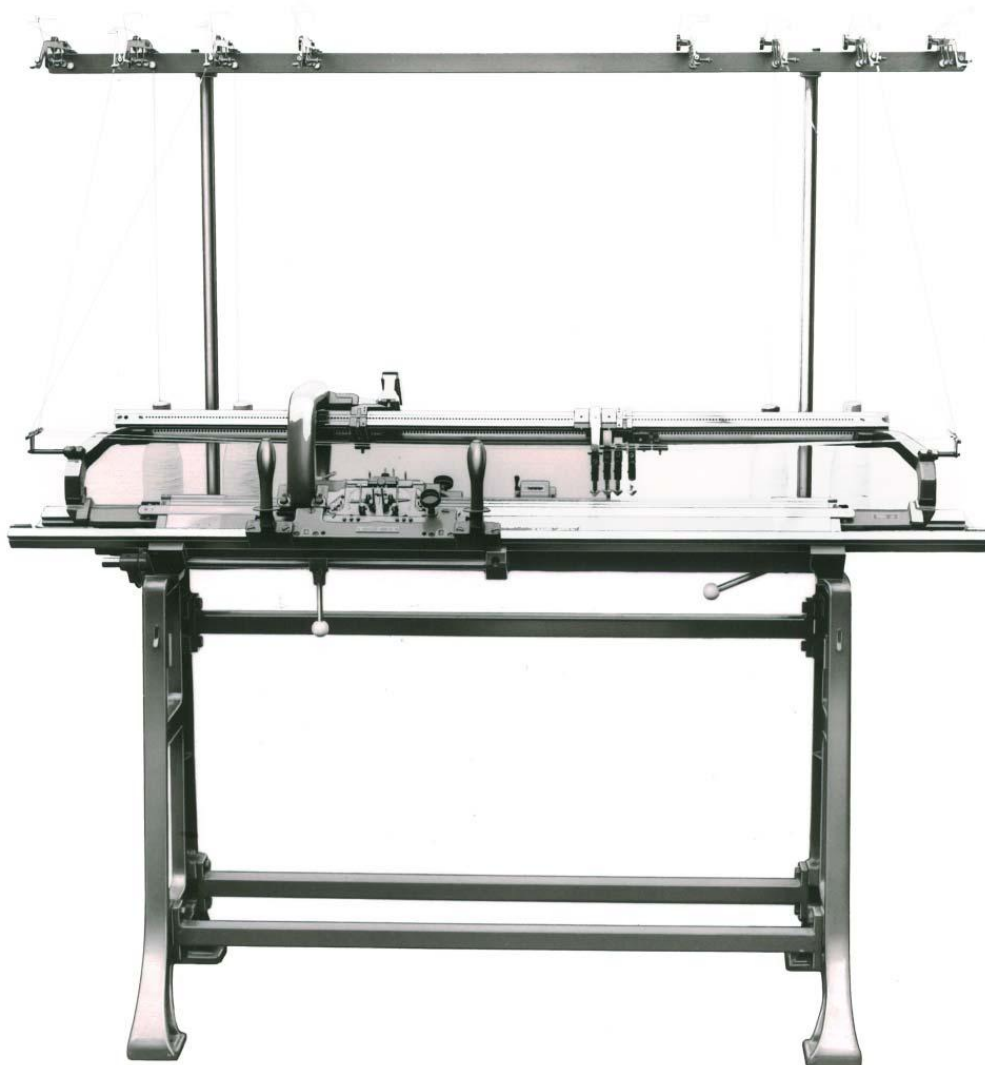


STOLL

KNIT AHEAD

Stoll Training Manual Flat Knitting Machine



Date: 17/01/2013

H.Stoll GmbH&Co. KG, Reutlingen

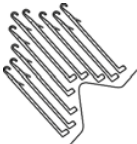
Content

1	Classification of Stitch Forming Machines	7
2	Terms and description of the machine.....	9
2.1	Terms: Gauge and nominal width	9
2.2	Description of the machine	11
2.3	Racking, needle classification in the racking	12
2.4	Yarn Tensioner	13
2.5	Sideview of the Needle Beds	14
2.6	Setting the Stitch Cams	15
3	Stitch Forming by Latch Needles.....	17
3.1	Elements of the Stitch	18
3.2	Binding Elements	19
4	Single Jersey / Double Jersey.....	21
4.1	Stitch Rows and Wales	22
5	Introduction to the SINTRAL Programming Language..	23
6	Designation of the Cams in the Carriage	25
6.1	Setting Example 1	26
6.2	Setting Example 2	27
6.3	Setting Example 3	28
6.4	Setting Example 4	29
6.5	Setting Example 5	30
6.6	Setting Example 6	31
6.7	Setting Example 7	32
6.8	Overview of Setting Options	33
7	Use of Stitch Cam Positions (NP)	35
8	Start with Comb	37
9	Overview of Basic Knitting Modes.....	39
9.1	Tubular / DJ / half cardigan	40
9.2	Double Half Cardigan / Full Cardigan	41
9.3	Double Full Cardigan / Half Milano / Colorful pattern	42
9.4	Knop / Tuck Pattern	44
9.5	Half Cardigan Racked	45
9.6	Full Cardigan Racked	46

9.7	Herringbone	47
9.8	Milano Rib	48
10	Classification of the knitting patterns.....	49
10.1	Group I: Basic structures	50
10.2	Knitting process: Start 2x1	51
10.3	Group II: Racking pattern	52
10.4	Procedure when transferring stitches	54
10.5	Group III: Missing needle pattern	55
10.6	Group IV: Combinations	56
10.7	Group V: Casting-off pattern	57
10.7.1	Group V: Stitch look I	58
10.7.2	Group V: Stitch look II	59
10.8	Use of draw thread when knitting	60
10.8.1	Transition with Draw Thread for 2x1 Start.....	62
10.8.2	Transition with Draw Thread for DJ Start and Tubular Start	65
10.9	Group VI: Cable	67
10.9.1	Stitch Line of 3x3< Cable	70
10.10	Group VII: Pointelle	71
10.10.1	Stitch Line of Pointelle	73
10.11	Group VIII: Fully Fashion	74
10.11.1	Stitch Ratio.....	76
10.11.2	Widening and Narrowing with Fully Fashion.....	77
10.11.3	Widening Procedure by the Example of Single Jersey fabric	79
10.11.4	Narrowing Procedure by the Example of Single Jersey.....	81
11	More Knitting Techniques.....	85
11.1	Knitting Technique: Jacquard	85
11.2	Knitting Technique: Intarsia	88
11.3	Knitting Technique: multi gauge	89
11.4	Knitting Technique: Knit and wear	90
11.5	Knitting Technique: Plating	91
11.6	Knitting Technique: Plush	92
11.7	Knitting Technique: Split	93
11.8	Knitting Technique: Applications	95
11.9	Knitting Technique: Gore Technique	96
12	Yarn	97
12.1	Natural Fibers	98
12.2	Synthetic Fibers	101
12.3	Classification of Yarns	103
12.4	Classification of Plied Yarns	104

12.5	Yarn Structure	106
12.6	Yarn Count	108
12.6.1	By Length = count.....	109
12.6.2	By Weight.....	112
12.6.3	Conversion Formulas.....	115
12.7	Yarn Table	116
12.8	Bobbin Types	118

1 Classification of Stitch Forming Machines

Knitting machines (Knitwear / Weft Knit)						Warp Knitting Machines (Warp Knit / Weft Knit)			
♦ individually driven needles 						♦ jointly driven needles 			
↙			↙			↓			
Single thread knitting machine (knitting machine) Thread feed crosswise _____			Warp knitting machine Warp thread feed lengthwise 			Single thread warp knitting machines (Weft knitting machine) Thread feed crosswise _____			
↙		↙		currently no construction type		↓			
Flat knitting machine 		Circular knitting machine 				Cotton machine 			
↙	↓	↙	↙			↓	↙		
SJ	DJ	LL	SJ			DJ	LL	Single Jersey	Double Jersey
	↓		↓			↓	↓		
				♦ Small circular knitting machine (Ø < 165 mm)		♦ flat weft knitting machine (Cotton system) ♦  : Production of – Cut goods – Fully Fashion			
				♦ Small circular knitting machine ♦ Large circular knitting machine (Ø > 165 mm) (rib and interlock machines)					
				♦ Small circular knitting machine  : Production of stockings, socks, technical items) ♦ Large circular knitting machine  : Production of cut goods (e.g. underwear, outer clothing)					
♦ Manual flat knitting machine ♦ Motor-driven flat knitting machine ♦ Computer-controlled flat knitting machine (CMS) ♦ Production of: – Cut goods – semi-shaped fabric (with tight starts) – Fully Fashion									



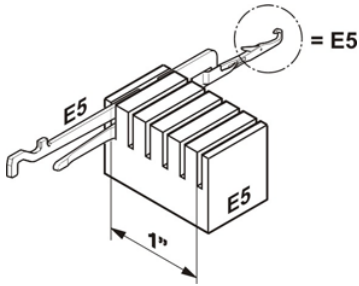
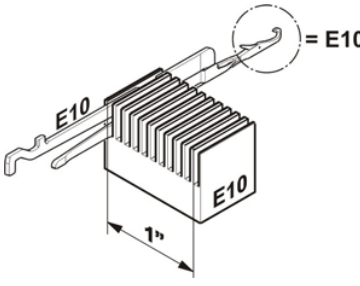
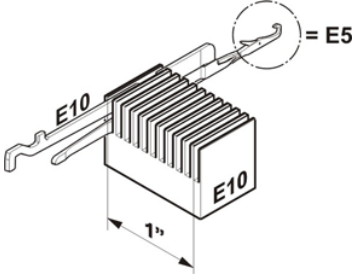
In the classification the construction types of the warp machines are not considered in detail.

2 Terms and description of the machine

2.1 Terms: Gauge and nominal width

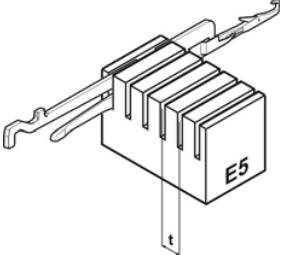
Terms

- ♦ Gauge

Terms	Meaning
Gauge E	Number of needles per 1 English inch (= 2,54 cm) in one needle bed.
	Needle bed gauge Number of needle bed tricks (= needles) per 1 English inch (= 25,4 mm)
	Needle hook gauge = needle hook size in E
	 : For the 'standard' gauges the needle bed gauge = needle hook gauge.
Examples	
Gauge E 5	Gauge E 10
	
Gauge E 5.2 (Multi-Gauge gauge)	

2 Terms and description of the machine

♦ Gauge

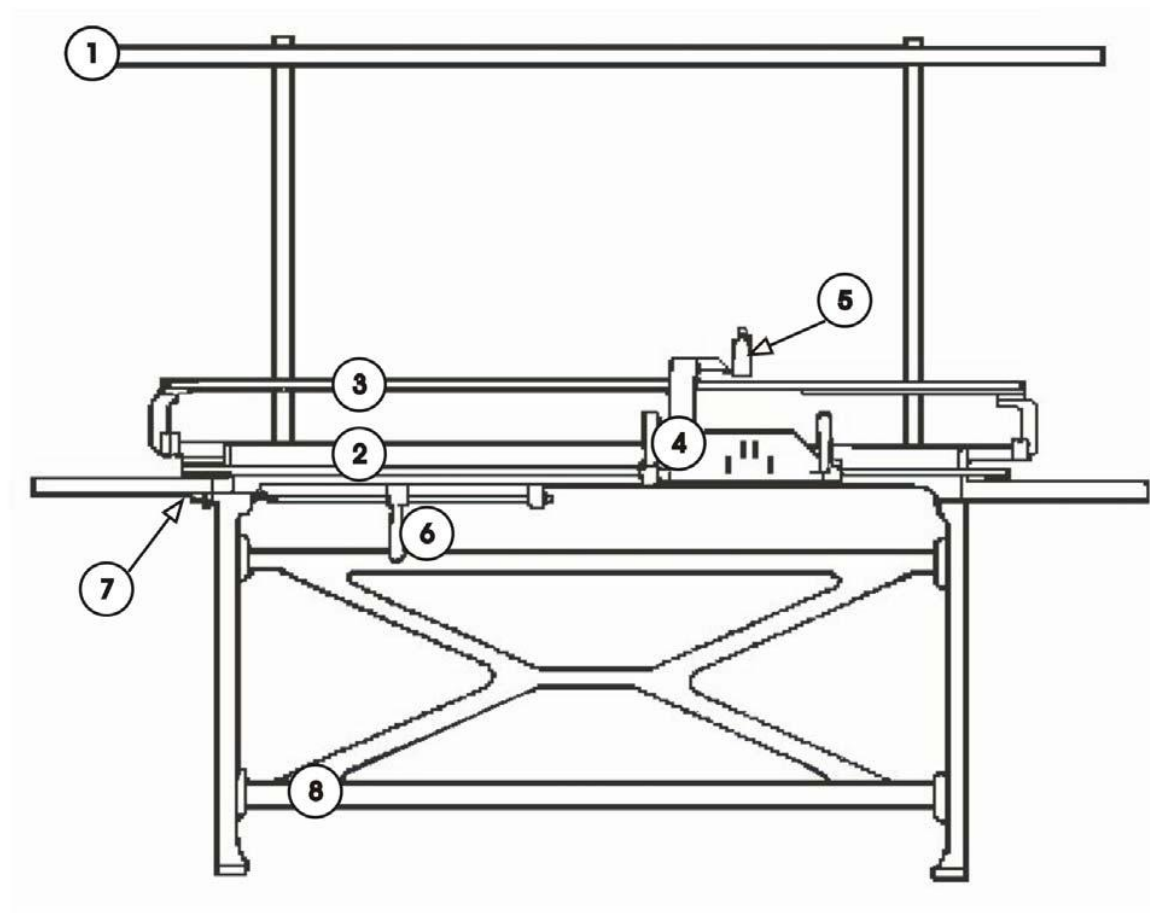
Terms	Meaning
Gauge t	Distance [mm] between two needle tricks (grooves) Calculation with the formula: $t = 25,4 \text{ mm} / E$
	

