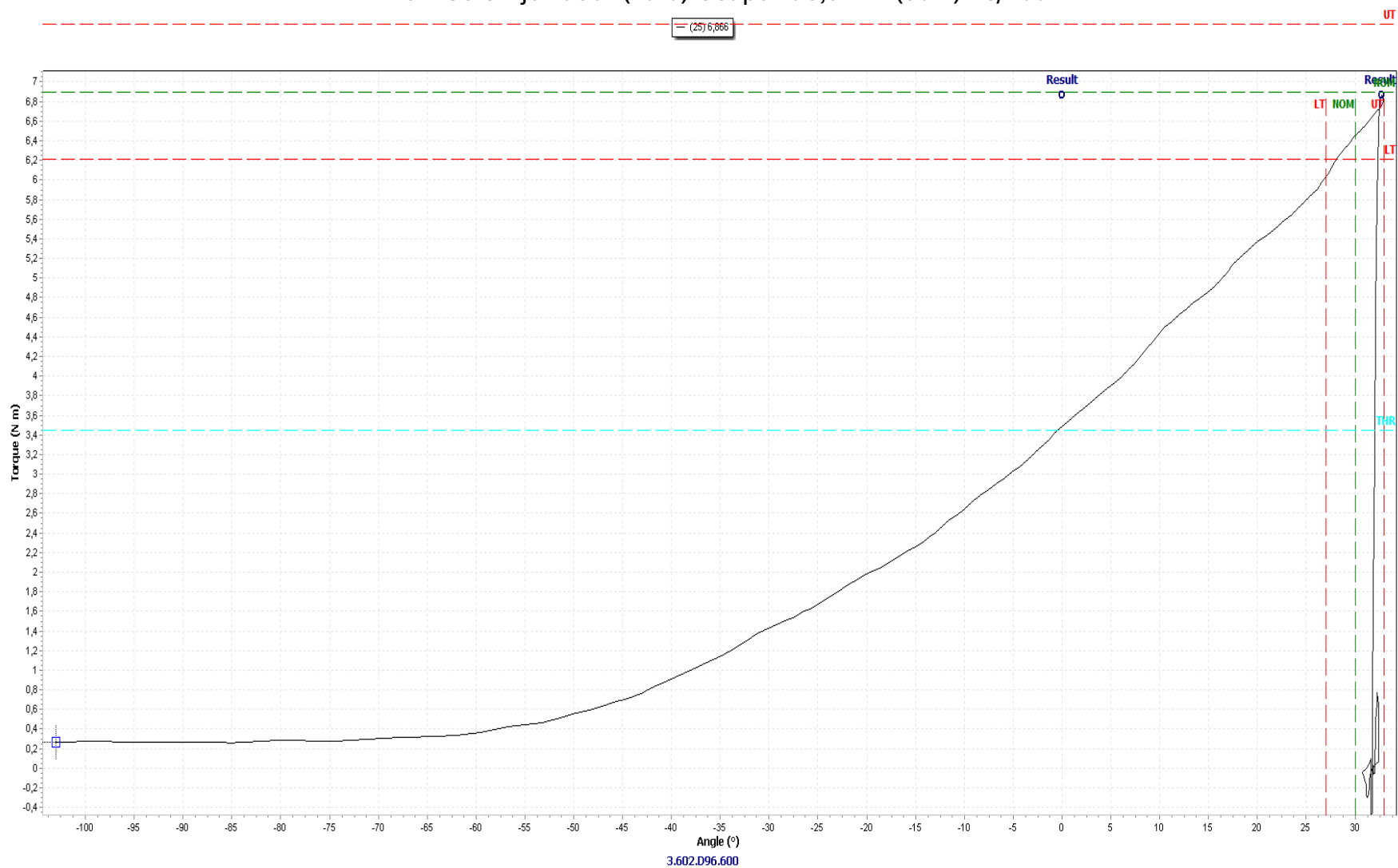




### 2.1.5 Screw joint 30° (hard) Set point 6,9 Nm (80%)

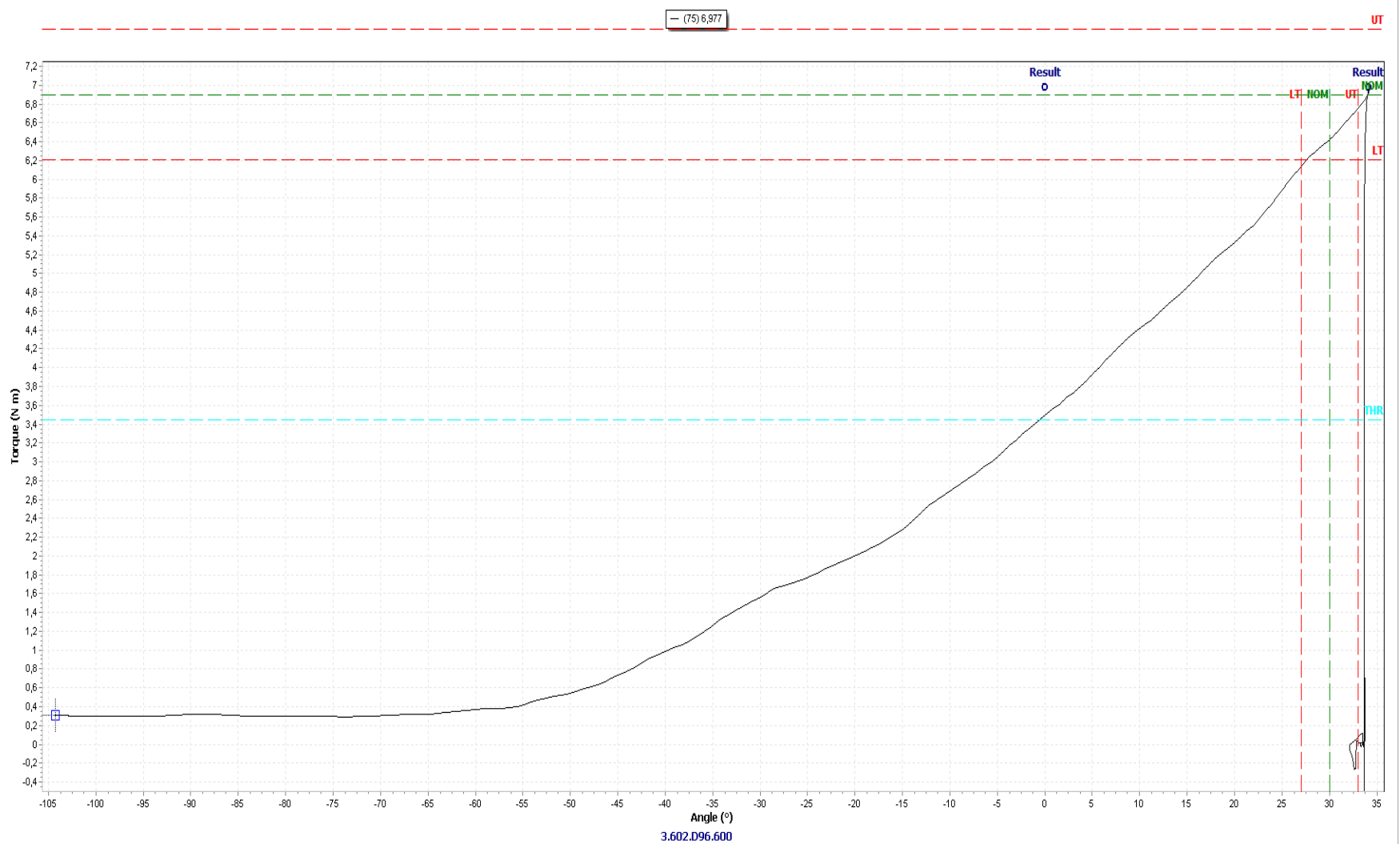


### 2.1.5.1 Screw joint 30° (hard) Set point 6,9 Nm (80%) 25/100



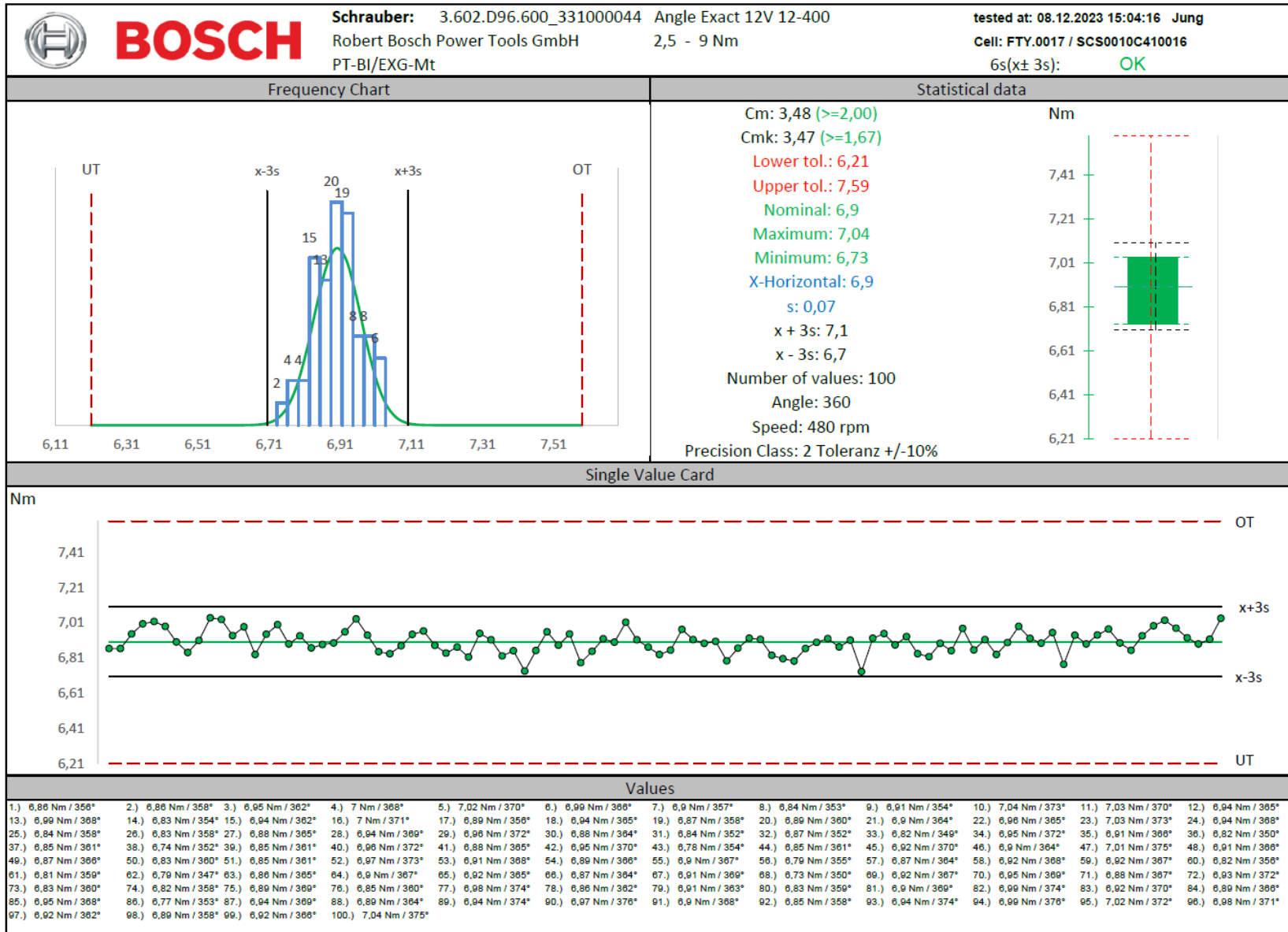


### 2.1.5.2 Screw joint 30° (hard) Set point 6,9 Nm (80%) 75/100

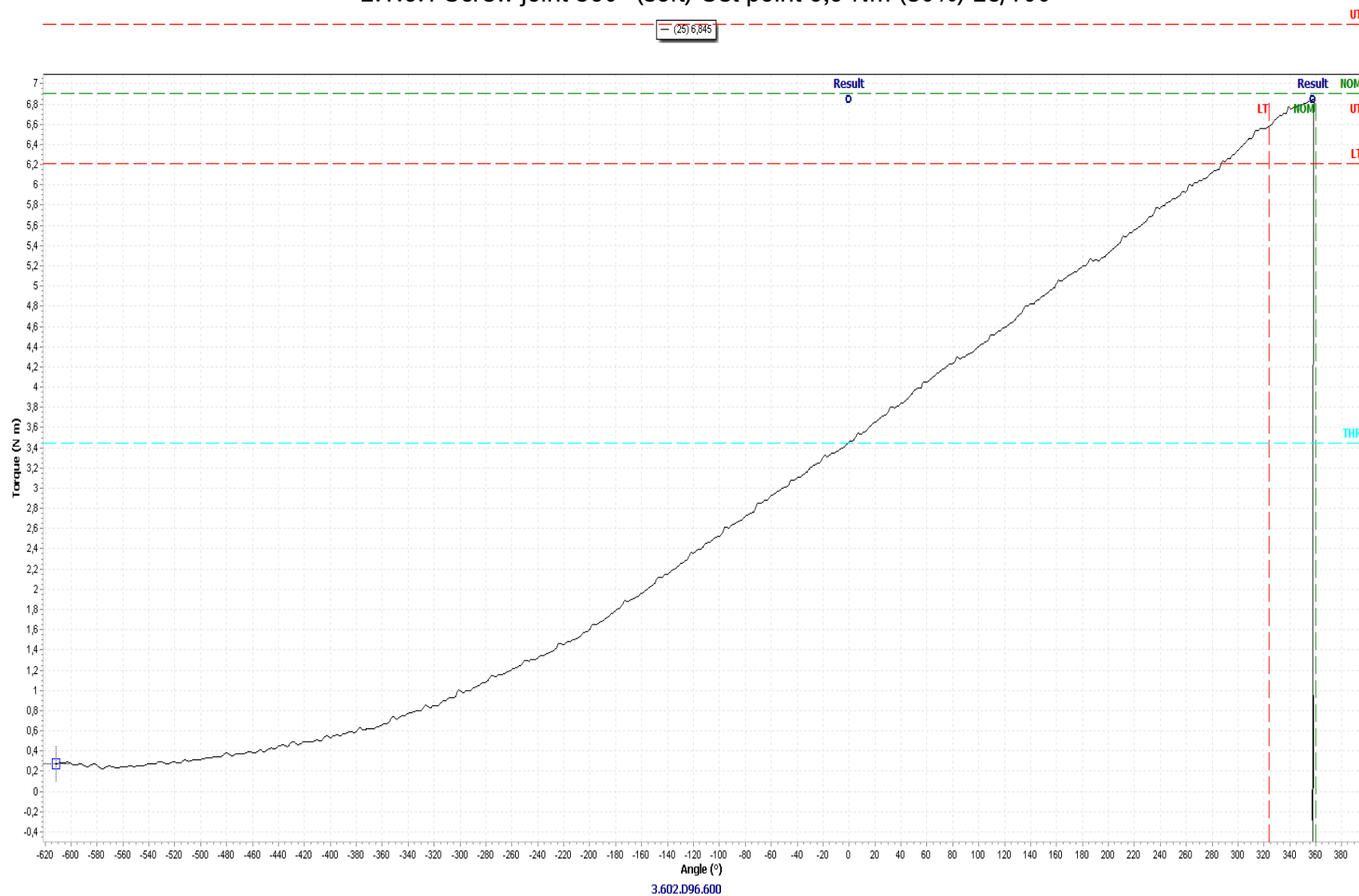




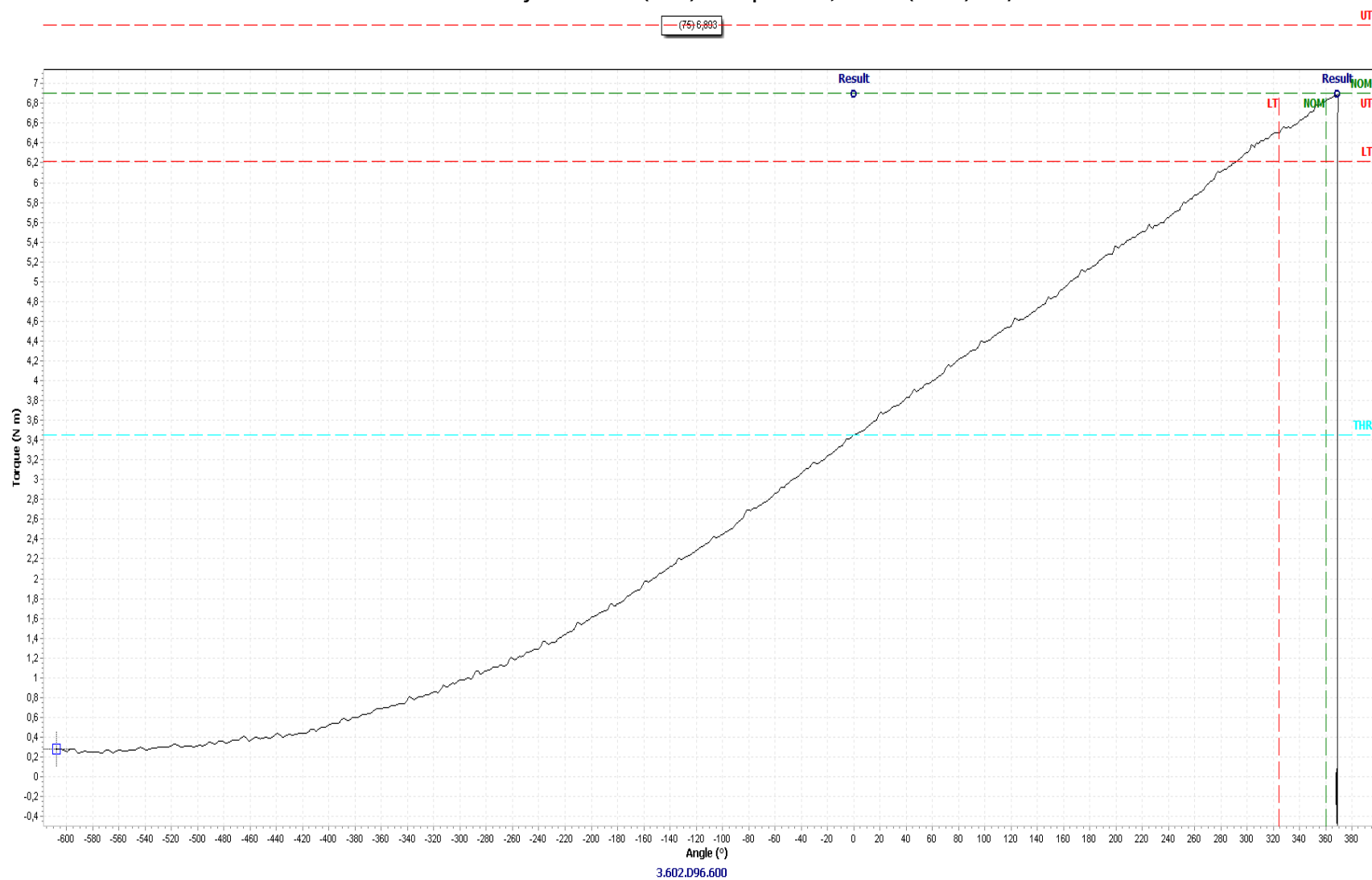
### 2.1.6 Screw joint 360° (soft) Set point 6,9 Nm (80%)



### 2.1.6.1 Screw joint 360° (soft) Set point 6,9 Nm (80%) 25/100

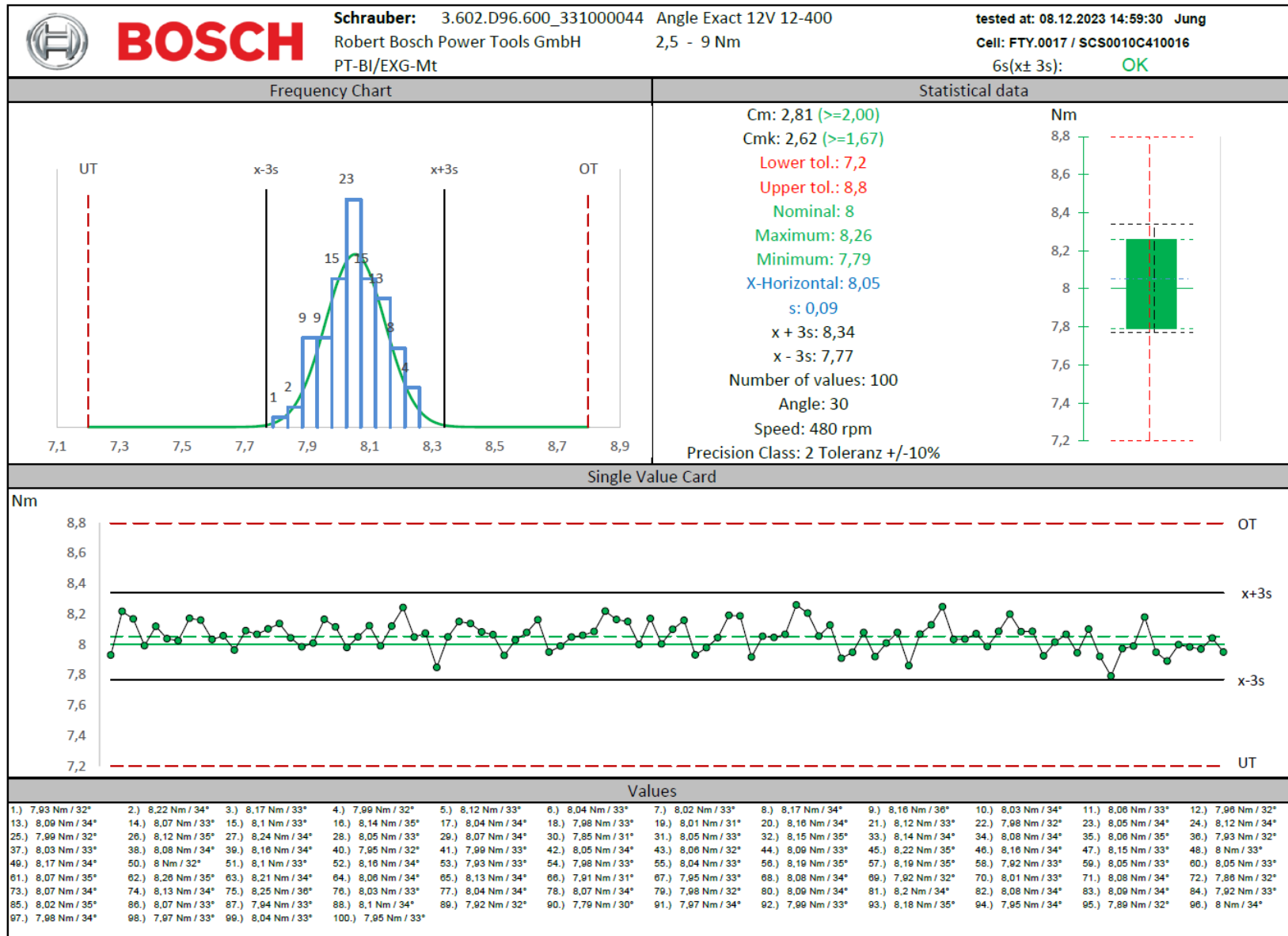


### 2.1.6.2 Screw joint 360° (soft) Set point 6,9 Nm (80%) 75/100



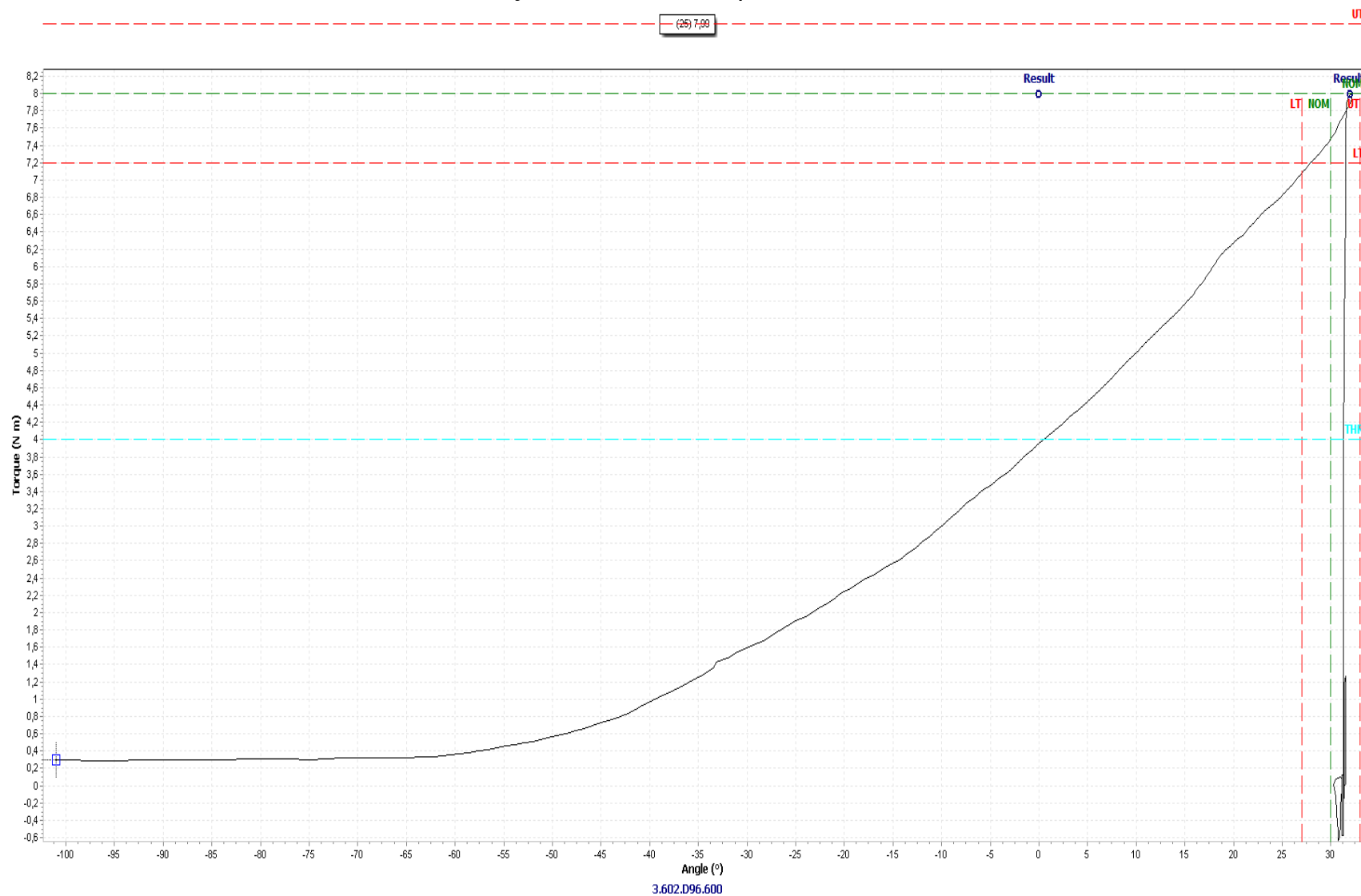


### 2.1.7 Screw joint 30° (hard) Set point 8,00 Nm (100%)



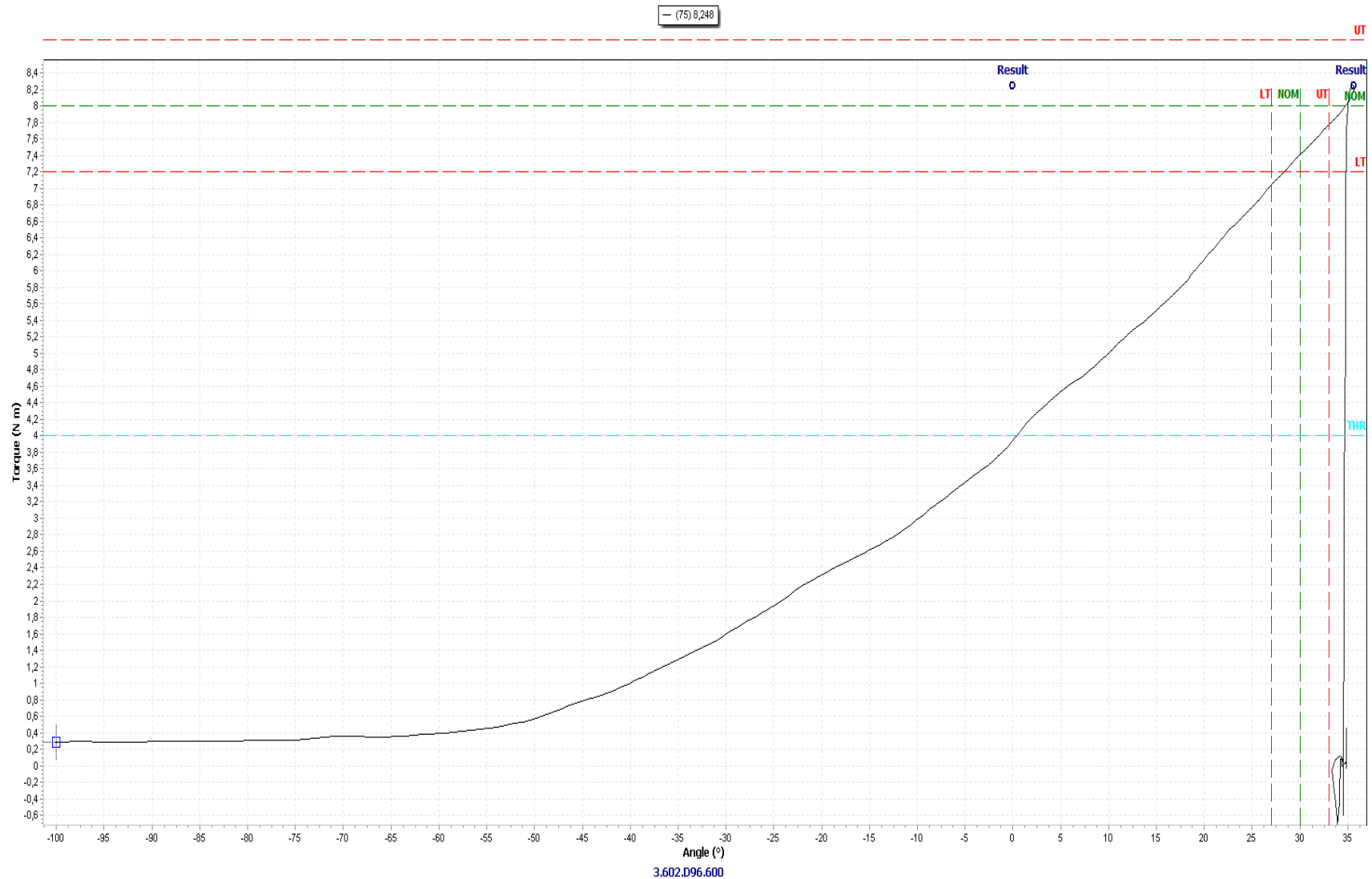


### 2.1.7.1 Screw joint 30° (hard) Set point 8,0 Nm (100%) 25/100



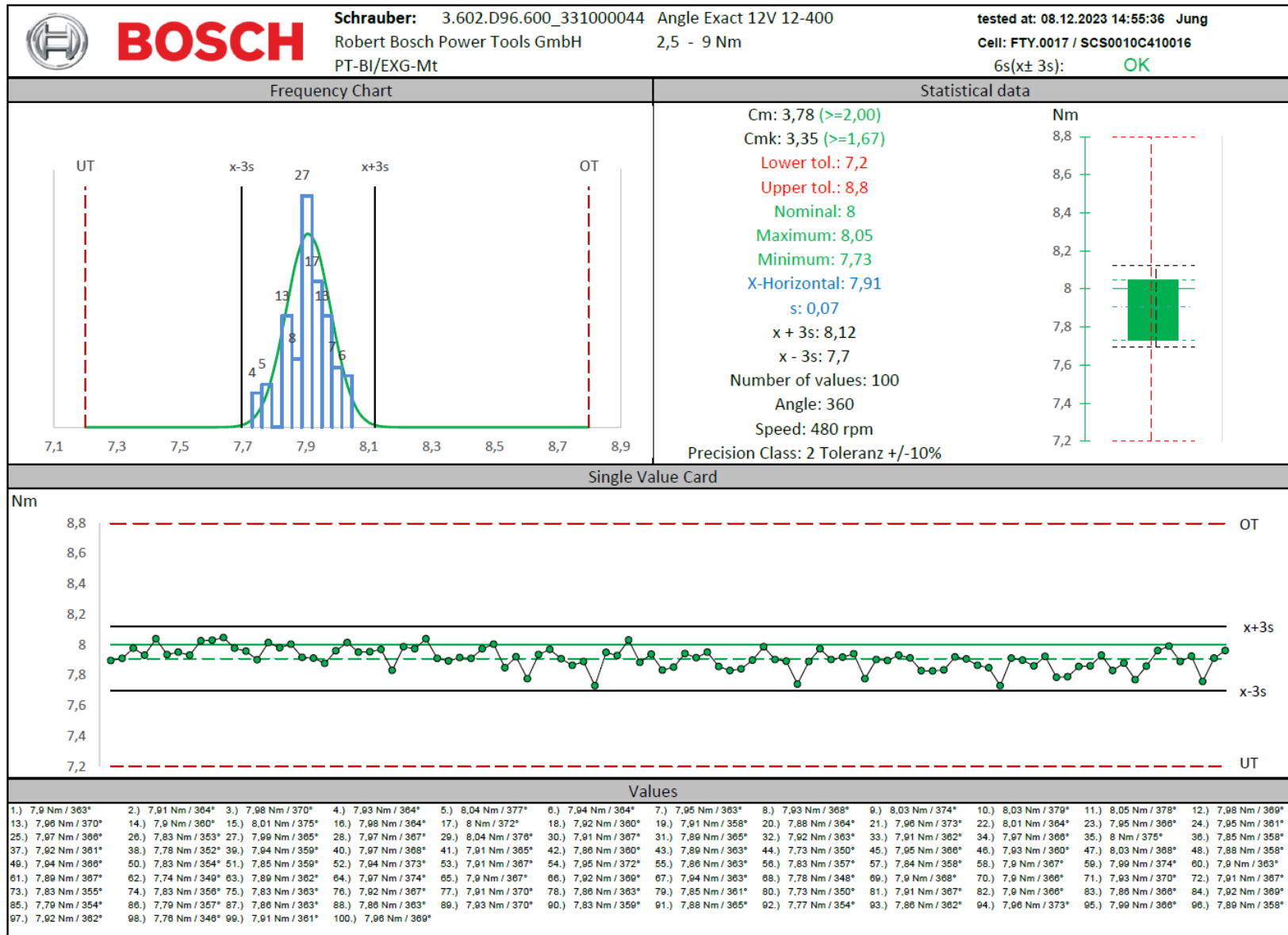


### 2.1.7.2 Screw joint 30° (hard) Set point 8,0 Nm (100%) 75/100

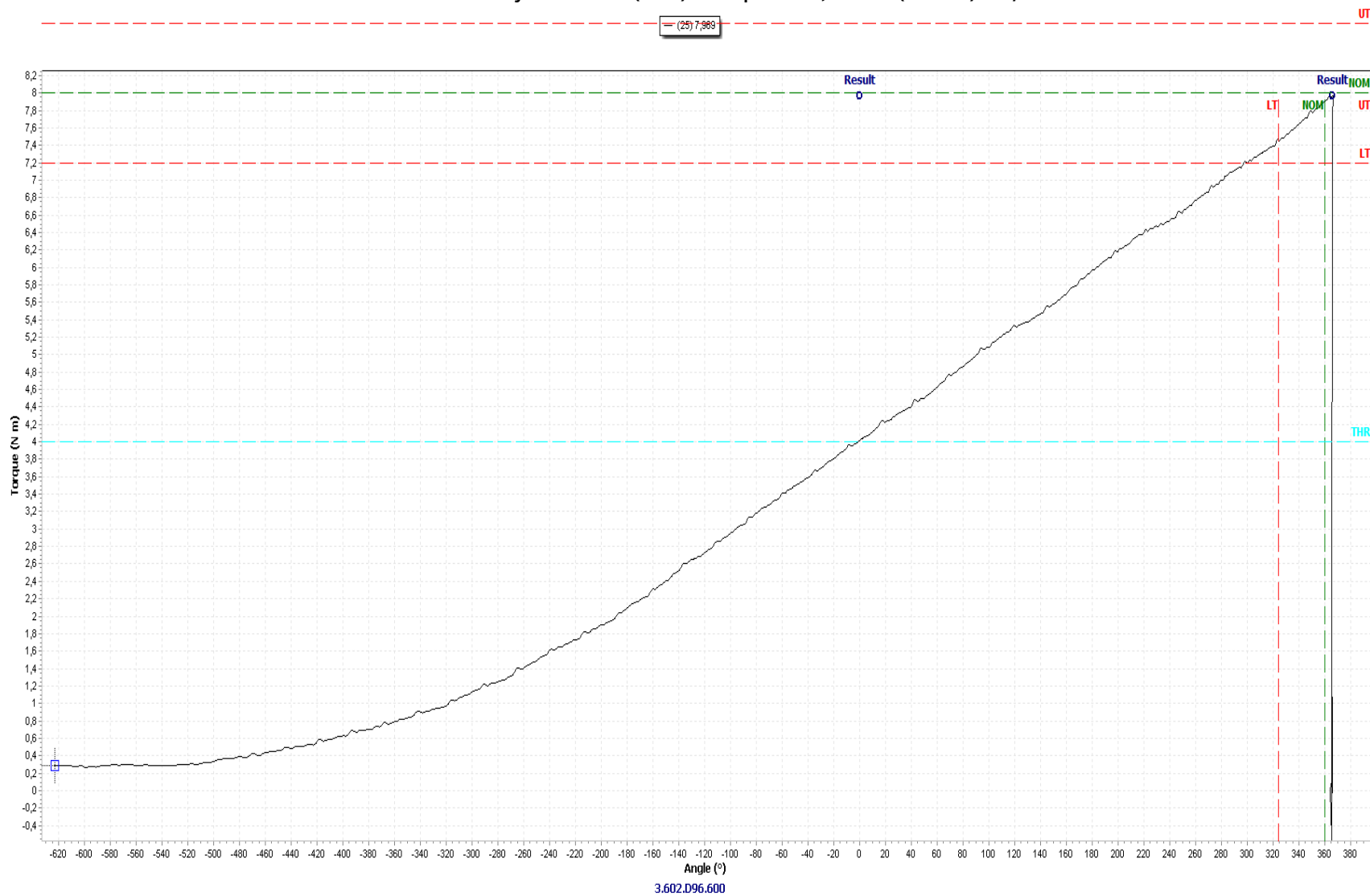




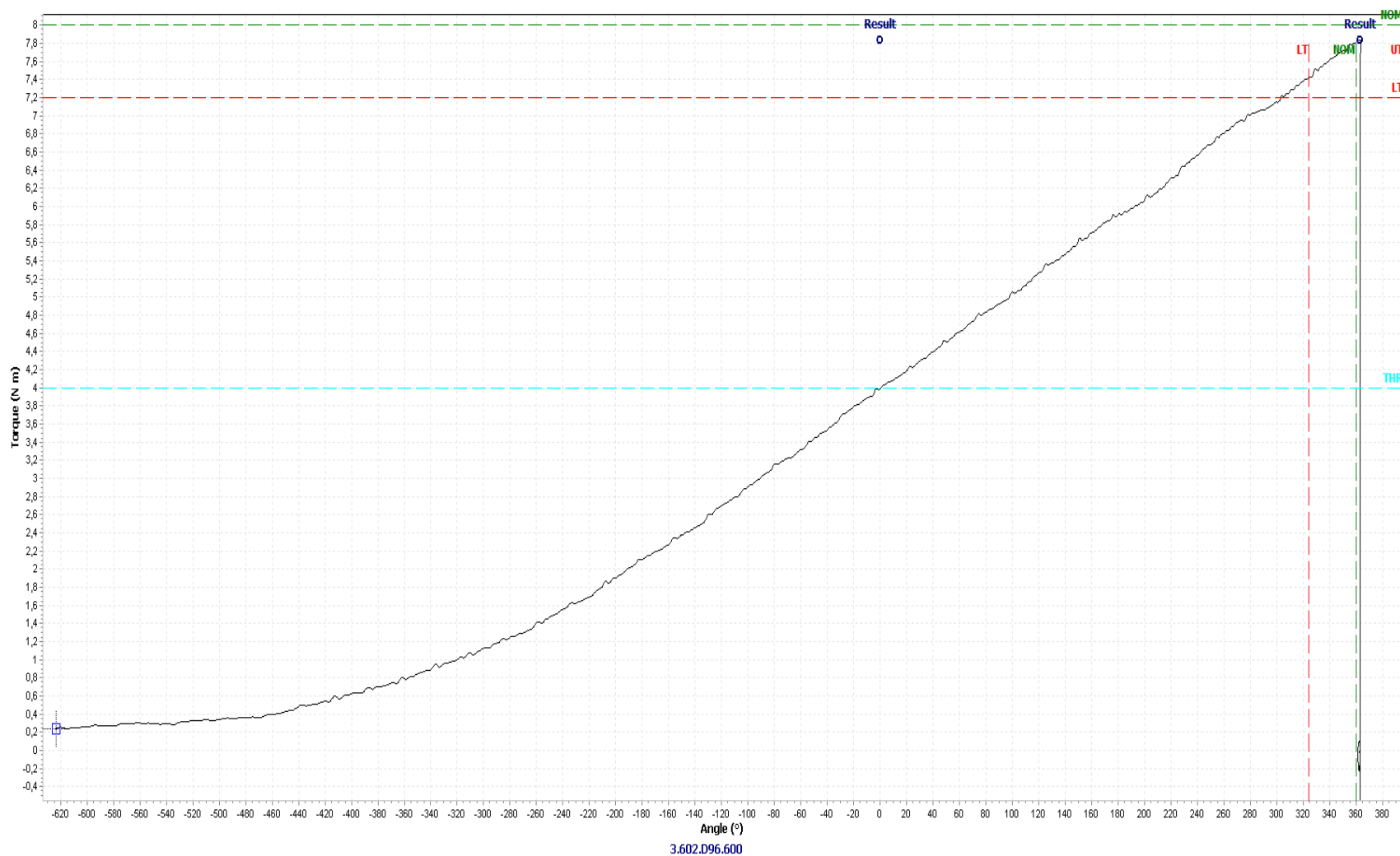
### 2.1.8 Screw joint 360° (soft) Set point 8,0 Nm (100%)



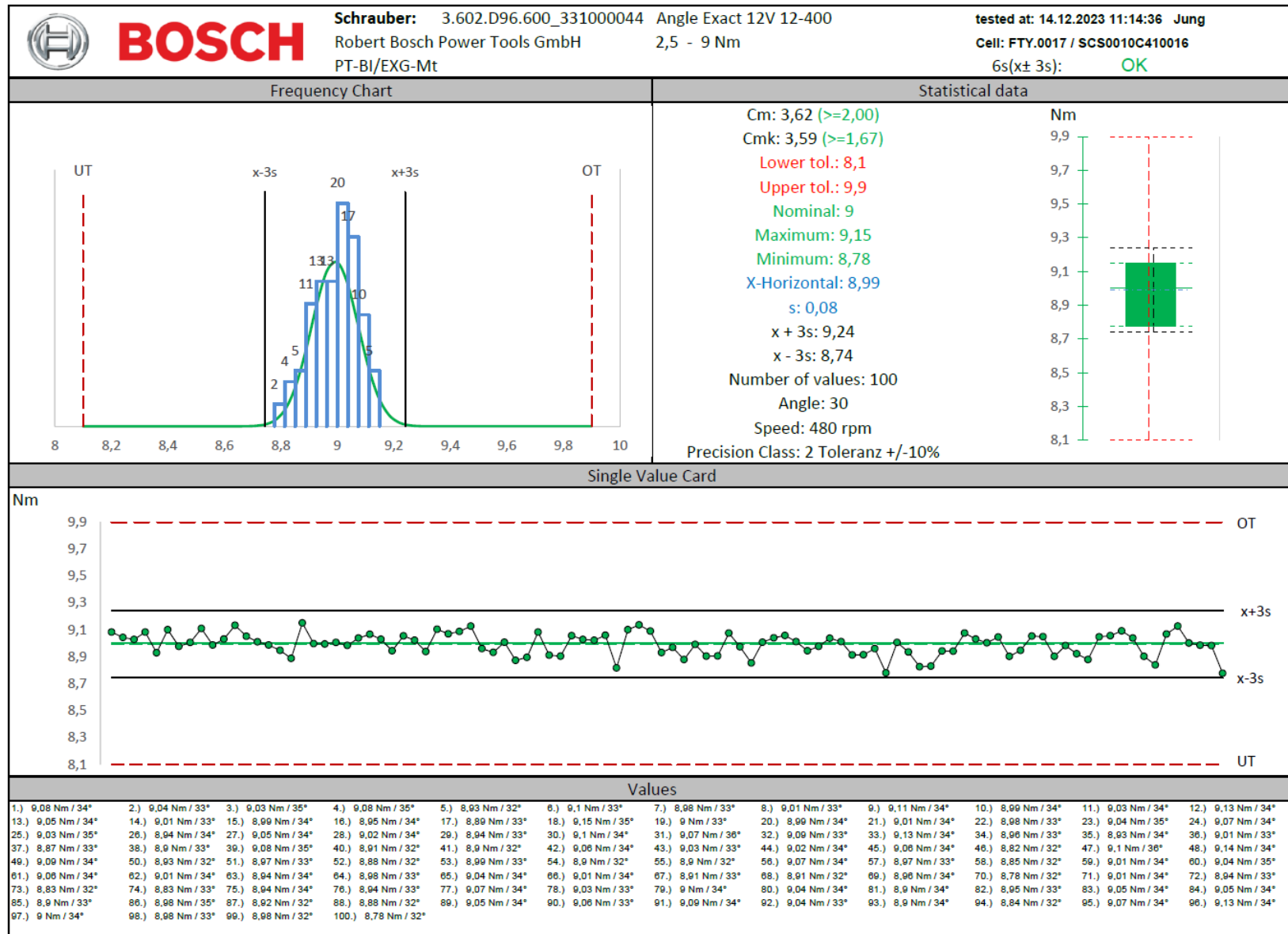
### 2.1.8.1 Screw joint 360° (soft) Set point 8,0 Nm (100%) 25/100



— (75) 7,834

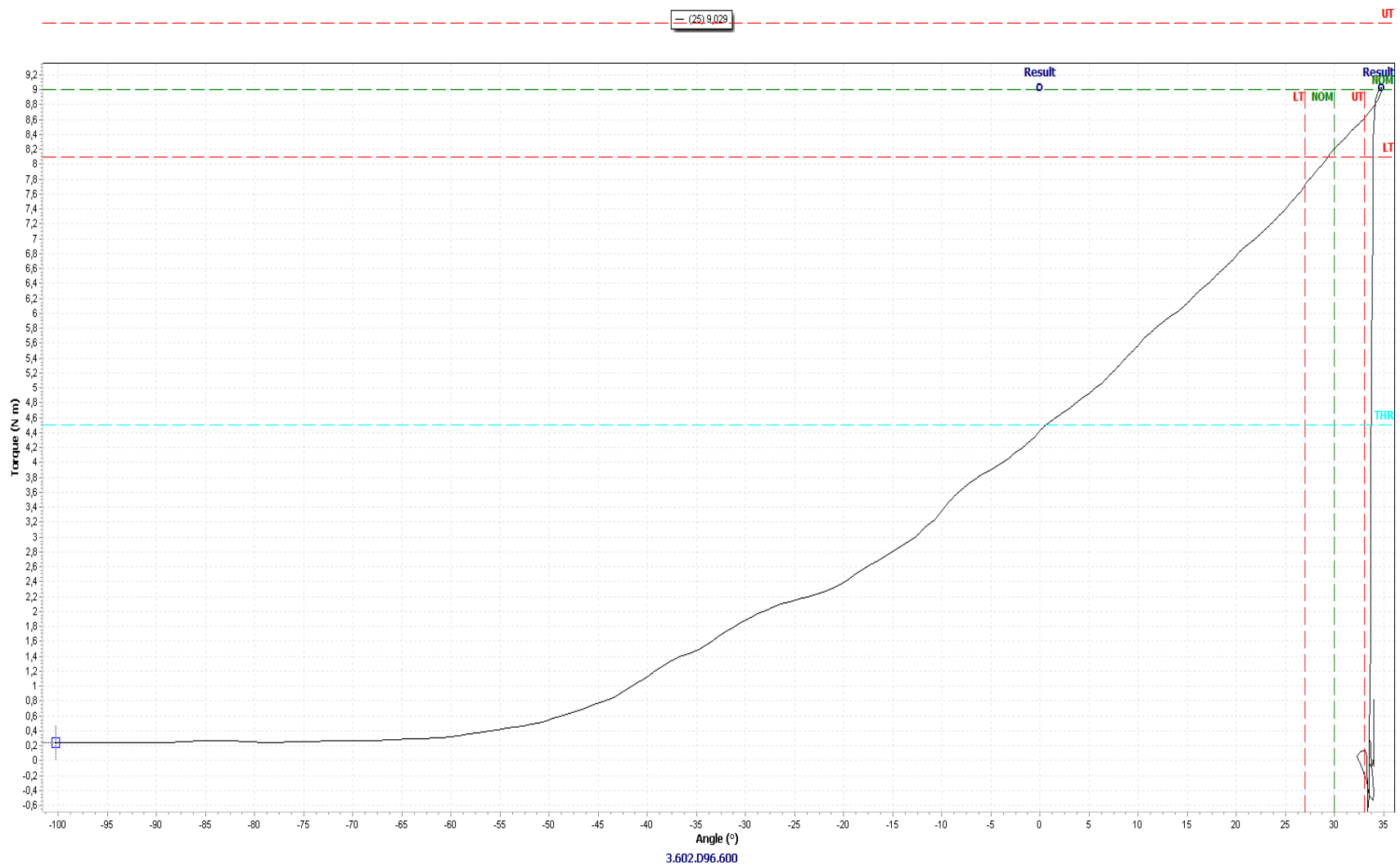


## 2.1.9 Screw joint 30° (hard) Set point 9,0 Nm (additional)

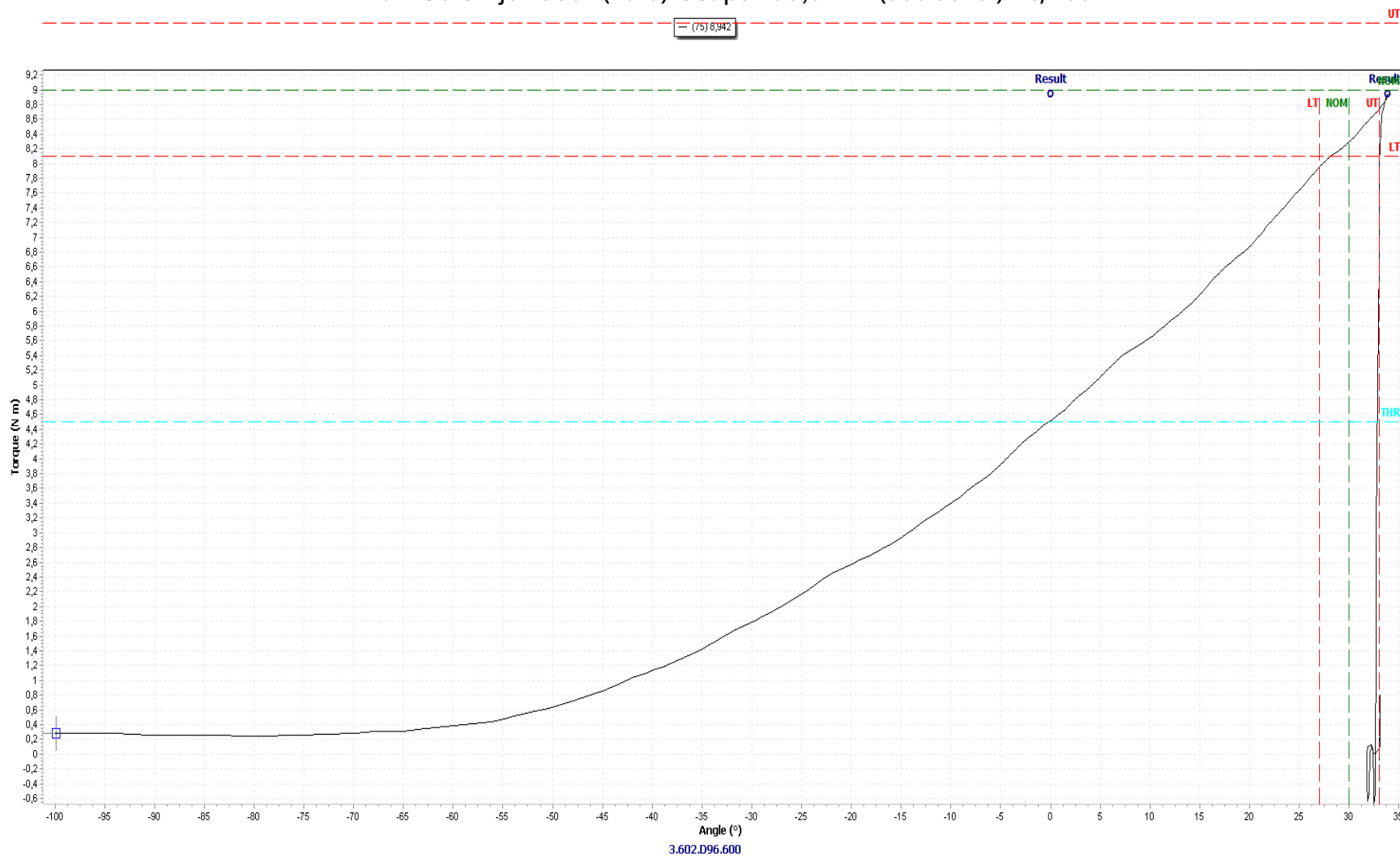




### 2.1.9.1 Screw joint 30° (hard) Set point 9,0 Nm (additional) 25/100

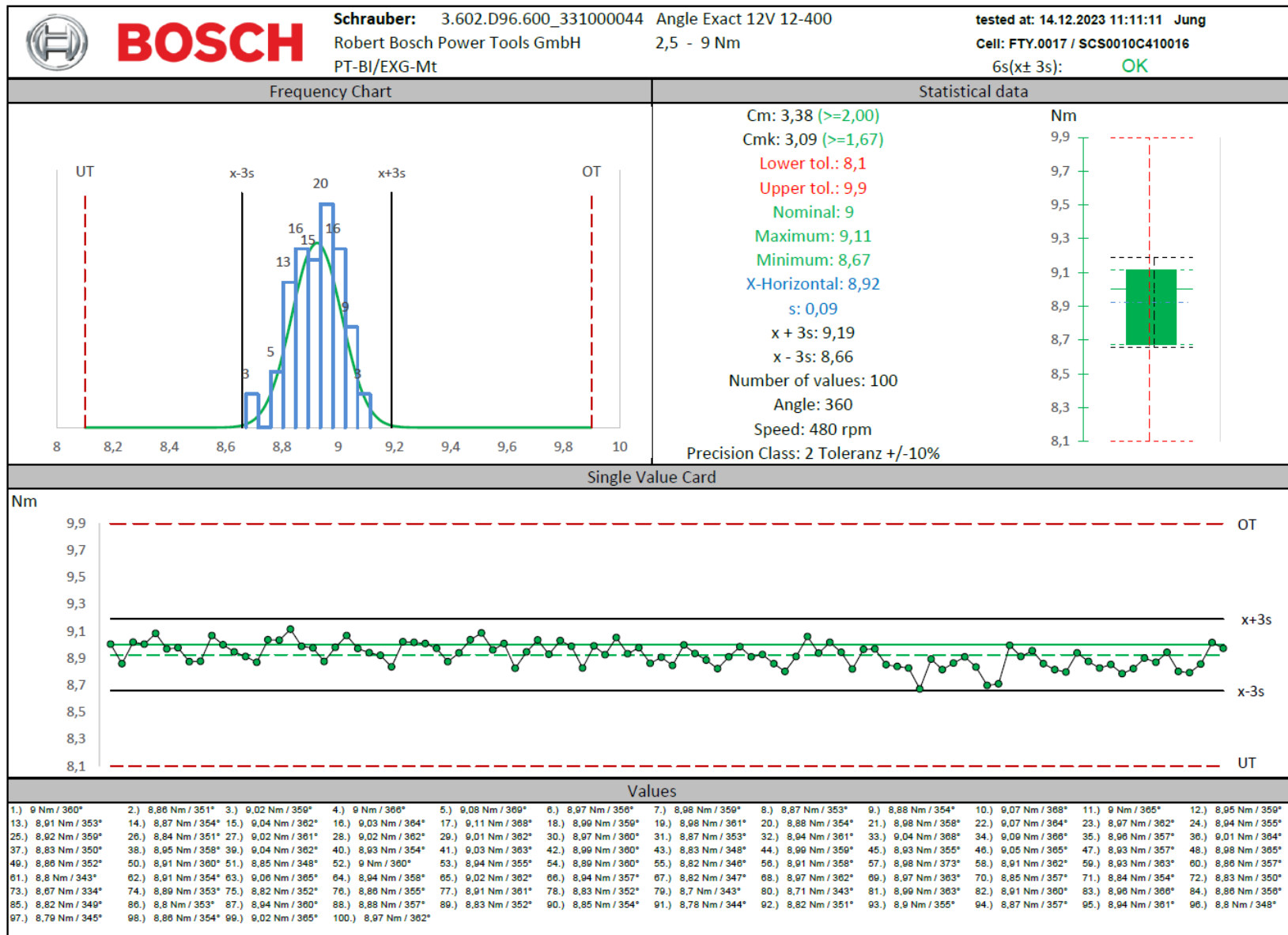


### 2.1.9.2 Screw joint 30° (hard) Set point 9,0 Nm (additional) 75/100

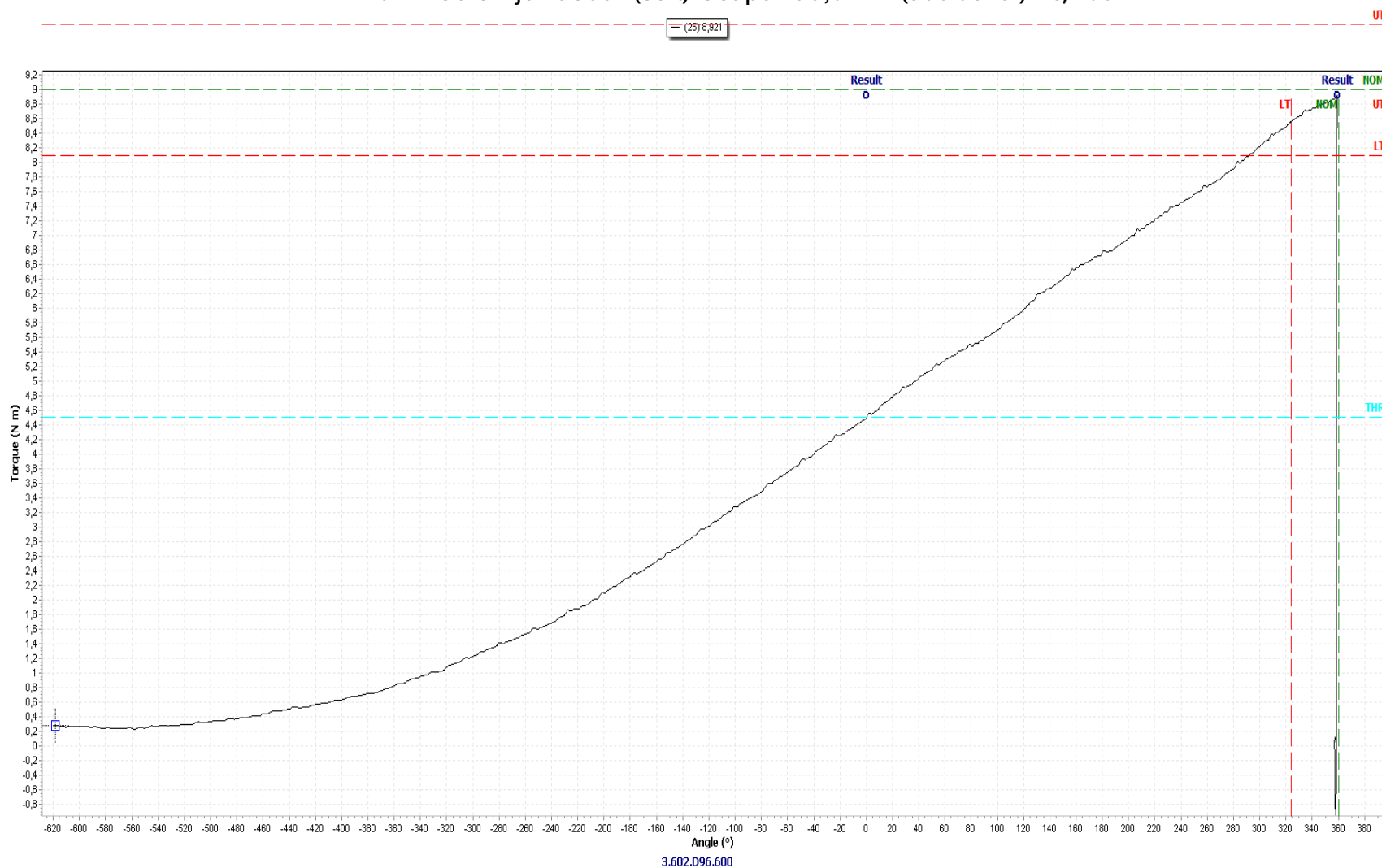




## 2.1.10 Screw joint 360° (soft) Set point 9,0 Nm (additional)

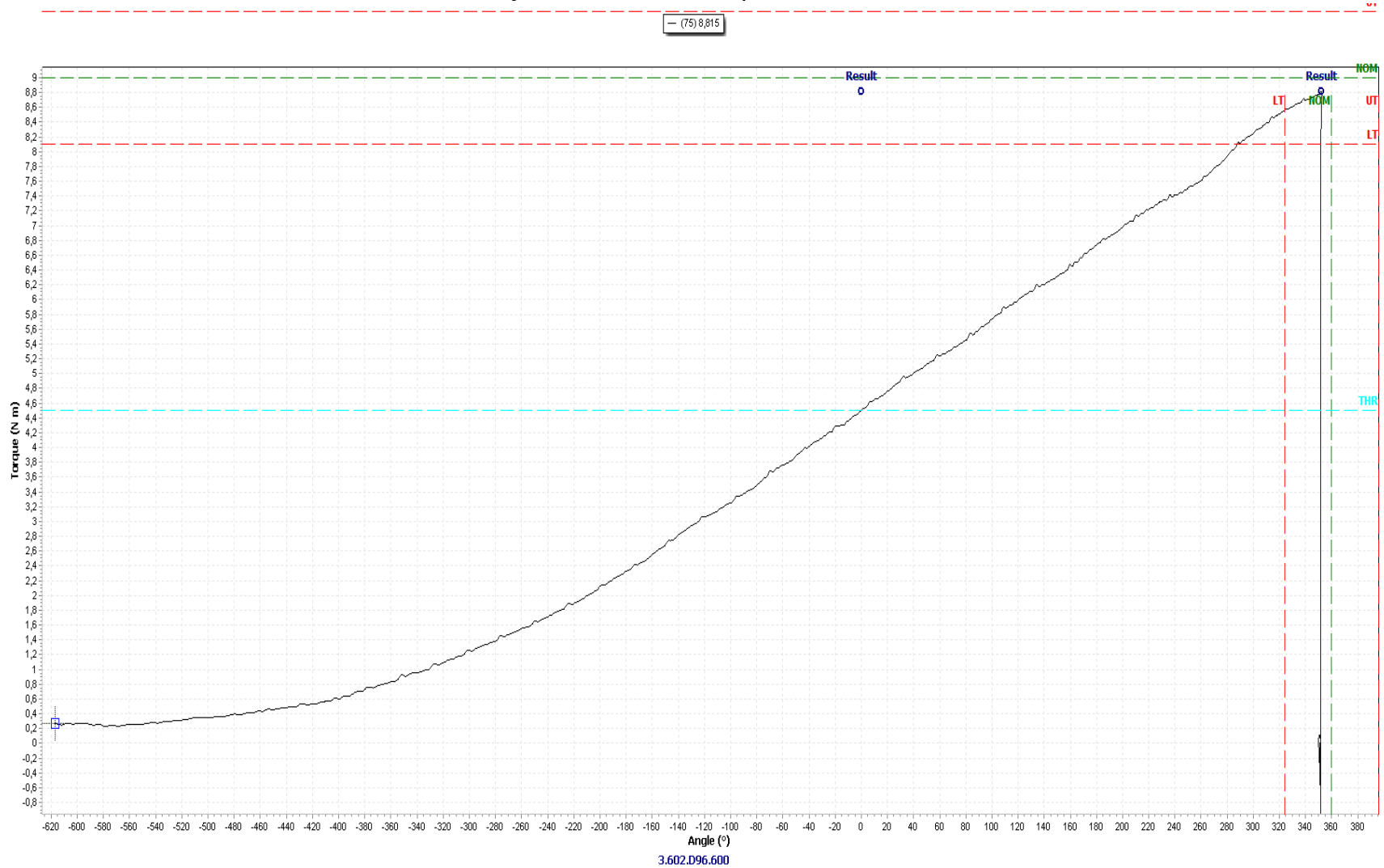


### 2.1.10.1 Screw joint 360° (soft) Set point 9,0 Nm (additional) 25/100





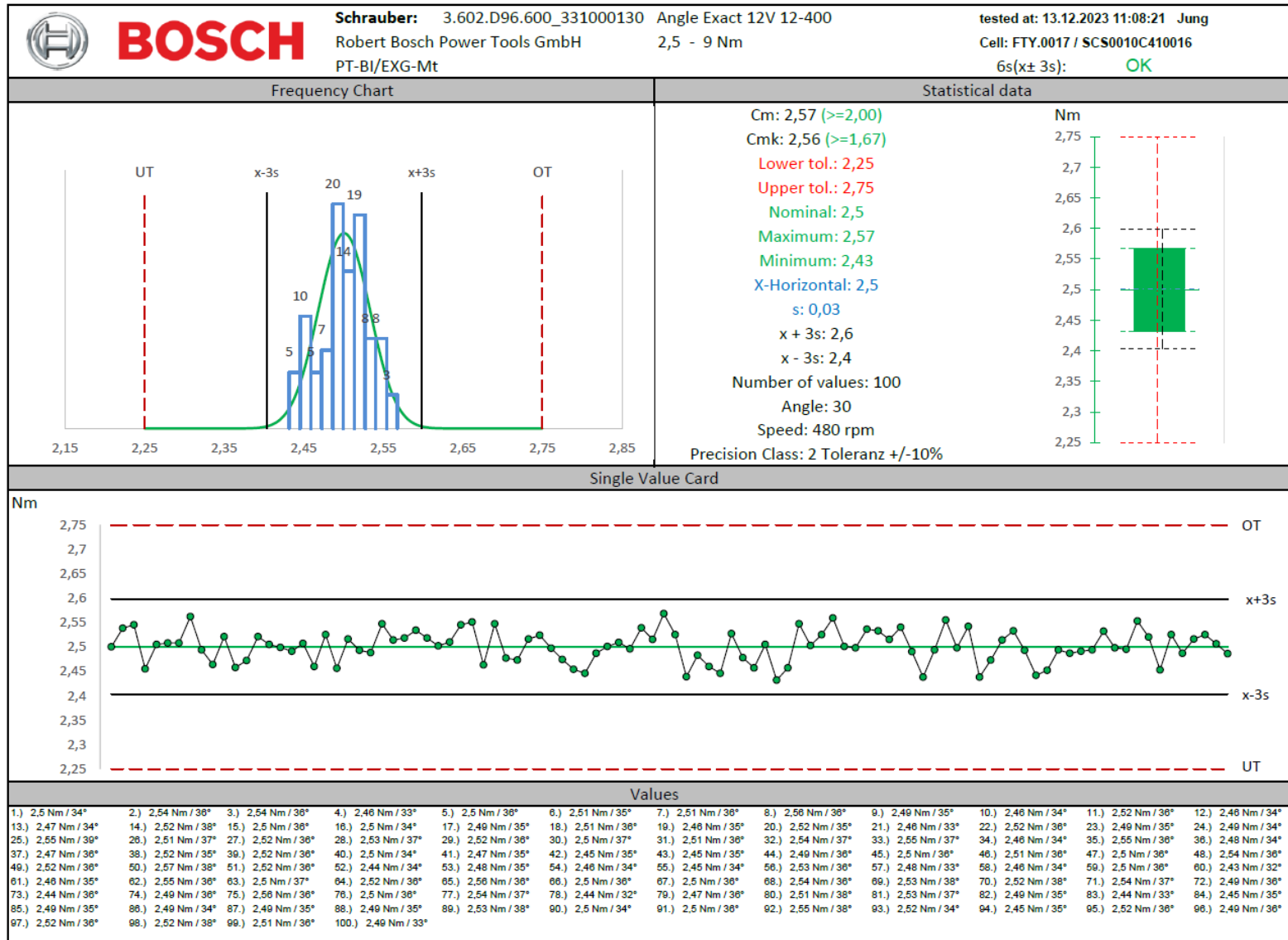
### 2.1.10.2 Screw joint 360° (soft) Set point 9,0 Nm (additional) 75/100



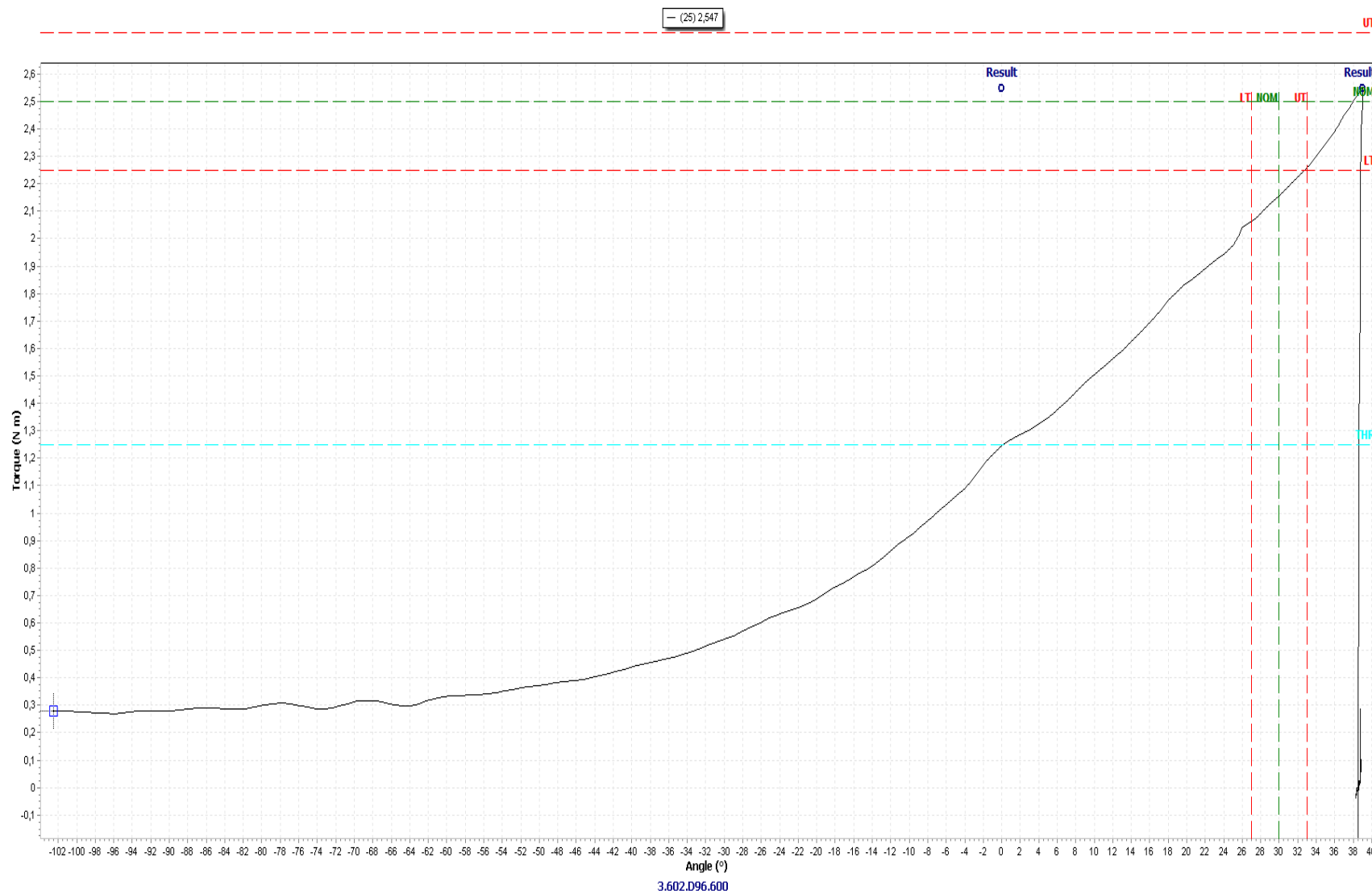


### 2.2 Machine capability analysis 331 000 130 (480 rpm)

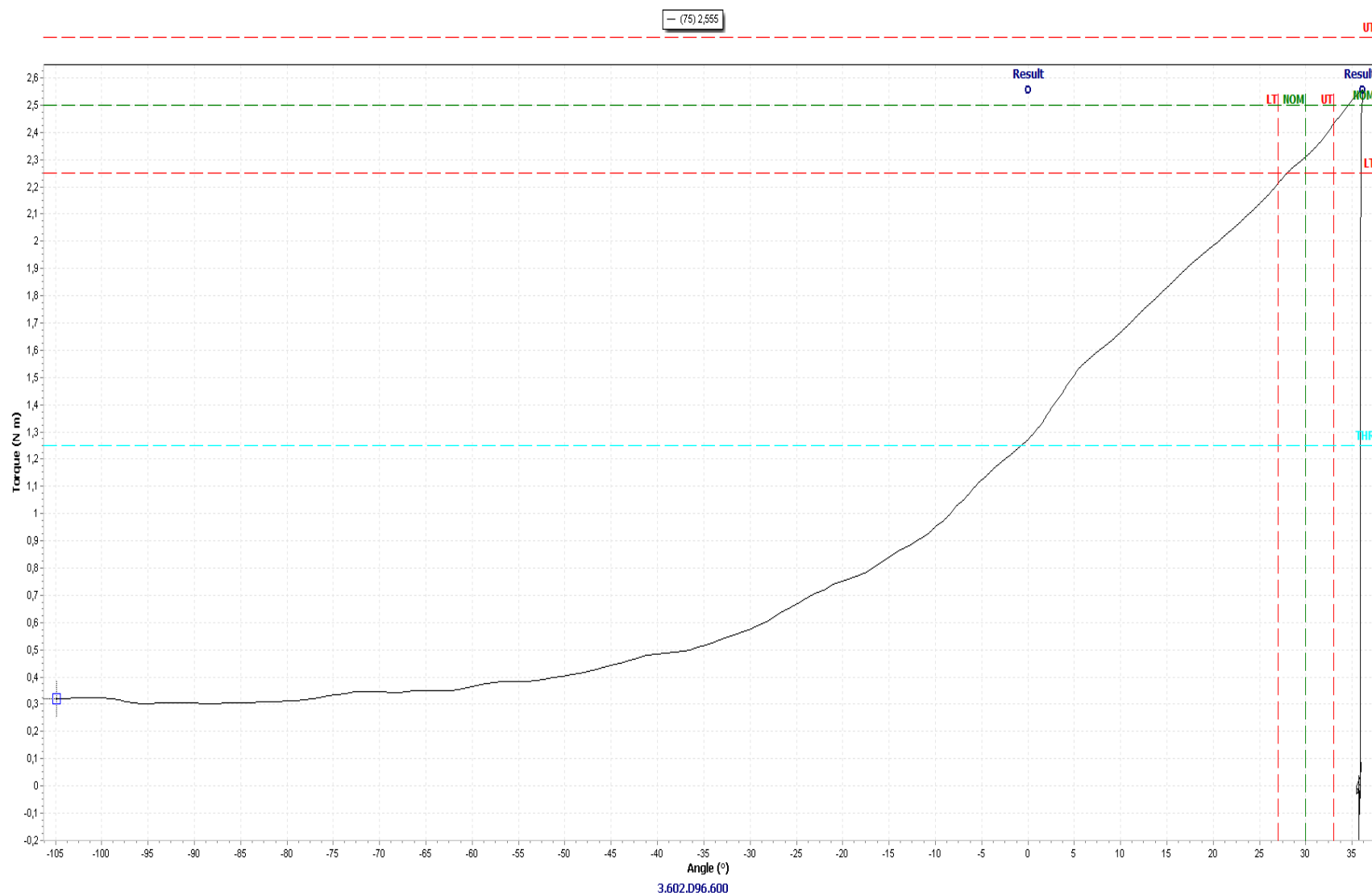
#### 2.2.1 Screw joint 30° (hard) Set point 2,5 Nm (0%)



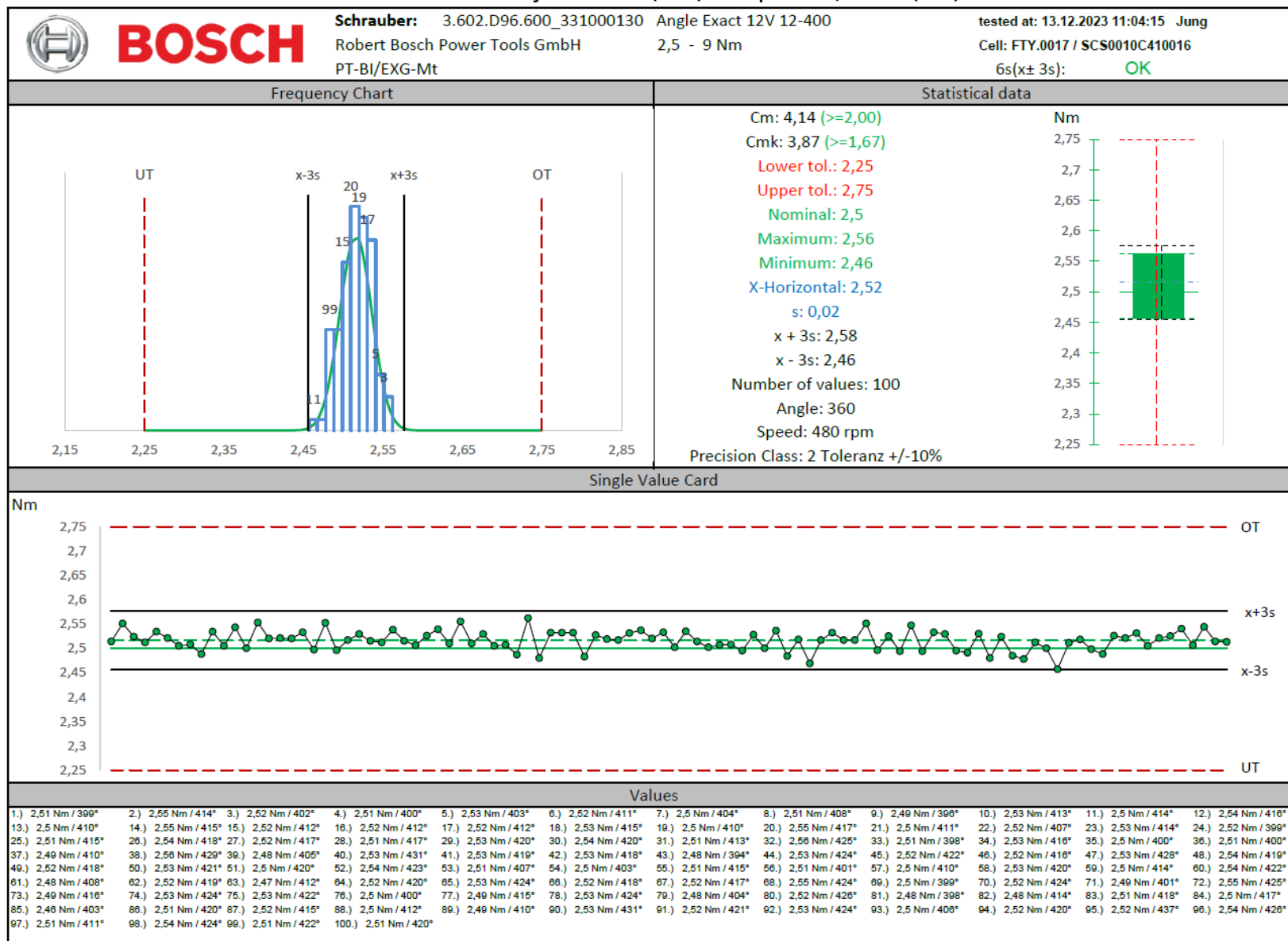
### 2.2.1.1 Screw joint 30° (hard) Set point 2,5 Nm (0%) 25/100