♦ Nominal width

Terms	Meaning
Nominal width	= Total width of the needle bed (= working width) in inches Examples for nominal width at Stoll: ♦ 45" ♦ 50" ♦ 72" ♦ 84" ♦ 96"

2.2 Description of the machine

Elements of the manual knitting machine:



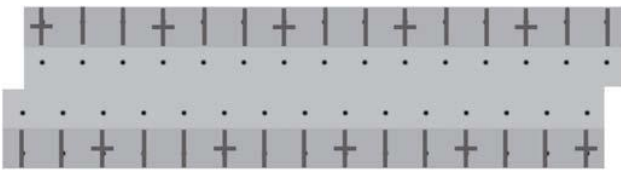
No.	Label
1	
2	
3	
4	
5	
6	
7	
8	

2.3 Racking, needle classification in the racking

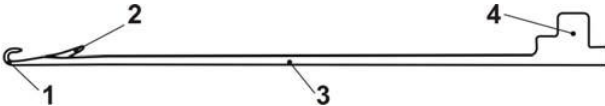
I. Explanation to racking:

Term	Meaning
Racking V	Move the rear needle bed to another position.
V0	Racking home position 0 – 1 – 2 – 3 – 4 – 5 – 6
V>1	Racking by one needle to the right
V<1	Racking one needle to the left

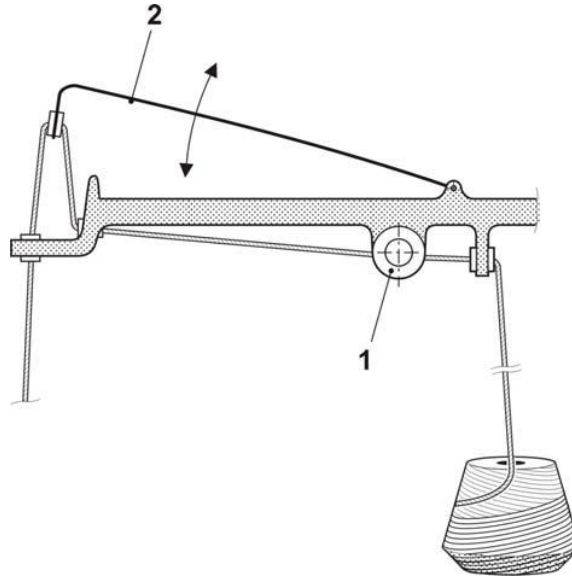
II. Needle classification in the racking home position V0:

	
Symbols	Meaning
+	
•	

III. Elements of the needle:

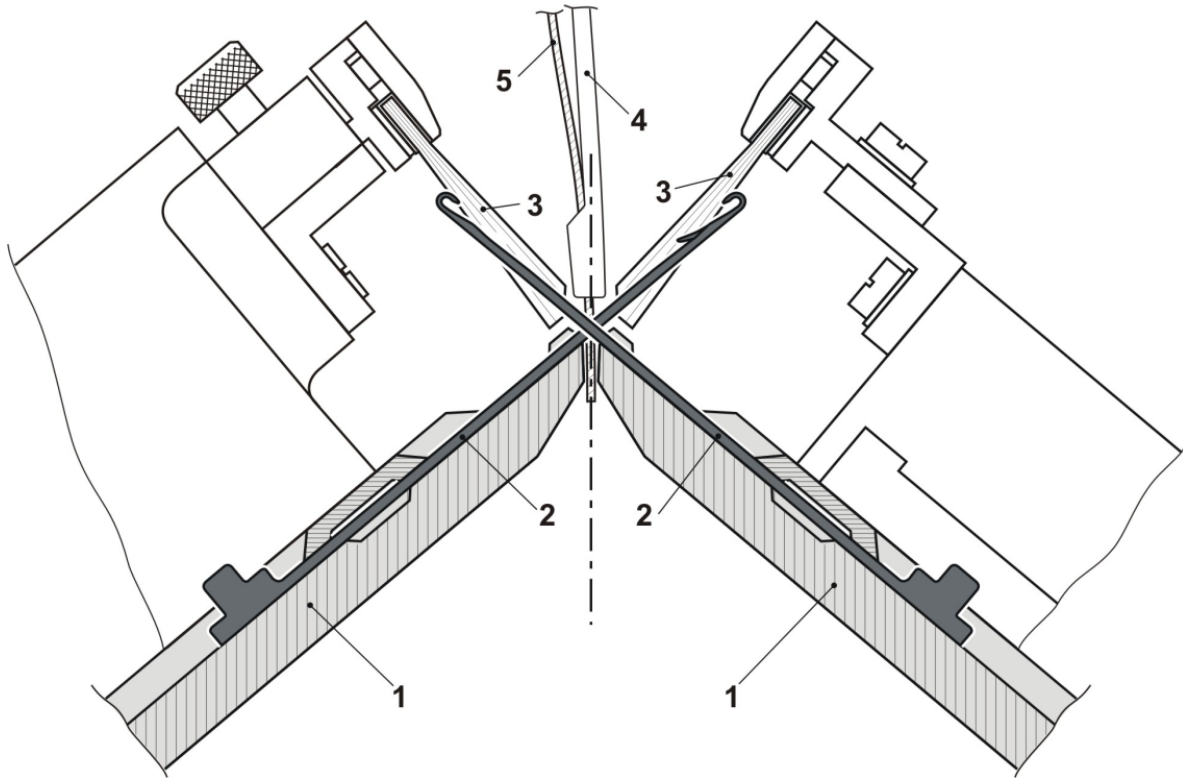
	
No.	Label
1	
2	
3	
4	♦ ♦

2.4 Yarn Tensioner



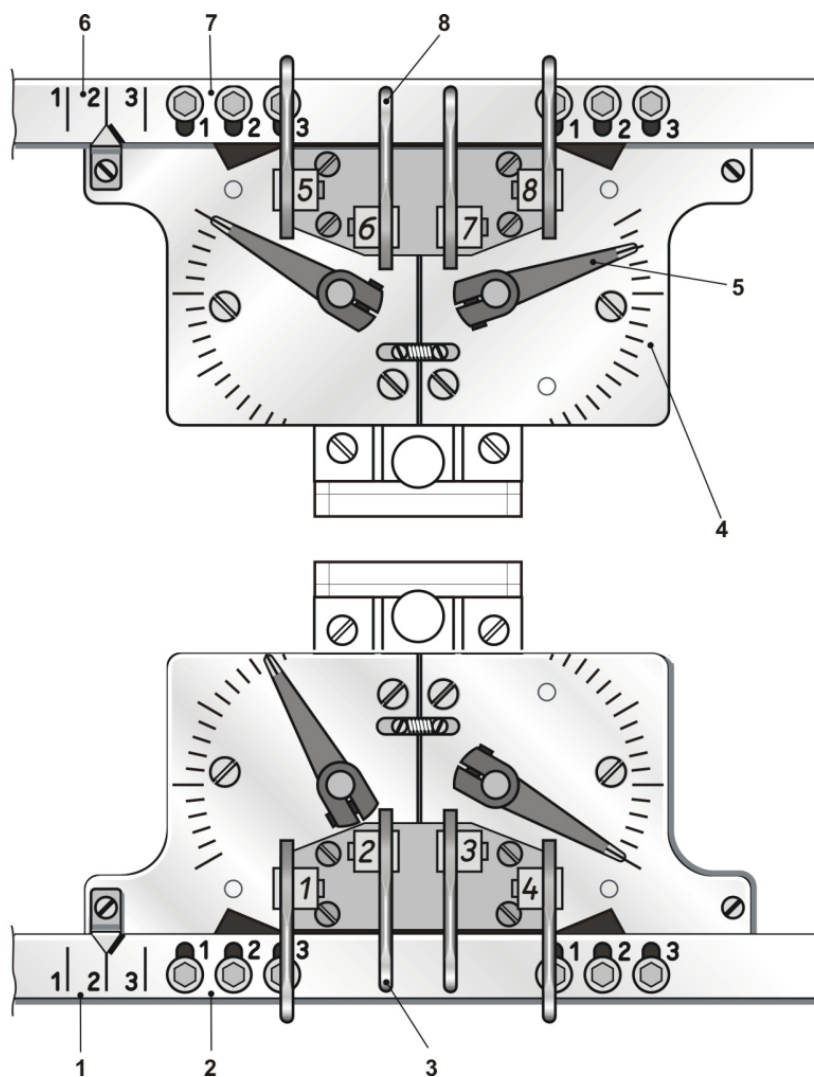
No.	Label
1	
2	

2.5 Sideview of the Needle Beds



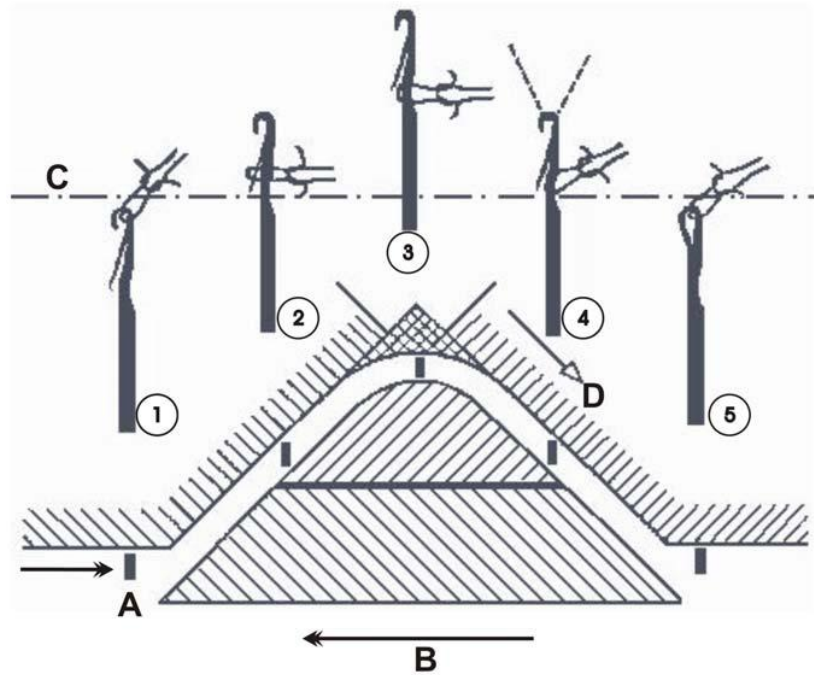
No.	Meaning
1	
2	
3	
4	 : For opening the latches.
5	

2.6 Setting the Stitch Cams



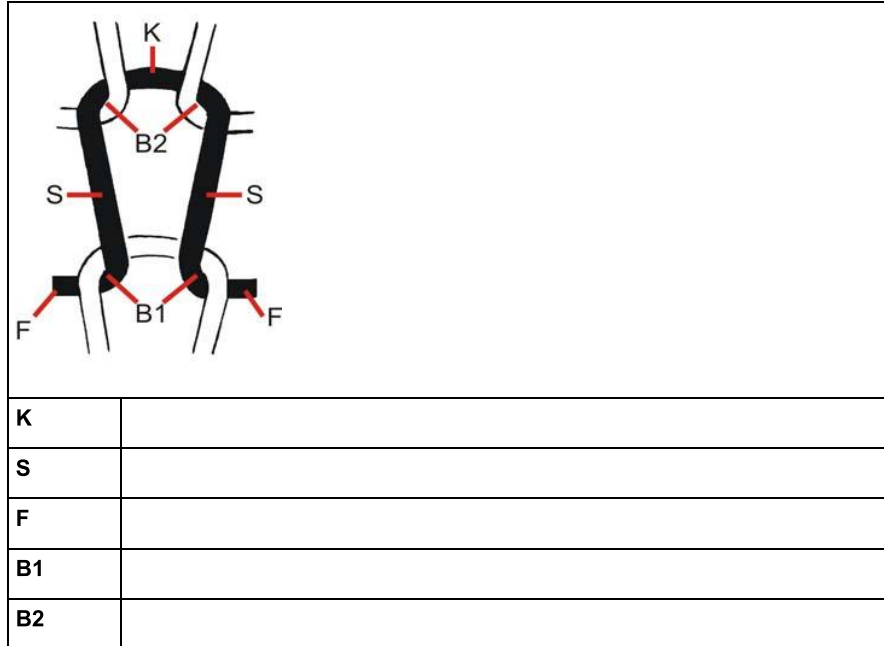
No.	Meaning
1	Nadelsenker (stitch cam) Positions for the front needle bed (NP)
2	Set screw for adjusting the stitch cam positions of the front needle bed
3	Lever (1-4) for the cams for the front needle bed
4	Value scale for the stitch cam positions
5	Indicator for the stitch tension
6	Nadelsenker Positionen (stitch cam positions) for the rear needle bed (NP)
7	Set screw for adjusting the stitch cam positions of the rear needle bed
8	Lever (5-8) for the cams of the rear needle bed

3 Stitch Forming by Latch Needles

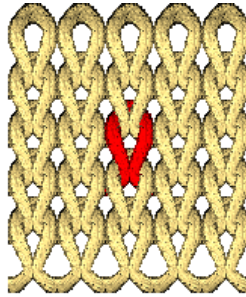
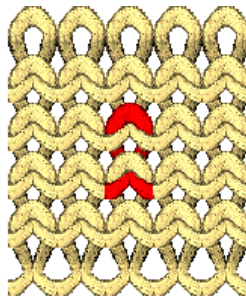
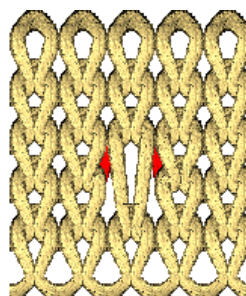
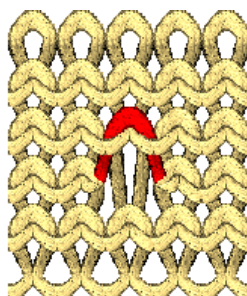
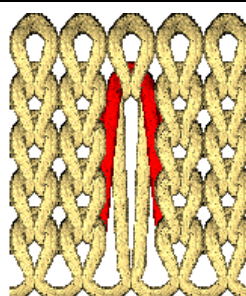
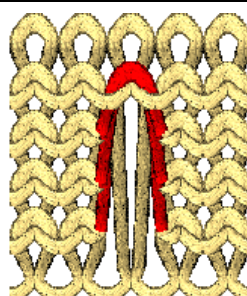