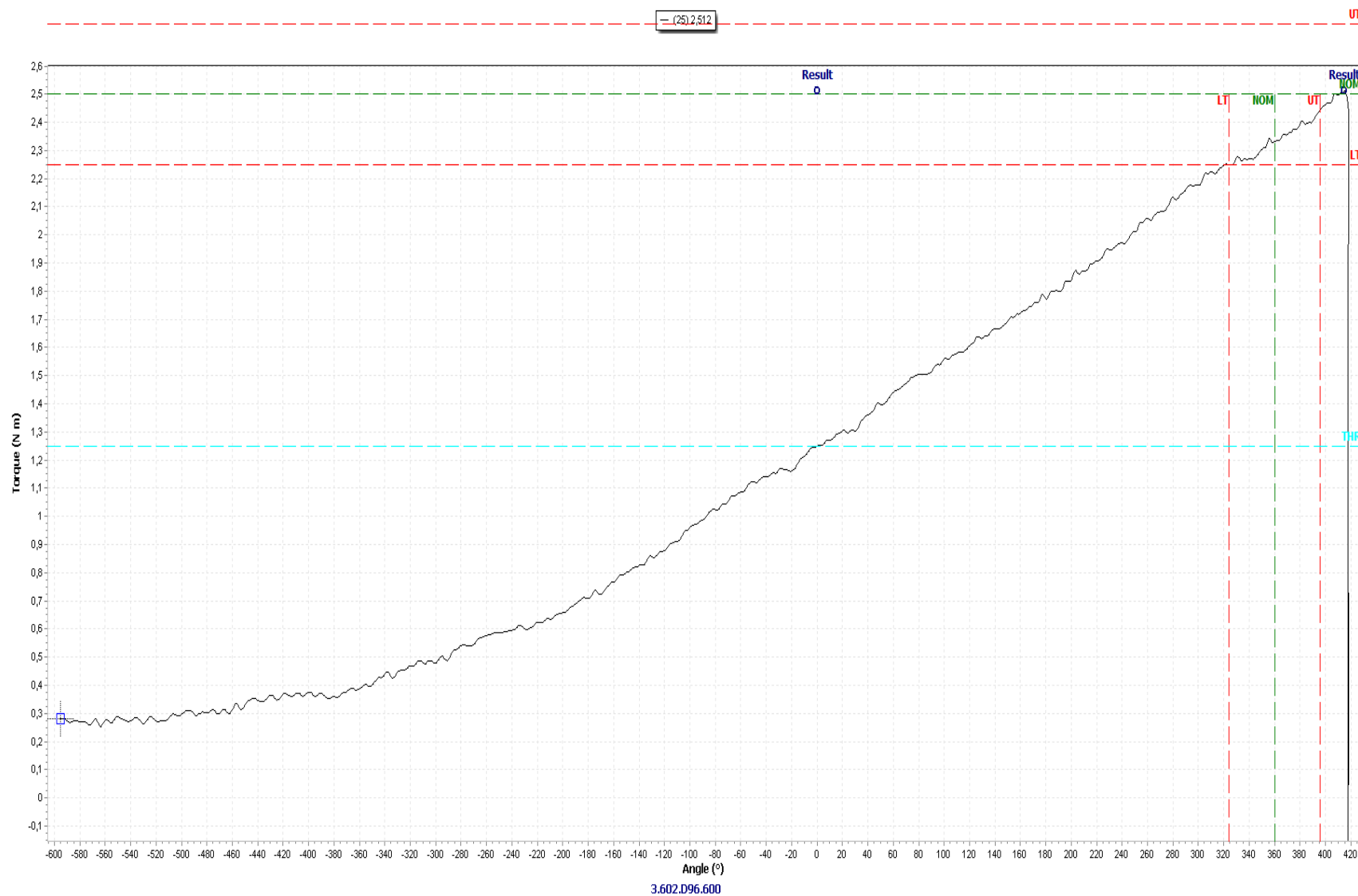
### 2.2.1.2 Screw joint 30° (hard) Set point 2,5 Nm (0%) 75/100



## 2.2.2 Screw joint 360° (soft) Set point 2,5 Nm (0%)

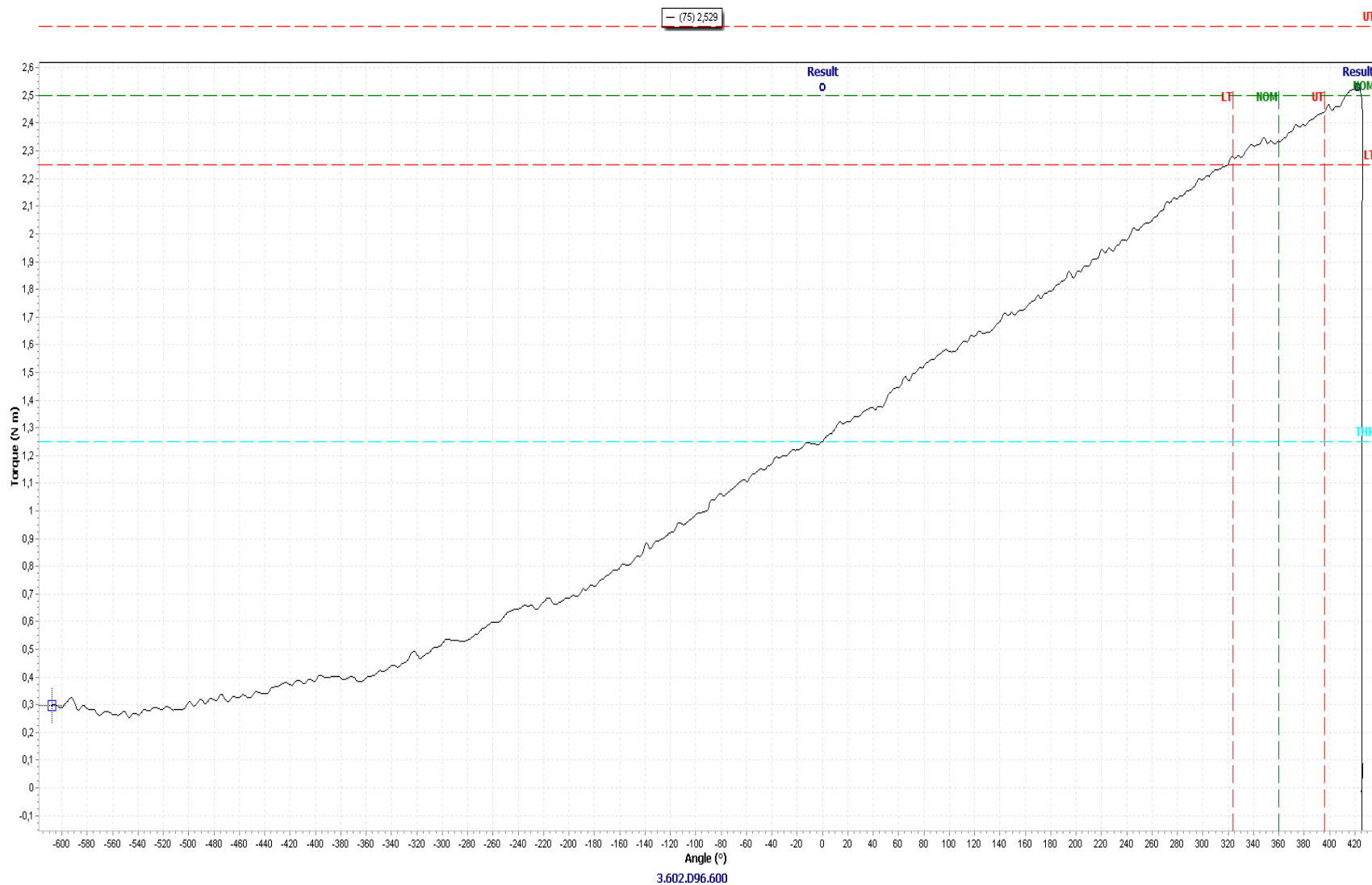


### 2.2.2.1 Screw joint 360° (soft) Set point 2,5 Nm (0%) 25/100



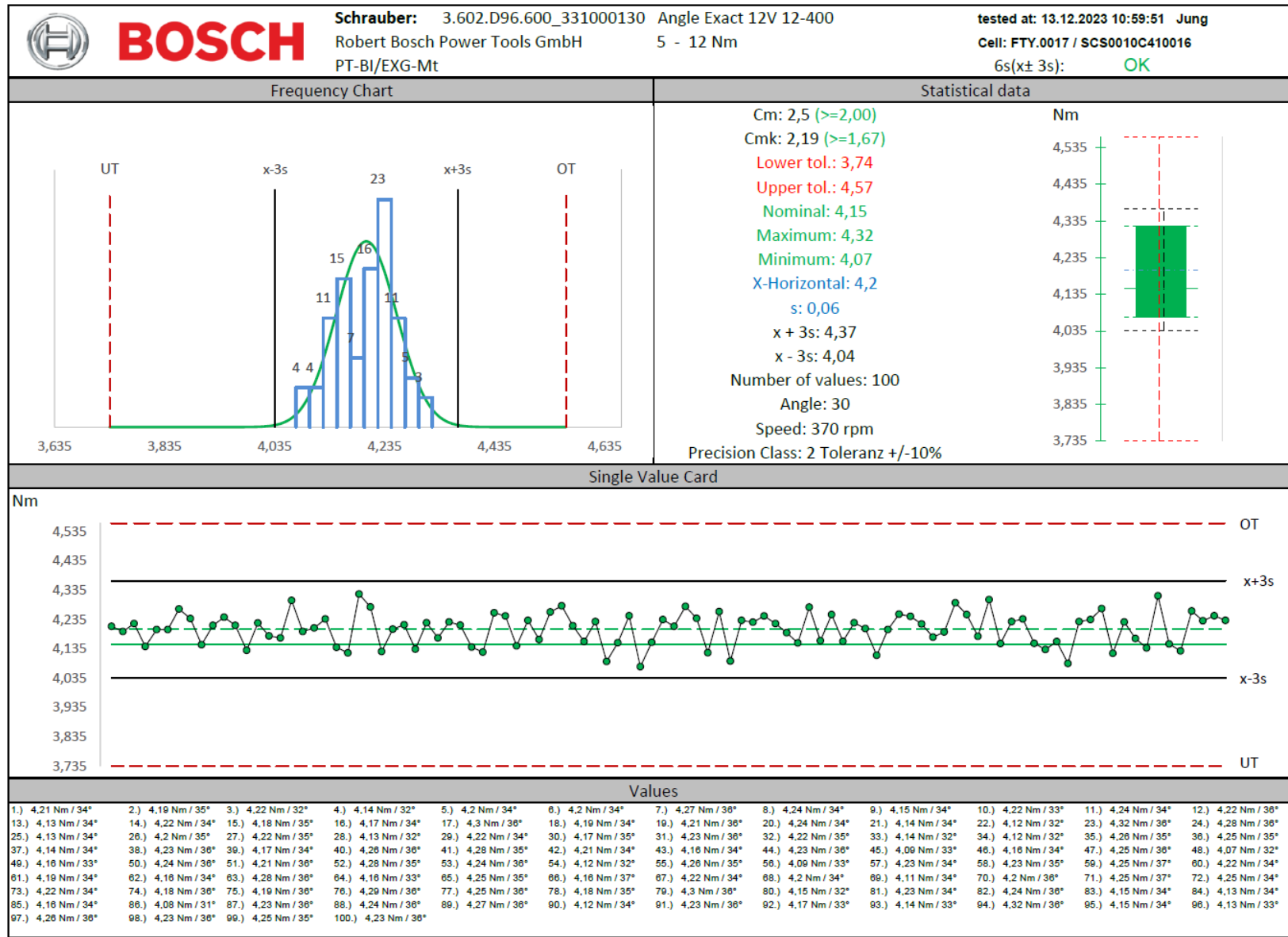


### 2.2.2.2 Screw joint 360° (soft) Set point 2,5 Nm (0%) 75/100

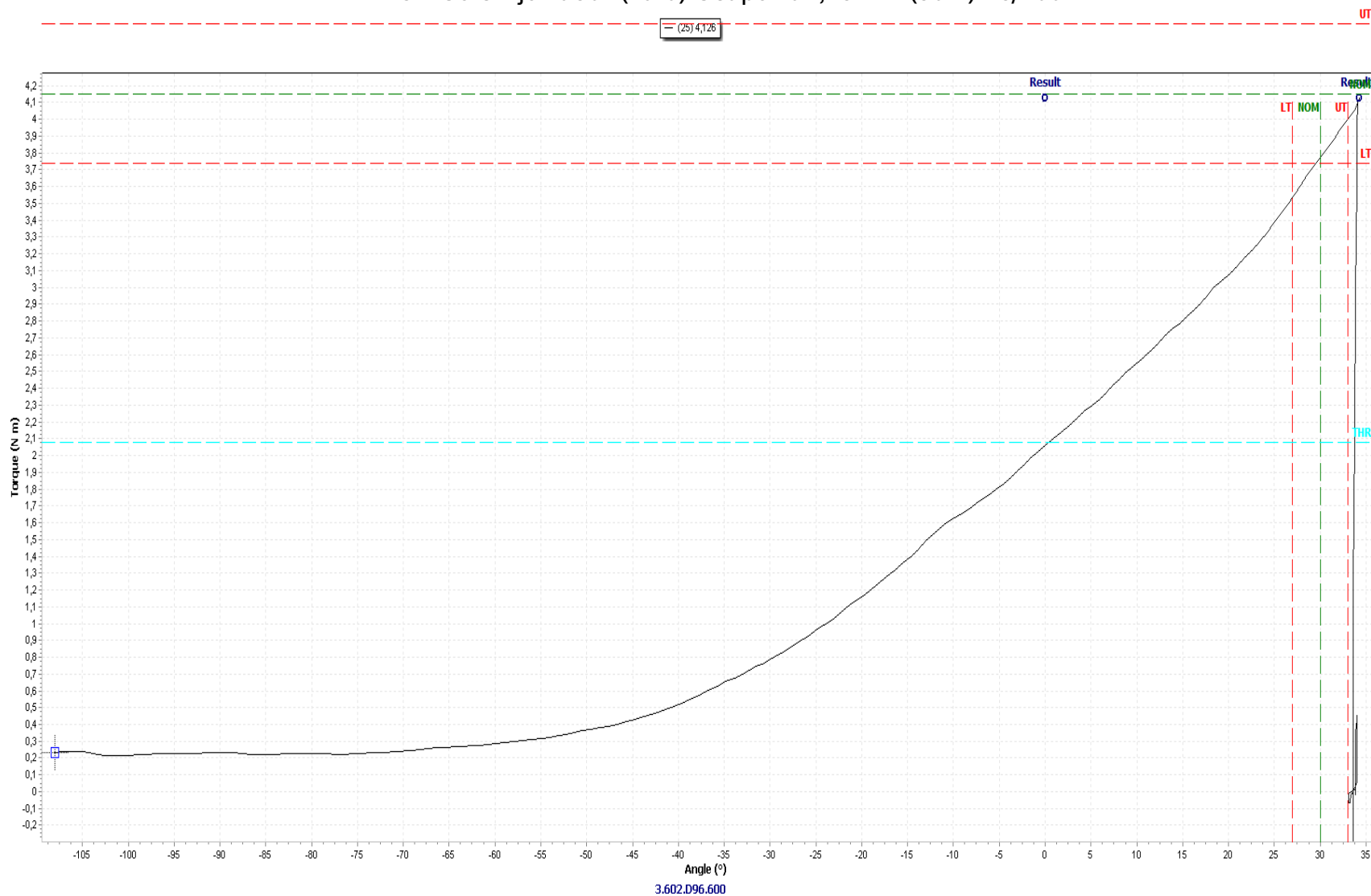




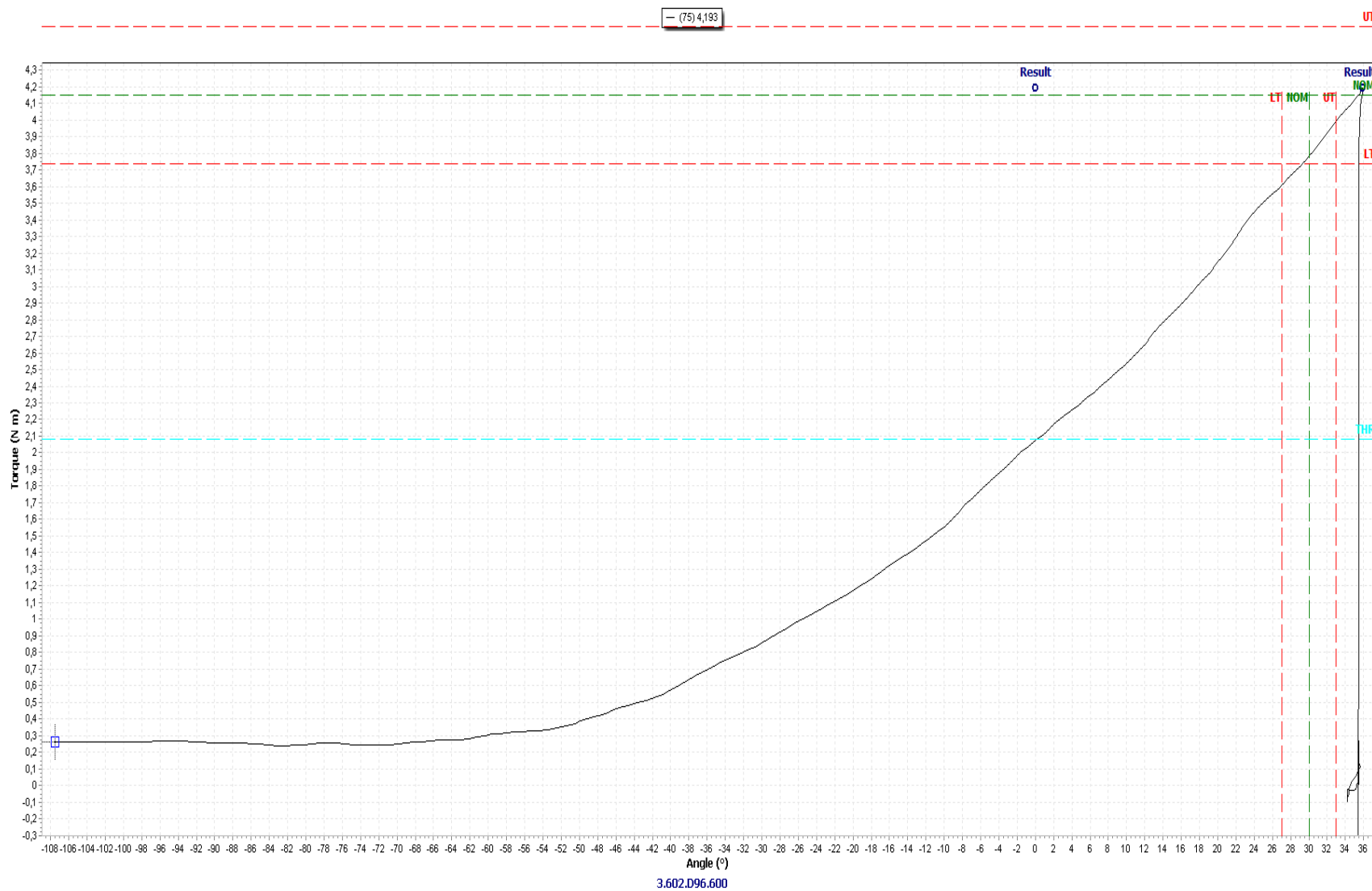
### 2.2.3 Screw joint 30° (hard) Set point 4,15 Nm (30%)



### 2.2.3.1 Screw joint 30° (hard) Set point 4,15 Nm (30%) 25/100

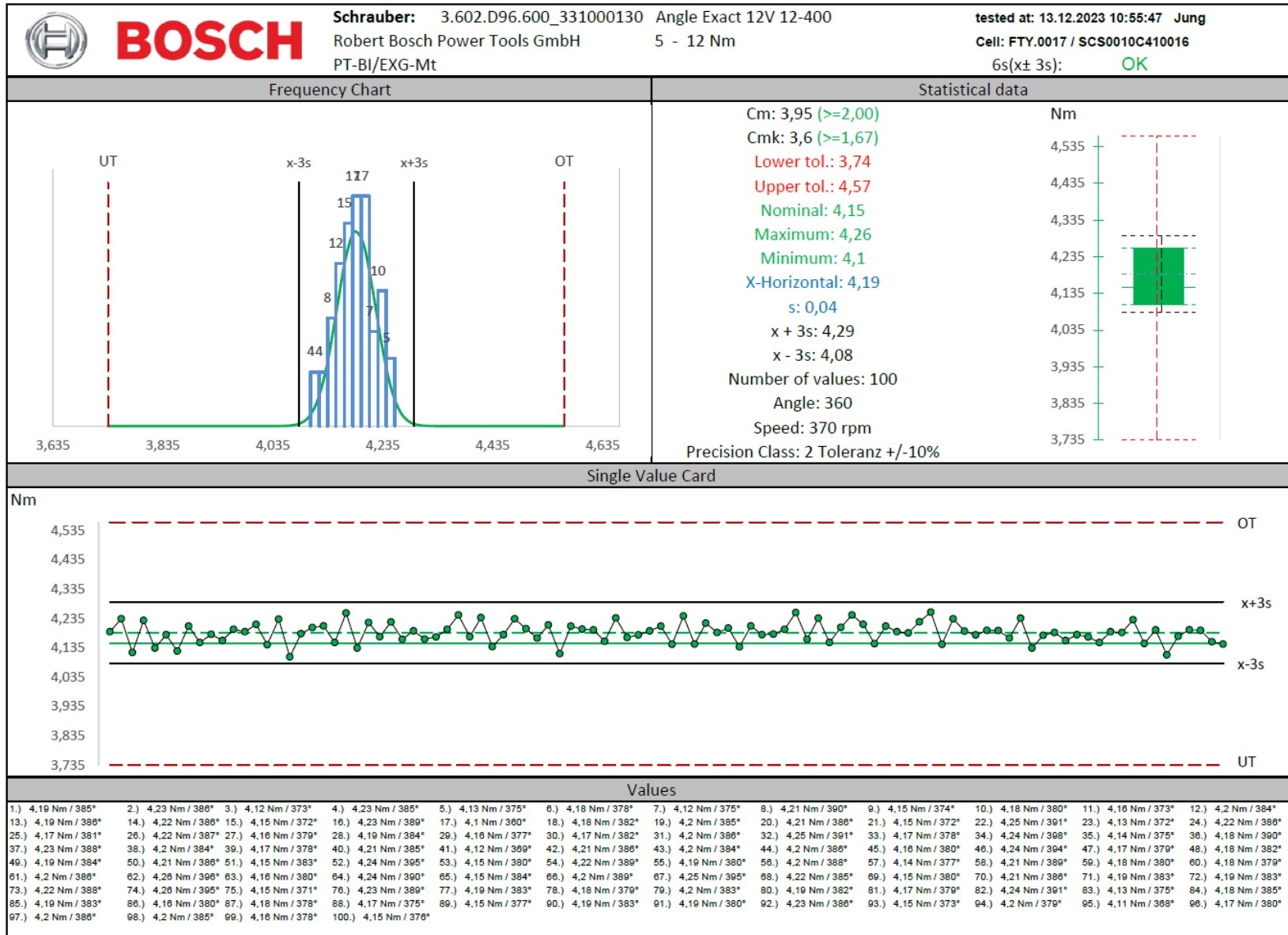


### 2.2.3.2 Screw joint 30° (hard) Set point 4,15 Nm (30%) 75/100

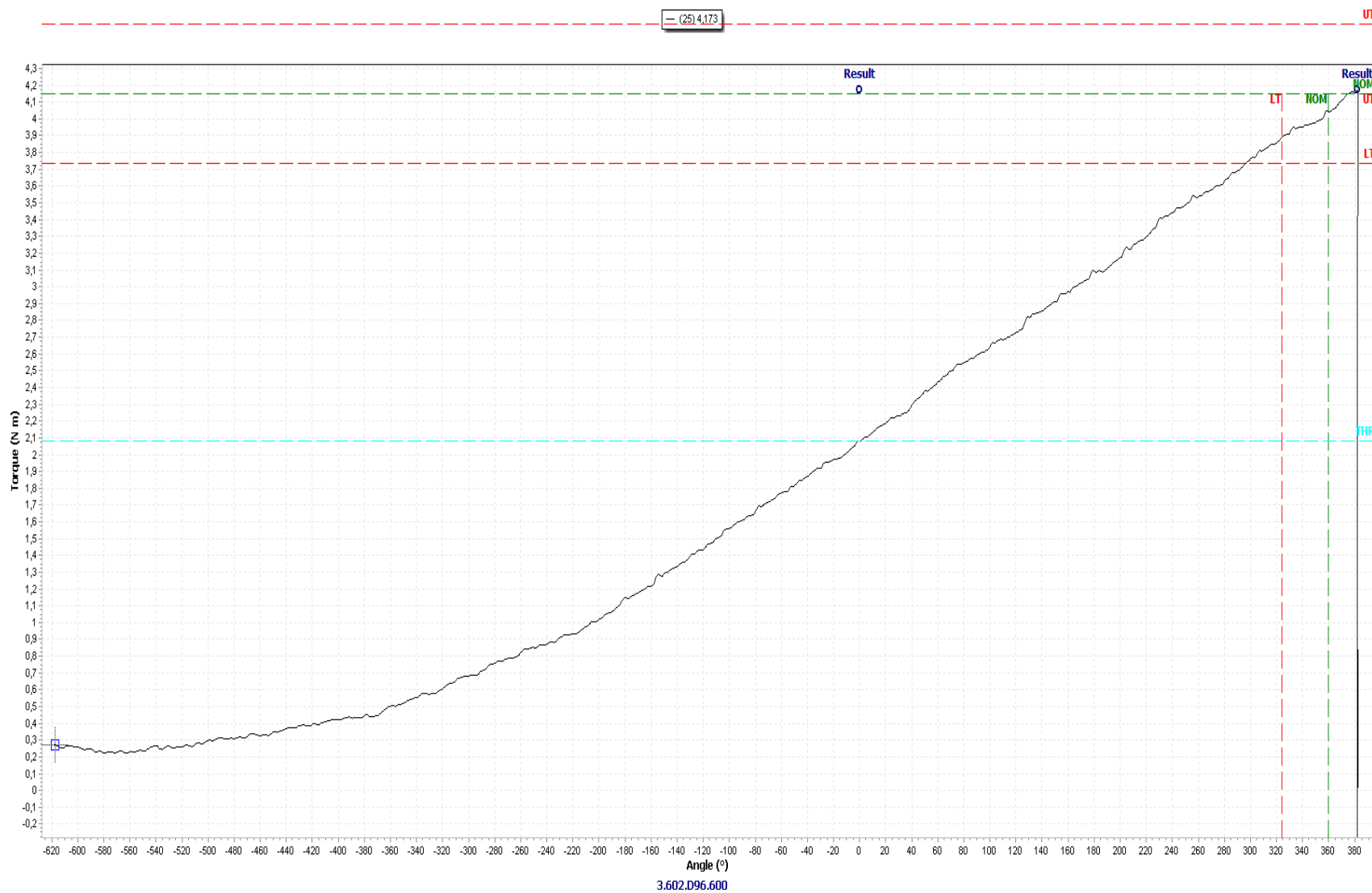




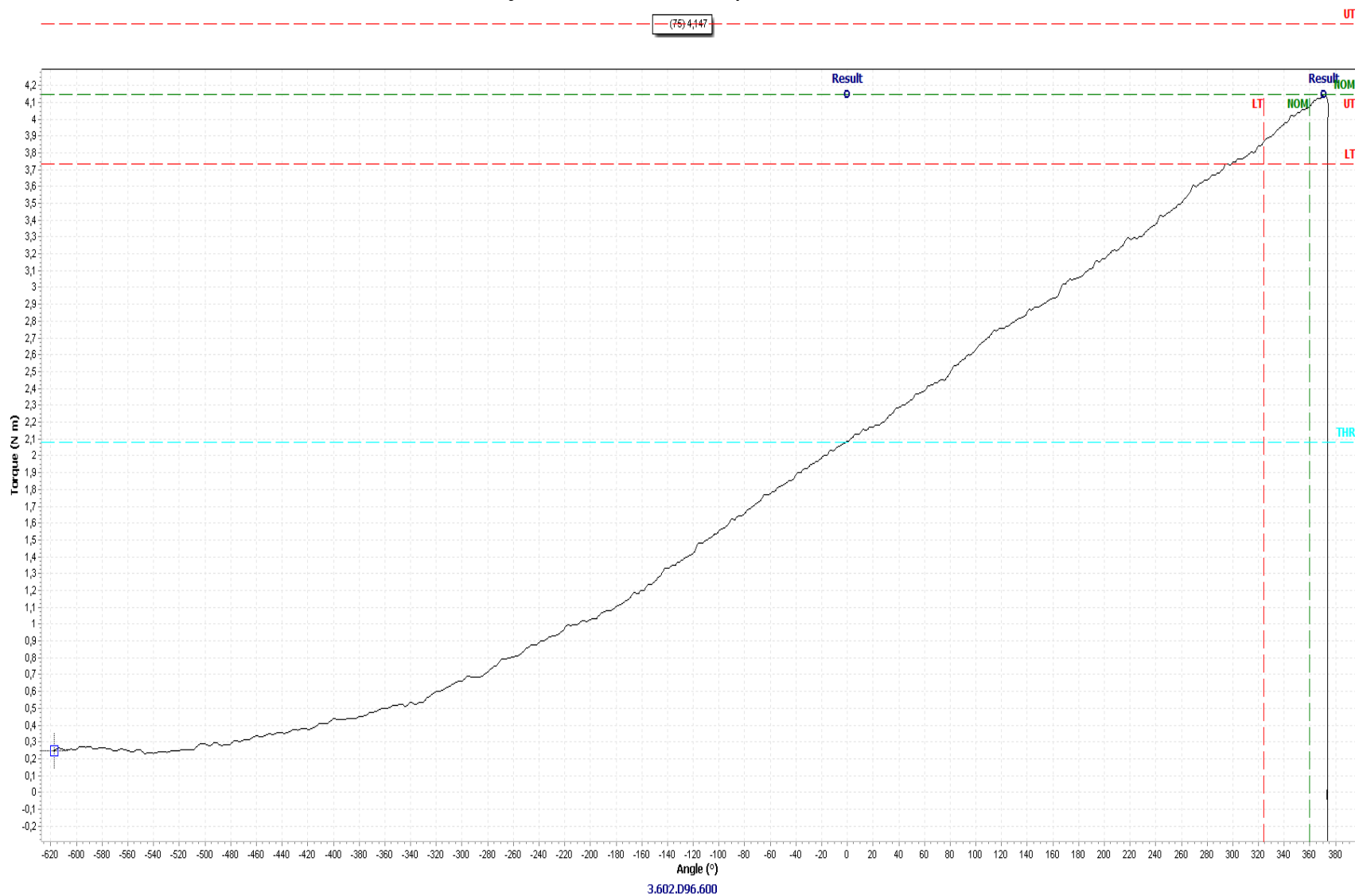
### 2.2.4 Screw joint 360° (soft) Set point 4,15 Nm (30%)



### 2.2.4.1 Screw joint 360° (soft) Set point 4,15 Nm (30%) 25/100

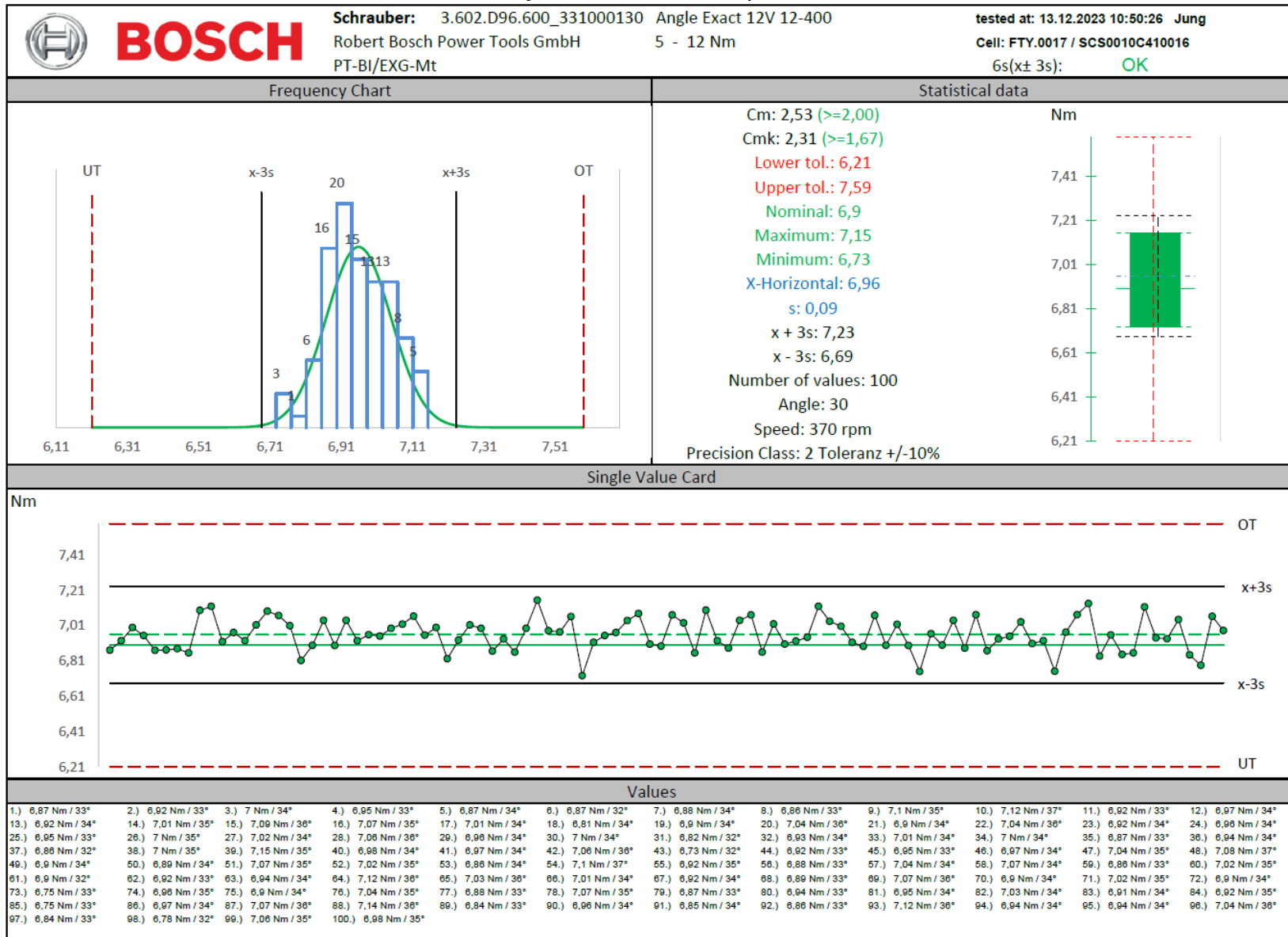


### 2.2.4.2 Screw joint 360° (soft) Set point 4,15 Nm (30%) 75/100





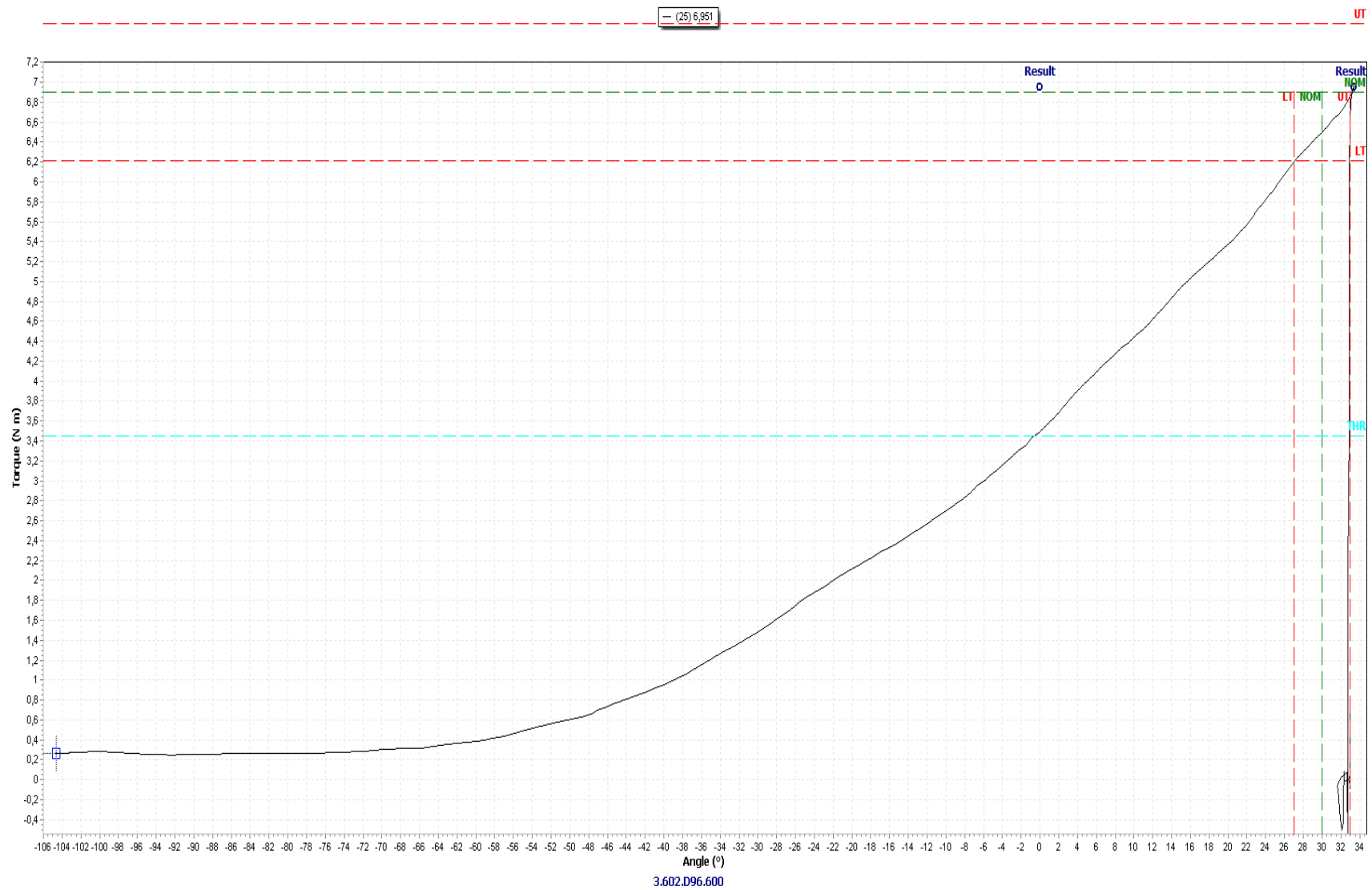
### 2.2.5 Screw joint 30° (hard) Set point 6,9 Nm (80%)