No.	Meaning
A	
B	
C	
D	
1	
2	
3	
4	
5	

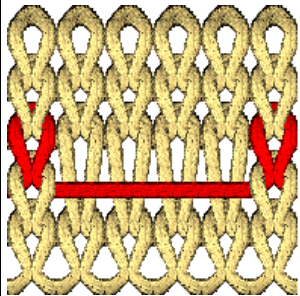
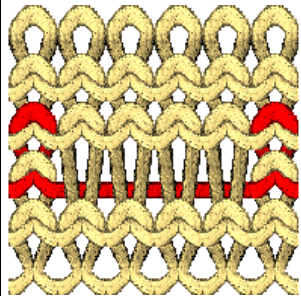
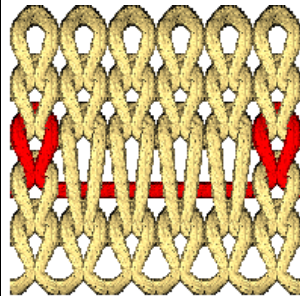
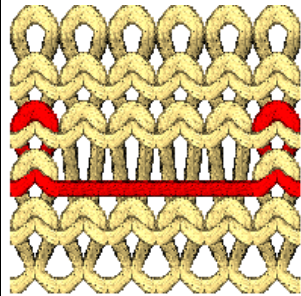
3.1 Elements of the Stitch



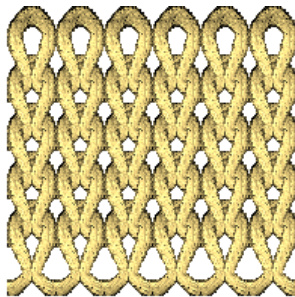
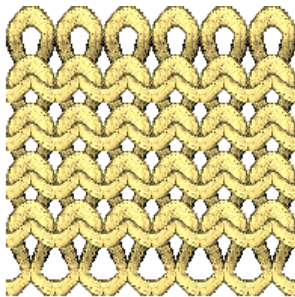
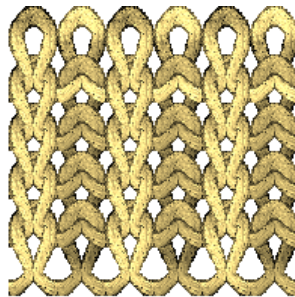
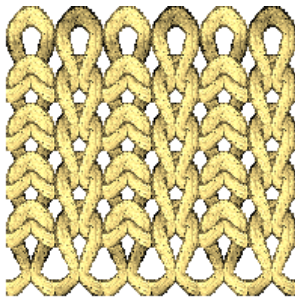
3.2 Binding Elements

Jersey stitch		
	Technologically right fabric side	
		
Reverse jersey		
	Technologically reverse fabric side	
		
Tuck		
	Technologically right fabric side	Technologically reverse fabric side
Tuck on a needle in the front needle bed		
3x tuck on a needle in the front needle bed		

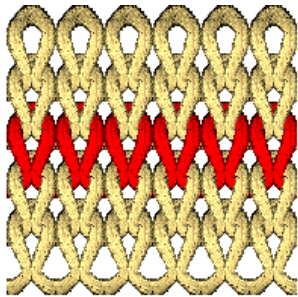
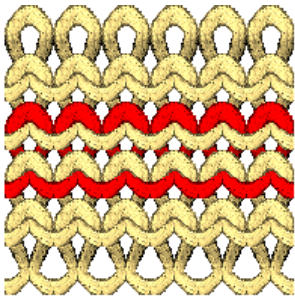
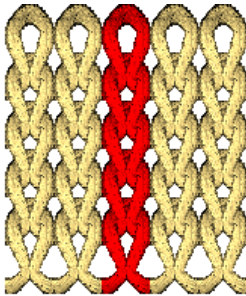
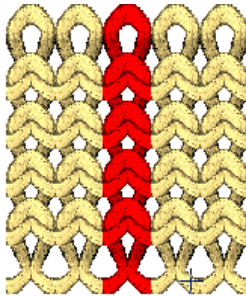
3 Stitch Forming by Latch Needles

Float		
	Technologically right fabric side	Technologically reverse fabric side
Front float		
Rear float		

4 Single Jersey / Double Jersey

Single jersey fabric (RL)		
	Technologically right fabric side	Technologically reverse fabric side
Single-bed fabric = single jersey fabric		
All needle knit fabric (DJ)		
Double-bed fabric = Double jersey fabric (without elongation)		
Double-bed fabric = Double jersey fabric (with elongation)		

4.1 Stitch Rows and Wales

Stitch row		
	Technologically right fabric side	Technologically reverse fabric side
		
Wale		
		

5 Introduction to the SINTRAL Programming Language

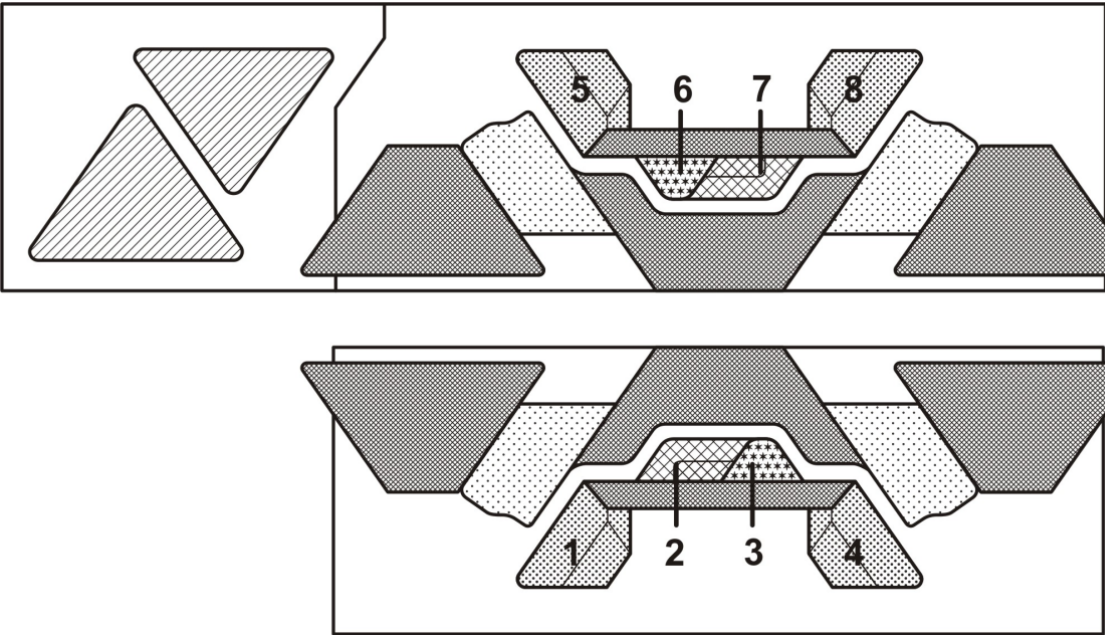
I. Knitting specifications

Knitting specifications for the carriage stroke from right to left	
Sintral command	<< S: R - R; Y: 2; NP 1 - 2 S1
Knitting specifications for the carriage stroke from left to right	
Sintral command	>> S: FR - R; Y: 2; NP 2 - 2 S1

II. Commands in Sintral:

Sintral command	Meaning
<<	Carriage direction to the left
>>	Carriage direction to the right
<>	Carriage direction optional
S:....-...;	Knitting specification
R	All needles knit a stitch
F	All needles knit a tuck
0	No knitting
FR	High but needles knit stitch Low but needles knit tuck
RH	High but needles knit stitch Low butt needles do not knit
FH	High but needles knit tuck Low butt needles do not knit
-	Symbol for splitting the specification between front and rear needle bed
;	Symbol for ending a Sintral command
Y:....;	Yarn Carrier Setting
RBEG	Cycle start
REND	Cycle end
REP x n	Repetition start with repetition factor
REPEND	Repetition end

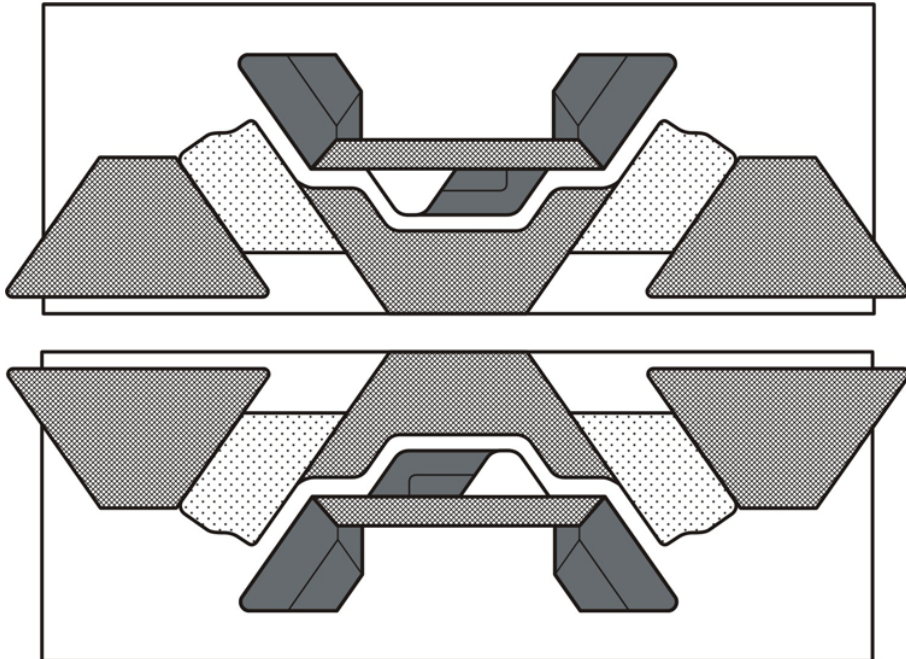
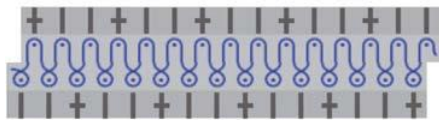
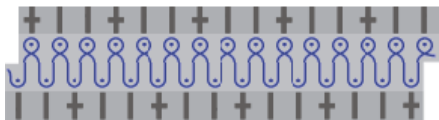
6 Designation of the Cams in the Carriage

Rear cam plate		
		
Front cam plate		
Designation of the cams		
	Fixed cams	
	Stitch cams (needle sinker)	
	Tuck cams	Lever 1 + 4 + 5 + 6
	Raising cams	Lever 2 + 7
	Raising cams	Lever 3 + 6
	Casting-off cams	

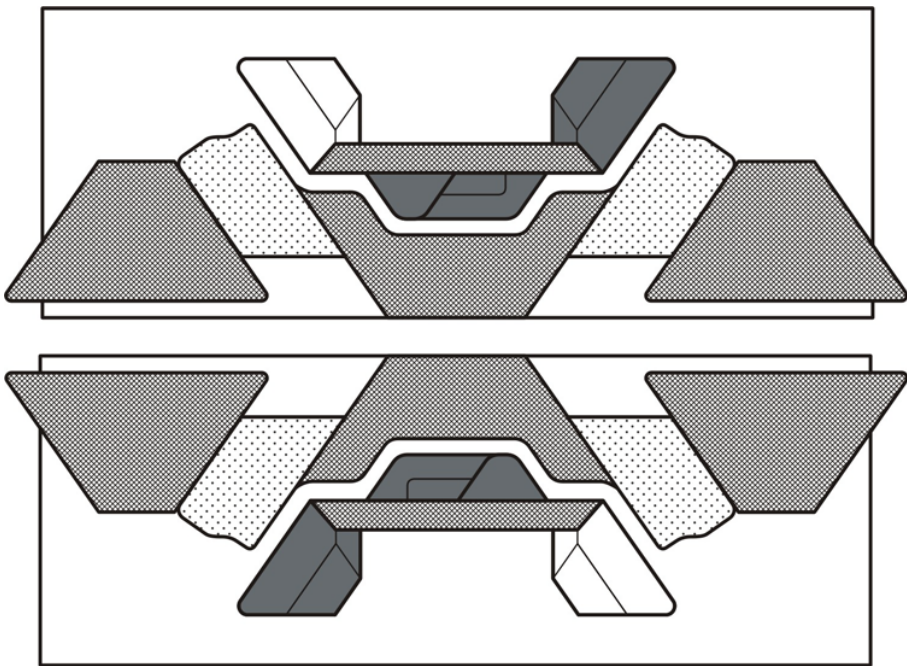
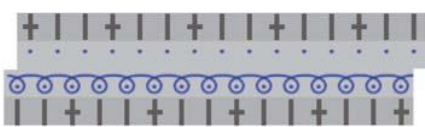
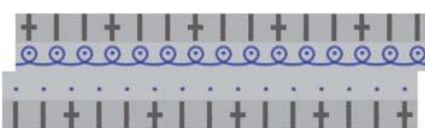
6.1 Setting Example 1

Legend										
	1	Down lever (on)								
	1/2	Halfway up lever								
	0	Up lever (off)								
Stitch line	Sintral command	Lever position								
	< > S: R – R;	<table><tr><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td></tr></table>	1	1	1	1	1	1	1	1
1	1									
1	1									
1	1									
1	1									

6.2 Setting Example 2

						
Legend						
	1	Down lever (on)				
	1/2	Halfway up lever				
	0	Up lever (off)				
Stitch line	Sintrial command	Lever position				
	<< S: R – F;	<table><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td></tr></table>	1	1	0	1
1	1					
0	1					
	>> S: F – R;	<table><tr><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td></tr></table>	1	0	1	1
1	0					
1	1					

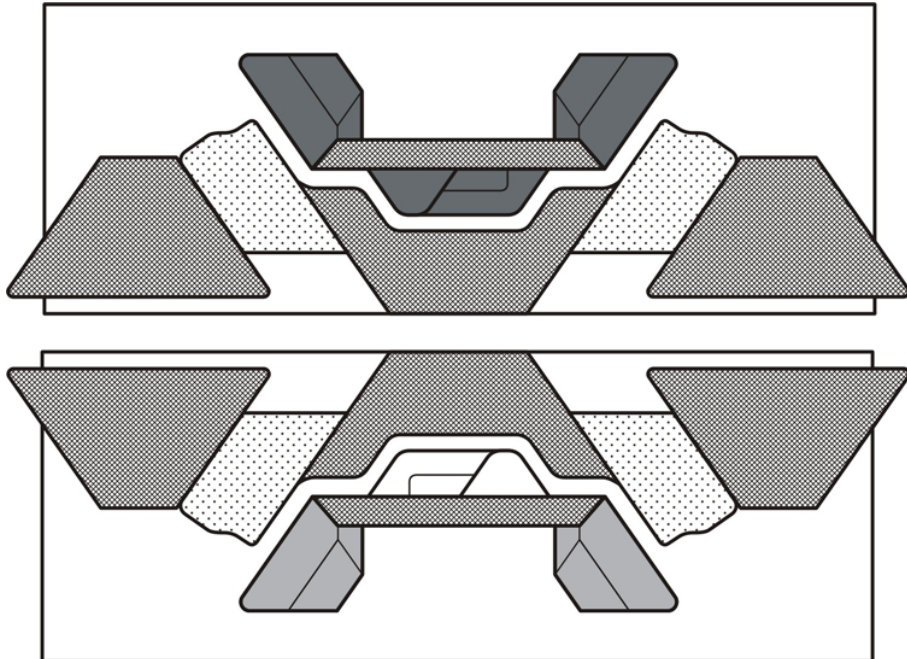
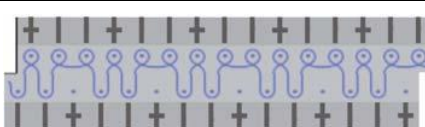
6.3 Setting Example 3

		
Legend		
	1	Down lever (on)
	1/2	Halfway up lever
	0	Up lever (off)
Stitch line	Sintral command	Lever position
	<< S: R – 0;	0 1 1 1
	>> S: 0 – R;	1 1 1 0

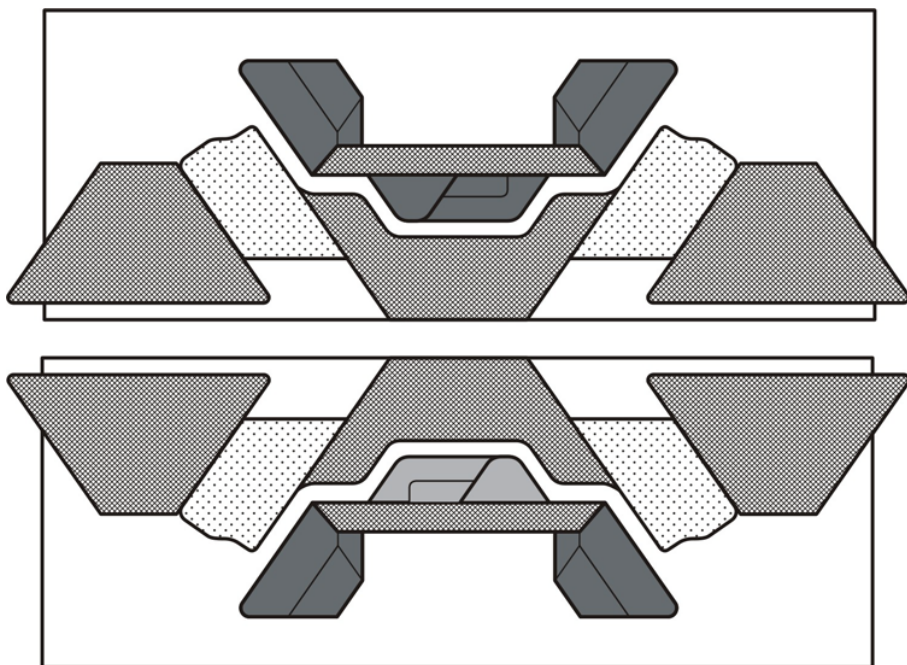
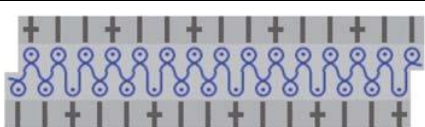
6.4 Setting Example 4

Legend										
	1	Down lever (on)								
	1/2	Halfway up lever								
	0	Up lever (off)								
Stitch line	Sintral command	Lever position								
	$\leftrightarrow$ S: RH – RH;	<table><tr><td> 1/2 </td><td> 1/2 </td></tr><tr><td> 1 </td><td> 1 </td></tr><tr><td> 1 </td><td> 1 </td></tr><tr><td> 1/2 </td><td> 1/2 </td></tr></table>	1/2	1/2	1	1	1	1	1/2	1/2
1/2	1/2									
1	1									
1	1									
1/2	1/2									

6.5 Setting Example 5

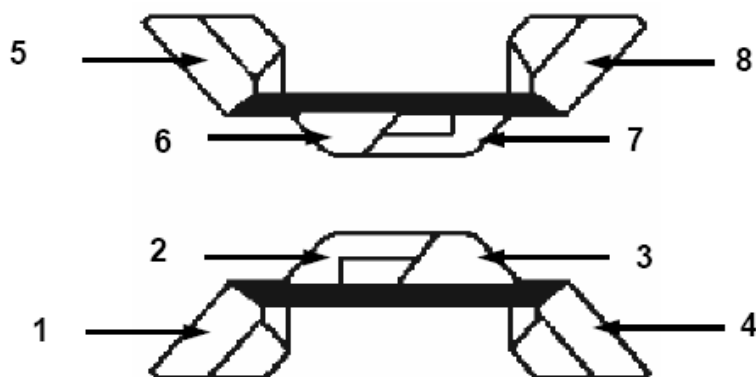
										
Legend										
	1	Down lever (on)								
	1/2	Halfway up lever								
	0	Up lever (off)								
Stitch line	Sintral command	Lever position								
	<> S: FH – R;	<table><tr><td> 1 </td><td> 1 </td></tr><tr><td> 1 </td><td> 1 </td></tr><tr><td> 0 </td><td> 0 </td></tr><tr><td> 1/2 </td><td> 1/2 </td></tr></table>	1	1	1	1	0	0	1/2	1/2
1	1									
1	1									
0	0									
1/2	1/2									

6.7 Setting Example 7

										
Legend										
	1	Down lever (on)								
	1/2	Halfway up lever								
	0	Up lever (off)								
Stitch line	Sintral command	Lever position								
	<> S: FR – R;	<table><tr><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td></tr><tr><td>1/2</td><td>1/2</td></tr><tr><td>1</td><td>1</td></tr></table>	1	1	1	1	1/2	1/2	1	1
1	1									
1	1									
1/2	1/2									
1	1									

6.8 Overview of Setting Options

Cam box view:



i

Caution!

Cams (lever) 2 + 7 cannot be put out of action separately since they are connected with the cams 3 + 6. This means: If the levers 2 + 7 are up (out of action) the levers 3 + 6 are automatically up as well.

Lever positions for different knitting specifications

Carriage direction	Cam instruction	Lever position	
<	S: R – R;	Lever 1+2 and 5+6 down	
>		Lever 3+4 and 7+8 down	
<	S: 0 – R;	Lever 1 up	
>		Lever 4 up	
<	S: R – 0;	Lever 5 up	
>		Lever 8 up	
<	S: F – R;	Lever 2 up	1: up to 4 carriage strokes = 4 tuck loops on needle
>		Lever 3 up	
<	S. R – F;	Lever 6 up	
>		Lever 7 up	
<	S: RH – R;	Lever 1 halfway up	
>		Lever 4 halfway up	
<	S: R – RH;	Lever 5 halfway up	
>		Lever 8 halfway up	
<	S: FR – R;	Lever 2 halfway up	1: up to 4 carriage strokes = 4 tuck loops on low butt needle
>		Lever 3 halfway up	
<	S: R – FR;	Lever 6 halfway up	
>		Lever 7 halfway up	
<	S: R – FH;	Lever 5 halfway up + lever 6 up	1: up to 4 carriage strokes = 4 tuck loops on high butt needle
>		Lever 8 halfway up + lever 7 up	
<	S: FH – R;	Lever 1 halfway up + lever 2 up	
>		Lever 4 halfway up + lever 3 up	

7 Use of Stitch Cam Positions (NP)

Stitch cam position 1 (NP1): tight

Knitting mode	
Double Jersey	All needles knit a stitch
F	All needles knit a tuck
Net row	Knitting on empty needles

Stitch cam position 2 (NP2): medium

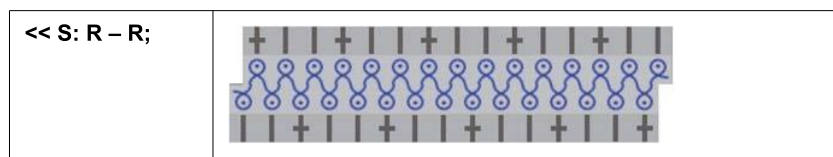
Knitting mode	
Combinations of double jersey, tuck and single jersey	
All racking patterns	
Net row	Start with comb

Stitch cam position 3 (NP3): loose

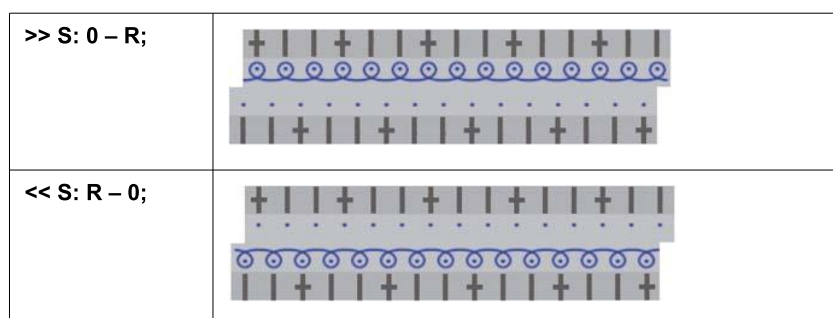
Knitting mode	
Single jersey rows	Not all the needles knit
Tubular	

8 Start with Comb

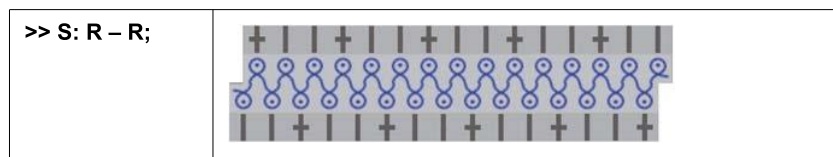
- 1) Stop carriage on the right at the reversion.
- 2) Select the desired yarn carrier (e.g. yarn carrier 1).
- 3) Activate all cams (= all levers 1-8 down) and set stitch cam position **NP** 2 - 2.
- 4) Move the carriage from right to left.



- 5) Then the comb up between the needle beds.
- 6) Close the comb hook with wire and hang the weights.
- 7) Change the stitch cam position **NP** to 3 – 3 and knit one tubular course:



- 8) Change the stitch cam position **NP** to 1 – 1.
- 9) Activate all cams (= all levers 1-8 down).
- 10) Move the carriage from left to right.

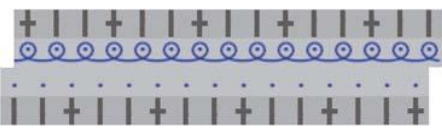
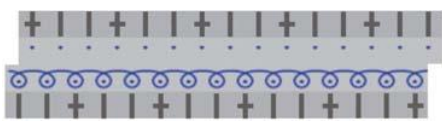
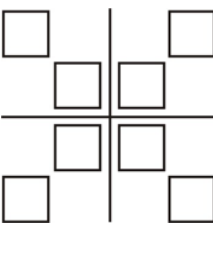
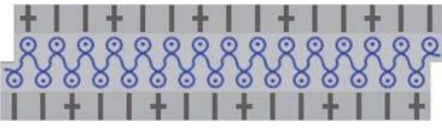
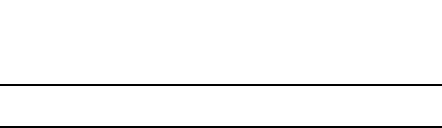
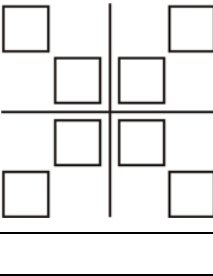
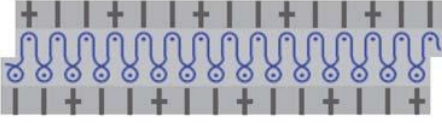
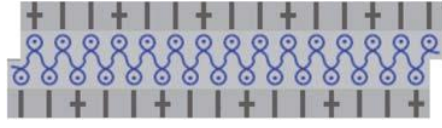
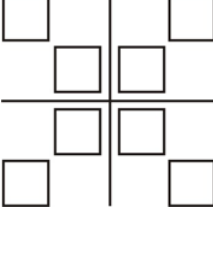


- 11) Carry on with the desired basic structure.