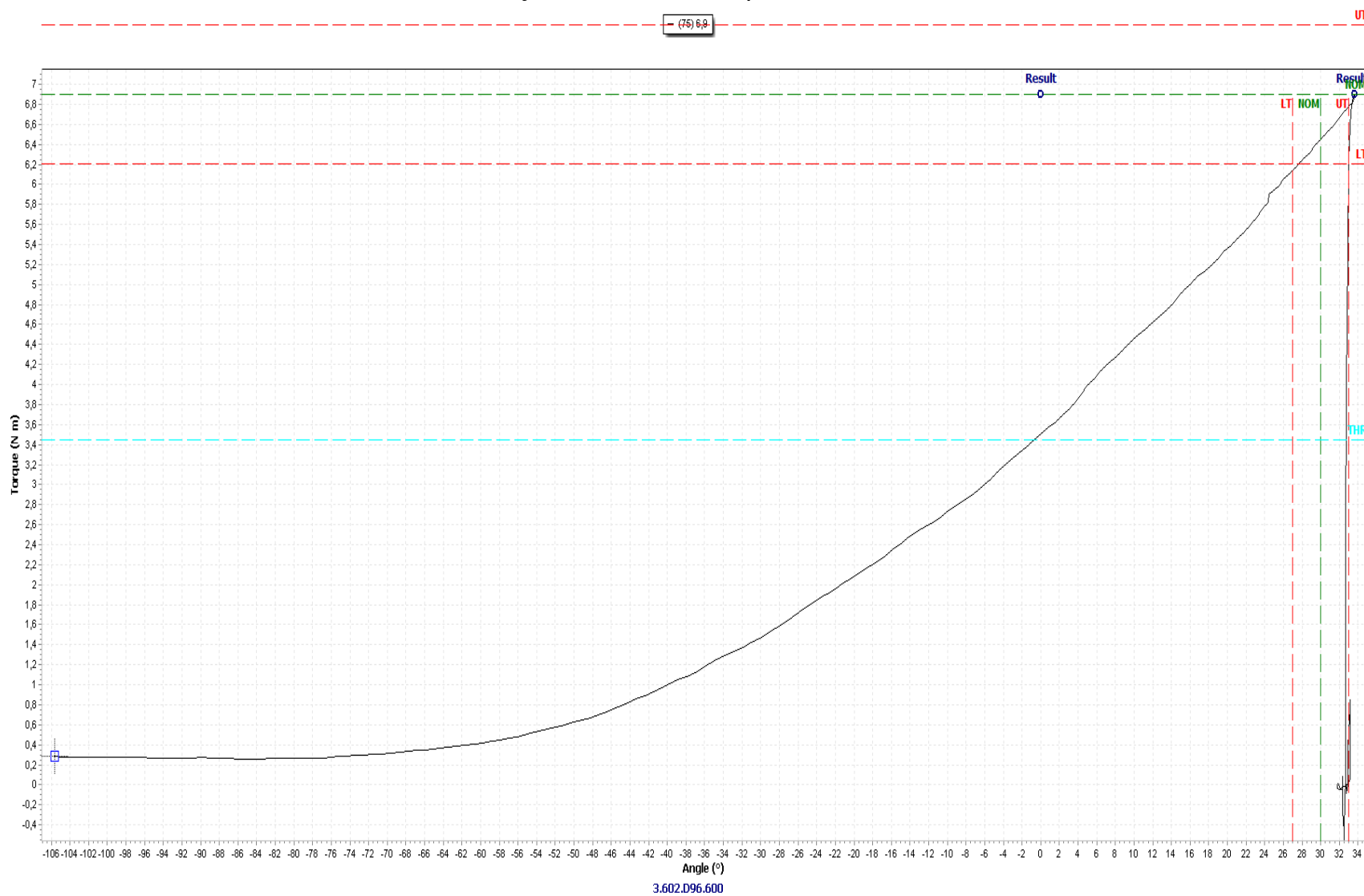




### 2.2.5.1 Screw joint 30° (hard) Set point 6,9 Nm (80%) 25/100

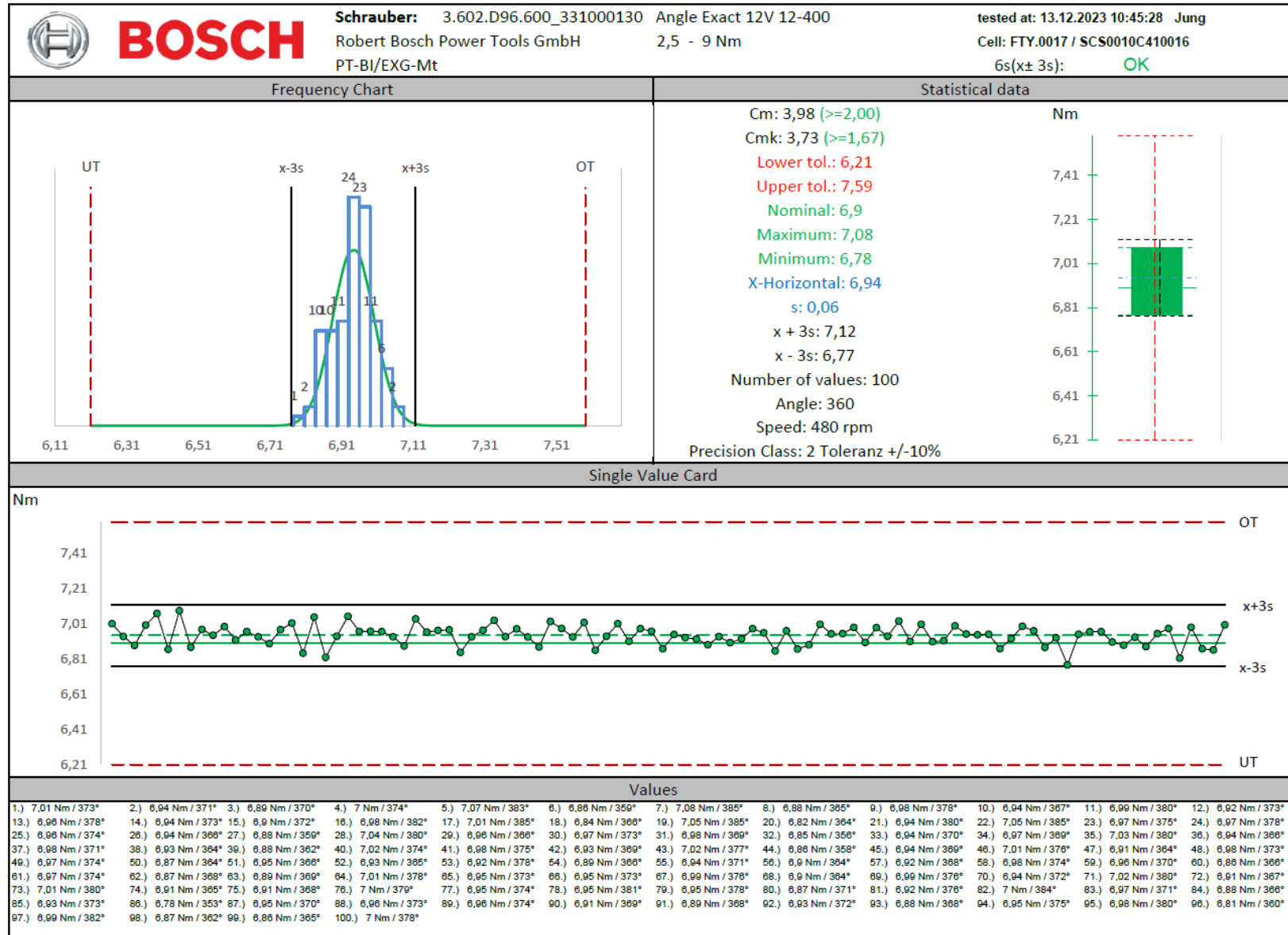


#### 2.2.5.2 Screw joint 30° (hard) Set point 6,9 Nm (80%) 75/100





### 2.2.6 Screw joint 360° (soft) Set point 6,9 Nm (80%)

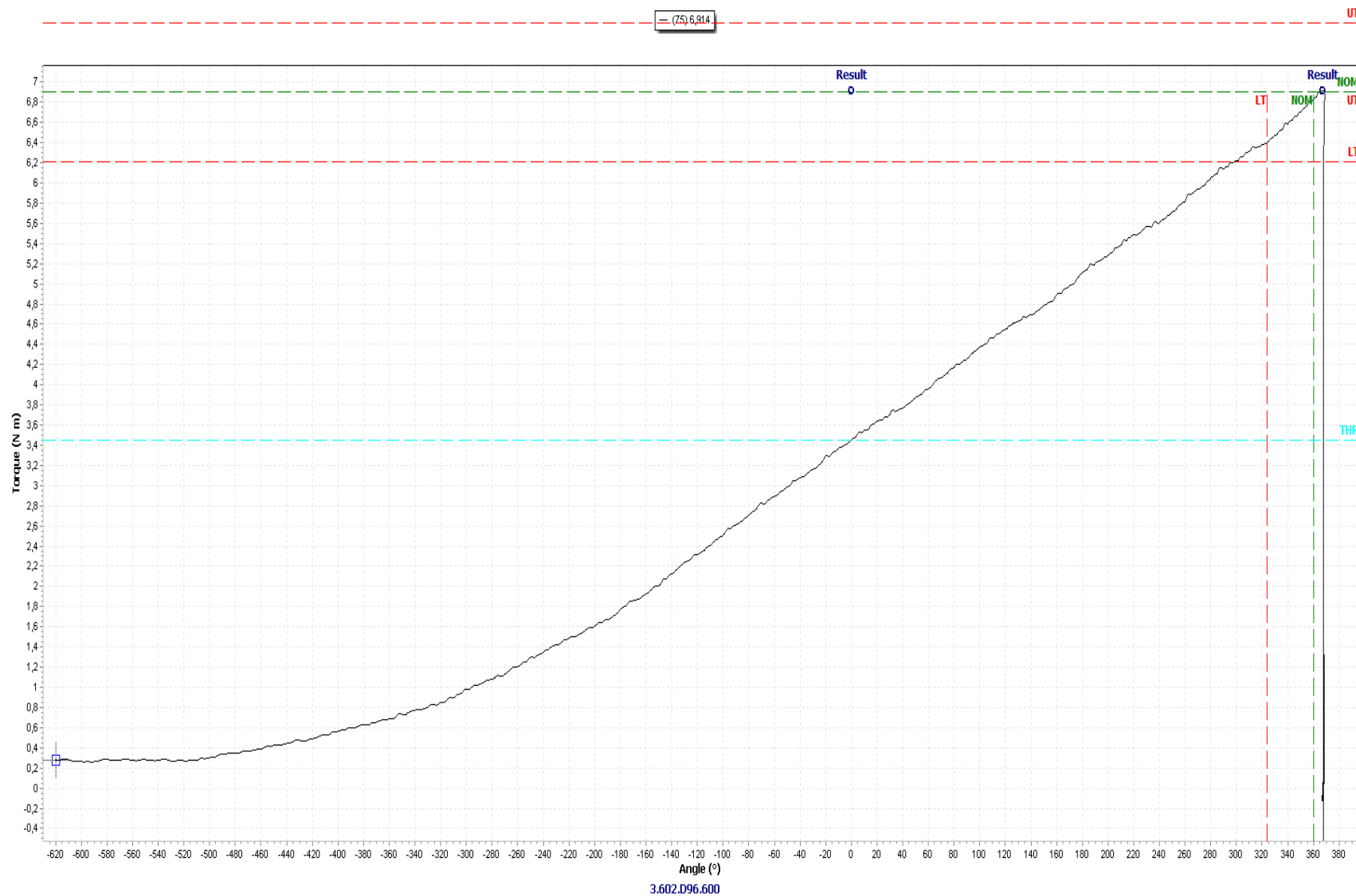


Graph showing Torque (N.m) versus Angle (°) for a 25 kg load. The curve starts at approximately -620° and 0.3 N.m, rises steadily, and reaches a peak of approximately 7.0 N.m at 380°. Key points marked on the graph include:

- THR (Threshold):** Indicated by a cyan dashed line at approximately 3.4 N.m.
- LT (Limit):** Indicated by a red dashed line at approximately 6.2 N.m.
- NOM (Nominal):** Indicated by a green dashed line at approximately 6.9 N.m.

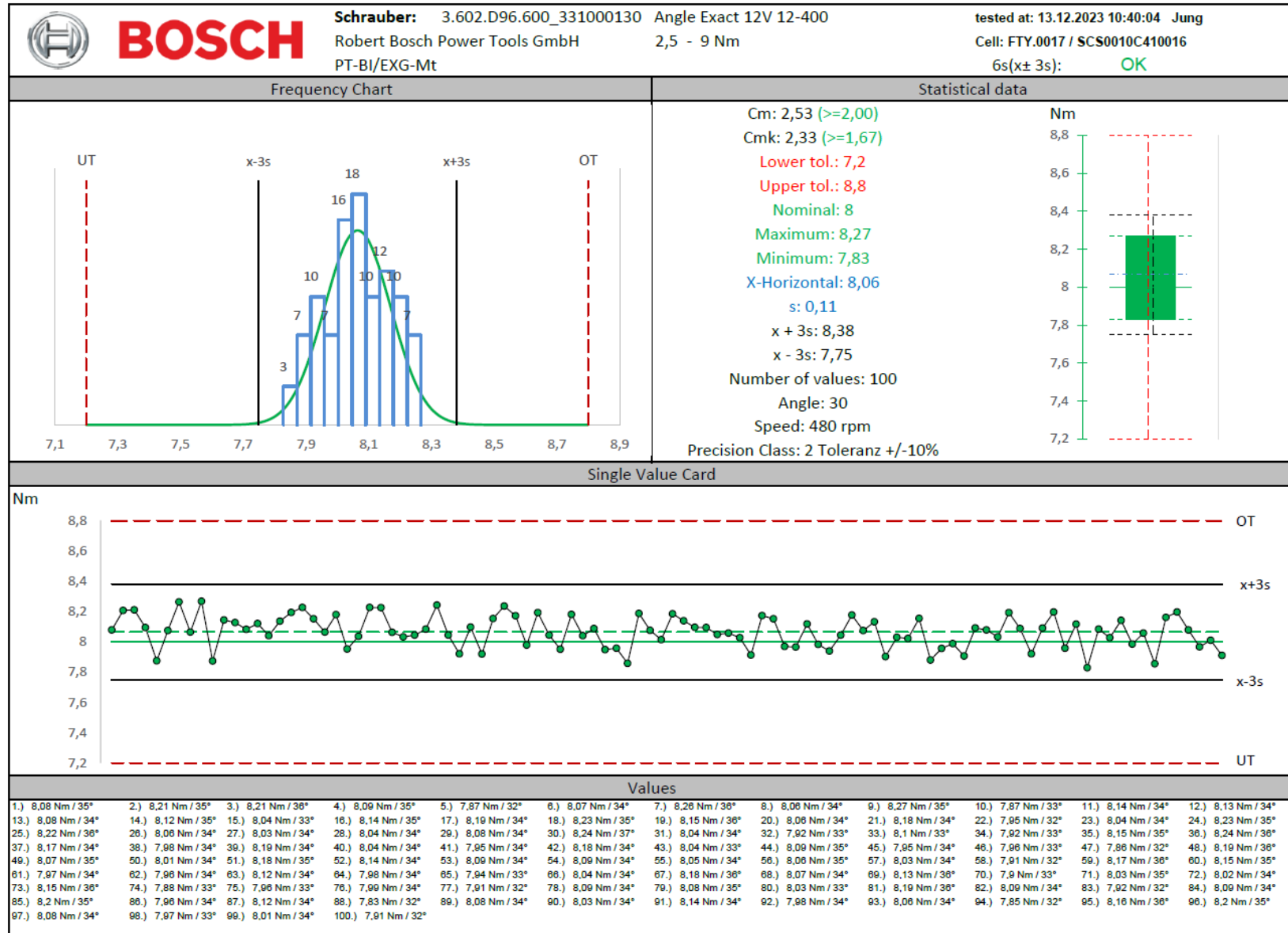
The graph also shows a legend for the 25 kg load and a result value of 0.

### 2.2.6.2 Screw joint 360° (soft) Set point 6,9 Nm (80%) 75/100



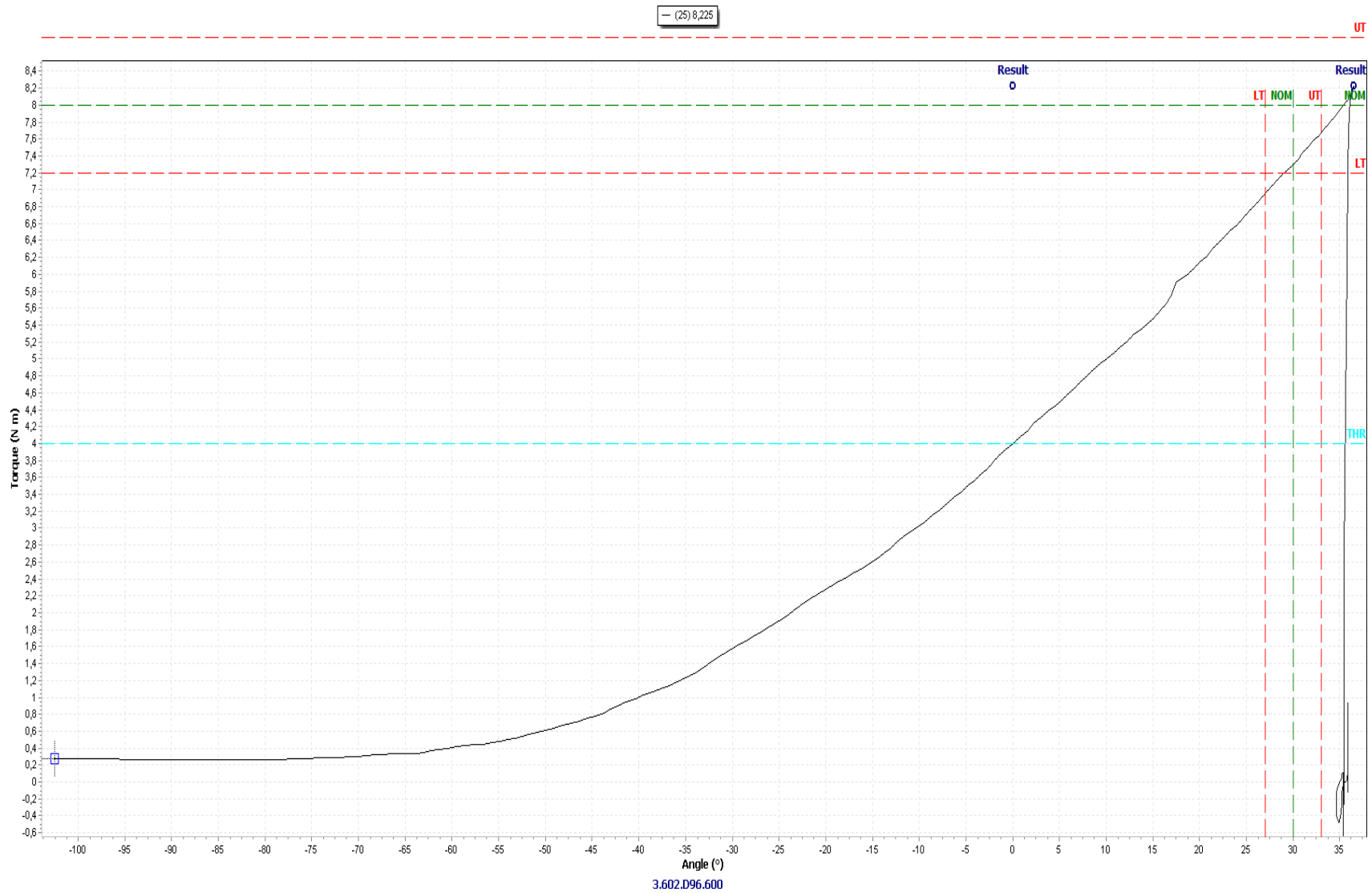


### 2.2.7 Screw joint 30° (hard) Set point 8,0 Nm (100%)

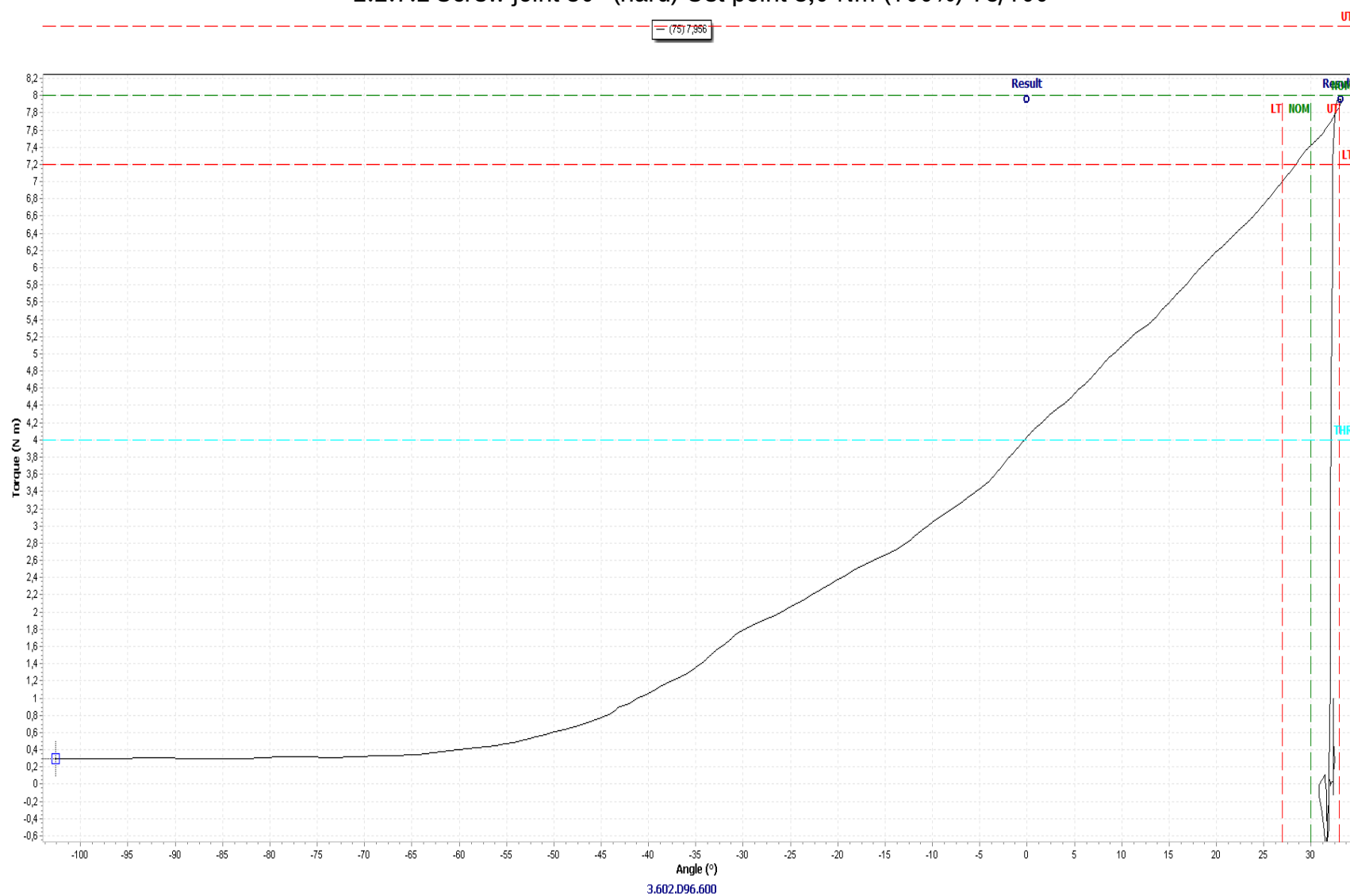




2.2.7.1 Screw joint 30° (hard) Set point 8,0 Nm (100%) 25/100



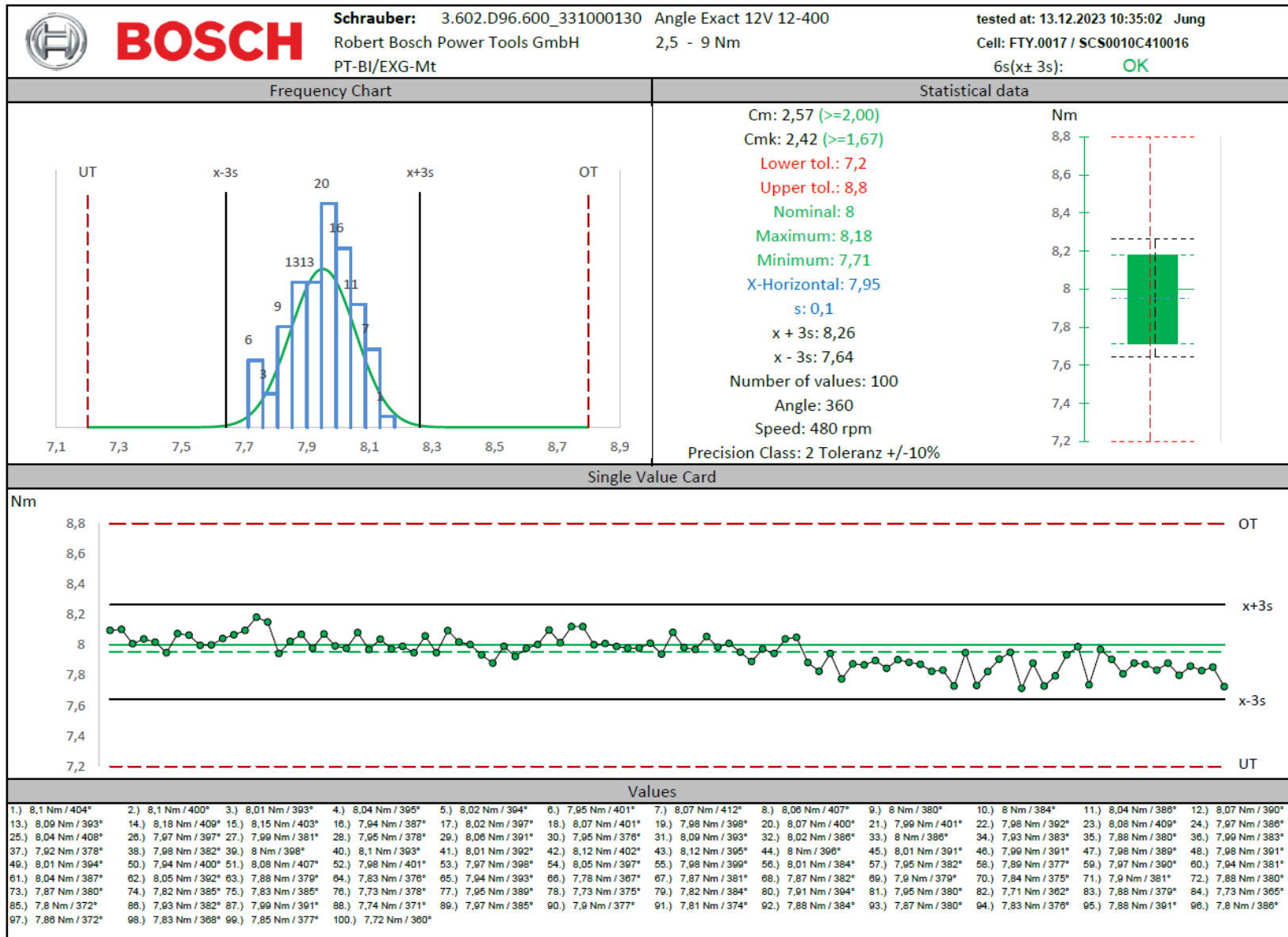
### 2.2.7.2 Screw joint 30° (hard) Set point 8,0 Nm (100%) 75/100