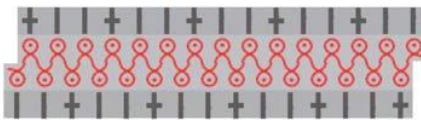
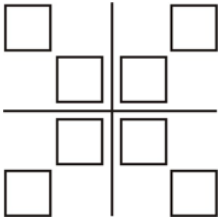
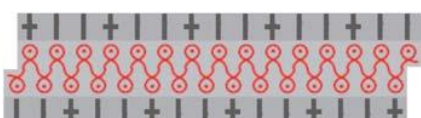
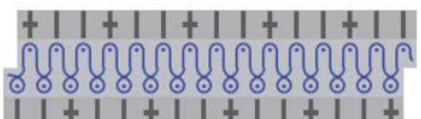
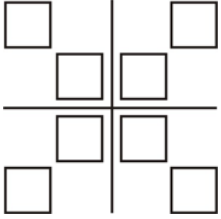
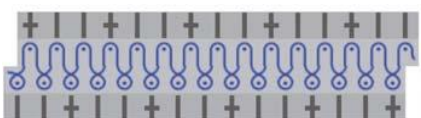
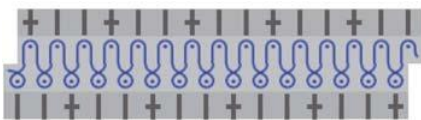
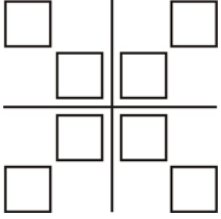
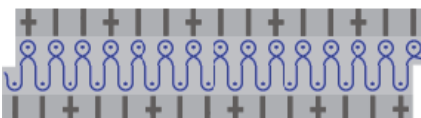
9 Overview of Basic Knitting Modes

No.	Name of the basic structure
1	Tubular
2	Double Jersey
3	Half Cardigan
4	Double Half Cardigan
5	Full Cardigan
6	Double Full Cardigan
7	Half Milano / Half Tubular
8	Colorful pattern / Buntmuster
9	Knop
10	Fancy Stitch / Tuck Pattern
11	Half Cardigan Racked (with racking)
12	Full Cardigan Racked (with racking)
13	Herringbone
14	Milano Rib

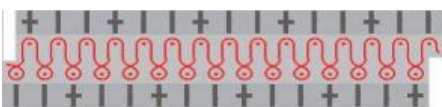
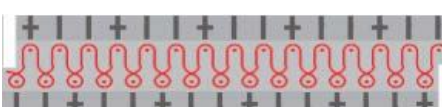
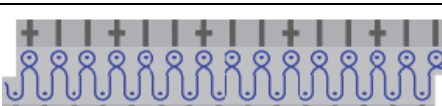
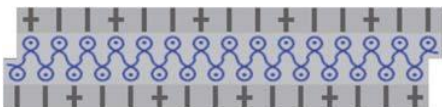
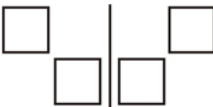
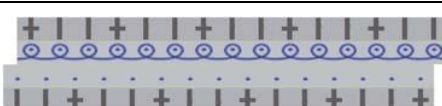
9.1 Tubular / DJ / half cardigan

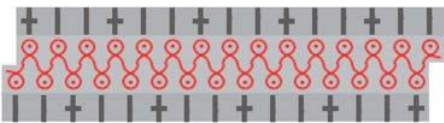
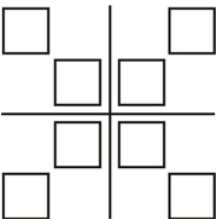
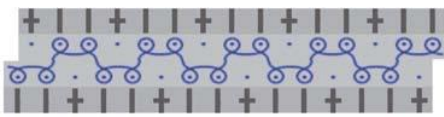
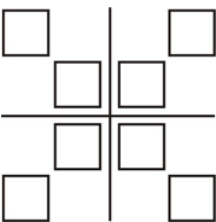
Tubular					
<< S: 0 – R;	Y:1;	NP 3 - 3			
>> S: R – 0;					
Double Jersey (DJ)					
<> S: R – R;	Y:1;	NP 1 - 1			
Half Cardigan					
<< S: R – F;	Y:1;	NP 2 - 1			
>> S: R – R;					

9.2 Double Half Cardigan / Full Cardigan

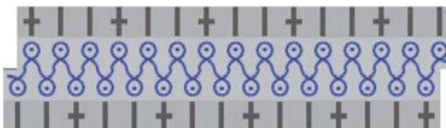
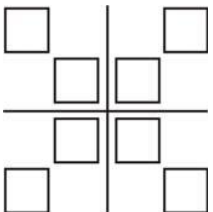
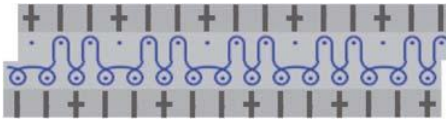
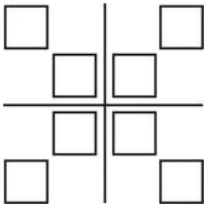
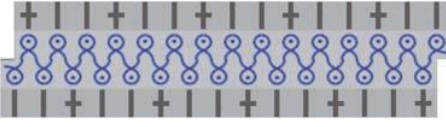
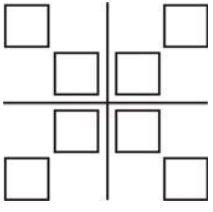
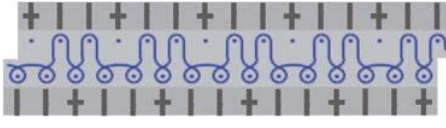
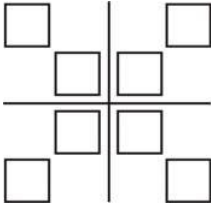
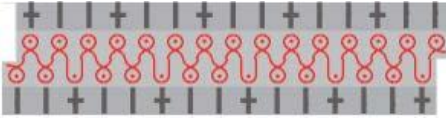
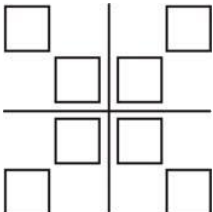
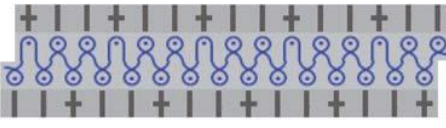
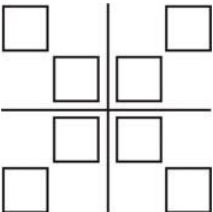
Double Half Cardigan				
<< S: R – R;	Y:1;	NP 2 - 1		
>> S: R – R;				
<< S: R – F;	Y:2;			
>> S: R – F;				
Full Cardigan / tuck				
<< S: R – F;	Y:1;	NP 1 -1		
>> S: F – R;				

9.3 Double Full Cardigan / Half Milano / Colorful pattern

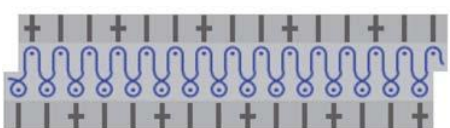
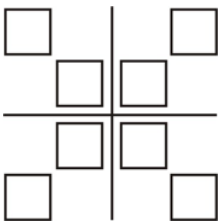
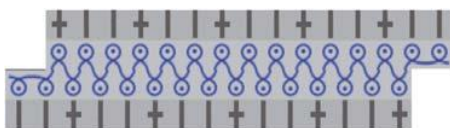
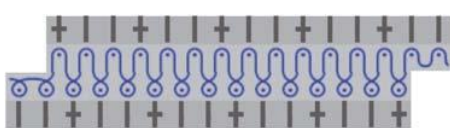
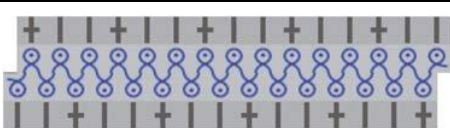
Double Full Cardigan					
<< S: R – F;	Y:1;	NP 1 - 1			
>> S: R – F;					
<< S: F – R;	Y:2;				
>> S: F – R;					
Half Milano / Half Tubular					
<< S: R – R;	Y:1;	NP 2 - 2			
>> S: 0 – R;					

Colorful pattern				
REP x 4 <> S: R – R; REPEND	Y:1;	NP 2 - 2		
REP x 4 <> S: RH – RH; REPEND	Y:2;			

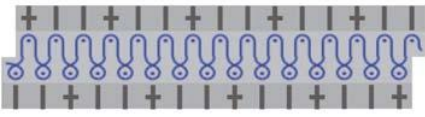
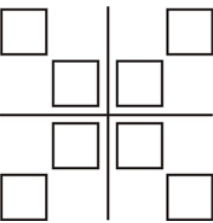
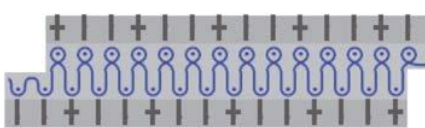
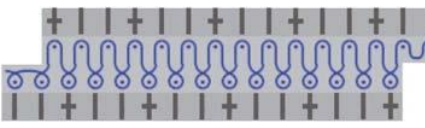
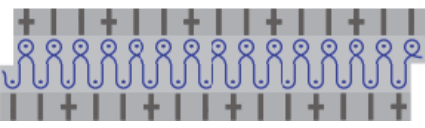
9.4 Knop / Tuck Pattern

Knop				
REP x 2 <> S: R – R; REPEND	Y:1;	NP 1 - 1		
REP x 3 <> S: R - FH; REPEND				
REP x 2 <> S: R – R; REPEND				
REP x 3 <> S: R - FH; REPEND				
Tuck pattern				
REP x 4 <> S: FR – R; REPEND	Y:1;	NP 1 -1		
REP x 4 <> S: R – FR; REPEND	Y:2;			

9.5 Half Cardigan Racked

Half Cardigan Racked				
<< S: R – F;	Y:1;	NP 2 - 2		
Racking 0 – 1 (V>1)			Move the racking lever from position 0 to 1	
>> S: R – R;				
<< S: R – F;				
Racking 1 – 0 (V0)			Move the racking lever from position 1 to 0	
>> S: R – R;				

9.6 Full Cardigan Racked

Full Cardigan Racked				
<< S: R – F;	Y:1;	NP 2 - 2		
Racking 0 – 1 (V>1)			Move the racking lever from position 0 to 1	
>> S: F – R;				
<< S: R – F;				
Racking 1 – 0 (V0)			Move the racking lever from position 1 to 0	
>> S: F – R;				

9.7 Herringbone

Herringbone						
REP x 12						
<< S: R – F;	Y:1;	NP 2 - 2				
Racking 0 – 1 (V>1)			Move the racking lever from position 0 to 1			
>> S: F – R;						
Racking 1 – 0 (V0)			Move the racking lever from position 1 to 0			
REPEND						
<< S: R – F;						
Racking 0 – 1 (V>1)			Move the racking lever from position 0 to 1			
>> S: F – R;						
REP x 12						
<< S: R – F;						
Racking 1 – 0 (V0)			Move the racking lever from position 1 to 0			
>> S: F – R;						
Racking 0 – 1 (V>1)			Move the racking lever from position 0 to 1			
REPEND						
<< S: R – F;						
Racking 1 – 0 (V0)			Move the racking lever from position 1 to 0			
>> S: F – R;						

9.8 Milano Rib

Milano Rib			
<< S: 0 – R;	Y:1;	NP 2 - 2	
>> S: R – 0;			
<< S: R – R;			
>> S: R – 0;			
<< S: 0 – R;			
>> S: R – R;			

10 Classification of the knitting patterns

Group	Contents
I	All patterns (basic structures) without special characteristics.
II	Racking pattern without and with missing needle
III	Missing needle pattern
IV	Pattern combinations
V	Casting-off pattern
VI	Cable
VII	Pointelle
VIII	Fully Fashion

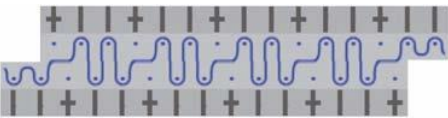
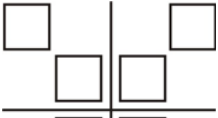
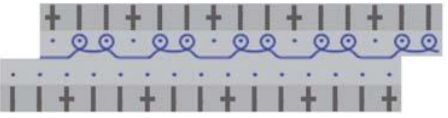
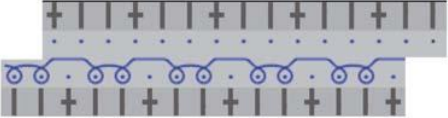
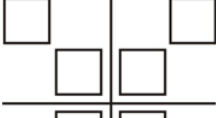
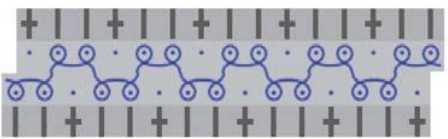
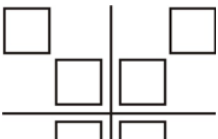
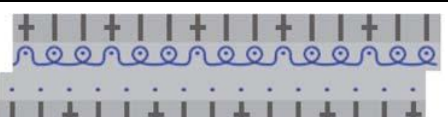
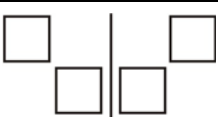
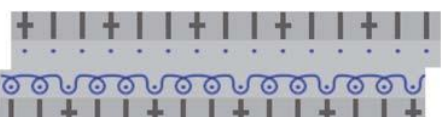
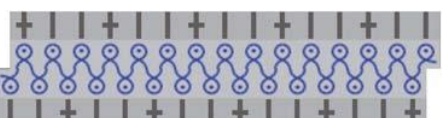
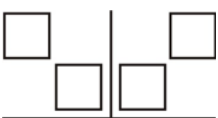
10.1 Group I: Basic structures

Basic structures	♦ Double Jersey ♦ Tubular ♦ Half Milano ♦ Milano Rib
Structure with tuck	♦ Half cardigan / double half cardigan ♦ Full cardigan / double full cardigan
Structures using different needle types	♦ Colorful pattern ♦ Knop ♦ Fancy stitch



The basic structures can be knitted with plain color or with color change.