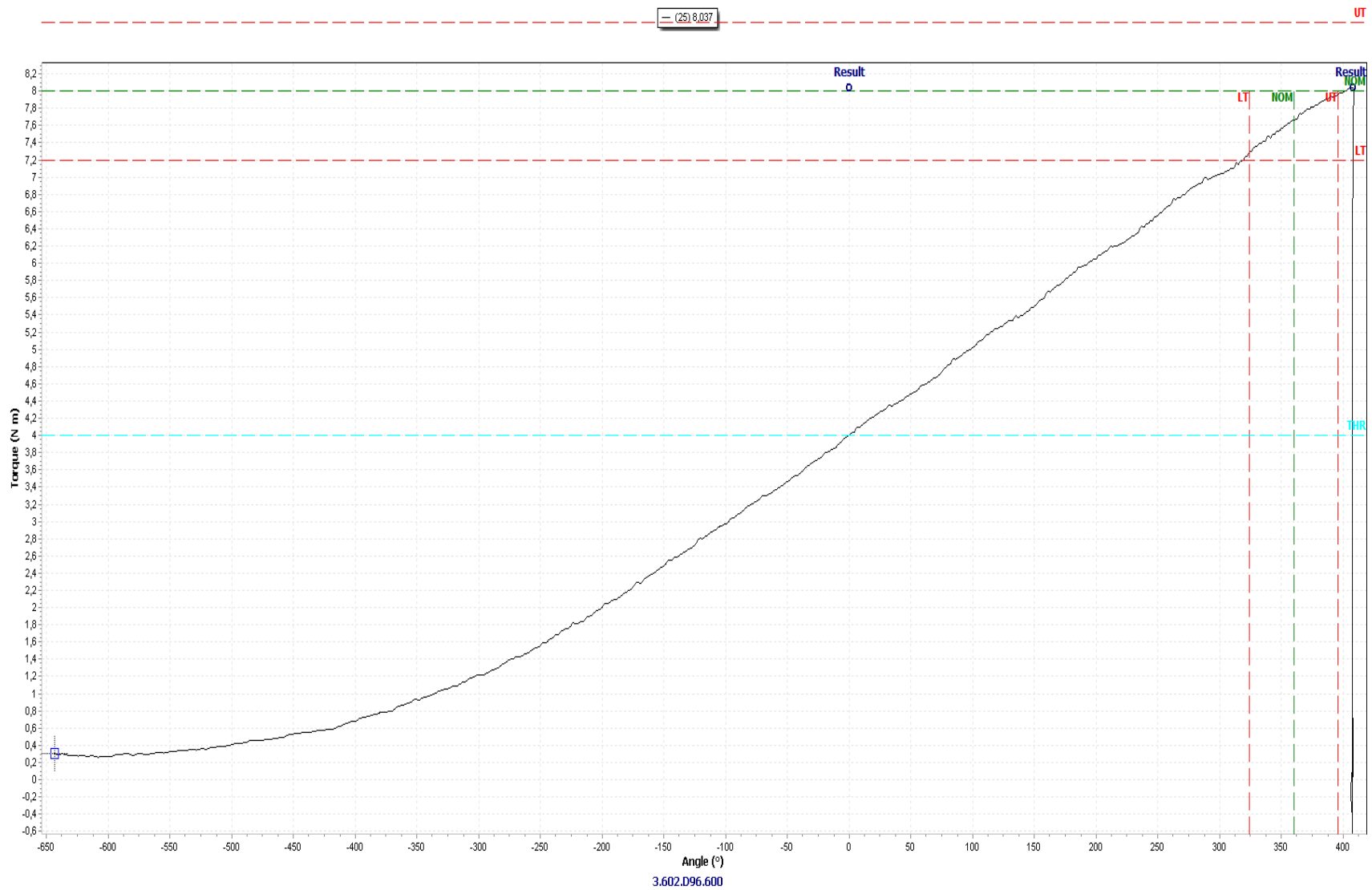


### 2.2.8 Screw joint 360° (soft) Set point 8,0 Nm (100%)



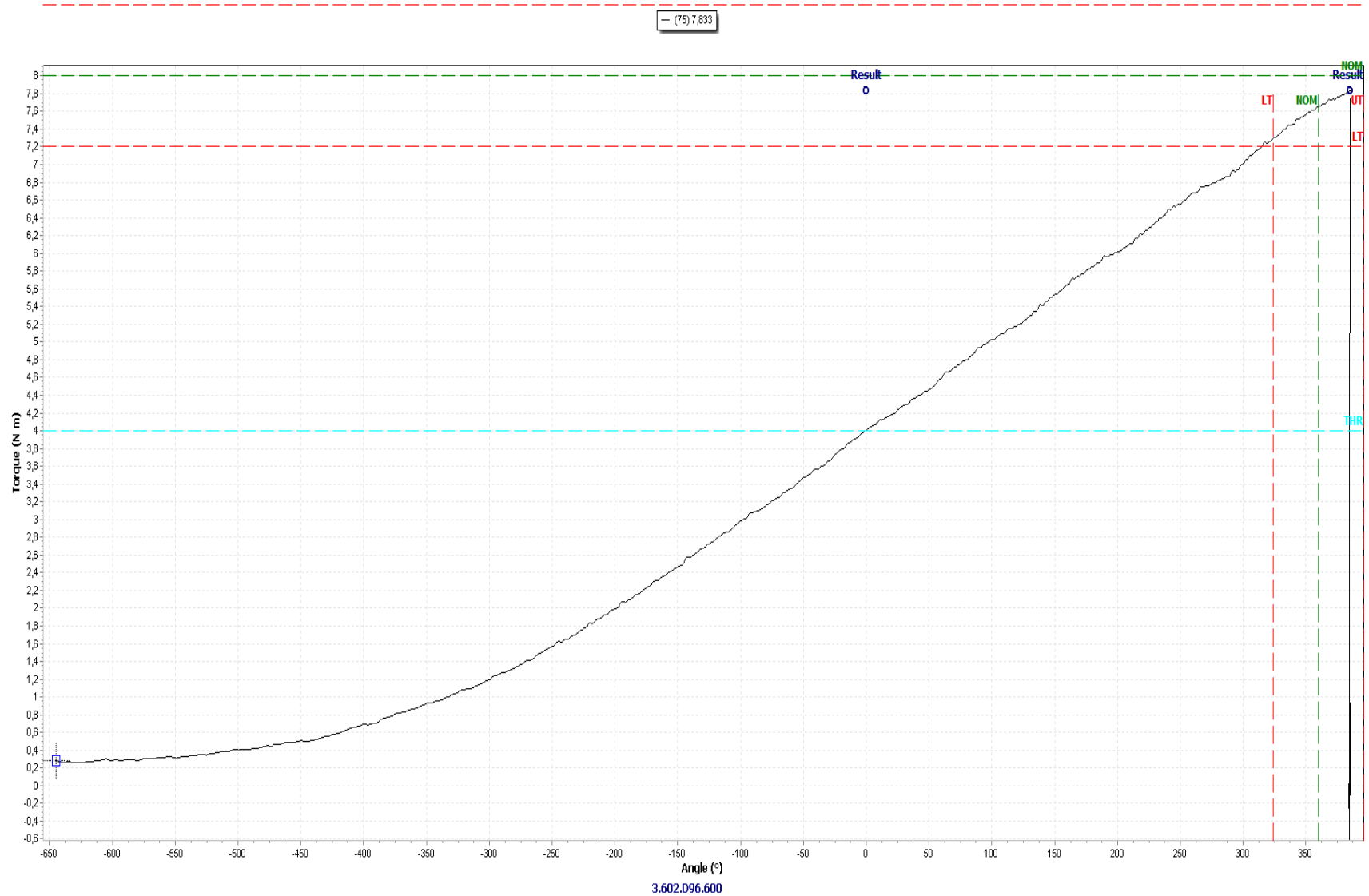


### 2.2.8.1 Screw joint 360° (soft) Set point 8,0 Nm (100%) 25/100

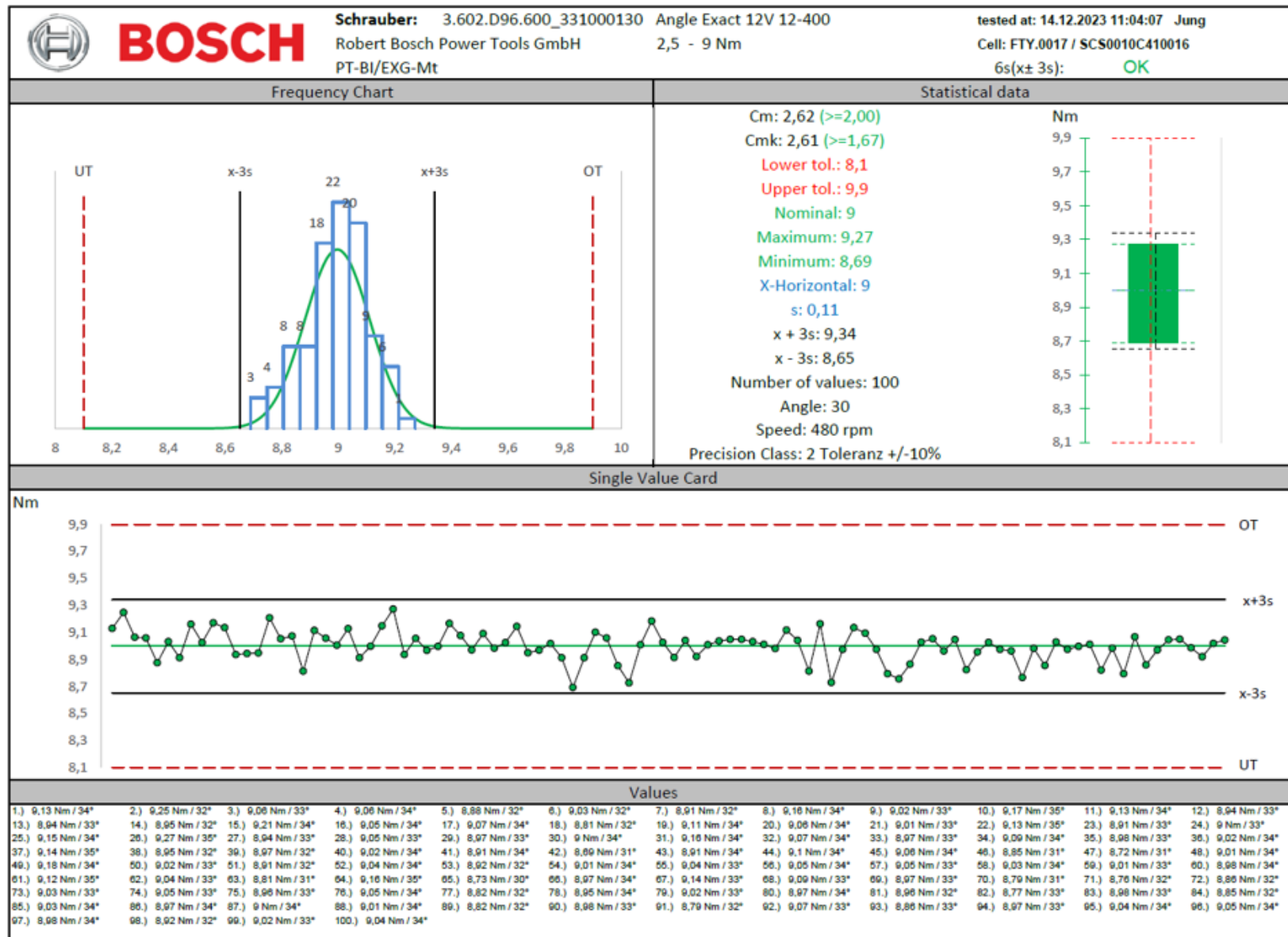




### 2.2.8.2 Screw joint 360° (soft) Set point 8,0 Nm (100%) 75/100

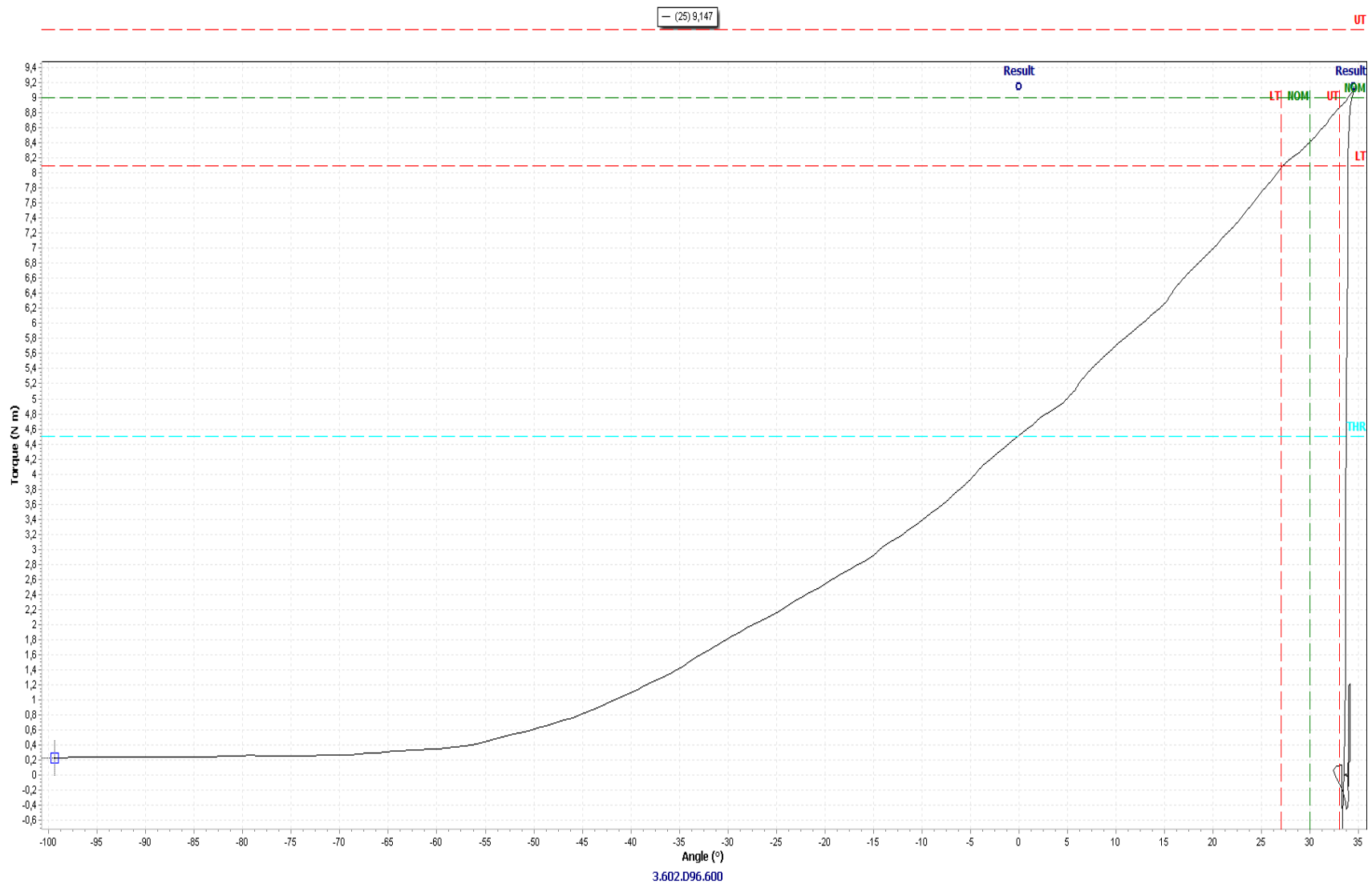


## 2.2.9 Screw joint 30° (hard) Set point 9,0 Nm (additional)



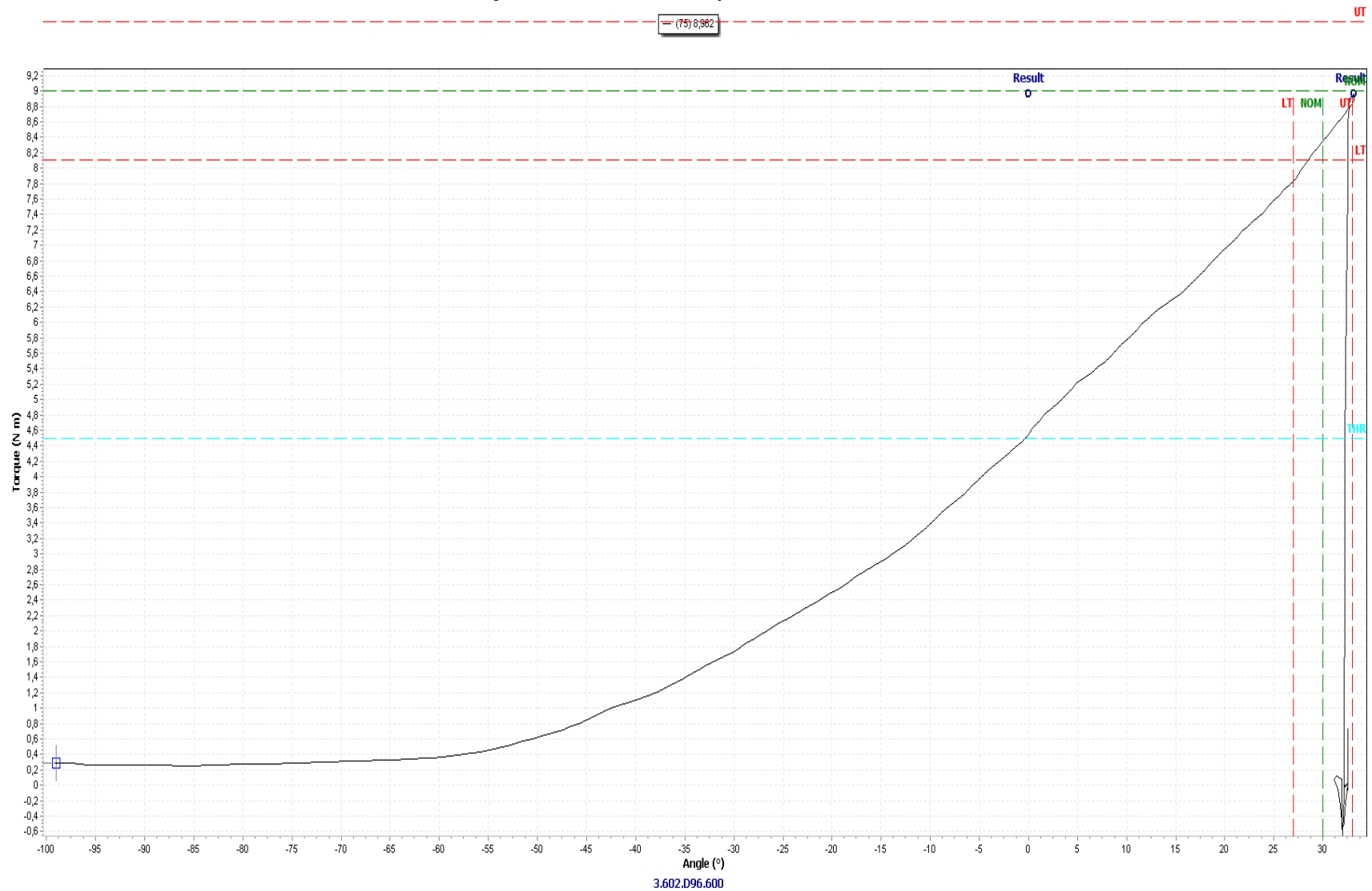


### 2.2.9.1 Screw joint 30° (hard) Set point 9,0 Nm (additional) 25/100

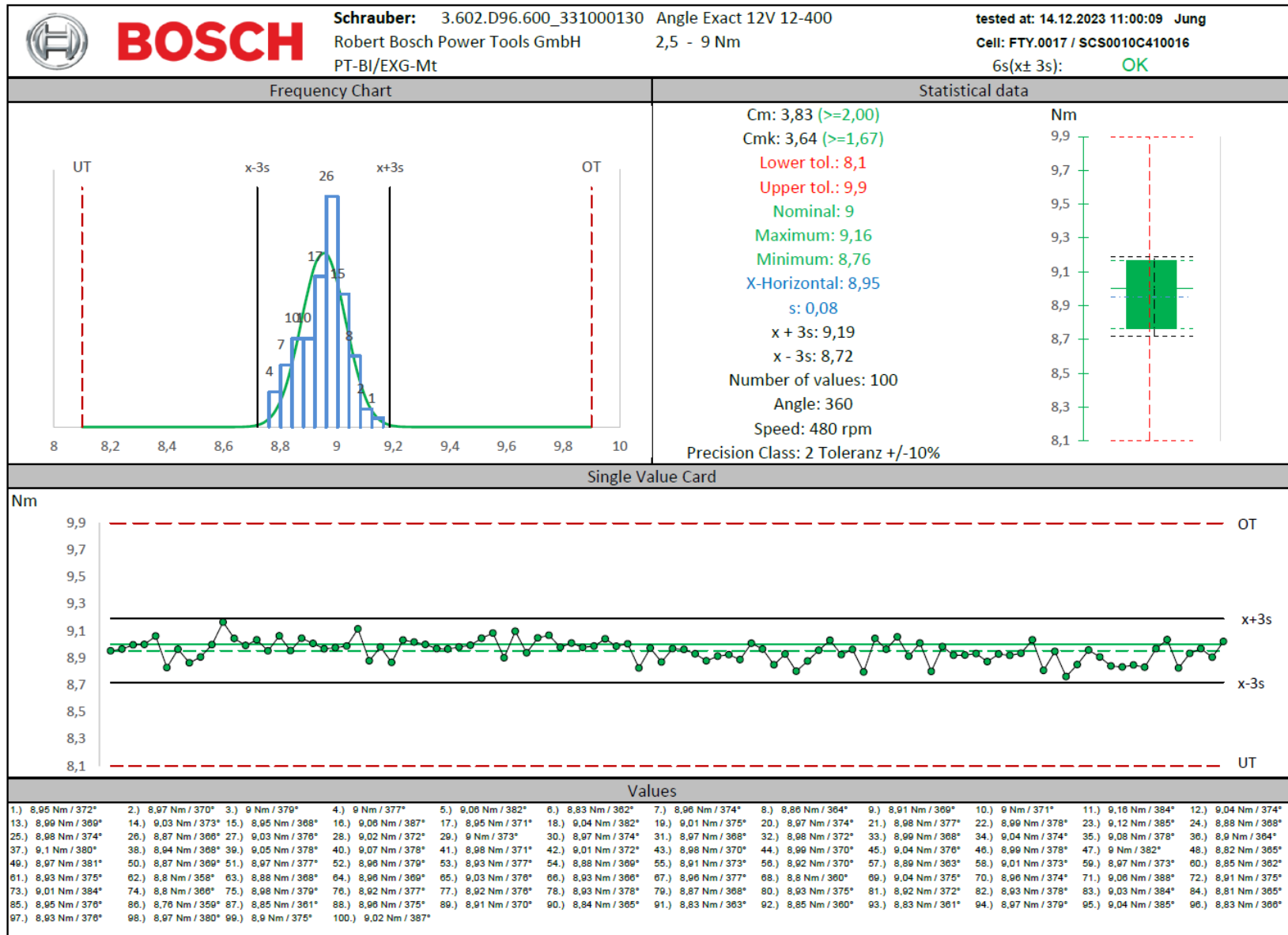




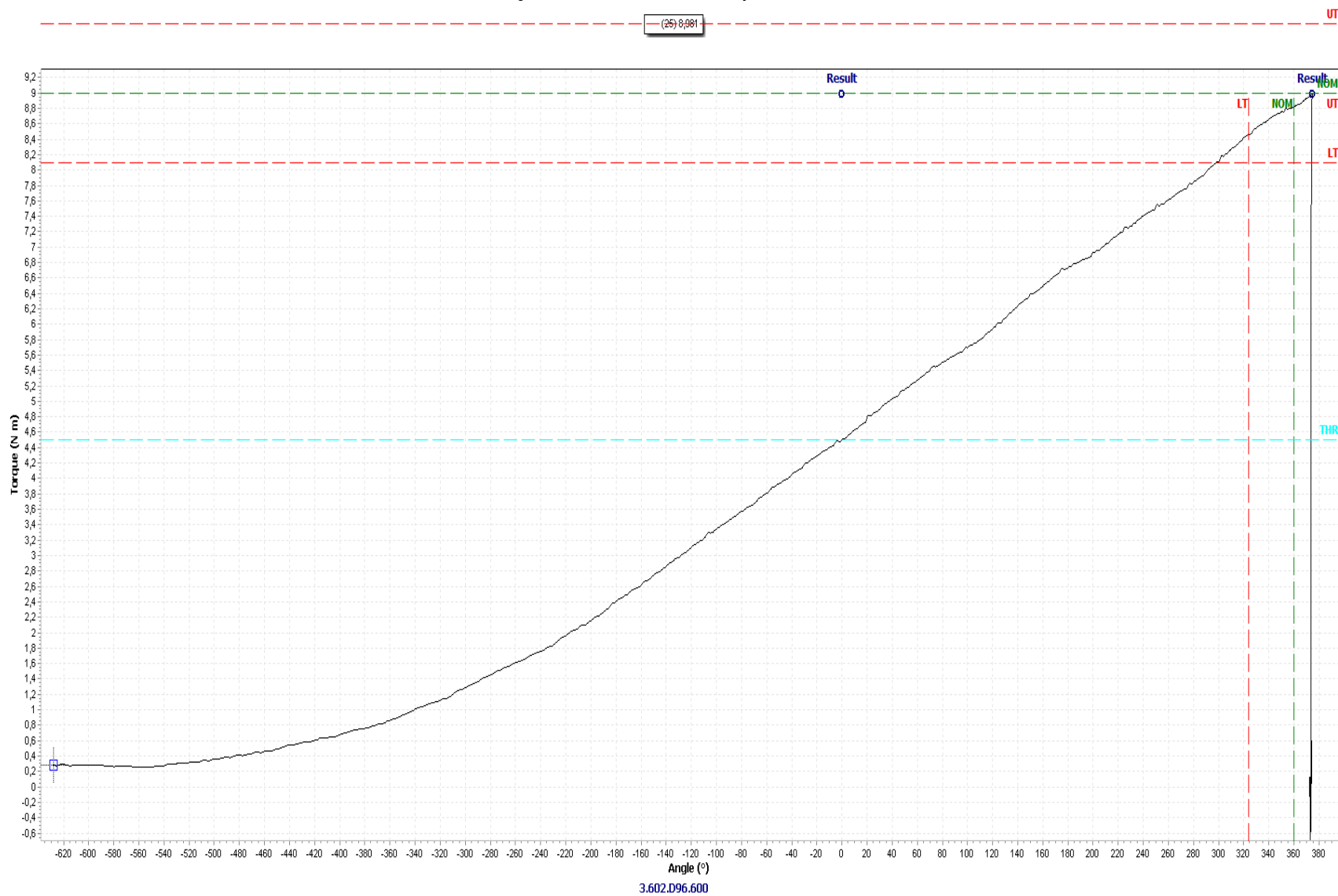
### 2.2.9.2 Screw joint 30° (hard) Set point 9,0 Nm (additional) 75/100



## 2.2.10 Screw joint 360° (soft) Set point 9,0 Nm (additional)



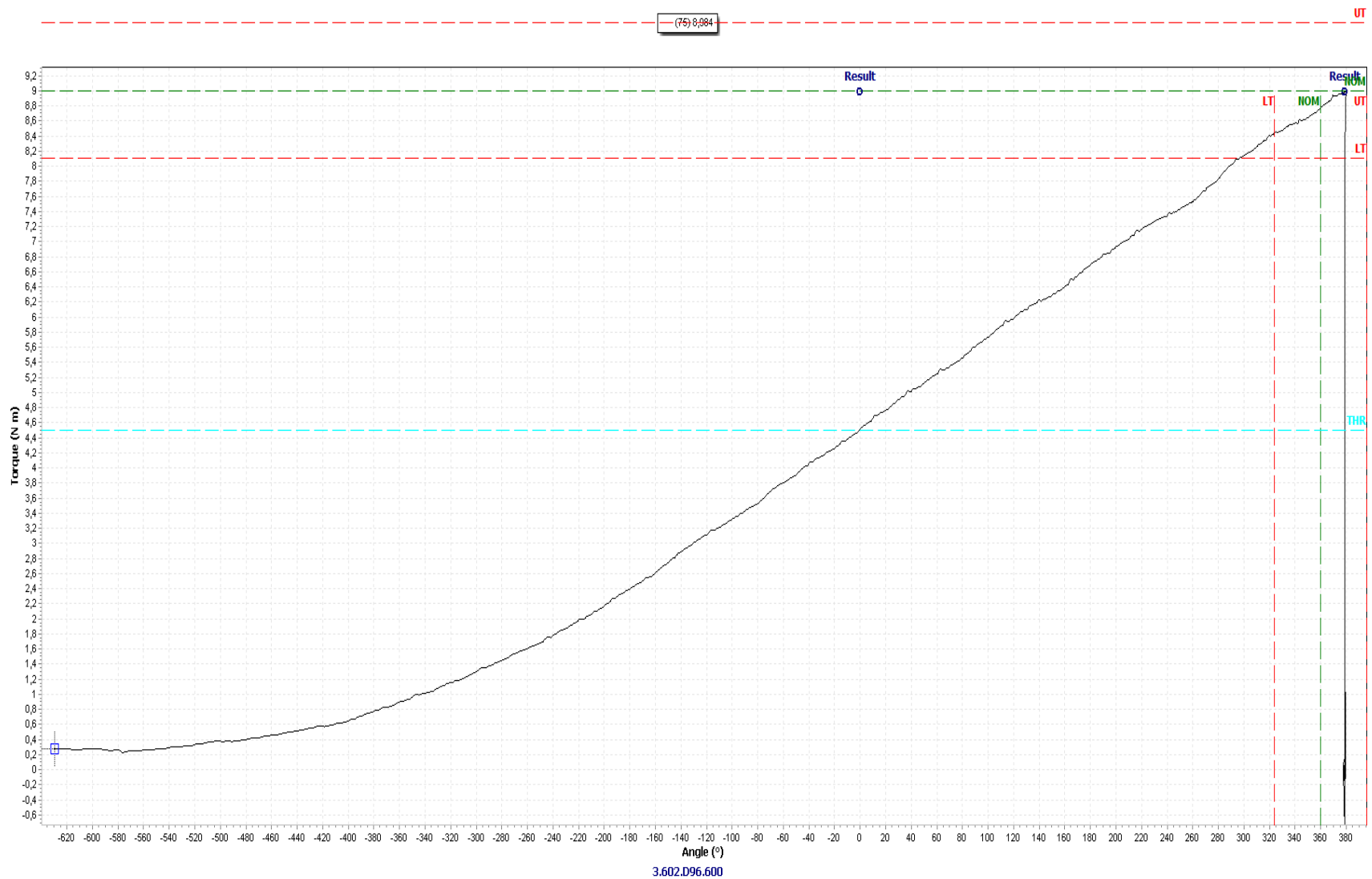
### 2.2.10.1 Screw joint 360° (soft) Set point 9,0 Nm (100%) 25/100







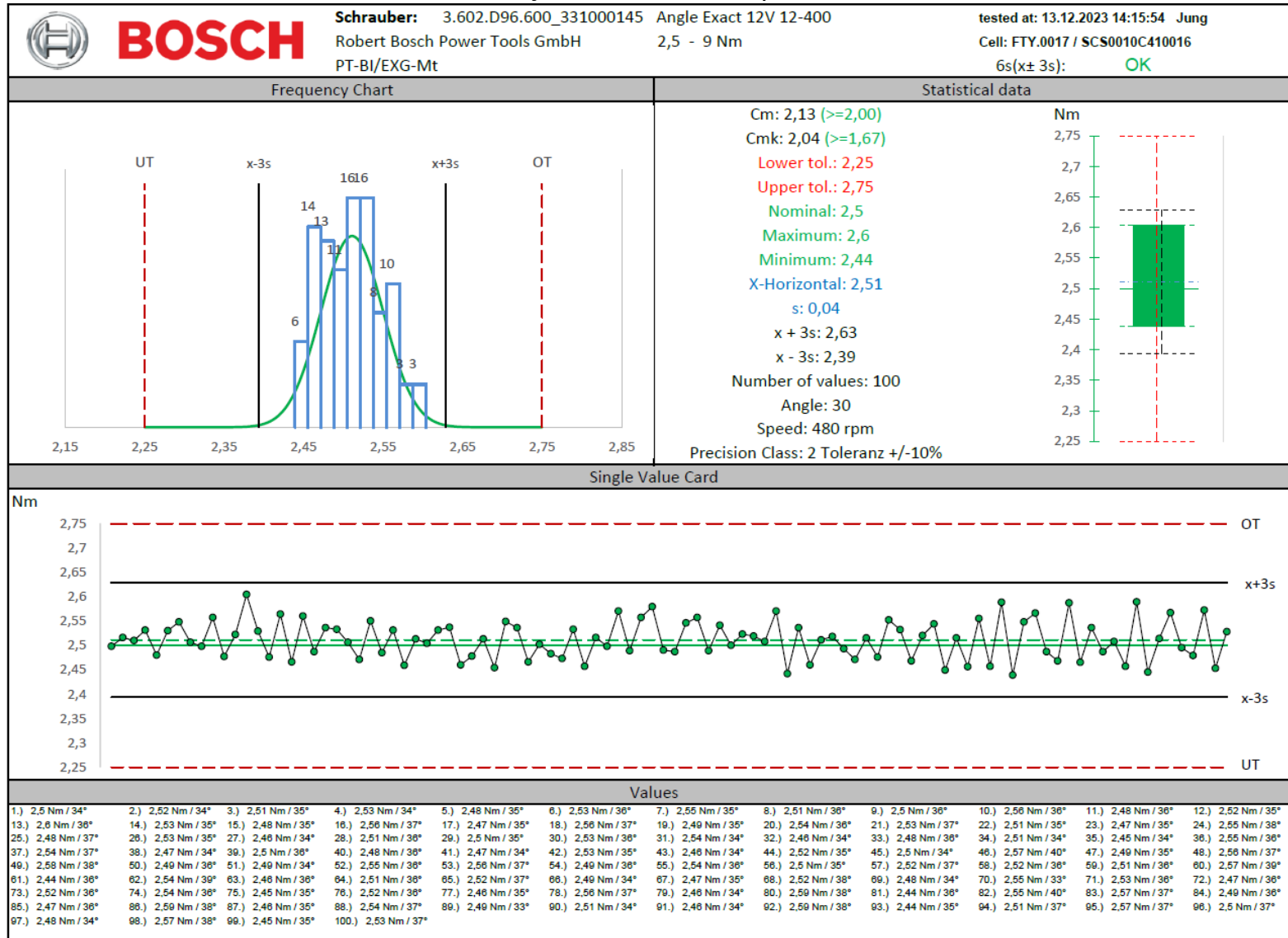
### 2.2.10.2 Screw joint 360° (soft) Set point 9,0 Nm (100%) 75/100



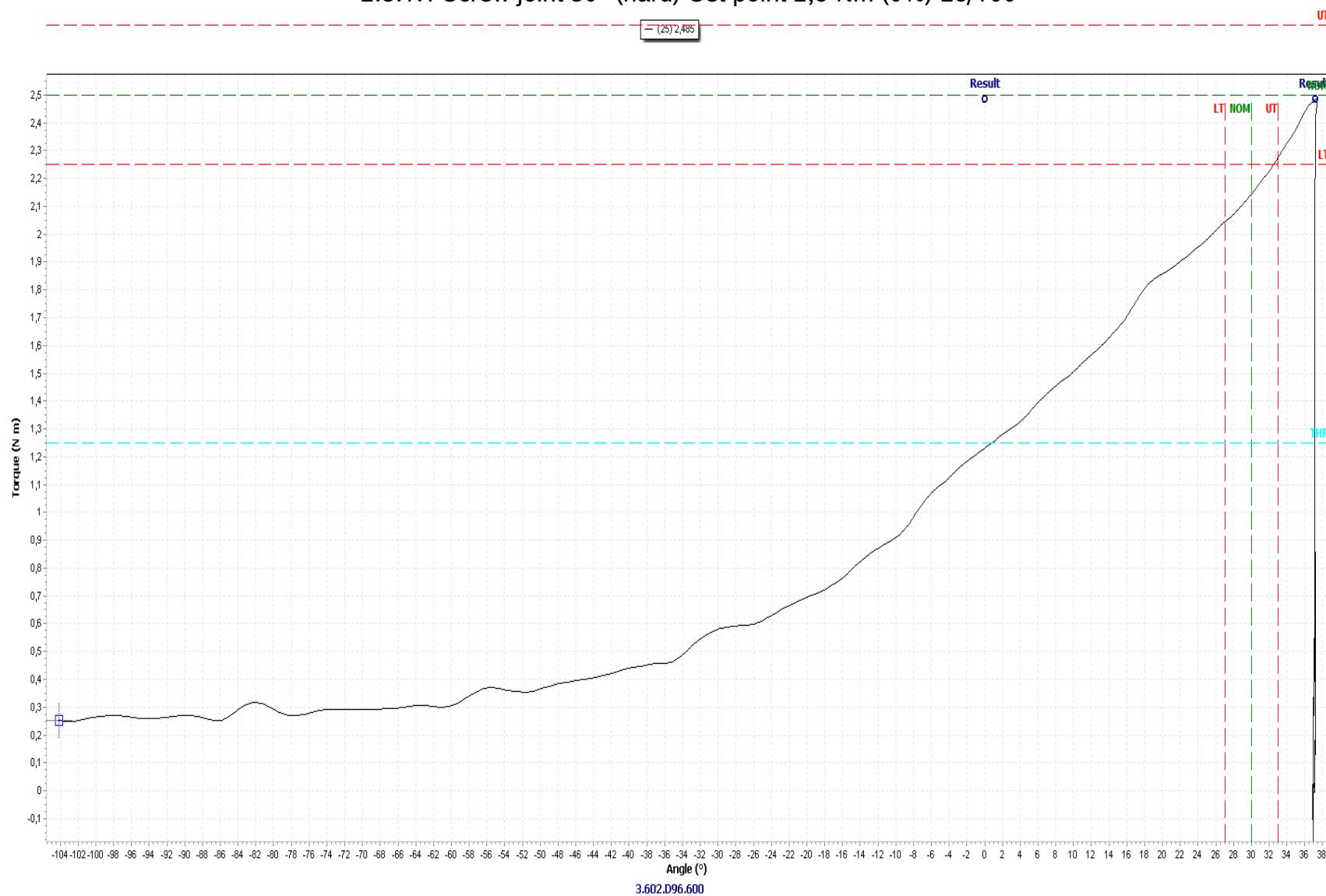


### 2.3 Machine capability analysis 331 000 145 (480 rpm)

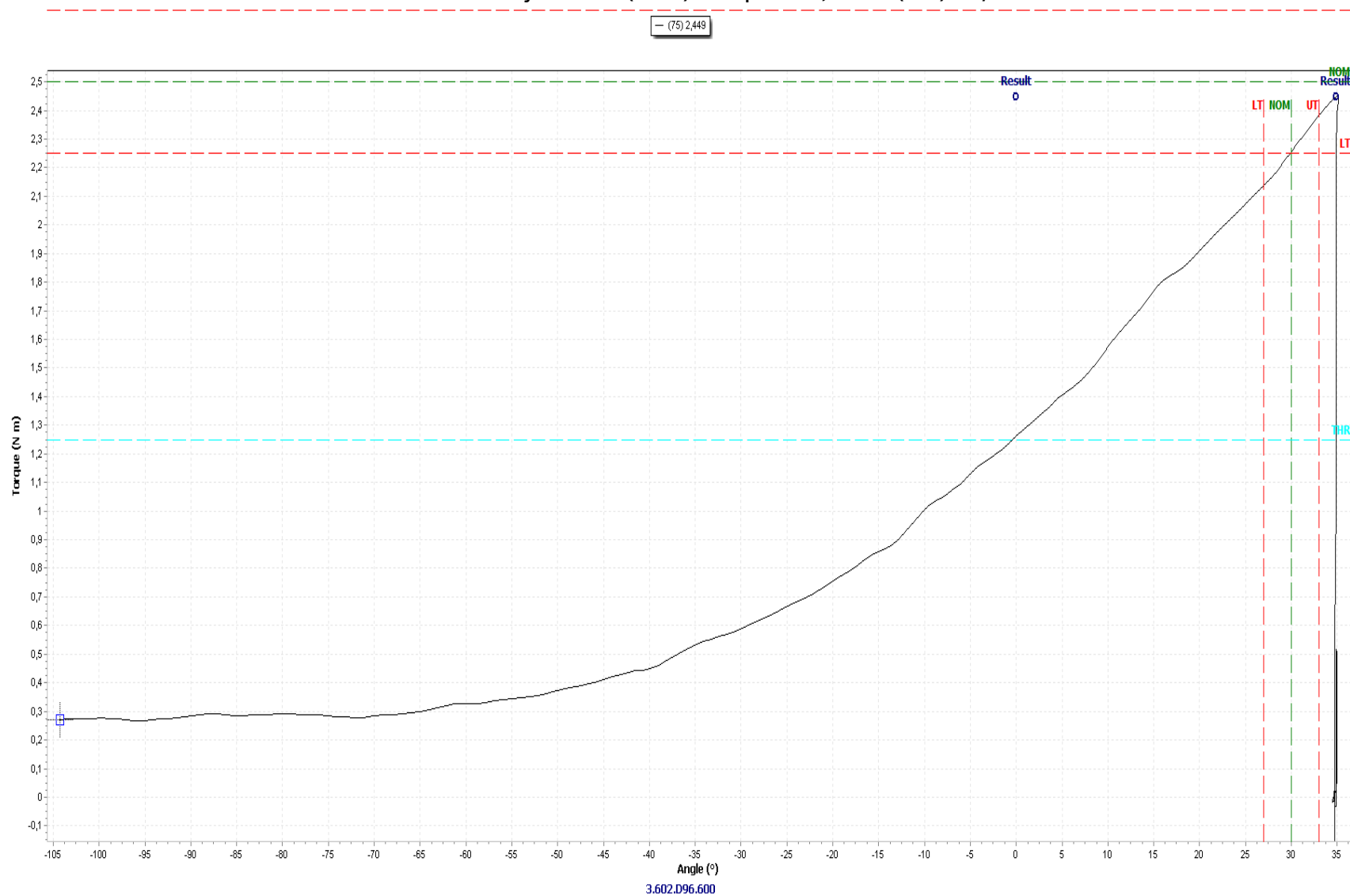
#### 2.3.1 Screw joint 30° (hard) Set point 2,5 Nm (0%)



### 2.3.1.1 Screw joint 30° (hard) Set point 2,5 Nm (0%) 25/100

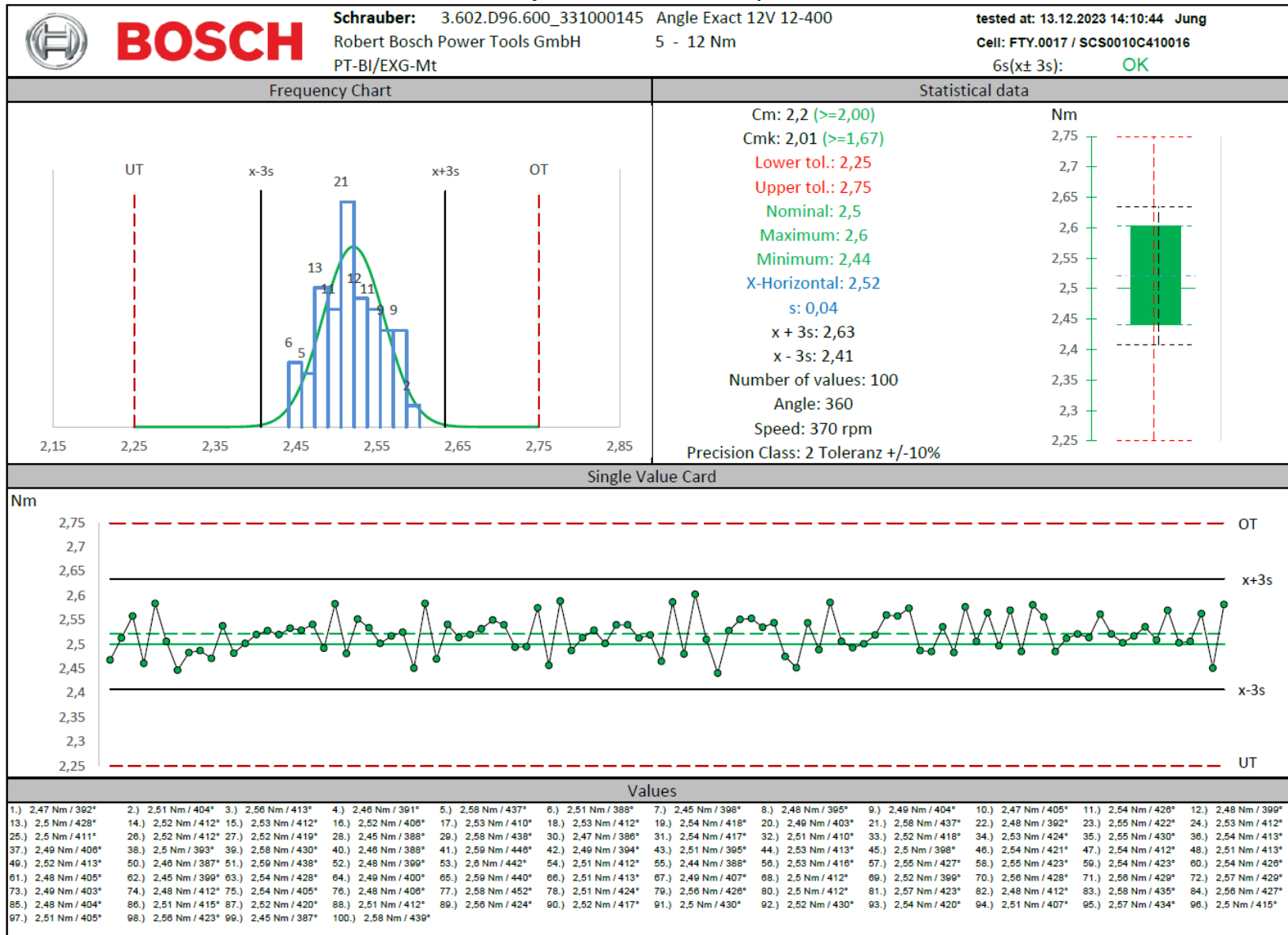


### 2.3.1.2 Screw joint 30° (hard) Set point 2,5 Nm (0%) 75/100

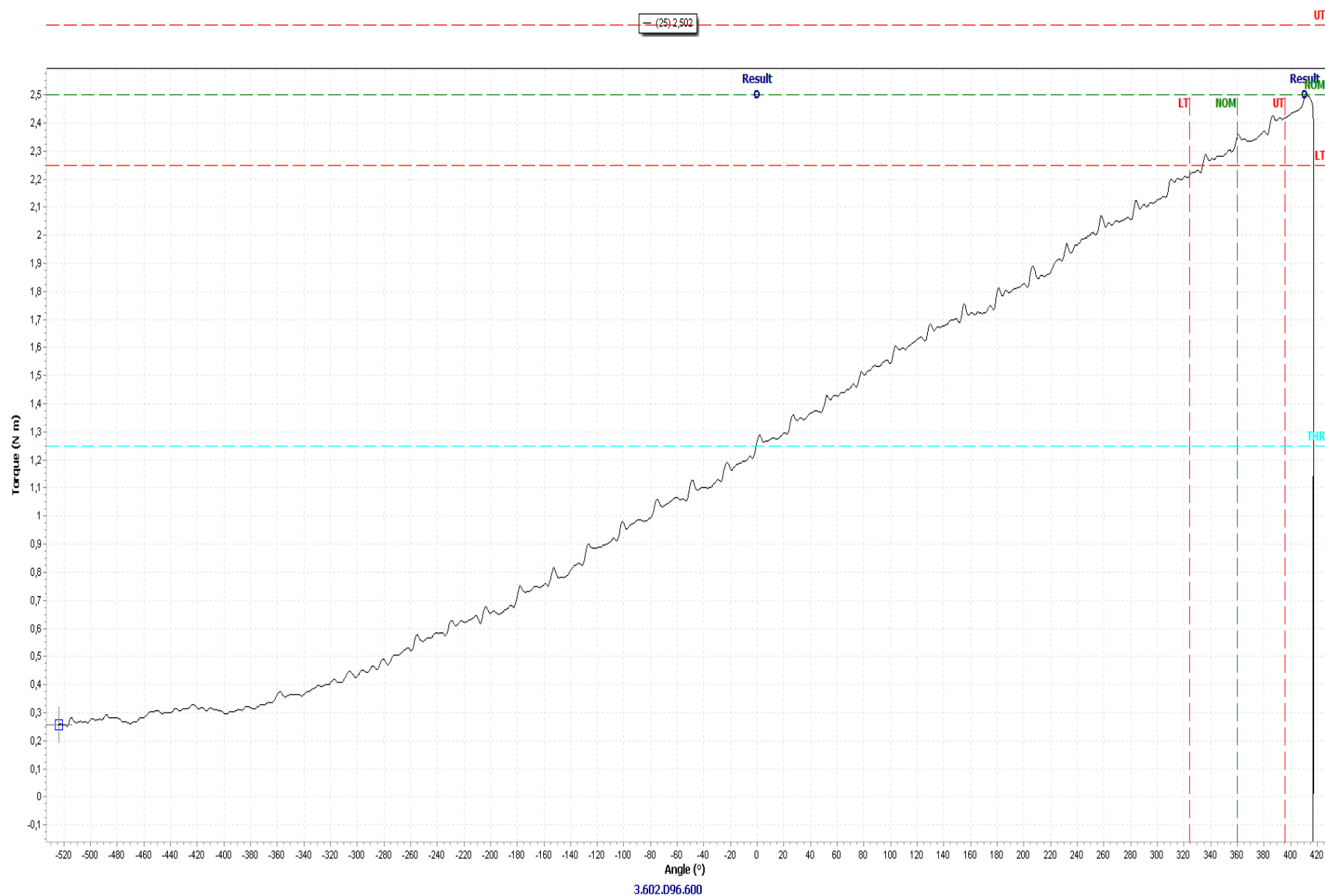




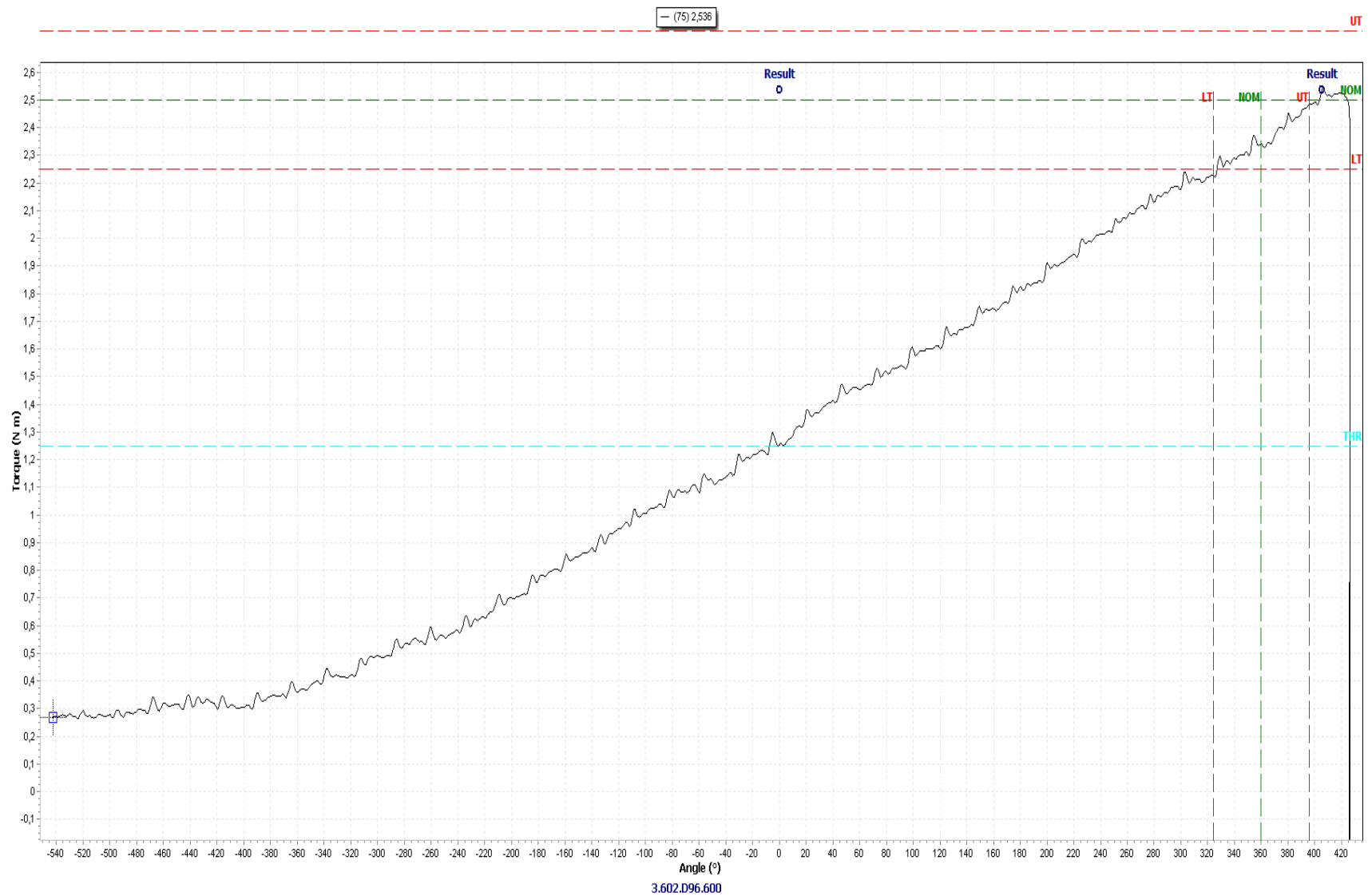
### 2.3.2 Screw joint 360° (soft) Set point 2,5 Nm (0%)



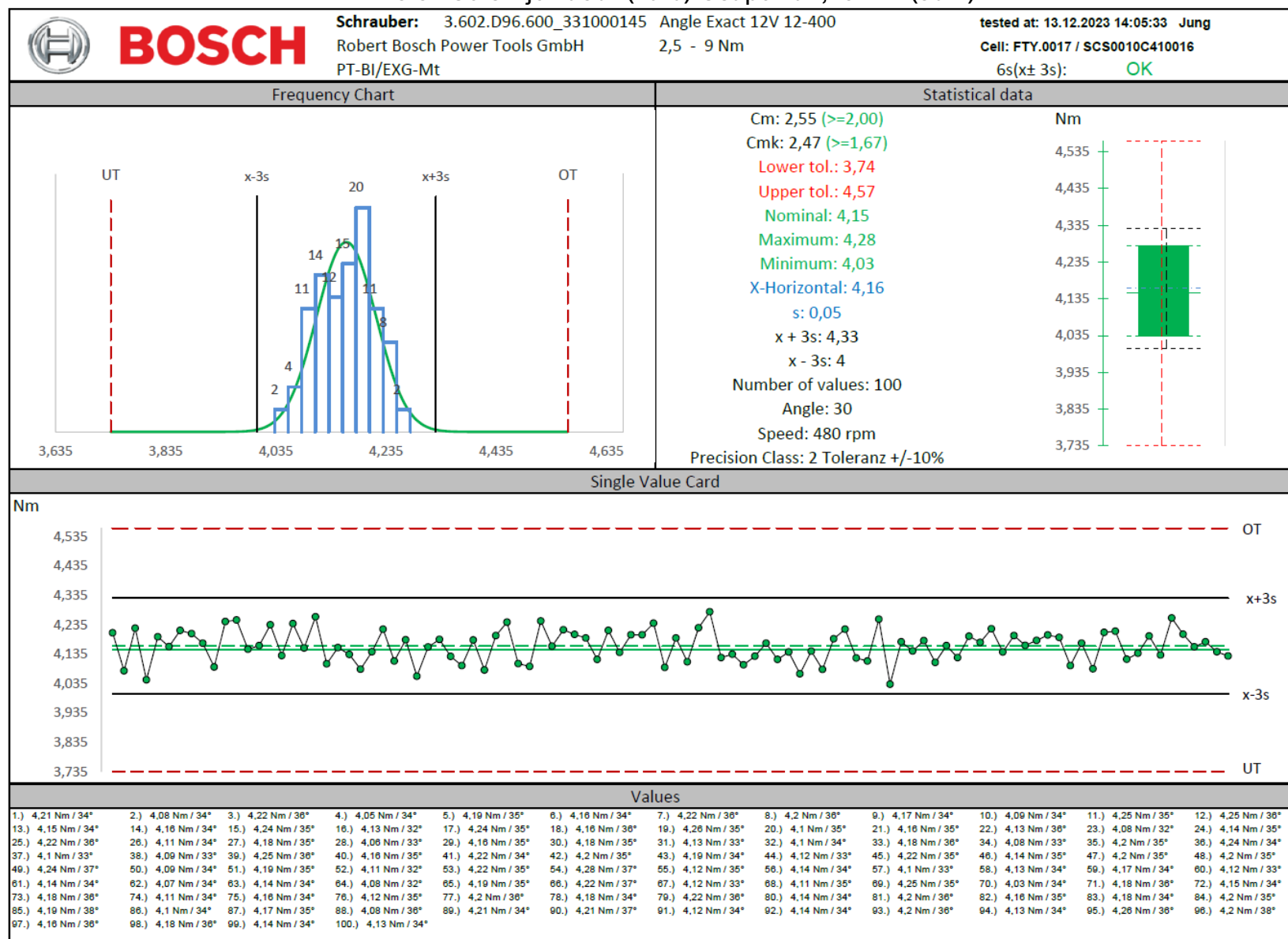
### 2.3.2.1 Screw joint 360° (soft) Set point 2,5 Nm (0%) 25/100