10.2 Knitting process: Start 2x1

Before starting the knitting rack the needle bed into the racking position 1 (V>1)!				
<< S: RH – RH; (Net row)	Y:1;	NP 2 - 2		
>> S: 0 – RH;				
<< S: RH – 0;				
Racking 1 - 0 (V0)			Move the racking lever from position 1 to 0	
RBEG x ? <> S: RH – RH; REND				
>> S: 0 – R;				
<< S: R – 0;				
>> S: R – R;				

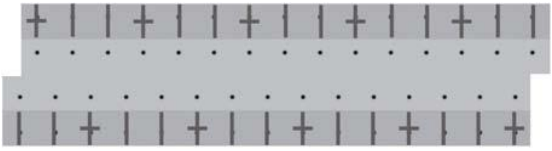
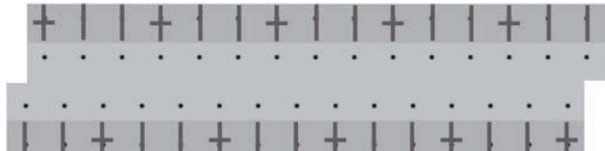
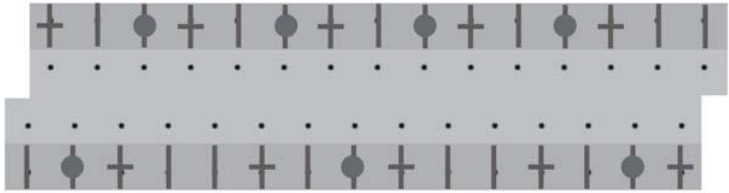
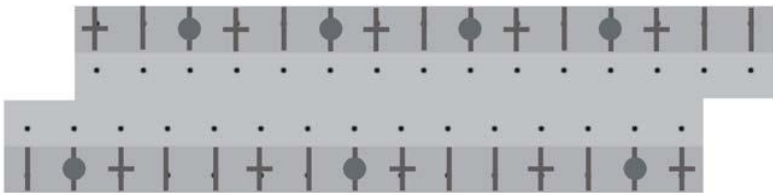
10.3 Group II: Racking pattern

Without missing needle:

Front tuck - Rear stitch	Front stitch - Rear tuck
Rack the rear needle bed V>1	
Result:	
Racked stitch	Racked tuck
♦	♦
♦	
♦	

Course-related racking	Row-related racking
Meaning:	
Racking after every 2 stitch rows.	Racking after every stitch row.
=>	=>
Related basic structures:	
♦	
♦	

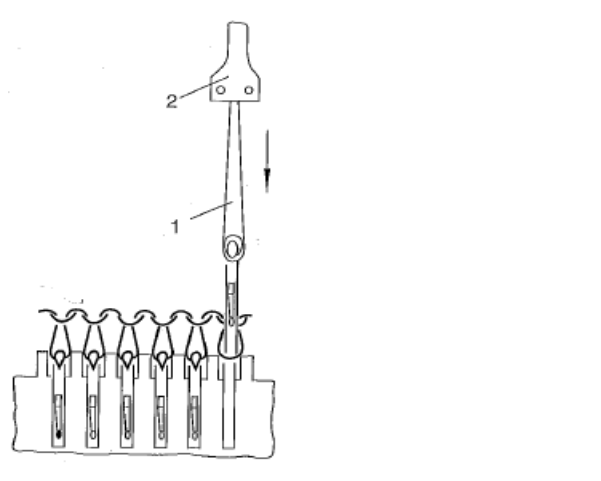
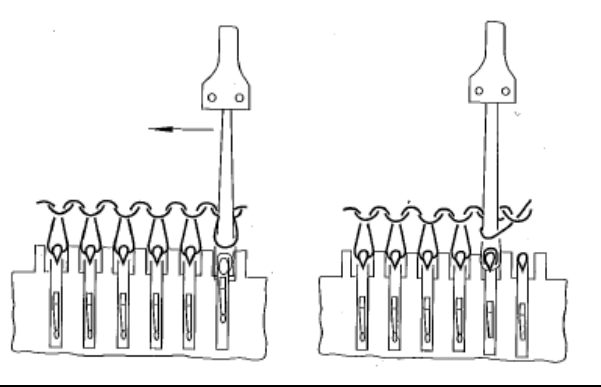
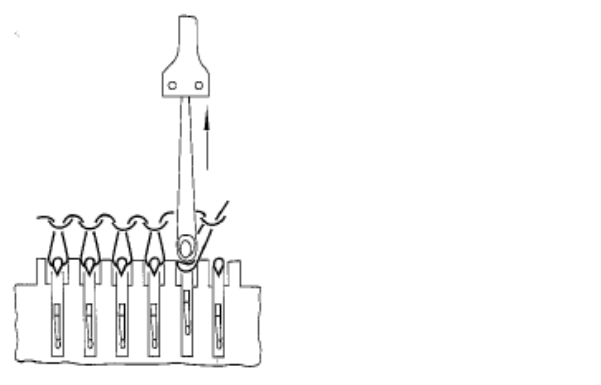
With missing needle:

	
No connection to the rear needle bed	Connection to the rear needle bed
Result:	
=> => Wales (MS)	=> => Wales (MS)
♦ If a wale is to zigzag ♦ If a wale is to run straight	
Example with missing needles:	
	
	
Rack the rear needle bed by one position V>1	
	

10.4 Procedure when transferring stitches



Transfer = stitches are brought from one needle to another.

Sequence when transferring stitches	
	1st step: 1. Hook the eyed transfer needle (1) (inserted in the transfer needle (2) in the needle hook of the needle to be transferred (with stitch)). 2. Move the eyed transfer needle upward until the stitch is located behind the latch. 3. Move the eyed transfer needle downward until the stitch is located on the guide needle. 4. Unhook the eyed transfer needle from the needle hook.
	2nd step: 1. Move the eyed transfer needle with the stitch carefully to the desired position. 2. Hook the eyed transfer needle in the needle hook of the desired needle.
	3rd step: 1. Move the needle upward until the stitch of the eyed transfer needle slides into the needle hook of the needle hooked-in. 2. Unhook the eyed transfer needle from the needle hook. 3. i: At the new position of the transferred stitch there are 2 stitches in needle hook now (double-stitch).

10.5 Group III: Missing needle pattern

Needle classification	Used needle types	
Needle classification with only one needle type	◆  = High butt needle ◆  = missing needle	i: From a knitting technique point of view there is no difference between high and low butt needles.
Needle classification with two needle types	◆  = High butt needle ◆  = Low butt needle ◆  = missing needle	i: From a knitting technique point of view there is a difference between high and low butt needles.

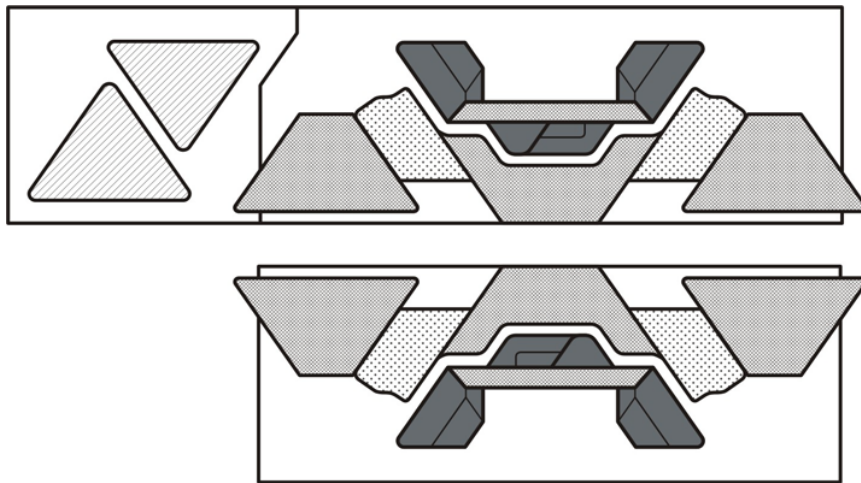
10.6 Group IV: Combinations

Pattern description
Pattern consisting (combined) of different knitting modes: ♦ Basic structures ♦ Drop needle ♦ Racking effect ♦ etc.

10.7 Group V: Casting-off pattern

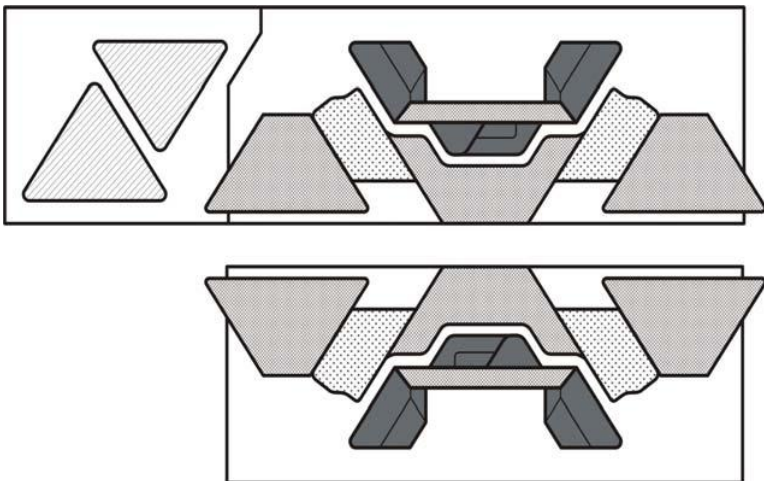
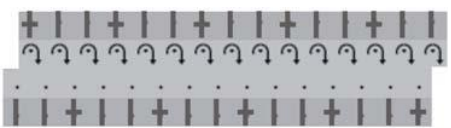
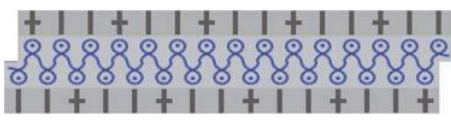
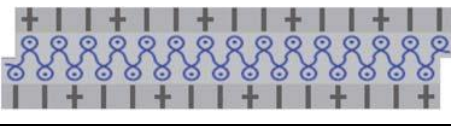
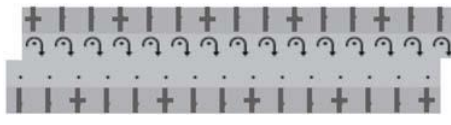
i

The casting-off technique is performed via the casting-off cam in the rear needle bed on manual knitting machines.
Condition: The basic fabric must be in the front needle bed.
(Single jersey fabric).

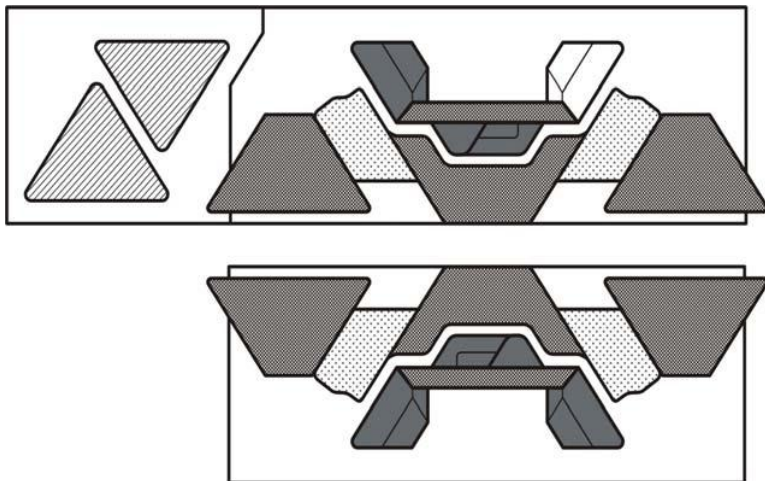
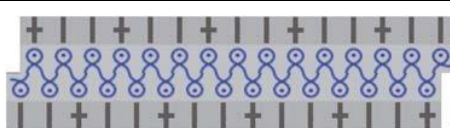
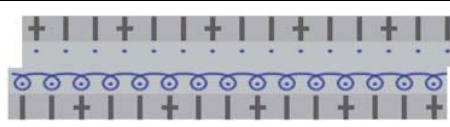
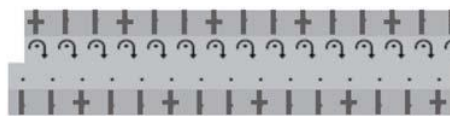


	Casting-off cams	
	0	Standard position: Casting-off cams are up i : Needles do not run through the casting-off cam
	1	Casting-off cams are down i : High butt / low butt needles run through the casting-off cam
	1/2	Casting-off cams are halfway up i : ♦ High butt needles run through the casting-off cam ♦ Low butt needles do not run through the casting-off cam
Working procedure:		The casting-off cams raise the needles until stitch formation, whereby no yarn feeding takes place. i : Knitting without yarn = casting-off.

10.7.1 Group V: Stitch look I

Stitch look in the basic fabric (single jersey fabric)					
1: After the start all stitches in the rear needle bed are transferred to the front!!!					
					
	<< S: R – R;	Y:1;	NP 3 - 3		
					
	>> S: R – R;				
					

10.7.2 Group V: Stitch look II

Stitch look in the basic fabric (single jersey fabric)					
i : After the start all stitches in the rear needle bed are transferred to the front!!!					
					
	<< S: R – R;	Y:1;	NP 3 - 3		
					
	>> S: R – 0;				
					

10.8 Use of draw thread when knitting

Use of draw thread:



A thread that is worked-in between two fabrics, which has to be easily removable afterwards.

Application examples:

- ♦ Small pieces with reduced knitting height, e.g. collars, borders
- ♦ Use of knitting machines without comb take-down

i: Fabrics are knitted together ('in warp') due to the fabric take-down and the following finishing process 'damping'

- ♦ Use of knitting machines with comb take-down
 - For the starting rows up to the net row of the fabric only

Draw thread types:

- ♦ Thread with very high tear resistance:
 - Polyamide draw thread
 - Polyester draw thread

i: The thread will be pulled out after finishing

- ♦ Melting separation thread
 - Material properties of the draw thread depend on the desired melting temperature

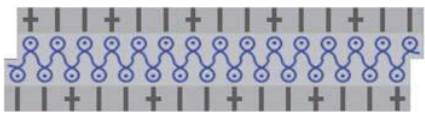
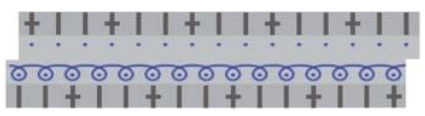
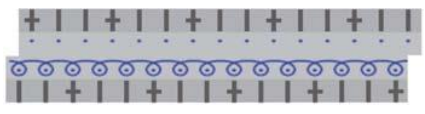
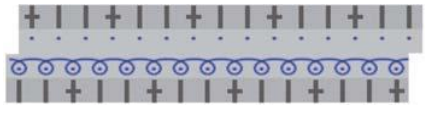
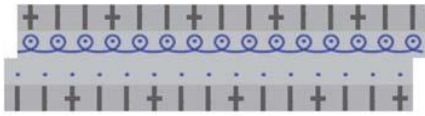
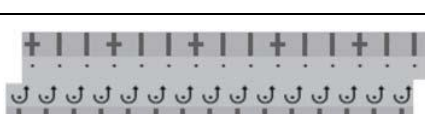
i: The thread is dissolved when damping the fabrics. Leaves residues.

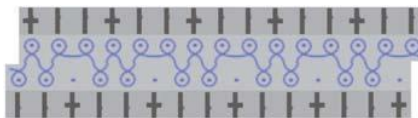
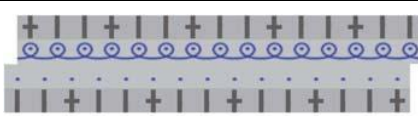
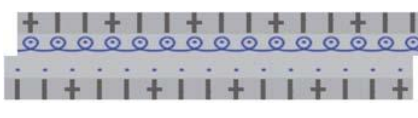
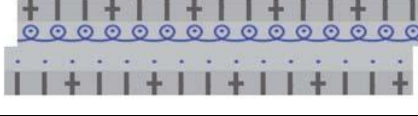
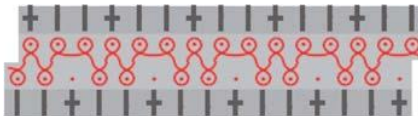
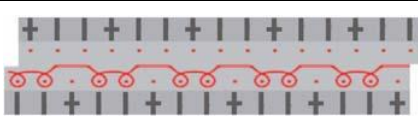
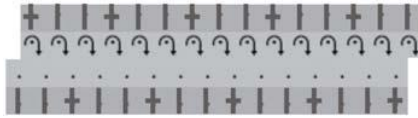
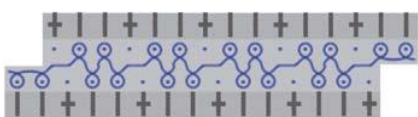
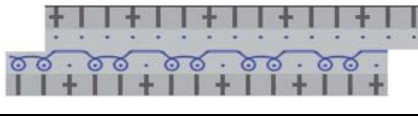
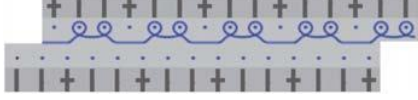
- ♦ Metal draw thread
 - Use in the area of technical textiles (e.g. Kevlar, glass fiber)

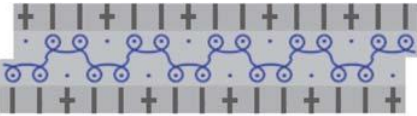
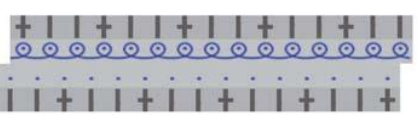
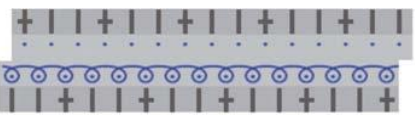
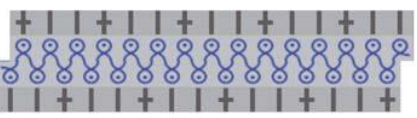
Pattern examples for the manual flat knitting machine

Graphic presentation	No.	Knitting sequence
Perlfang / Half Cardigan 3 Pressmuster / Fancy Stitch 3 Volfang / Full Cardigan 3 7 6 5 4 2 1	1	Knitting start ♦ Start with Comb
	2	2x1 start rib
	3	Specified basic structures
	4	Transition with draw thread for ♦ Tubular start ♦ DJ start
	5	Tubular start
	6	Transition with draw thread for the 2x1 start rib
	7	2x1 start rib

10.8.1 Transition with Draw Thread for 2x1 Start

Last row of the previous fabric				
>> S: R – R;	Y:1;	NP 2 - 2		
<< S: R – 0;		NP 3 - 2		Protective rows in the front needle bed i : After casting-off the stitches this prevents ladders
>> S: R – 0;				
<< S: R – 0;				
>> S: 0 – R;		NP 2 - 2		
<< S: R – 0;	Y:0;	NP 2 - 2		Casting-off stitches in the front needle bed => Needles are empty i : Knitting without yarn carrier => casting-off.
>> S: R – 0;				

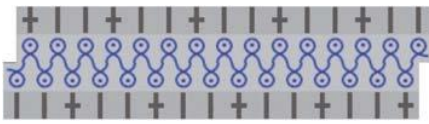
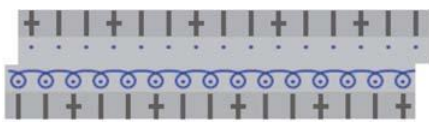
<< S: RH – R;	Y:1;	NP 1 - 1		
>> S: 0 – R;		NP 1 - 3		Protective rows in the rear needle bed i: After casting-off the stitches this prevents ladders
<< S: 0 – R;				
>> S: 0 – R;				
Knitting-in the draw thread				
<< S: RH – R;	Y:3;	NP 2 - 2		
>> S: RH – 0;				
<< S: 0 – R;	Y:0;			Casting-off the protective rows + draw thread in the rear needle bed => Needles are empty
>> S: 0 – R;				
Set racking from position 0 to 1 (V>1)				
<< S: RH – RH;	Y:1:	NP 1 - 1		i: Net row of the new fabric
>> S: RH - 0;		NP 2 - 2		
<< S: 0 – RH;				

Set racking from position 1 to 0 (V0)				
REP x 20 <> S: RH – RH; REPEND	Y:1;	NP 2 - 2		
>> S: 0 – R;				
<< S: R – 0;				
>> S: R – R;				

10.8.2 Transition with Draw Thread for DJ Start and Tubular Start

Last row of the previous fabric				
>> S: R – R;	Y:1;	NP 2 - 2		
<< S: R – 0;		NP 3 - 2		Protective rows in the front needle bed i: After casting-off the stitches this prevents ladders
>> S: R – 0;				
<< S: R – 0;				
>> S: 0 – R;		NP 2 - 2		
Knitting-in the draw thread				
<< S: R – R;	Y:3;	NP 2 - 2		
>> S: 0 – R;				
<< S: R – 0;	Y:0;			Casting-off the protective rows + draw thread in the front needle bed => Needles are empty i: Knitting without yarn carrier => casting-off.
>> S: R - 0;				

10 Classification of the knitting patterns

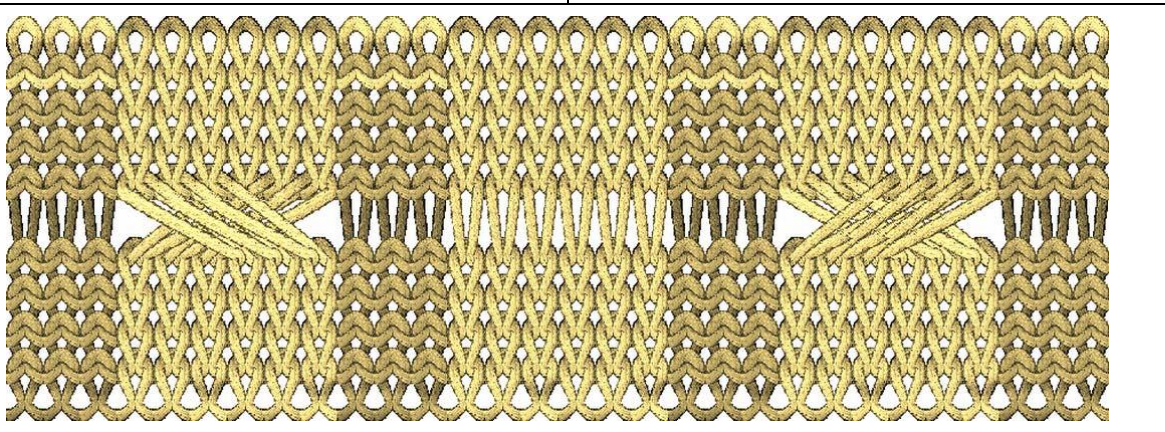
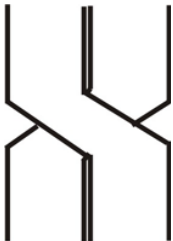
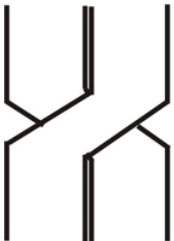
<< S: R – R;	Y:1:	NP 1 - 1		i: Net row of the new fabric
>> S: R - 0;		NP 2 - 2		
Carry on in the cycle of the desired start!				

10.9 Group VI: Cable

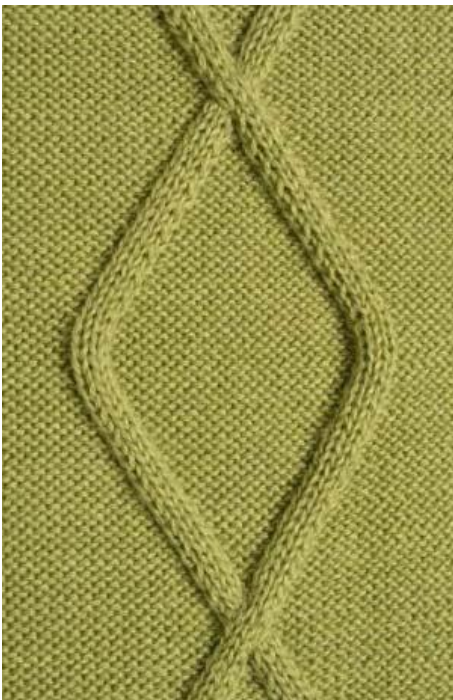
i

Knitting technique with cable stitch:

Cable stitch cross-overs are achieved by transferring stitches.

Cable stitch cross-over to the left (crossed to the left)	Cable stitch cross-over to the right (crossed to the right)
	
	
Designation of cables	
old	♦ $2 \times 3 <$ (cross-over to the left) ♦ $2 \times 3 >$ (cross-over to the right) ♦ i: The total width of the cable are 6 stitches ($2 \times 3 = 6$), where 3 stitches are crossed over 3 stitches.
new	♦ $3 \times 3 <$ ♦ $3 \times 3 >$ ♦ i: The total width of the cable are 6 stitches ($3+3 = 6$), where 3 stitches are crossed over 3 stitches.

10 Classification of the knitting patterns

Cable examples	
Cables 3x3< and 3x3> 	Cable 3x3< with rib 
2x2> cable 	2x2> cable with spread needle 
3x3 cable with intarsia 	3x1 Aran 

Cable examples	
Cable + Aran structure 	Aran structure 
3x3 cable with spread needle 	2x1 Aran 

10.9.1 Stitch Line of 3x3< Cable

Last row 2x1 start			
>> S: RH – RH;	Y:1;	NP2-2	
Transfer of the stitches according to the needle classification and take-down the needles			
RBEG			
REP x 7 <> S: R – R; REPEND		NP3-3	
In the area of the cable: Activate needle 1, 3, 5 manually			
>> S: R – R;		NP3-3	
In the area of the cable: Needle 1, 3, 5 manually cast-off the tuck			
Transferring the stitches in the cable stitch cross-over area			
REP x 4 <> S: R – R; REPEND		NP3-3	
REND			

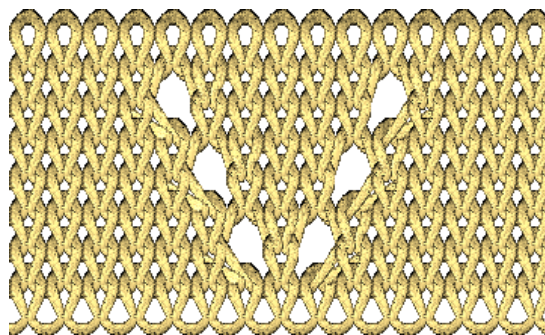
10.10 Group VII: Pointelle

i

Knitting technique pointelle:

Transferring individual stitches, needles will be free, which then are picked-up again through the subsequent knitting (= tuck). At this position results a hole = pointelle

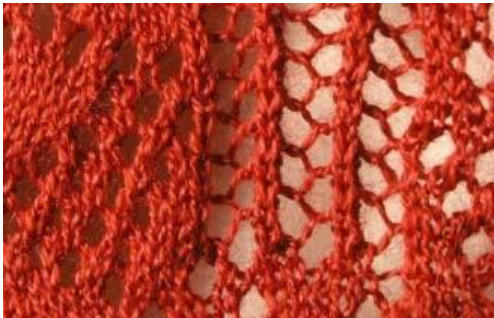
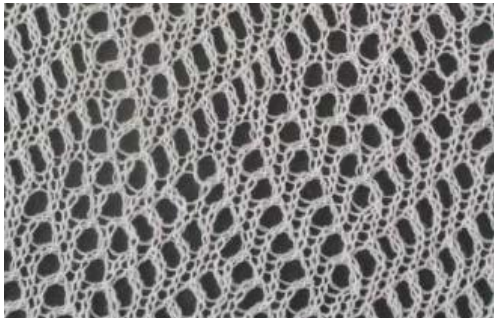
Fabric view of Pointelle



Stitches will be transferred to the left
=> on the left referring to the emptied needle
(=pointelle) results a double stitch

Stitches will be transferred to the right
=> on the right referring to the emptied needle (= pointelle)
results a double stitch

10 Classification of the knitting patterns

Examples of Pointelle	
	
	
	
	

10.10.1 Stitch Line of Pointelle

Stitch Line of Pointelle in knitting direction				
7	REPx2 <> S: R – 0; REPEND			
6	Transfer of stitches at the desired position (=pointelle)			
5	REPx2 <> S: R – 0; REPEND			
4	Transfer of stitches at the desired position (=pointelle)			
3	REPx2 <> S: R – 0; REPEND			
2	Transfer of stitches at the desired position (=pointelle)			
1	REPx2 <> S: R – 0; REPEND	Y: 1;	NP 3-3	
	Last row of the 2x1 rib with transfer of the stitches to the front			

10.11 Group VIII: Fully Fashion

i

Fully Fashion knitwear

= a shaped fabric produced with single or double bed knitting mode. The shaping results via narrowing, binding-off and widening of stitches at the selvages.

Fixed edges are the result where no stitches can run.

Standard shapes

Raglan	
Saddle shoulder	
Inserted sleeve	
French Shoulder	

Components of a pullover

	Front piece	Without neckline	The collar will be sewed on ♦ Stand-up collar ♦ Turtleneck, etc. ♦ 1: If necessary a gore will be knitted in the front.
		With neckline	♦ V-neck ♦ Round neck neckline ♦ Boat neck neckline ♦ Other neckline variants
	Back piece	1 : If necessary a gore will be knitted in the back.	
	Sleeve	♦ Long sleeve ♦ Short sleeve	

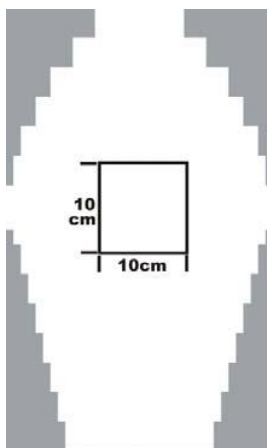
10.11.1 Stitch Ratio



A stitch ratio is needed to convert a dimensionally accurate shape (**mm / cm / inch**) into a stitch accurate shape (stitches).