### 2.3.2.2 Screw joint 360° (soft) Set point 2,5 Nm (0%) 75/100



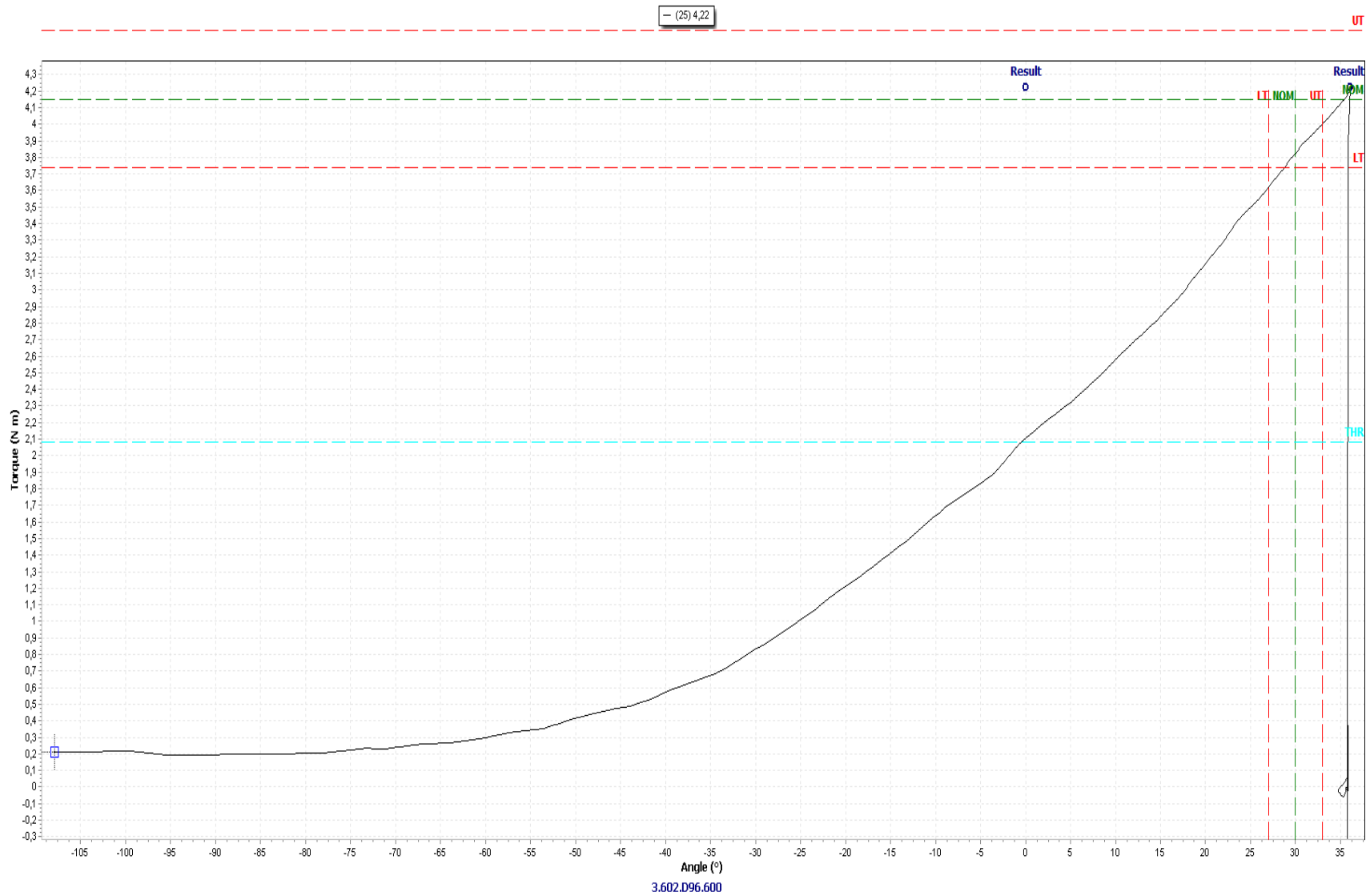
## 2.3.3 Screw joint 30° (hard) Set point 4,15 Nm (30%)





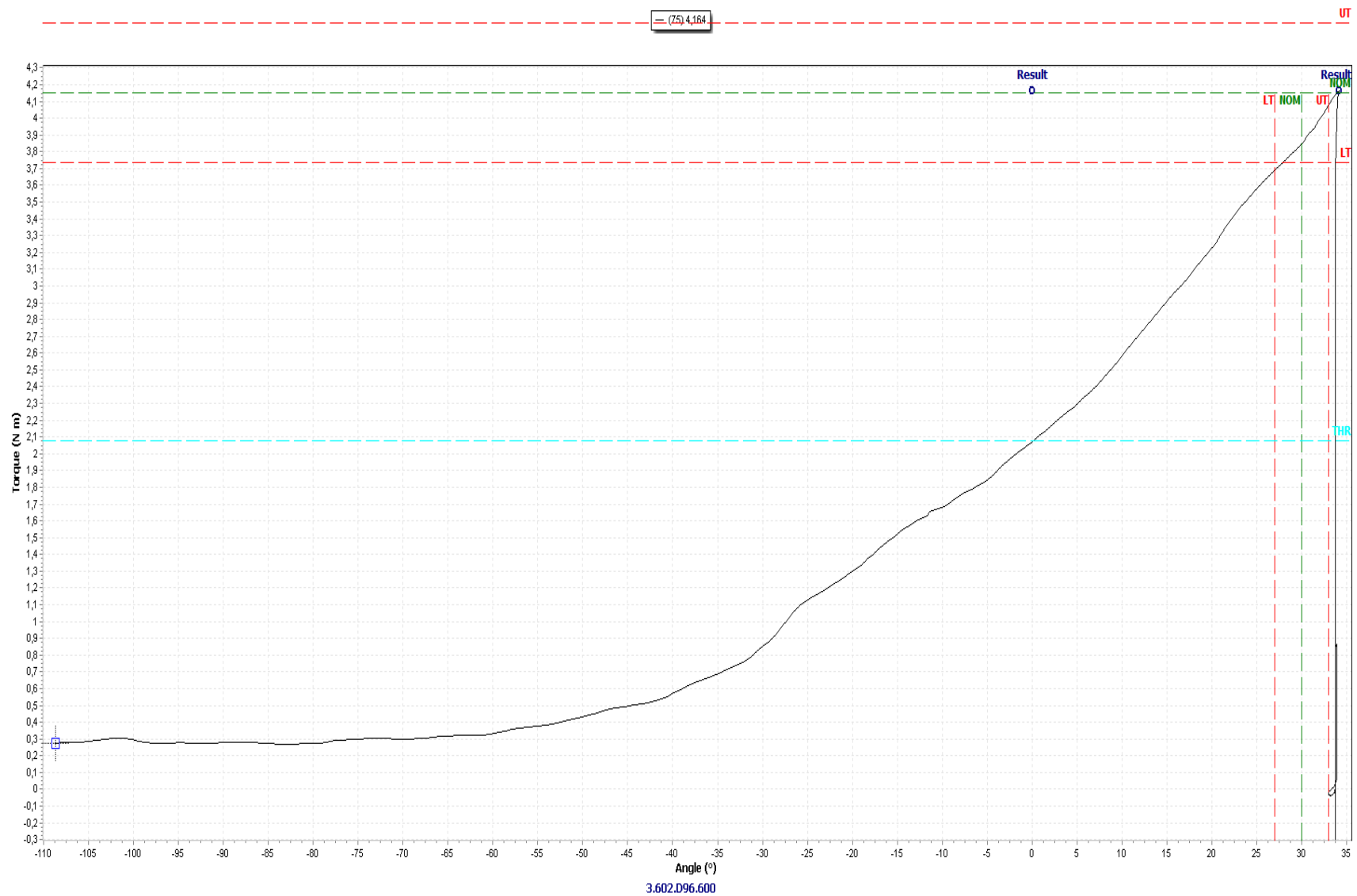


### 2.3.3.1 Screw joint 30° (hard) Set point 4,15 Nm (30%) 25/100



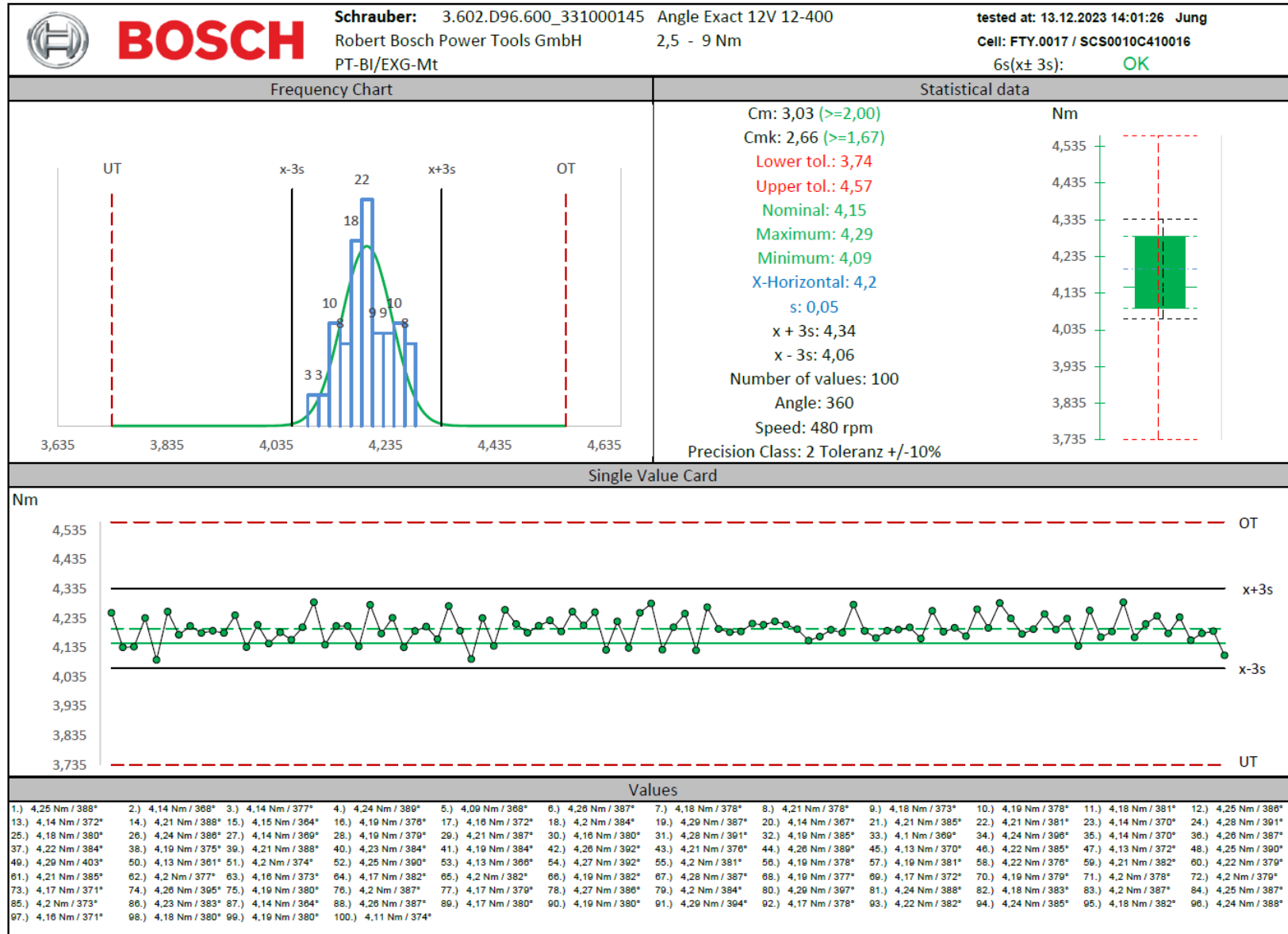


### 2.3.3.2 Screw joint 30° (hard) Set point 4,15 Nm (30%) 75/100



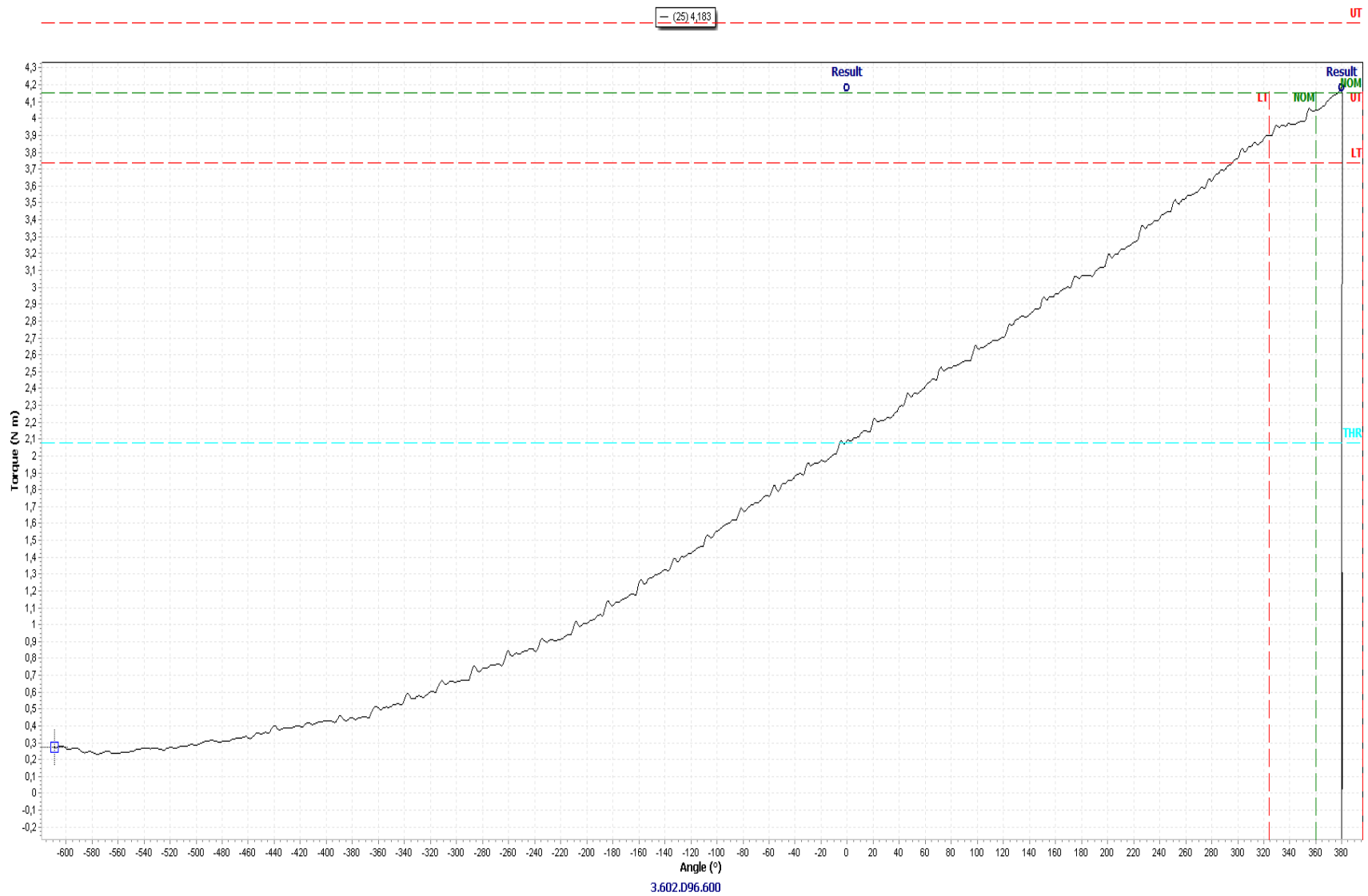


### 2.3.4 Screw joint 360° (soft) Set point 4,15 Nm (30%)



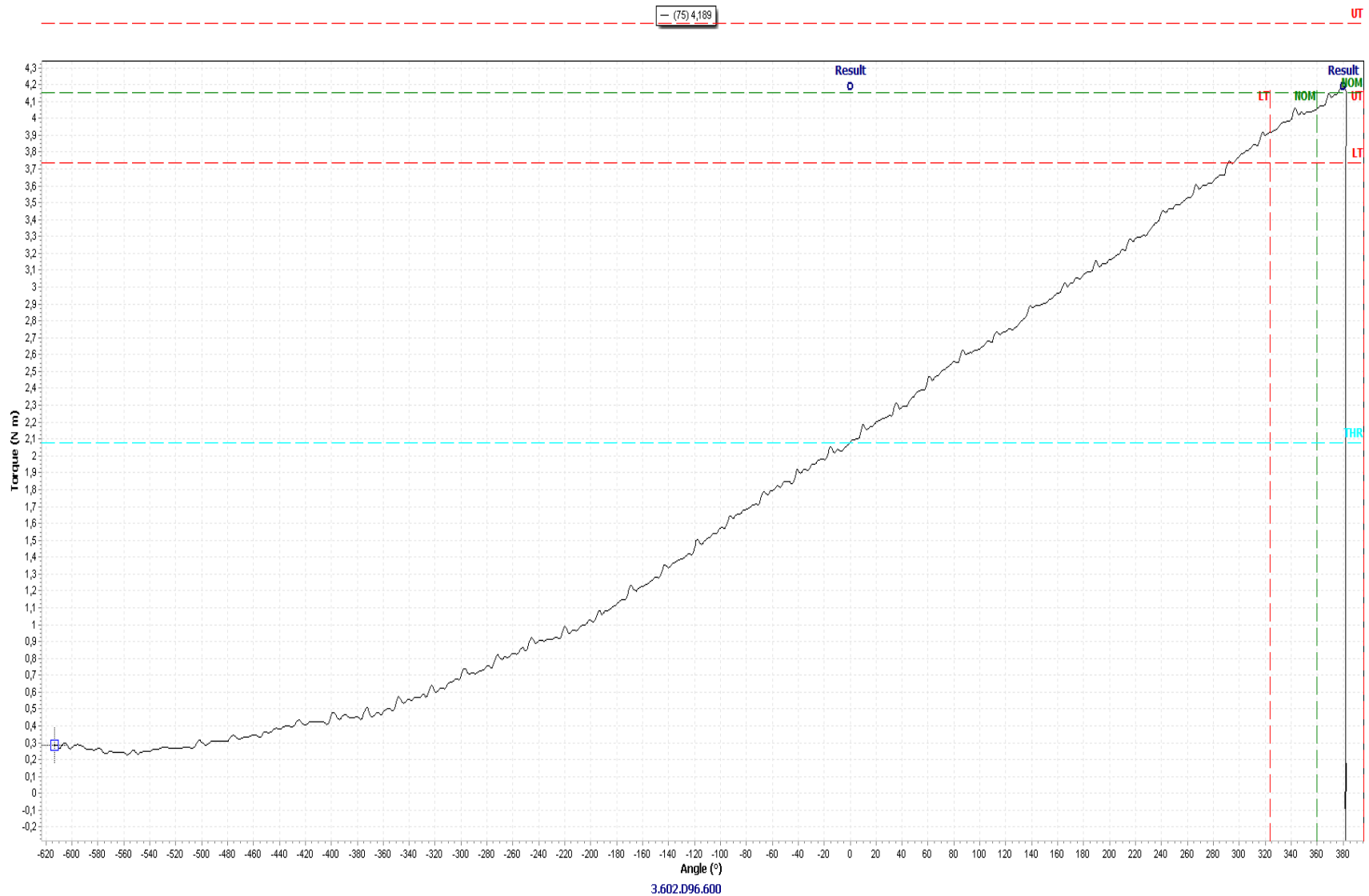


2.3.4.1 Screw joint 360° (soft) Set point 4,15 Nm (30%) 25/100



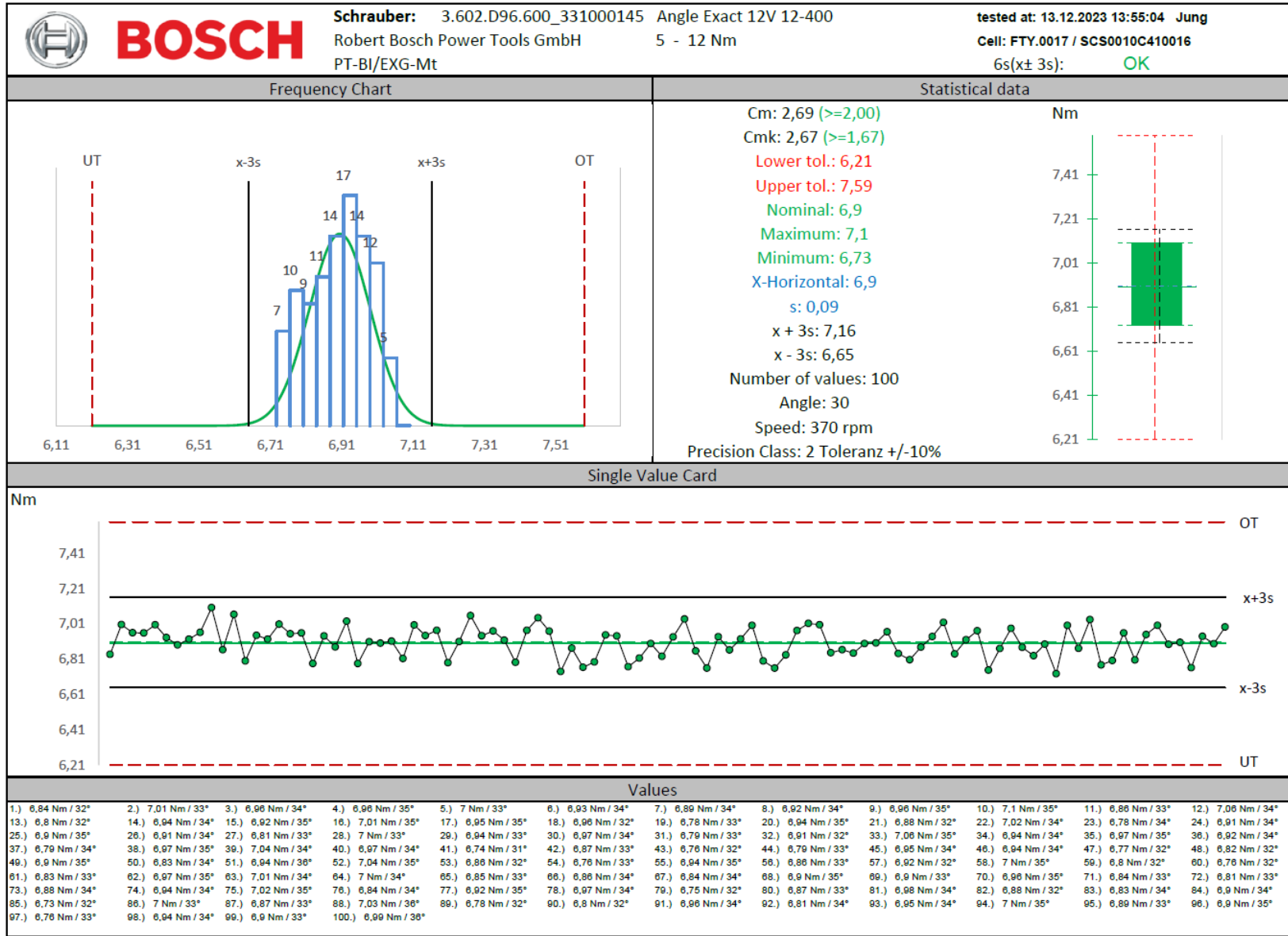


### 2.3.4.2 Screw joint 360° (soft) Set point 4,15 Nm (30%) 75/100

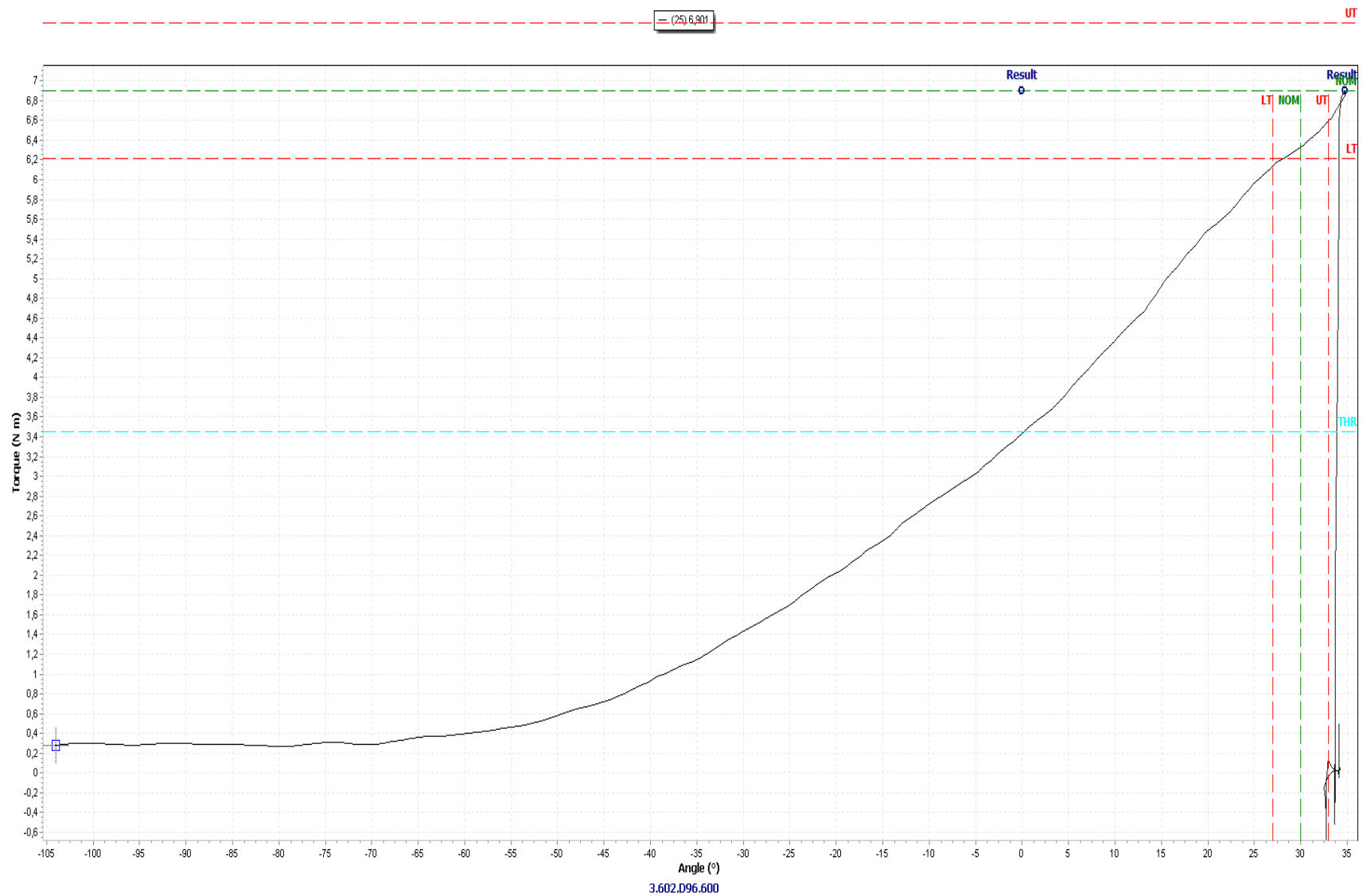




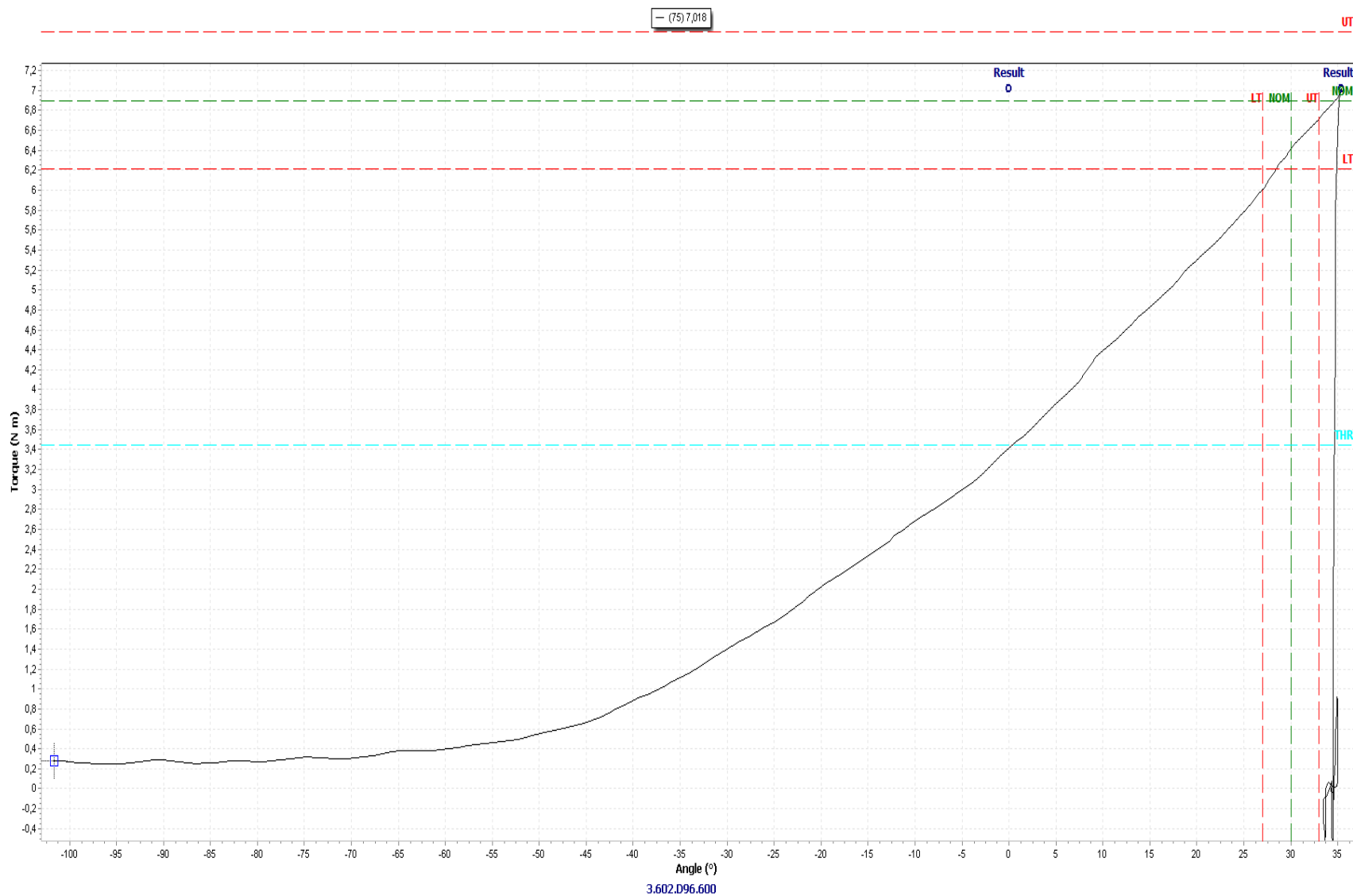
### 2.3.5 Screw joint 30° (hard) Set point 6,9 Nm (80%)



#### 2.3.5.1 Screw joint 30° (hard) Set point 6,9 Nm (80%) 25/100



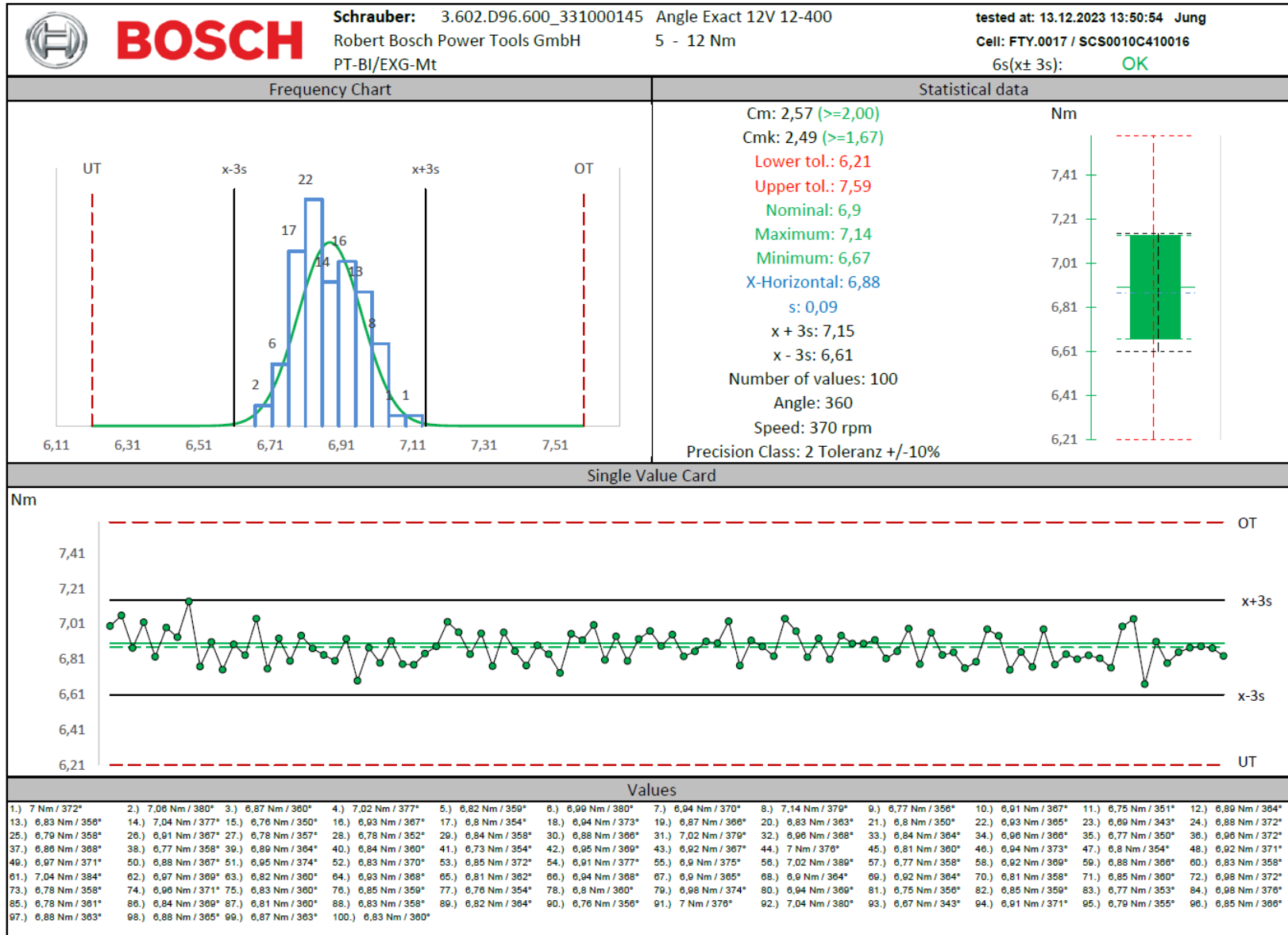
### 2.3.5.2 Screw joint 30° (hard) Set point 6,9 Nm (80%) 75/100



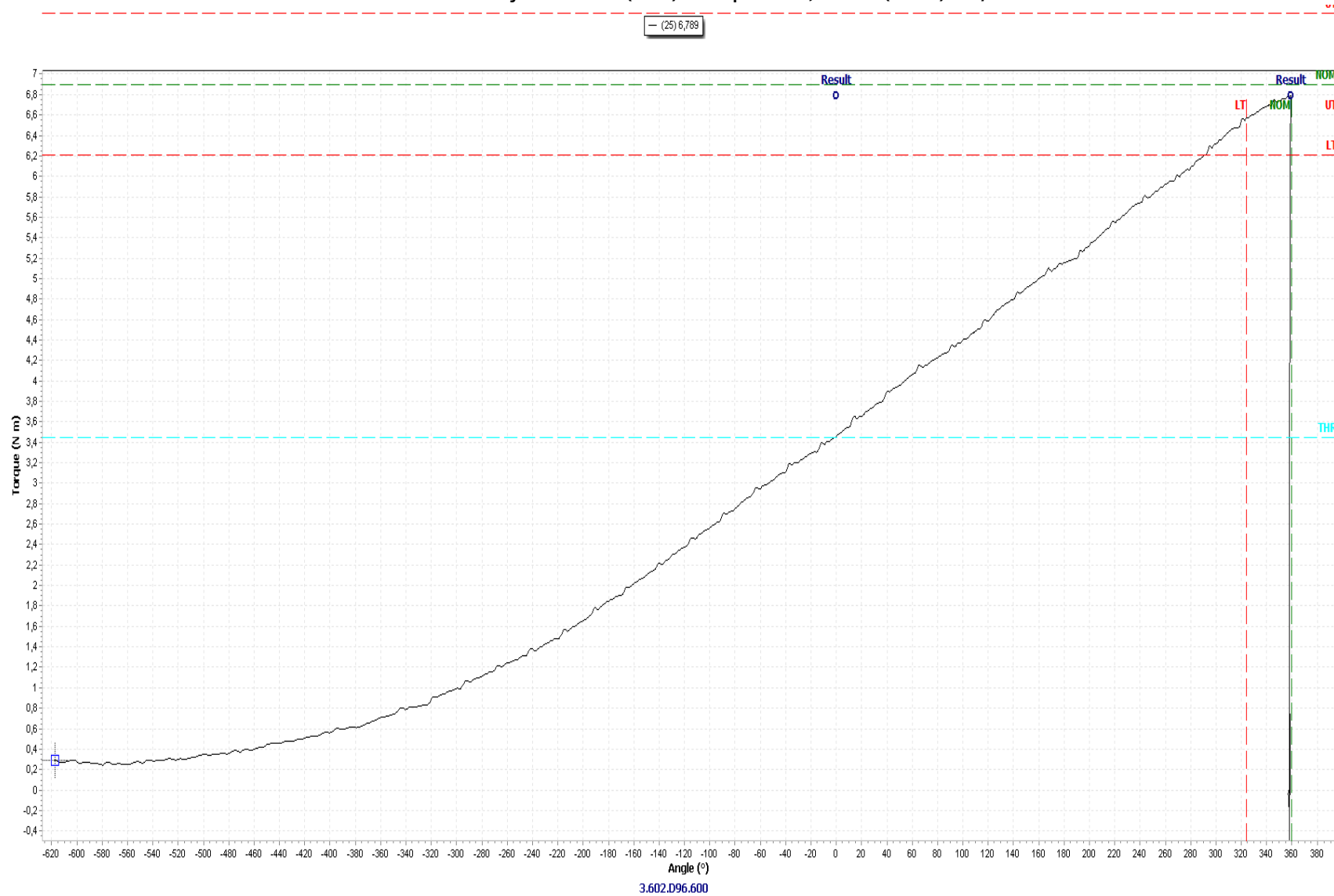




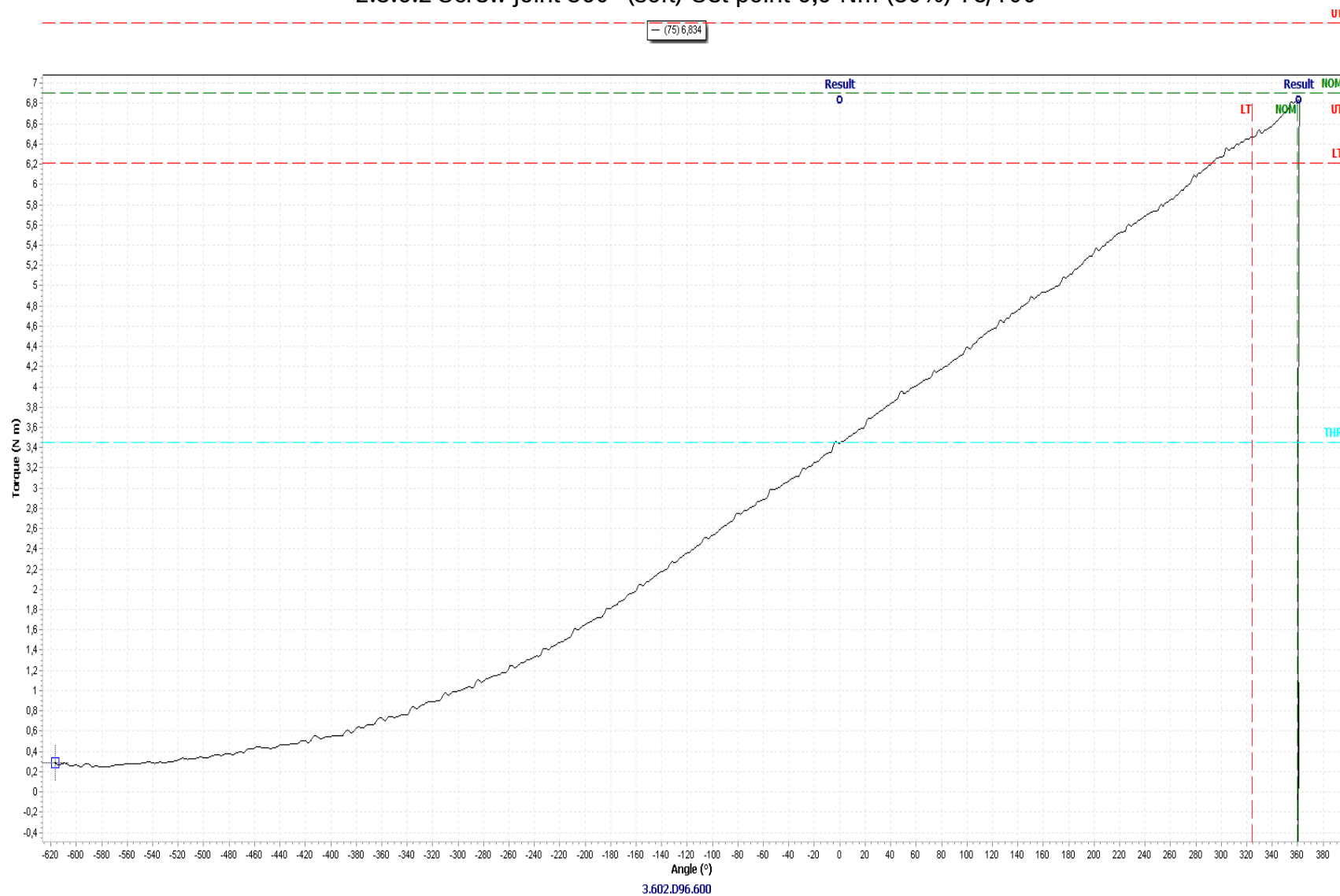
### 2.3.6 Screw joint 360° (soft) Set point 6,9 Nm (80%)



### 2.3.6.1 Screw joint 360° (soft) Set point 6,9 Nm (80%) 25/100

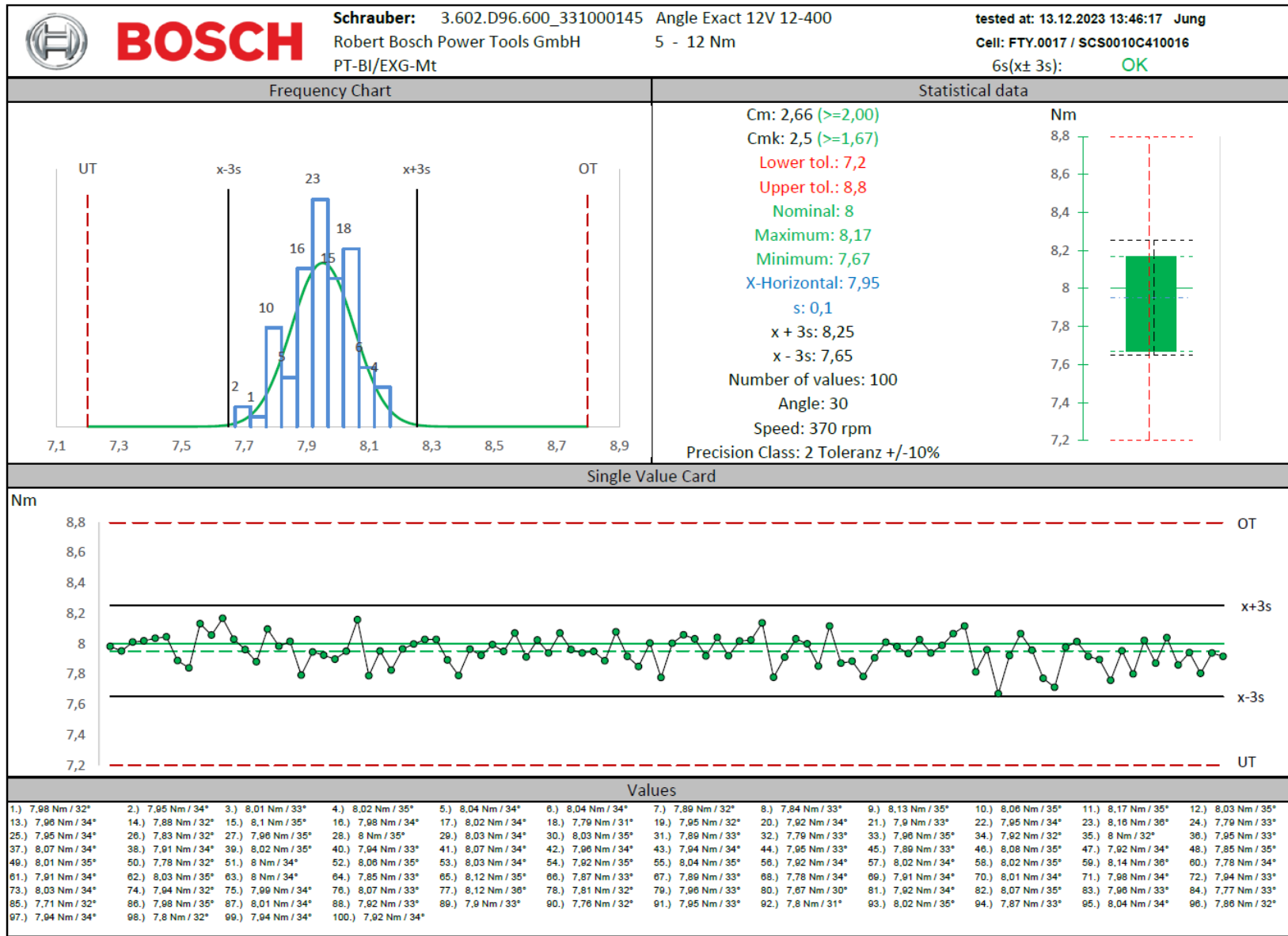


### 2.3.6.2 Screw joint 360° (soft) Set point 6,9 Nm (80%) 75/100

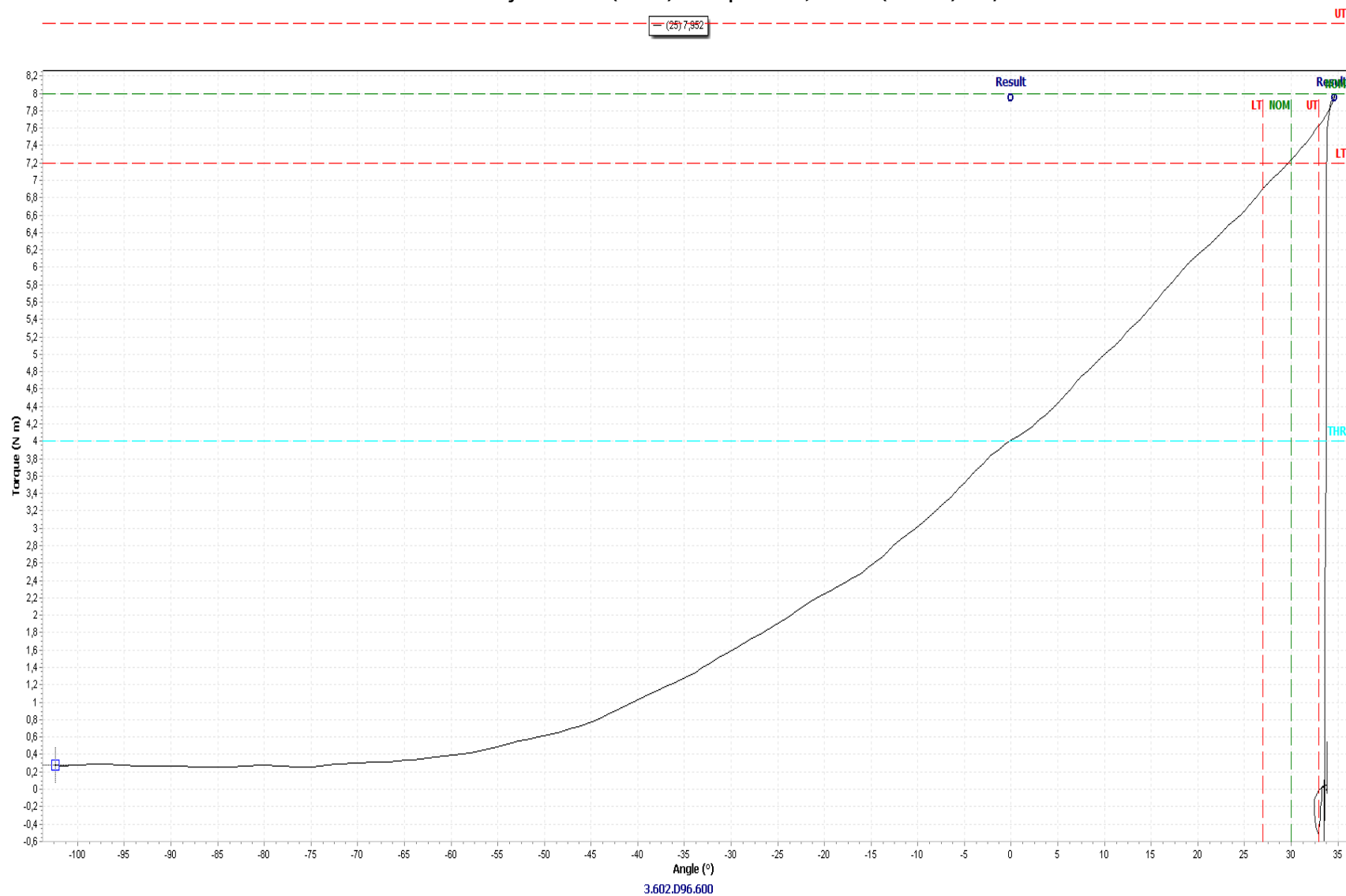




### 2.3.7 Screw joint 30° (hard) Set point 8,0 Nm (100%)

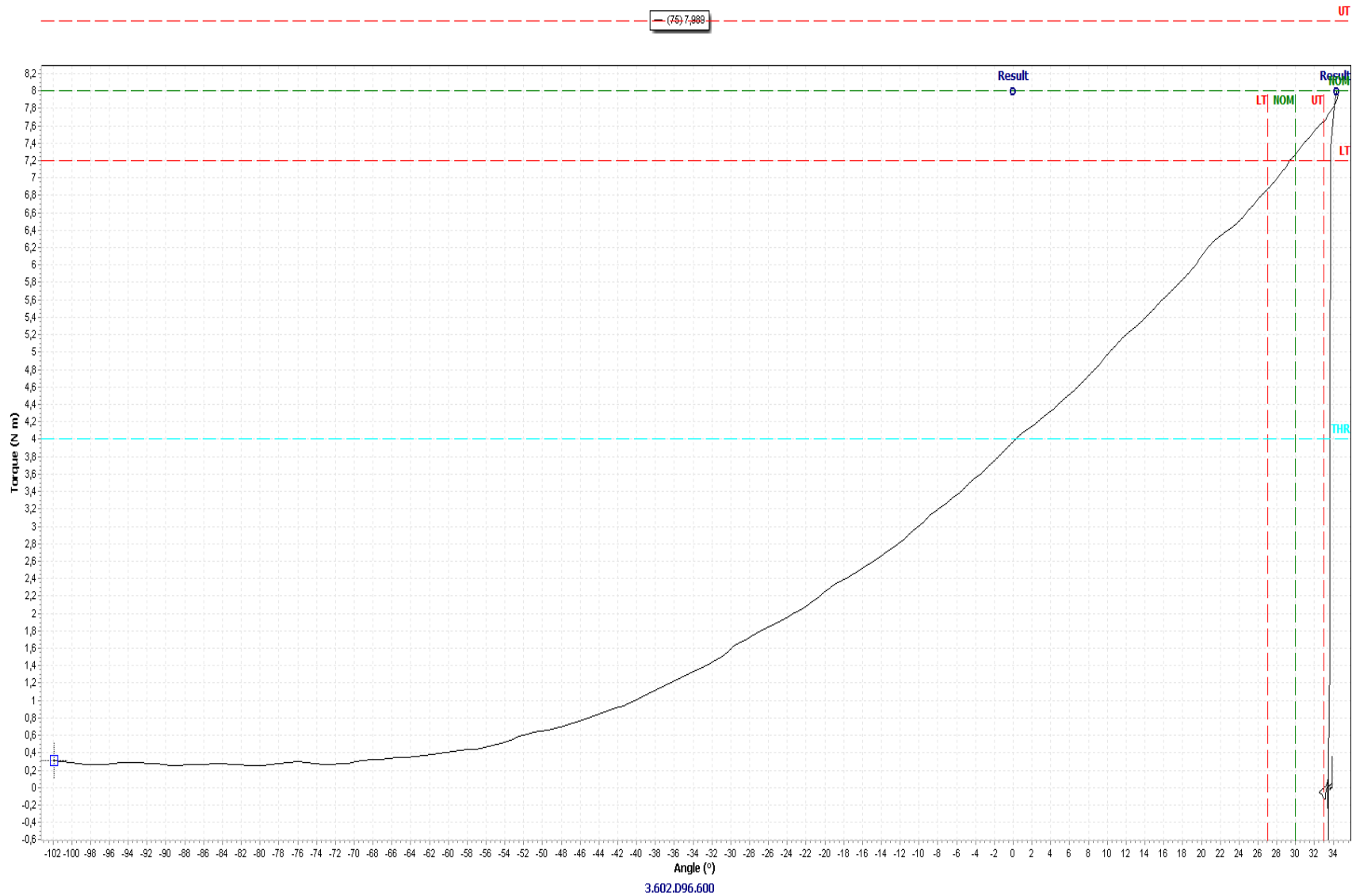


### 2.3.7.1 Screw joint 30° (hard) Set point 8,0 Nm (100%) 25/100



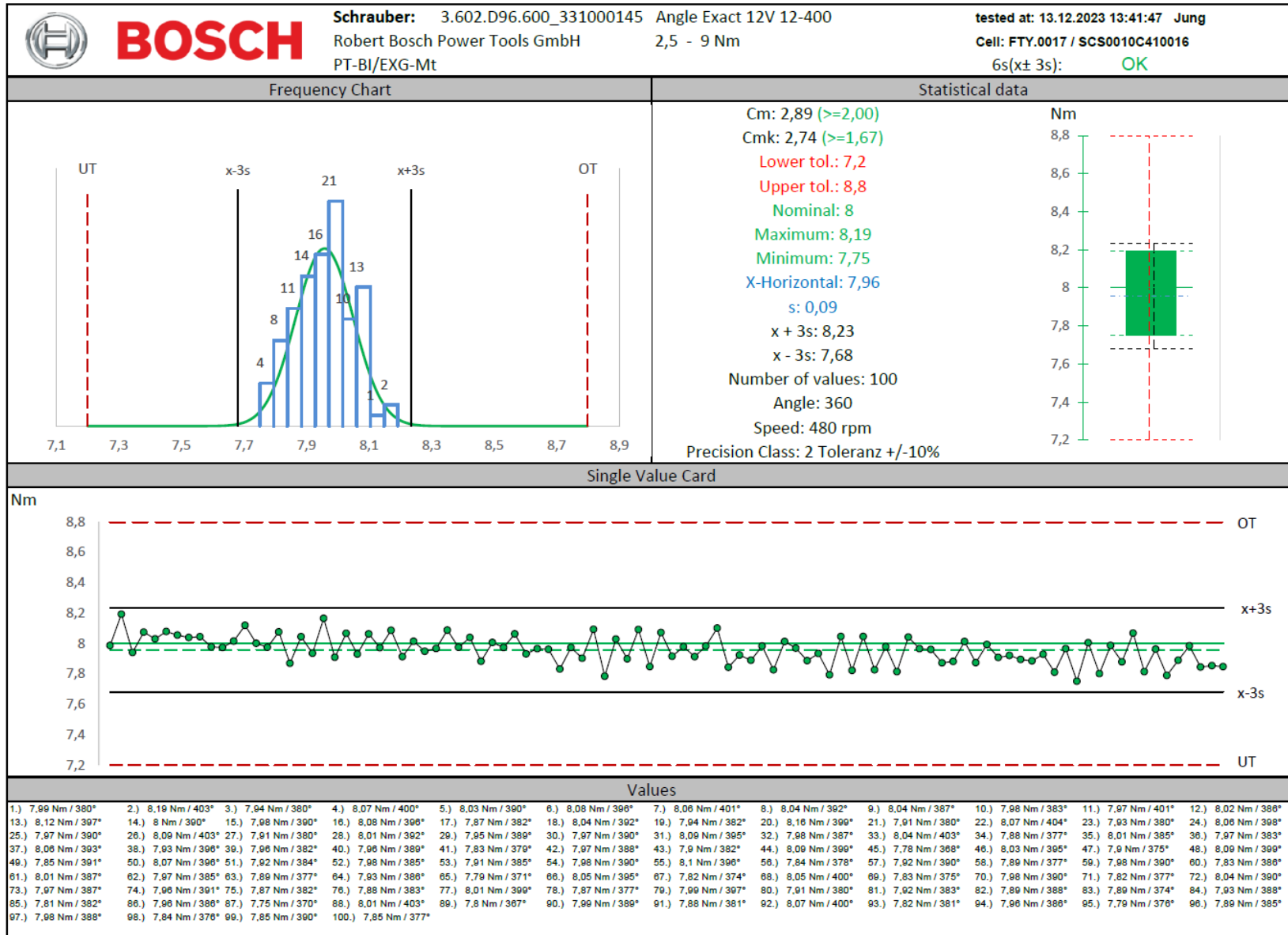


### 2.3.7.2 Screw joint 30° (hard) Set point 8,0Nm (100%) 75/100

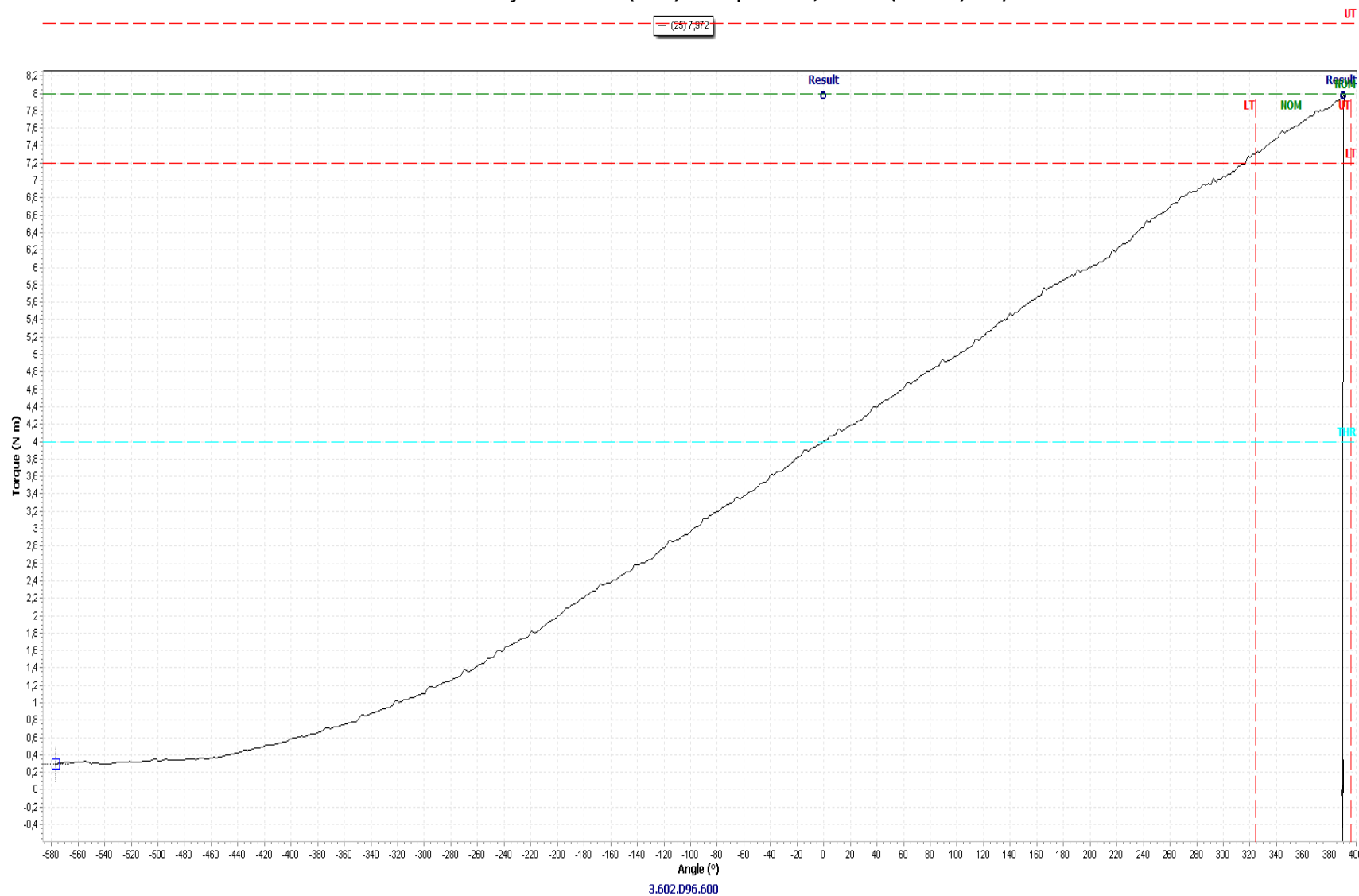




### 2.3.8 Screw joint 360° (soft) Set point 8,0 Nm (100%)

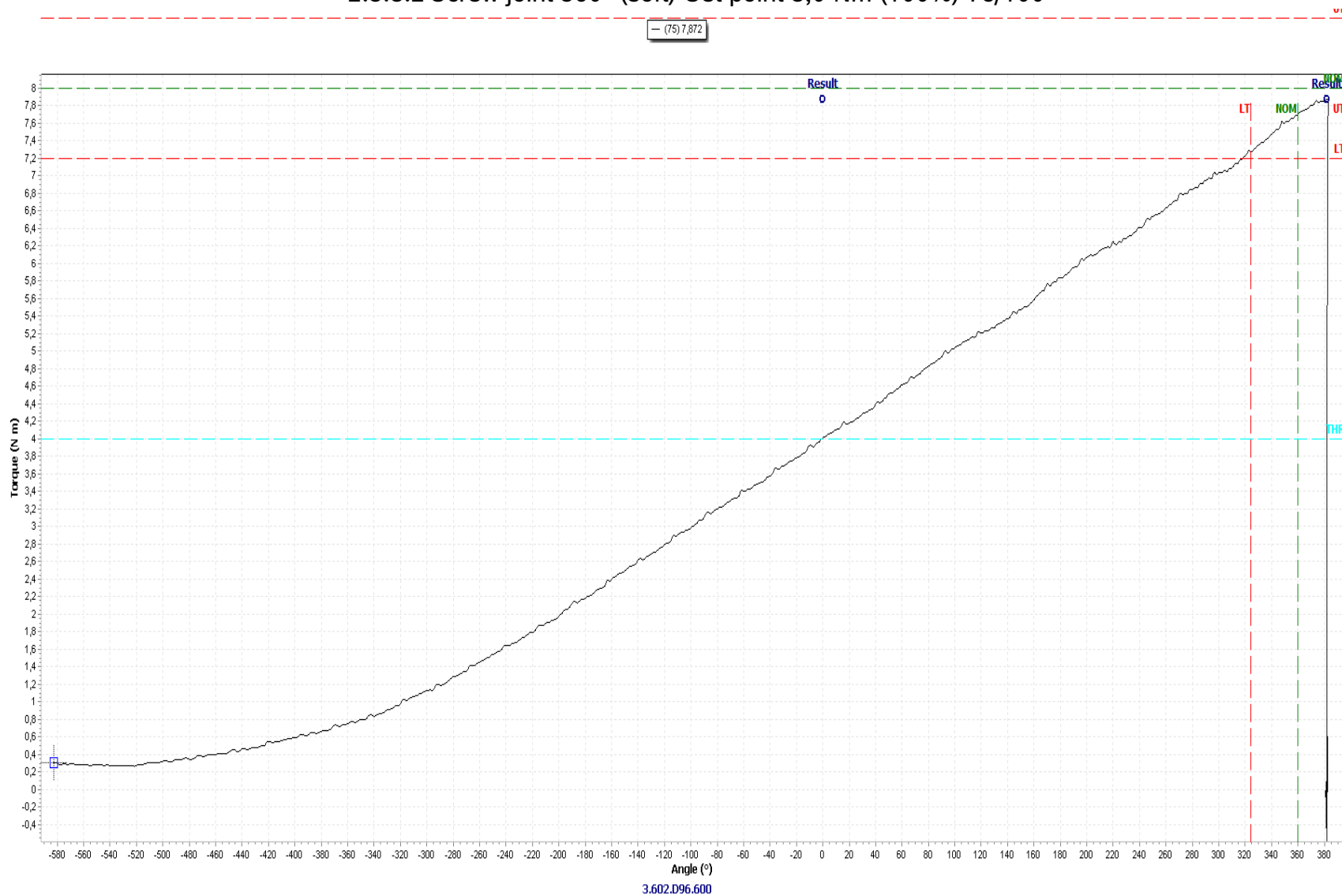


### 2.3.8.1 Screw joint 360° (soft) Set point 8,0 Nm (100%) 25/100

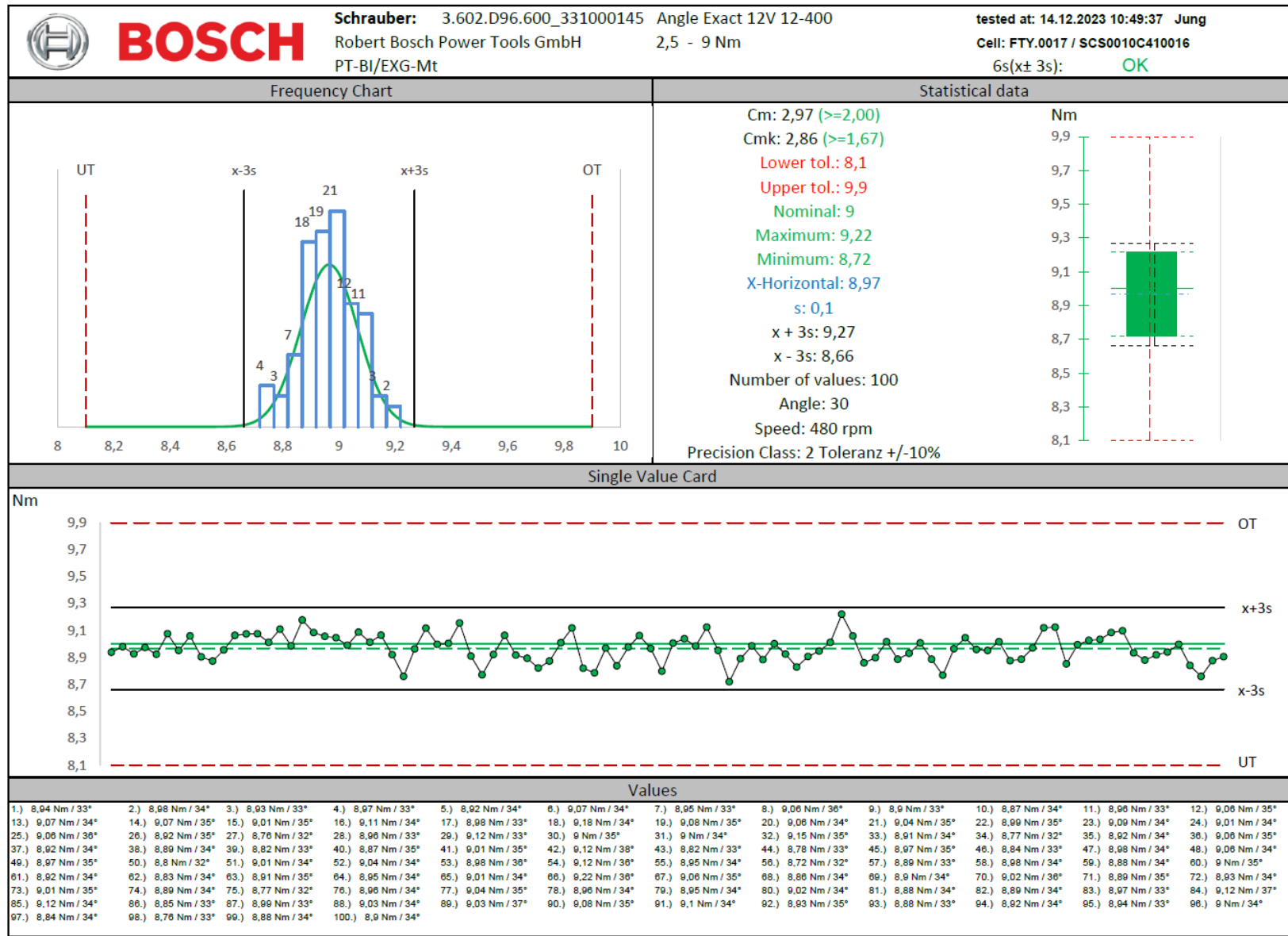




### 2.3.8.2 Screw joint 360° (soft) Set point 8,0 Nm (100%) 75/100



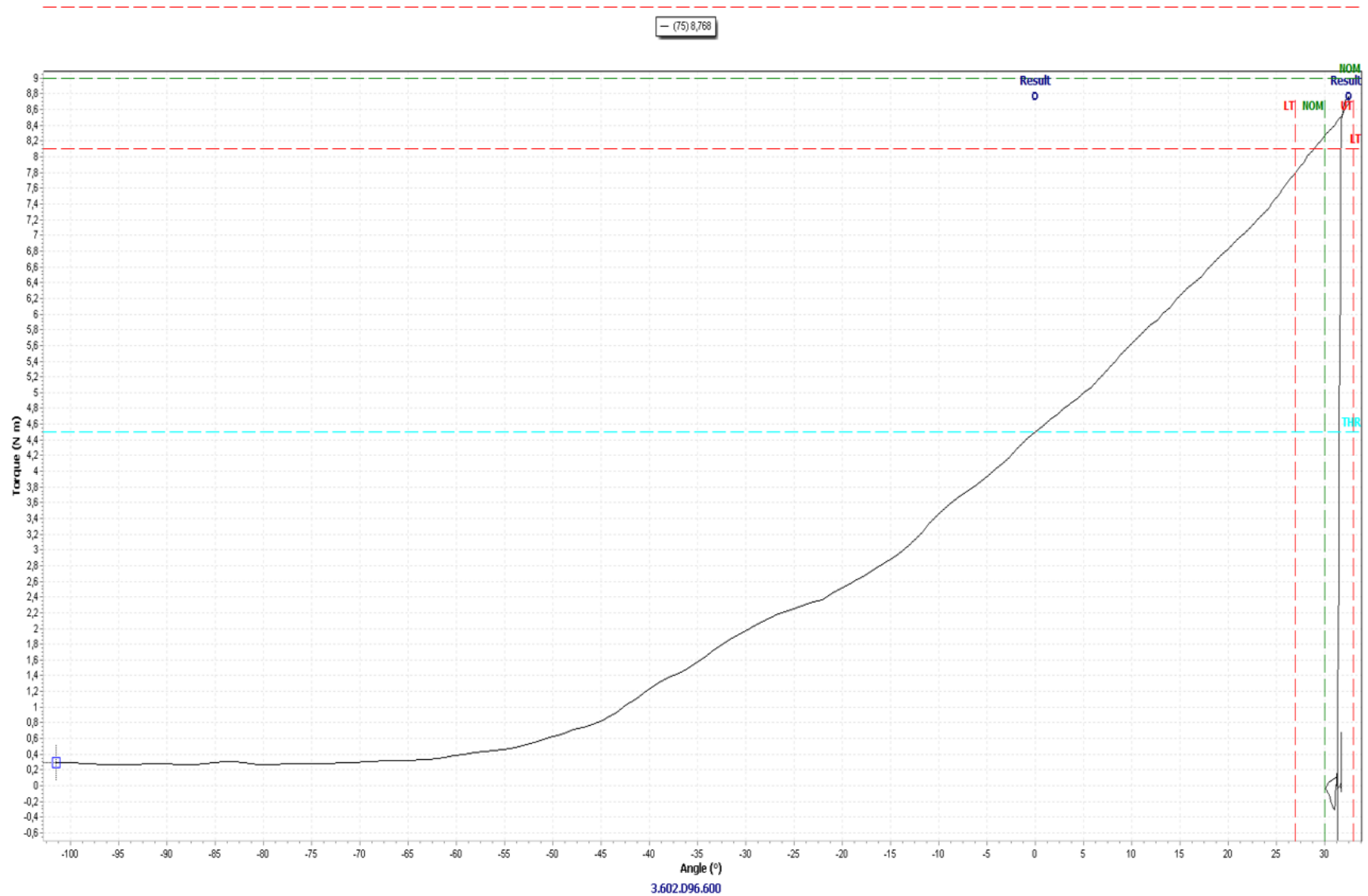
## 2.3.9 Screw joint 30° (hard) Set point 9,0 Nm (additional)



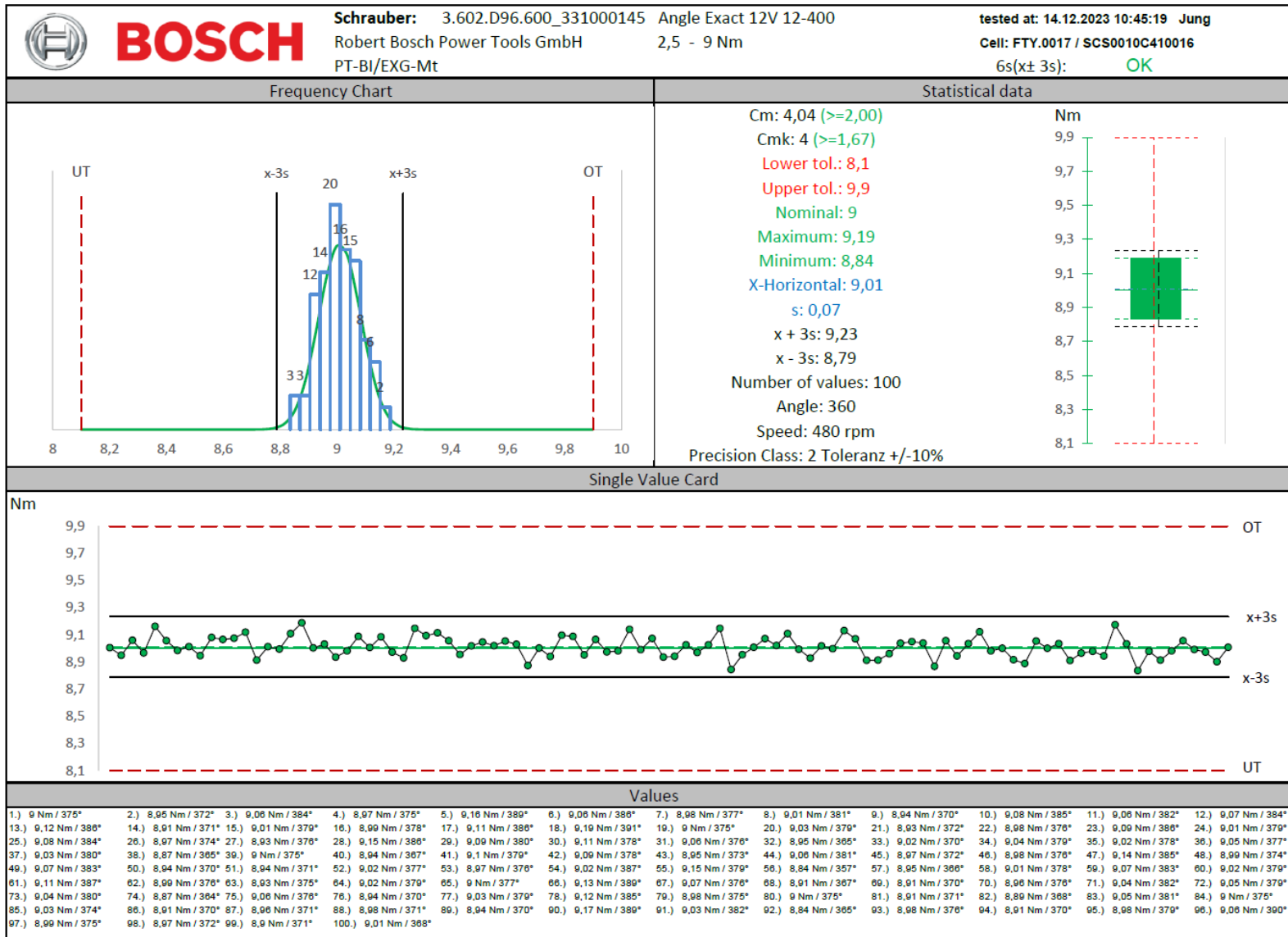
Graph showing Torque (N.m) versus Angle (°) for a 3.602.D96.600 motor. The curve shows torque increasing from approximately 0.2 N.m at -100° to a peak of about 9.0 N.m at 35°. Key limits are marked: LT (red dashed line at ~26.5°), NOM (green dashed line at ~30°), and THUR (cyan dashed line at ~4.5 N.m). A red dashed line is also present at ~8.2 N.m. A legend at the top right shows 'Result' with a blue circle and 'UT' with a red circle.



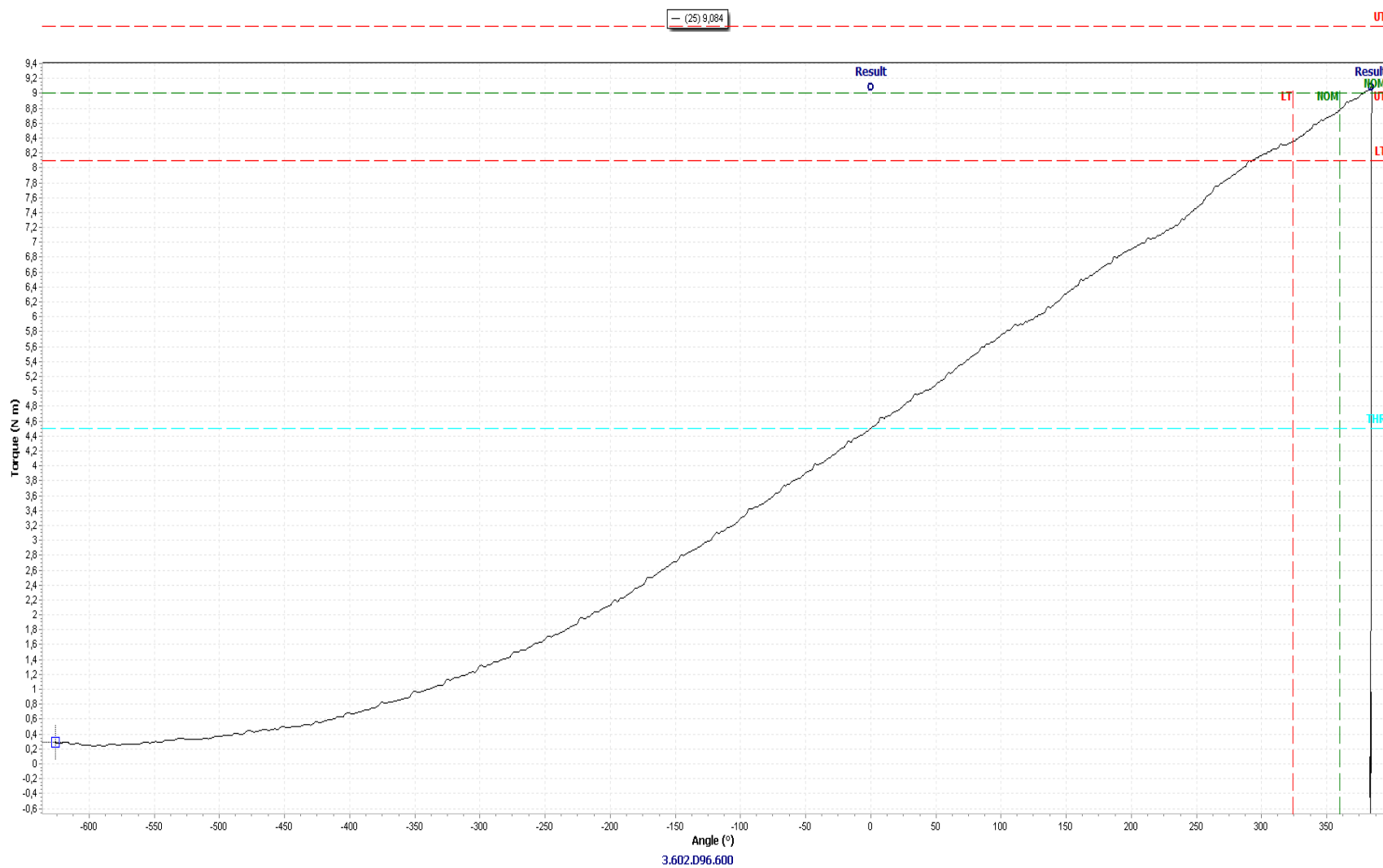
### 2.3.9.2 Screw joint 30° (hard) Set point 9,0 Nm (additional) 75/100



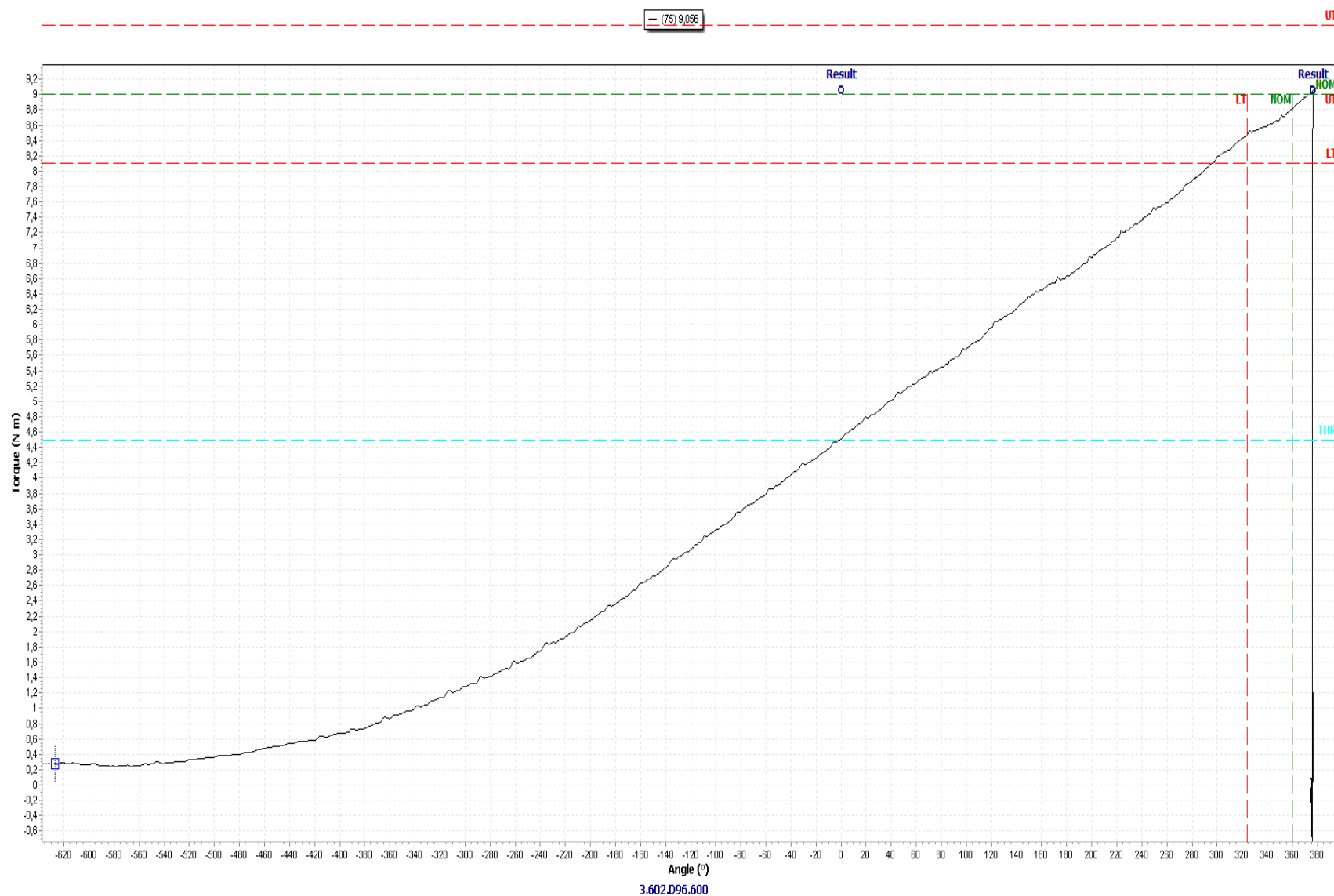
## 2.3.10 Screw joint 360° (soft) Set point 9,0 Nm (additional)



### 2.3.10.1 Screw joint 360° (soft) Set point 9,0 Nm (additional) 25/100



### 2.3.10.2 Screw joint 360° (soft) Set point 9,0Nm (additional) 75/100





### 3. Certificates

#### 3.1 Calibration certificate torque and angle sensor 10 Nm



#### Kalibrierschein / Calibration Certificate

erstellt durch das Kalibrierlaboratorium  
*issued by the calibration laboratory*

**SCS Concept Deutschland GmbH**  
Zeppelinstr. 2  
D-84180 Loiching-Kronwieden

akkreditiert nach DIN EN ISO/IEC 17025:2018  
*German translation of ISO/IEC 17025:2017*



Kalibrierzeichen  
*Calibration mark*

25795
D-K-
15001-01-00
2022-09

Gegenstand <i>Object</i>	<b>Drehmoment-/Drehwinkelsensor</b>	
Hersteller <i>Manufacturer</i>	<b>SCS Concept</b>	
Typ <i>Type</i>	<b>FTY 10</b>	Anzeigegerät / <i>Indicating device</i> <b>FTY</b>
Fabrikat/Serien-Nr. <i>Betriebsmittelnummer:</i>	<b>SCS.0010.C4.1.0016</b>	<b>FTY.0017</b> 22600412-1
Auftraggeber: <i>Applicant:</i>	<b>Robert Bosch Power Tools GmbH</b> <b>Fornsbacher Str. 92</b> <b>71540 Murrhardt</b>	
Auftragsnummer <i>Order No.</i>	<b>PR22-0325 KAL - 20-34801 - 8010004</b>	
Anzahl der Seiten des Kalibrierscheines <i>Number of pages of the certificate</i>	<b>6</b>	
Datum der Kalibrierung <i>Date of Calibration</i>	<b>2022-09-29</b>	

Dieser Kalibrierschein dokumentiert die metrologische Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem internationalen Einheitensystem (SI). Die DAkkS ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

*This calibration certificate documents the metrological traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates. The user is obliged to have the object recalibrated at appropriate intervals.*

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine sind bei Nennung des für die Freigabe Verantwortlichen in Klarschrift auch ohne Unterschrift gültig.

*This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates with the full name of the approval responsible person are valid without signature.*

Datum der Ausstellung <i>Date of Issue</i>	Kalibrierschein freigegeben durch <i>Calibration certificate released by</i>	Bearbeiter <i>Person in charge</i>
<b>2022-10-10</b>	<b>Claudia Weber</b>	<b>Adam Siegert</b>





Seite 2 zum Kalibrierschein vom 2022-10-10

Page 2 of the calibration certificate of 2022-10-10

In case of doubts the German text of this certificate is valid.

25795

D-K-

15001-01-00

2022-09

1	Kalibrierverfahren / Calibration Procedure :	DIN 51309 : 2005-12 Werkstoffprüfmaschinen - Kalibrierung von Drehmomentmessgeräten für statische Drehmomente												
2	Kalibriereinrichtung / Calibration device :	10-N-m-Drehmoment-KE #TT1136												
2.1	Messunsicherheit für jede Drehmomentstufe in % / Uncertainty of measurement related to torque in %	<table><tr><th>Drehmoment / Torque in N-m</th><th>Erw. Messunsicherheit / Exp. Uncertainty (k = 2) in % :</th></tr><tr><td>1</td><td>0,11</td></tr><tr><td>2</td><td>0,1</td></tr><tr><td>4</td><td>0,1</td></tr><tr><td>6</td><td>0,1</td></tr><tr><td>10</td><td>0,1</td></tr></table>	Drehmoment / Torque in N-m	Erw. Messunsicherheit / Exp. Uncertainty (k = 2) in % :	1	0,11	2	0,1	4	0,1	6	0,1	10	0,1
Drehmoment / Torque in N-m	Erw. Messunsicherheit / Exp. Uncertainty (k = 2) in % :													
1	0,11													
2	0,1													
4	0,1													
6	0,1													
10	0,1													
2.2	Referenzaufnehmer / Reference transducer :	TT1 / 10 N-m, #TT1136												
2.3	Anzeigegerät / Indication device :	MGCplus												
	Seriennummer / Serial number :	SCS MGCplus #11 Kanal 1 ML10B												
	Hersteller / Manufacturer :	Hottinger Baldwin Messtechnik GmbH												
2.4	Einstellung des Anzeigegegerätes / Settings of the Indication device :	Spisespannung / Supply voltage : 5VDC Filtereinstellung / Filter settings : 0,2Hz Bessel Auflösung / Resolution : 0,000001 Schwankung / Fluctuation : 0,000007 Anzeigeeneinheit / Indication unit : mV/V												
2.5	Anschlusskabel / Input cable :	fest am Verstärker angeschlossen												
	Schaltungsart / Circuit type :	6-Leiter-Schaltung												
2.6	Einspanntelle / Adaptors :	Vierkant-Square 10mm (3/8") F												
2.7	Auswertung / Evaluation :	WF-K-03_Kalibrierscheine_Rev_2022-08-19												
3	Kalibriergegenstand / Calibration device :	FTY 10, SCS.0010.C4.1.0016, -												
3.1	Anzeigegerät / Indication device :	FTY												
	Seriennummer / Serial number :	FTY.0017												
	Hersteller / Manufacturer :	SCS Concept												
3.2	Einstellung des Anzeigegegerätes / Settings of the Indication device :	Spisespannung / Supply voltage : 5VDC Filtereinstellung / Filter settings : 1kHz Ziffernschritt / Numeral resolution : 0,0001 Schwankung / Fluctuation : 0 Anzeigeeneinheit / Indication unit : N-m												
3.3	Anschlusskabel / Input cable :	Intern												
	Schaltungsart / Circuit type :	4-Leiter												
3.4	Einspanntelle / Adaptors :	Vierkant-Square 10mm (3/8") M												
3.5	Justierwert / adjustment value :	rechts / clockwise      links / counter clockwise												
	vor Kalibrierung / before calibration :	-1,91103 mV/V      -												
	nach Kalibrierung / after calibration :	-1,91103 mV/V      -												
	Justage / adjustment:	0 %      0 %												
4	Kalibrieranordnung / Calibration installation :													
4.1	Einbaustellungen / Mounting positions :	2 x 90°												
4.2	Drehmomentvektor / Torque vector :	horizontal / horizontal												
5	Umgebungsbedingungen / Ambient conditions :													
5.1	Kalibriertemperatur / Calibration temperature :													
	vor Kalibrierung / before calibration :	21,2 °C												
	nach Kalibrierung / after calibration :	21,3 °C												
5.2	Relative Luftfeuchtigkeit / relative humidity	49 %												
5.3	Ort der Kalibrierung / Place of calibration :	On Site Bosch Murrhardt												
6	Aufnehmernullsignale / Transducer zero signals :													
	vor Einbau / before mounting :	-298,0000 AE												
	nach Kalibrierung / after calibration :	-301,0000 AE												
7	Zusätzliche Angaben / Additional information :													
7.1	Nächster Kalibriertermin gemäß Kundenvorgabe : Next calibration date according to customer specification :	29.09.2023 2023-09-29												



Seite 3 zum Kalibrierschein vom 2022-10-10

Page 3 of the calibration certificate of 2022-10-10

25795

D-K-

15001-01-00

2022-09

**8 Auswertung / Analysis****8.1 Kalibrierergebnis / Calibration results**

Drehmoment / torque	Fall I / case I				Fall II / case II			
	Signal / signal	rel. Uns.-Intervall / rel. uncert. Intervall $k = 2$			Signal / signal	rel. Uns.-Intervall / rel. uncert. Intervall $k = 2$		
	In N-m	benannte Skale / defined scale In %			In N-m	benannte Skale / defined scale In %		
Rechtsdrehmoment / clockwise torque								
0	0,0000				-0,0009			
1	0,9962			0,54	0,9975			0,61
2	1,9941			0,45	1,9970			0,46
4	3,9893			0,42	3,9911			0,43
6	5,9831			0,40	5,9860			0,41
10	9,9790			0,32	9,9790			0,32
Linksdrehmoment / anticlockwise torque								

Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor  $k = 2$  ergibt. Sie wurde gemäß EA-4/02 M: 2013 ermittelt. Der Wert der Messgröße liegt mit einer Wahrscheinlichkeit von 95 % im zugeordneten Werteintervall.

Stated is the expanded uncertainty, which is obtained by multiplying the standard uncertainty by the coverage factor  $k = 2$ . This has been determined in accordance with Guideline EA-4/02 M: 2013. The value of measurement corresponds to a coverage probability of 95%.

Zusätzlich zu den Empfehlungen der DIN 51309:2005, wurde bei benannter Skale auch das relative Unsicherheitsintervall für Fall I bestimmt.

In addition to the recommendations of the DIN 51309:2005, also the relative uncertainty interval for case I was determined in case of a designated scale.

$$W^*(M_K) = \left| \frac{f_0(M_K)}{Y(M_K)} \right| \cdot 100\% + k \cdot w(M_K)$$

**8.2 Klasseneinstufung nach DIN 51309 / Classification according to DIN 51309**

Klasse Class	Fall I / case I				Fall II / case II			
	benannte Skale / defined scale		benannte Skale / defined scale		benannte Skale / defined scale		benannte Skale / defined scale	
	von/from In N-m	bis / to In N-m	von/from In N-m	bis / to In N-m	von/from In N-m	bis / to In N-m	von/from In N-m	bis / to In N-m
Rechtsdrehmoment / clockwise torque								
0,05								
0,1								
0,2								
0,5								
1			1,0	10,0			1,0	10,0
2								
5								
Linksdrehmoment / anticlockwise torque								
0,05								
0,1								
0,2								
0,5								
1								
2								
5								

**8.3 Kriechenfluss aus Kurzzeitkriechen / Creep influence from short-term creep**

Vor der ersten Messreihe jeder Einbaustellung wurde die Signaländerung während einer dreiminütigen Wartezeit registriert.

Das arithmetische Mittel der auf den zugehörigen Endwert bezogenen Änderungen ist das Kurzzeitkriechen.

The signal variation during a three-minute waiting interval was recorded before the first series of every mounting position.

The short-term creep is the arithmetic mean of the related to the corresponding full-scale value variations.

Das im geschlossenen Strang ermittelte und mit dem Faktor 4 multiplizierte Kurzzeitkriechen ergibt:

0,036 %

The determined in a closed string and multiplied by the factor 4 short-term creep results:



Seite 4 zum Kalibrierschein vom 2022-10-10

Page 4 of the calibration certificate of 2022-10-10

25795

D-K-

15001-01-00

2022-09

**9 Interpolationsgleichungen / Interpolation equations**

S in N-m

M in N-m

**9.1 Fall I, Kubische Interpolationsgleichung / Case I, Cubic interpolation equation:****9.1.1 Rechtsdrehmoment / clockwise torque:**

$$\begin{aligned} S_{kl} &= 0,997080 \cdot M_1 + -4,400E-05 \cdot M_1^2 + 1,260E-05 \cdot M_1^3 \\ M_{kl} &= 1,002900 \cdot S_1 + 4,000E-05 \cdot S_1^2 + -1,300E-05 \cdot S_1^3 \end{aligned}$$

**9.1.2 Linksdrehmoment / anticlockwise torque:**

$$\begin{aligned} S_{kl} &= \cdot M_1 + \cdot M_1^2 + \cdot M_1^3 \\ M_{kl} &= \cdot S_1 + \cdot S_1^2 + \cdot S_1^3 \end{aligned}$$

**9.2 Fall I, Lineare Interpolationsgleichung / Case I, Linear interpolation equation****9.2.1 Rechtsdrehmoment / clockwise torque:**

$$\begin{aligned} S_{kl} &= 0,997640 \cdot M_1 \\ M_{kl} &= 1,002400 \cdot S_1 \end{aligned}$$

**9.2.2 Linksdrehmoment / anticlockwise torque:**

$$\begin{aligned} S_{kl} &= \cdot M_1 \\ M_{kl} &= \cdot S_1 \end{aligned}$$

**9.2.3 Rechts- und Linksdrehmoment / clockwise and anticlockwise torque:**

$$\begin{aligned} S_{kl} &= \cdot M_1 \\ M_{kl} &= \cdot S_1 \end{aligned} \quad (\text{siehe Fußnote / see footnote})$$

**9.3 Fall II, Lineare Interpolationsgleichung / Case II, Linear interpolation equation****9.3.1 Rechtsdrehmoment / clockwise torque:**

$$\begin{aligned} S_{kl} &= 0,997850 \cdot M_1 \\ M_{kl} &= 1,002200 \cdot S_1 \end{aligned}$$

**9.3.2 Linksdrehmoment / anticlockwise torque:**

$$\begin{aligned} S_{kl} &= \cdot M_1 \\ M_{kl} &= \cdot S_1 \end{aligned}$$

**9.3.3 Rechts- und Linksdrehmoment / clockwise and anticlockwise torque:**

$$\begin{aligned} S_{kl} &= \cdot M_1 \\ M_{kl} &= \cdot S_1 \end{aligned} \quad (\text{siehe Fußnote 1) / see footnote 1})$$

**10 Kennwerte nach DIN 51309 / Classification criteria according to DIN 51309**

		Fall I / case I						Fall II / case II						
$M_K$	$\frac{f_0}{Y_k}$	$\frac{b'}{Y}$	$\frac{b}{Y}$	$\frac{f_{a,ach}}{Y}$	$\frac{f_{a,lin}}{Y}$	$\frac{f_0}{Y}$	$\frac{b'}{Y_k}$	$\frac{b}{Y_k}$	$\frac{h}{Y_k}$	$\frac{f_{a,lin}}{Y_k}$	$\frac{f_a}{Y_k}$ 2)	$r$		
in N-m	in %	in %	in %	in %	in %	in %	in %	in %	in %	in %	in %	in N-m		
10	-	0,033	0,070			-0,210	0,033	0,070	-		-0,210	0,00010		
6	-	0,042	0,104			-0,282	0,042	0,104	0,112		-0,234	0,00010		
4	-	0,105	0,168			-0,269	0,105	0,168	0,115		-0,224	0,00010		
2	-	0,080	0,176			-0,298	0,080	0,175	0,325		-0,149	0,00010		
1	-	0,141	0,141			-0,381	0,140	0,140	0,391		-0,256	0,00010		
0	0,019	-	-			-	-	-	-		-	-		

1) Die Bestimmung der linearen Interpolationsgleichung für Rechts- und Linksdrehmoment ist nicht identisch mit einem Kalibrierergebnis für Wechseldrehmoment. Sie ermöglicht es, mit nur einem Kalibrierfaktor das Anzeigergerät optimal für Rechts- und Linksdrehmoment anzupassen.

The linear interpolation equation for clockwise torque and anticlockwise torque can't be used as a calibration result for alternating torque. It only can be used to adjust the indicator optimally for clockwise torque and anticlockwise torque with a single calibration factor.

2) Im Fall II werden zur Bestimmung der Anzeigeschleifung  $f_0$  die Kalibrierergebnisse der Aufwärts- und Abwärtsreihen berücksichtigt. In case II for the determination of the display error  $f_0$  the calibration results of the upward and downward measurements are considered.

**Hinweise / notes:**

Berechnete Werte sind um die jeweilige Nullanzeige reduziert. Die Ergebnisse sind in der letzten Stelle gerundet und beziehen sich ausschließlich auf den in diesem Ergebnisbericht genannten Gegenstand.

Calculated values are reduced by the respective zero signal. The last digit of the results has been rounded and relates exclusively to the subject mentioned in this report.

Die Deutsche Akkreditierungsstelle GmbH ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine. Die weiteren Unterzeichner innerhalb und außerhalb Europas sind den Internetseiten von EA ([www.european-accreditation.org](http://www.european-accreditation.org)) und ILAC ([www.ilac.org](http://www.ilac.org)) zu entnehmen.

The Deutsche Akkreditierungsstelle GmbH is signatory to the multilateral agreement of the European co-operation for Accreditation (EA) and the ILAC for the mutual recognition of calibration certificates. The other signatories within and outside of Europe are found in the websites of EA ([www.european-accreditation.org](http://www.european-accreditation.org)) and ILAC ([www.ilac.org](http://www.ilac.org)).



Seite 5 zum Kalibrierschein vom 2022-10-10

Page 5 of the calibration certificate of 2022-10-10

25795

D-K-

15001-01-00

2022-09

**11 Messdaten / measuring data****In N-m****Rechtsdrehmoment / clockwise torque**

0	0,0000	0,0000	0,0000	0,0000	-0,0019	0,0000
1	-	-	-	0,9969	1,0008	0,9955
2	-	-	-	1,9923	1,9977	1,9907
4	-	-	-	3,9859	3,9905	3,9817
6	-	-	-	5,9800	5,9867	5,9825
10	9,9772	9,9800	9,9798	9,9755	9,9755	9,9788
N-m	1. Vorbel. preloading	2. Vorbel. preloading	3. Vorbel. preloading	0° / 1 up	0° / 1 down	0° / 2 up

0	0,0000	0,0000	-0,0017			
1	-	0,9955	0,9966			
2	-	1,9958	2,0023			
4	-	3,9926	3,9952			
6	-	5,9862	5,9911			
10	9,9824	9,9825	9,9825			
N-m	Vorbel. preloading	90° / up	90° / down	Vorbel. preloading	/ up	/ down

0			
1			
2			
4			
6			
10			
N-m	Vorbel. preloading	/ up	/ down

**Links drehmoment / anticlockwise torque**

N-m	1. Vorbel. preloading	2. Vorbel. preloading	3. Vorbel. preloading	0° / 1 up	0° / 1 down	0° / 2 up

N-m	Vorbel. preloading	90° / up	90° / down	Vorbel. preloading	/ up	/ down

N-m	Vorbel. preloading	/ up	/ down



Seite 6 zum Kalibrierschein vom 2022-10-10

Page 6 of the calibration certificate of 2022-10-10

25795

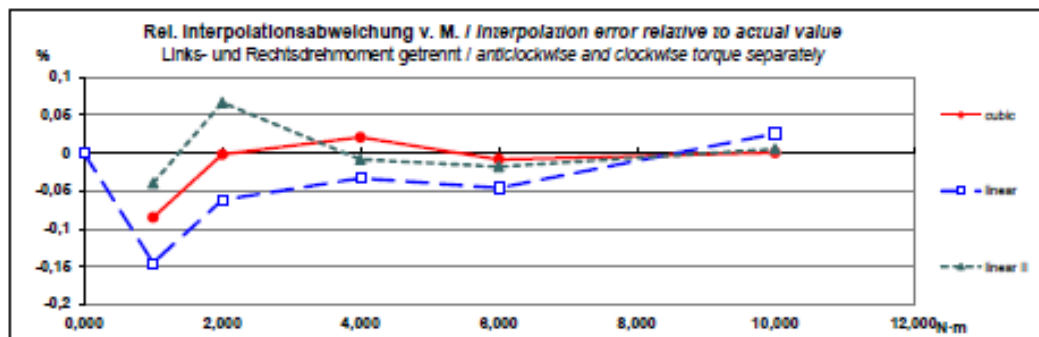
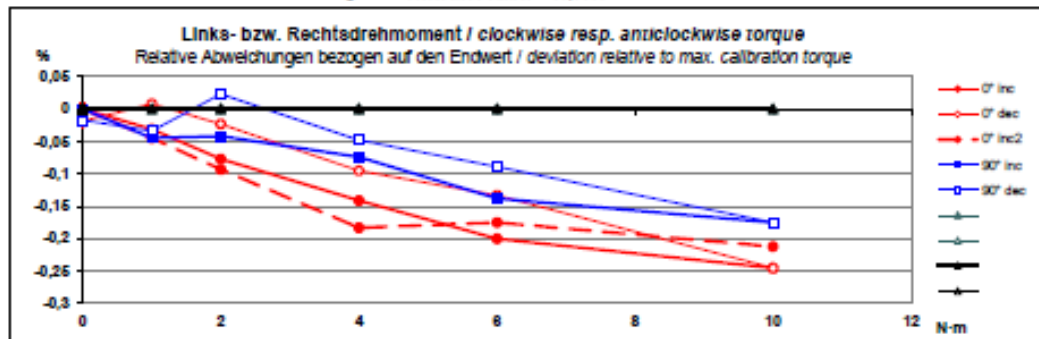
D-K-

15001-01-00

2022-09

### 12 Darstellung der Ergebnisse in Diagrammen / Results in diagrams

Bezugswert / Reference value: 10,000 N-m



### 13 Kubische Interpolationswerte ohne Bezug zur Messunsicherheit / Cubic interpol. values without reference to uncertainty

Rechtsdrehmoment nach 9.1.1 / clockwise torque acc. to 9.1.1

N-m	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9
0	0,0000	0,0997	0,1994	0,2991	0,3988	0,4985	0,5982	0,6979	0,7976	0,8973
1	0,9970	1,0968	1,1965	1,2962	1,3959	1,4956	1,5953	1,6950	1,7947	1,8944
2	1,9941	2,0938	2,1935	2,2932	2,3929	2,4926	2,5923	2,6920	2,7918	2,8915
3	2,9912	3,0909	3,1906	3,2903	3,3901	3,4898	3,5895	3,6892	3,7890	3,8887
4	3,9884	4,0882	4,1879	4,2876	4,3874	4,4871	4,5869	4,6866	4,7864	4,8861
5	4,9859	5,0856	5,1854	5,2852	5,3849	5,4847	5,5845	5,6843	5,7840	5,8838
6	5,9836	6,0834	6,1832	6,2830	6,3828	6,4826	6,5824	6,6823	6,7821	6,8819
7	6,9817	7,0816	7,1814	7,2812	7,3811	7,4809	7,5808	7,6807	7,7805	7,8804
8	7,9803	8,0802	8,1800	8,2799	8,3798	8,4797	8,5796	8,6796	8,7795	8,8794
9	8,9793	9,0793	9,1792	9,2792	9,3791	9,4791	9,5791	9,6790	9,7790	9,8790
10	9,9790									

Linksdrehmoment nach 9.1.2 / anticlockwise torque acc. to 9.1.2

N-m	0,0	-0,1	-0,2	-0,3	-0,4	-0,5	-0,6	-0,7	-0,8	-0,9
0										
-1										
-2										
-3										
-4										
-5										
-6										
-7										
-8										
-9										
-10										

N-m

- Ende des Kalibrierscheins / End of calibration certificate -



**Kalibrierlaboratorium für die Messgröße Drehmoment und Drehwinkel***Calibration laboratory for the measuring quantity torque and angle***SCS Concept Deutschland GmbH**

Zeppelinstr. 2  
D-84180 Loiching-Kronwieden  
Telefon: +49 8731 326 166 0  
Telefax: +49 8731 326 166 9

**W223548****SCS****2022-09****Messmittelfähigkeitsuntersuchung Drehwinkel***Drehmoment (MGF) nach VDI/VDE 2647, Februar 2013*

Gegenstand: **Drehmoment-/Drehwinkelsensor - 10 N·m**  
Object:

Hersteller: **SCS Concept**  
Manufacturer:

Typ: **FTY 10** **Anzeigegerät**  
Type: **FTY**

Kennnummer: **SCS.0010.C4.1.0016** **FTY.0017**  
ID-Nummer: **-** **22600412-1**

Auftraggeber: **Robert Bosch Power Tools GmbH**  
Applicant: **Fornsbacher Str. 92**  
**71540 Murrhardt**

Anzahl der Seiten: **2**  
Number of pages:

Geschäftszeichen: **PR22-0325 KAL / 20-34813**  
Reference No.:

Datum der Prüfung: **2022-09-29**  
Date of the Inspection:

Ort der Prüfung: **On Site Bosch Murrhardt**  
Place of the Inspection:

Die Untersuchung erfolgt durch Vergleich mit Bezugsnormen bzw. Bezugsnormaleinrichtungen, die im Kalibrierlaboratorium der SCS Concept Deutschland GmbH kalibriert und damit rückgeführt sind auf die nationalen Normale, mit denen die Physikalisch-Technische Bundesanstalt (PTB) die physikalischen Einheiten in Übereinstimmung mit den Internationalen Einheitensystem (SI) darstellt. Für die Kalibrierung und deren Dokumentation trägt der Aussteller dieses Kalibrierscheins die alleinige Verantwortung. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

*This inspection is performed by comparison with reference standards or standar measuring equipment which are calibrated by the calibration lab of the SCS Concept Deutschland GmbH and thus traceable to the national measurement standards maintained by the Physikalisch-Technische-Bundesanstalt (PTB) for the realization of the physical units according to the international system of units (SI). The issuing company is solely responsible for the performance and the documentation of the calibration. The user is obliged to have the object recalibrated at appropriate intervals.*

Dieser Nachweis darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung des ausstellenden Laboratoriums. Dieser Nachweis wurde elektronisch erstellt und ist auch ohne Unterschrift gültig.  
*This inspection document may not be reproduced other than in full except with the permission of the issuing laboratory. This proof was created electronically and is valid even without a signature.*

Datum:  
Date:

Bearbeiter:  
Person in charge:

2022-10-06

Robert Dusza

SCS Concept Deutschland GmbH  
Zeppelinstr. 2  
D-84180 Loiching-Kronwieden

Telefon: +49 8731 326 166 0  
Telefax: +49 8731 326 166 9  
E-Mail: deutschland@scsconcept.de



Seite 2 zum Kalibrierschein vom 2022-10-06

Page 2 of the calibration certificate of 2022-10-06

W223548

SCS

2022-09

- 1 Kalibrierverfahren / Calibration Procedure :** Drehmoment (MGF) nach VDI/VDE 2647, Februar 2013
- 2 Kalibriereinrichtung / Calibration device :** ERN 180, #54795491A
- 2.1 Erw. Messunsicherheit / Exp. Uncertainty  $U_{REF}$  : 0,05 °
- Drehwinkel / Angle
- 2.2 Gebrauchsnorm / Reference transducer : ROD 480 5000 27S12-03
- Drehwinkel / Angle : # 17 106 642 B
- 2.3 Anzeigergerät / Indication device : ND 281 B
- Seriennummer / Serial number : #16 369 085 A
- Hersteller / Manufacturer : Dr. Johannes Heidenhain GmbH
- 2.4 Drehmomentsensor in der Winkelkalibriereinrichtung / torque transducer in angle calibration station : QD-ANG-TQ-250-001-C, 250 N.m
- 2.5.1 Drehmomentsensor / Torque transducer : 0,2 % (Klasse 1 nach DIN51309)
- 2.5.2 Erw. Messunsicherheit / Exp. Uncertainty (k = 2)
- 2.5 Anschlusskabel Winkel / Input cable angle : fest am Verstärker angeschlossen
- 2.6 Einspannteile / Adaptors : Innenvierkant 1/2" fest verstiftet
- 3 Kalibriergegenstand / Calibration device :** FTY 10 - SCS.0010.C4.1.0016
- 3.1 Anzeigergerät / Indication device :  
Seriennummer / Serial number :  
Hersteller / Manufacturer :
- 3.2 Einstellung des Anzeigergerätes / Settings of the indication device :  
Speisespannung / Supply voltage : 5VDC  
Filtereinstellung / Filter settings : 1kHz  
Ziffernschritt / Numeral resolution : 0,25  
Schwankung / Fluctuation : -  
Anzeigeeinheit / Indication unit : Nm
- 3.3 Anschlusskabel / Input cable : intern
- 3.4 Einspannteile / Adaptors : Vierkant-Square 10mm (3/8") M
- 3.5 Justierwert Drehwinkel / adjustment angle value :  
vor Kalibrierung / before calibration : 1440  
nach Kalibrierung / after calibration : 1440
- 3.6 Justierwert Eigenverbiegung / adjustment self-deflexion :  
vor Kalibrierung / before calibration : -  
nach Kalibrierung / after calibration : -
- 4 Kalibrieranordnung / Calibration installation :**
- 4.1 Einbaulage / Mounting positions : horizontal
- 4.2 Definierte Nullmarke / Zero reference mark : keine
- 4.3 Hebelarmlänge / lever arm : kurz/short:- mm; lang/long:- mm
- 5 Umgebungsbedingungen / Ambient conditions :**
- 5.1 Kalibriertemperatur / Calibration temperature :  
vor Kalibrierung / before calibration : 22,1 °C  
nach Kalibrierung / after calibration : 22,2 °C
- 5.2 Temperaturgradient / Gradient of temperature : < 0,2 K/Stunde (während der Messung)
- 5.3 Relative Luftfeuchtigkeit / relative humidity : 39 %
- 5.4 Ort der Kalibrierung / Place of calibration : On Site Bosch Murrhardt

**6 Zusätzliche Angaben / Additional information :**

Berechnete Werte sind um die jeweilige Nullanzeige reduziert. Die Ergebnisse sind in der letzten Stelle gerundet.  
Calculated values are reduced by the respective zero signal. The calculated values are rounded in the last decimal.

Beurteilung: **OK**

Soll:40° / MIN:35° / MAX:45°

Standardabweichung:0,1658 / Mittelwert (x-quer): 40,06° / MAX:40,25° / MIN:39,75°

Cg:2,01 / Cgk:1,89

**7 Auswertung / Analysis****7.1 Kalibrierergebnis / Calibration results**

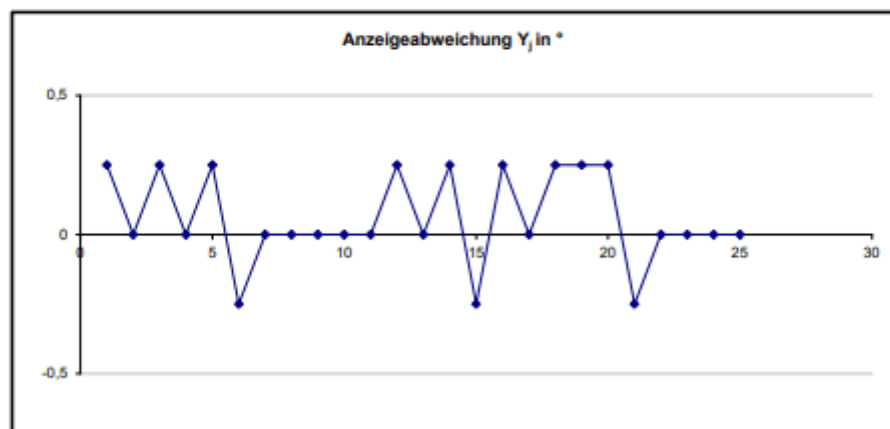
Vollständiges Kalibrierergebnis

Messpunkt Measuring point	Anzeigewert WI-KE Indication $\alpha_K$ in °	Anzeigewert Prüfling Indication $\bar{X}$ in °	Auflösung Resolution $r$ in °	Anzeige- abweichung Cal. Result $Y_i$ in °		
1	40,00	40,25	0,250	0,25		
2	40,00	40,00		0,00		
3	40,00	40,25		0,25		
4	40,00	40,00		0,00		
5	40,00	40,25		0,25		
6	40,00	39,75		-0,25		
7	40,00	40,00		0,00		
8	40,00	40,00		0,00		
9	40,00	40,00		0,00		
10	40,00	40,00		0,00		
11	40,00	40,00		0,00		
12	40,00	40,25		0,25		
13	40,00	40,00		0,00		
14	40,00	40,25		0,25		
15	40,00	39,75		-0,25		
16	40,00	40,25		0,25		
17	40,00	40,00		0,00		
18	40,00	40,25		0,25		
19	40,00	40,25		0,25		
20	40,00	40,25		0,25		
21	40,00	39,75		-0,25		
22	40,00	40,00		0,00		
23	40,00	40,00		0,00		
24	40,00	40,00		0,00		
25	40,00	40,00		0,00		

Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor  $k = 2$  ergibt. Sie wurde gemäß DKD-3 ermittelt. Der Wert der Messgröße liegt mit einer Wahrscheinlichkeit von 95 % im zugeordneten Werteintervall.

Stated is the expanded uncertainty, which is obtained by multiplying the standard uncertainty by the coverage factor  $k = 2$ . This has been determined in accordance with Guideline DKD-3. The value of measurement corresponds to a coverage probability of 95%.

Der Startpunkt der Messreihen erfolgte von einer undefinierten Nullmarke (USP - undefinierter Startpunkt). Die Messreihen können nicht zu einer möglichen Korrekturkurve herangezogen werden.

**7.2 Darstellung der Ergebnisse in Diagrammen / Results in diagrams**





- 1 Kalibrierverfahren / Calibration Procedure:** Drehmoment (MGF) nach VDI/VDE 2647, Februar 2013
- 2 Kalibriereinrichtung / Calibration device:** ERN 180, #54795491A
- 2.1 Erw. Messunsicherheit / Exp. Uncertainty  $U_{REF}$ : 0,05 °  
Drehwinkel / Angle
- 2.2 Gebrauchsnorm / Reference transducer: ROD 480 5000 27S12-03  
Drehwinkel / Angle # 17 106 642 B
- 2.3 Anzeigegerät / Indication device: ND 281 B  
Seriennummer / Serial number: #16 369 085 A  
Hersteller / Manufacturer: Dr. Johannes Heidenhain GmbH
- 2.4 Drehmomentsensor in der Winkelkalibriereinrichtung / torque transducer in angle calibration station: QD-ANG-TQ-250-001-C, 250 N.m  
2.5.1 Drehmomentsensor / Torque transducer: 0,2 % (Klasse 1 nach DIN51309)  
2.5.2 Erw. Messunsicherheit / Exp. Uncertainty ( $k = 2$ )
- 2.5 Anschlusskabel Winkel / Input cable angle: fest am Verstärker angeschlossen
- 2.6 Einspannteile / Adaptors: Innenvierkant 1/2" fest verstiftet
- 3 Kalibriergegenstand / Calibration device:** FTY 10 - SCS.0010.C4.1.0016
- 3.1 Anzeigegerät / Indication device: Seriennummer / Serial number:  
Hersteller / Manufacturer:
- 3.2 Einstellung des Anzeigegerätes / Settings of the indication device: Speisespannung / Supply voltage: 5VDC  
Filtereinstellung / Filter settings: 1kHz  
Ziffernschritt / Numeral resolution: 0,25  
Schwankung / Fluctuation: -  
Anzeigeeinheit / Indication unit: Nm
- 3.3 Anschlusskabel / Input cable: intern
- 3.4 Einspannteile / Adaptors: Vierkant-Square 10mm (3/8") M
- 3.5 Justierwert Drehwinkel / adjustment angle value: vor Kalibrierung / before calibration: 1440  
nach Kalibrierung / after calibration: 1440
- 3.6 Justierwert Eigenverbiegung / adjustment self-deflexion: vor Kalibrierung / before calibration: -  
nach Kalibrierung / after calibration: -
- 4 Kalibrieranordnung / Calibration installation:**
- 4.1 Einbaulage / Mounting positions: horizontal
- 4.2 Definierte Nullmarke / Zero reference mark: keine
- 4.3 Hebelarmlänge / lever arm: kurz/short:- mm; lang/long:- mm
- 5 Umgebungsbedingungen / Ambient conditions:**
- 5.1 Kalibriertemperatur / Calibration temperature: vor Kalibrierung / before calibration: 22,1 °C  
nach Kalibrierung / after calibration: 22,2 °C
- 5.2 Temperaturgradient / Gradient of temperature: < 0,2 K/Stunde (während der Messung)
- 5.3 Relative Luftfeuchtigkeit / relative humidity: 39 %
- 5.4 Ort der Kalibrierung / Place of calibration: On Site Bosch Murrhardt
- 6 Zusätzliche Angaben / Additional information:**  
Berechnete Werte sind um die jeweilige Nullanzeige reduziert. Die Ergebnisse sind in der letzten Stelle gerundet.  
Calculated values are reduced by the respective zero signal. The calculated values are rounded in the last decimal.
- Beurteilung:** **OK**
- Nom.: 180° / WI MIN: 170° / WI MAX: 190°  
Standardabweichung: 0,1528 / Mittelwert (x-quer): 180,01° / MAX: 180,3° / MIN: 179,8°  
Cg: 4,36 / Cgk: 4,34

**7 Auswertung / Analysis****7.1 Kalibrierergebnis / Calibration results**

Vollständiges Kalibrierergebnis

Messpunkt Measuring point	Anzeigewert WI-KE Indication $\alpha_K$ in °	Anzeigewert Prüfling Indication $\bar{X}$ in °	Auflösung Resolution $r$ in °	Anzeige- abweichung Cal. Result $Y_i$ in °		
1	180,00	180,00	0,250	0,00		
2	180,00	180,00		0,00		
3	180,00	180,25		0,25		
4	180,00	180,00		0,00		
5	180,00	179,75		-0,25		
6	180,00	180,00		0,00		
7	180,00	180,00		0,00		
8	180,00	180,25		0,25		
9	180,00	180,00		0,00		
10	180,00	180,00		0,00		
11	180,00	180,00		0,00		
12	180,00	180,25		0,25		
13	180,00	180,00		0,00		
14	180,00	179,75		-0,25		
15	180,00	180,00		0,00		
16	180,00	180,00		0,00		
17	180,00	180,00		0,00		
18	180,00	180,25		0,25		
19	180,00	179,75		-0,25		
20	180,00	179,75		-0,25		
21	180,00	180,00		0,00		
22	180,00	180,00		0,00		
23	180,00	180,25		0,25		
24	180,00	180,00		0,00		
25	180,00	180,00		0,00		

Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor  $k = 2$  ergibt. Sie wurde gemäß DKD-3 ermittelt. Der Wert der Messgröße liegt mit einer Wahrscheinlichkeit von 95 % im zugeordneten Werteintervall.  
 Stated is the expanded uncertainty, which is obtained by multiplying the standard uncertainty by the coverage factor  $k = 2$ . This has been determined in accordance with Guideline DKD-3. The value of measurement corresponds to a coverage probability of 95%.

Der Startpunkt der Messreihen erfolgte von einer undefinierten Nullmarke (USP - undefinierter Startpunkt). Die Messreihen können nicht zu einer möglichen Korrekturkurve herangezogen werden.

**7.2 Darstellung der Ergebnisse in Diagrammen / Results in diagrams**