Determining the stitch ratio:

- ♦ Knit a **test fabric** with the following conditions:
 - Select the desired machine gauge
 - Use the desired yarn
 - Knit the desired structure (single or double jersey structure)
 - Knit the fabric with the desired stitch tension (stitch length)
- ♦ Calculate the **Stitch ratio**:



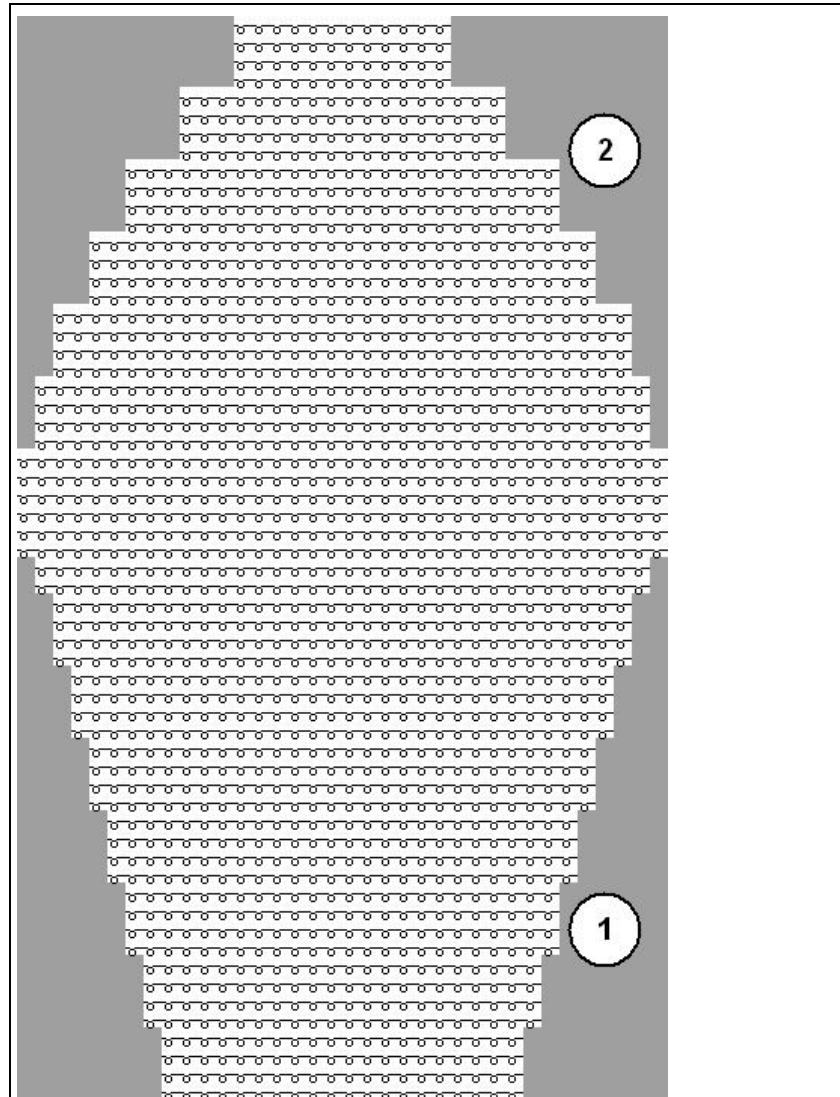
- In the test fabric mark an area with the desired measure unit (**mm / cm / inch**).
- In this area count the number of stitches in terms of width and height (rows)

Conversion of a dimensionally accurate shape into a stitch accurate shape:

- ♦ **Formula for the height:**
Counted number of stitches in height per length unit **x** total height of the dimensionally accurate shape = total stitch number in height (= rows)
- ♦ **Formula for the width:**
Counted number of stitches in width per length unit **x** total width of the dimensionally accurate shape = total number of stitches in width (wales).

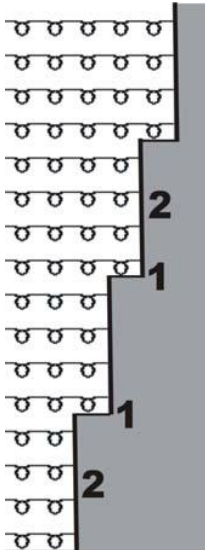
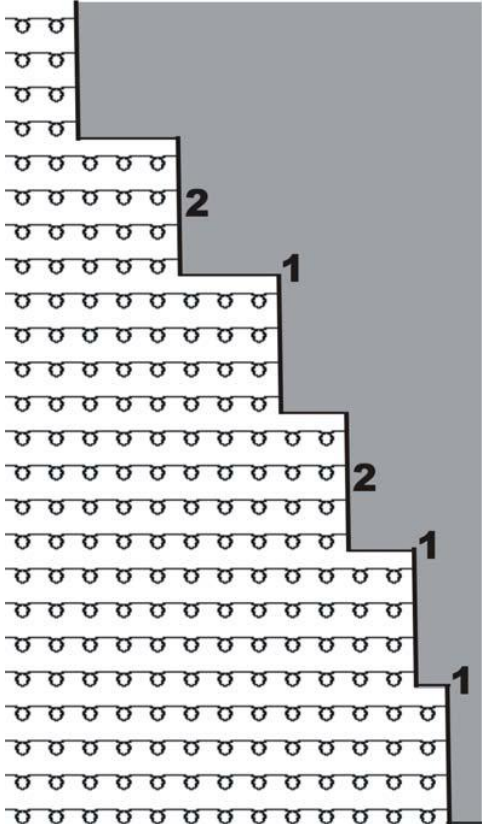
10.11.2 Widening and Narrowing with Fully Fashion

Shaping by widening / narrowing



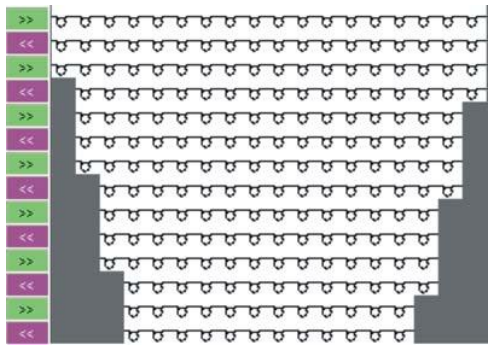
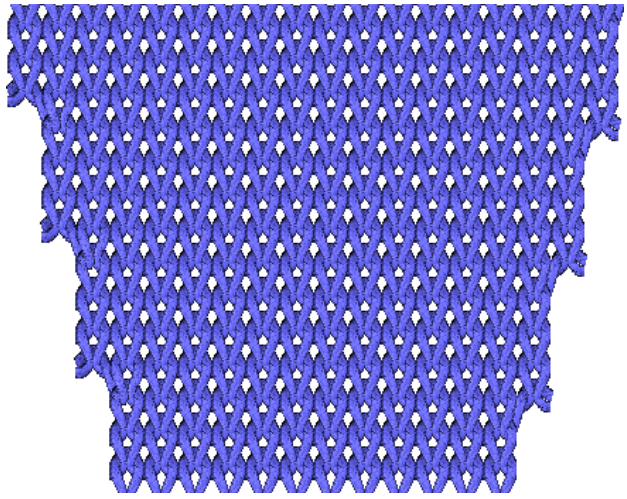
1	Widening	Enlarging the knitting width
2	Narrowing	Reducing the knitting width <i>i</i> : The transfer of stitches results in double stitches = Fully fashion marking (fashioning marks)

Step height and step width when widening / narrowing

Widening		
	1	Step width <i>i</i> : Widening always only 1 needle
	2	Step height = Number of rows between two widenings <i>i</i> : Step height is as desired
Narrowing		
	1	Step width ♦ 1 needle narrowing ♦ 2 needle narrowing ♦ 3 needle narrowing <i>i</i> : Step widths of more than 3 stitches are bind-off.
	2	Step height = Number of rows between two narrowings <i>i</i> : Step height is as desired

10.11.3 Widening Procedure by the Example of Single Jersey fabric

Widening

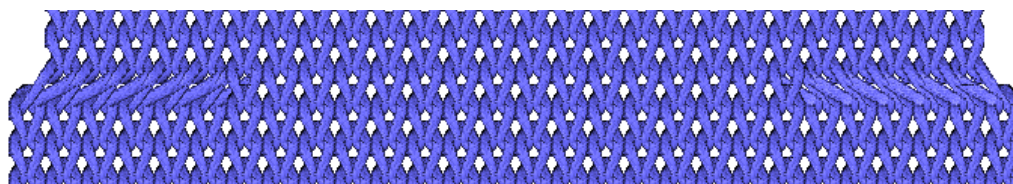
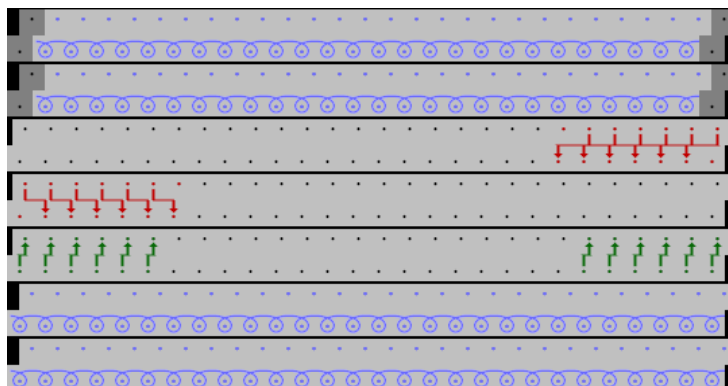
Widening onto an empty needle = tuck	
	i: A widening at the left edge is shifted in height by 1 row when knitting with a manual knitting machine. The widening is stroke-dependent and therefore the yarn insertion (=tuck) is more secure.
	

Widening by transferring stitches by one needle outward = pointelle (without closing)	
The diagram illustrates the process of widening a knit fabric by transferring stitches one needle outward. It shows a sequence of rows with arrows indicating the transfer of stitches. The final row shows the resulting fabric with holes (pointelle).	i: The hole (=pointelle) that resulted from transferring stitches outward (stitch group = widening width) can also be closed by knitting + transferring a tuck. (= Widening with Closing-Stitch)

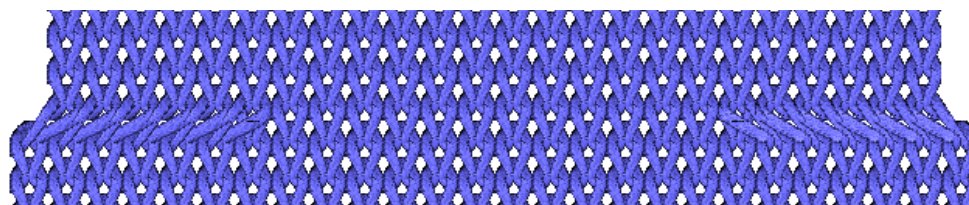
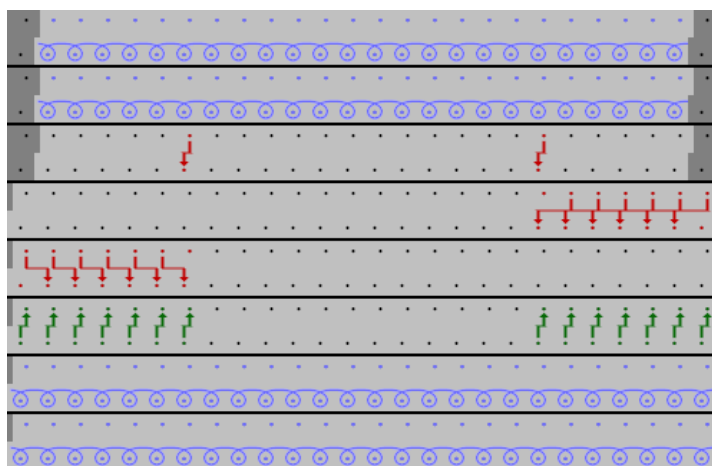
10.11.4 Narrowing Procedure by the Example of Single Jersey

Narrowing

1 needle narrowing underneath

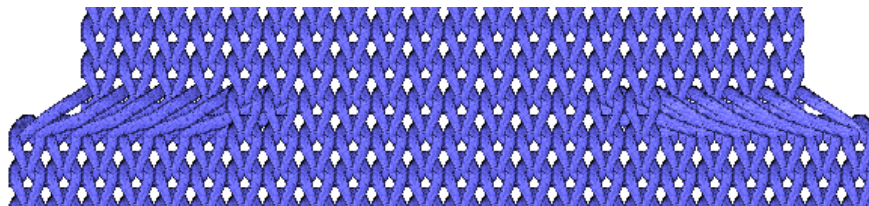
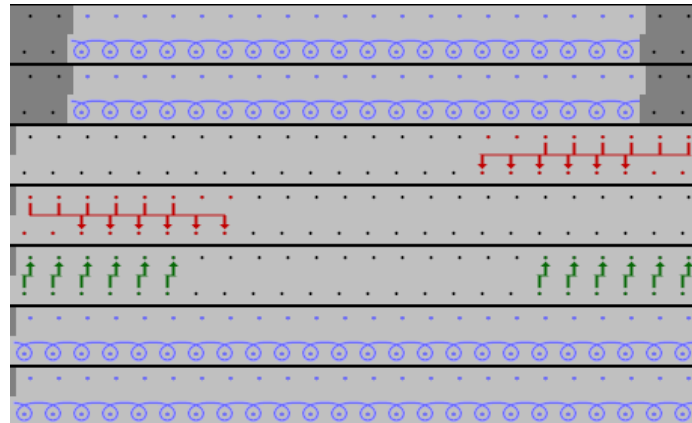


1 needle narrowing above

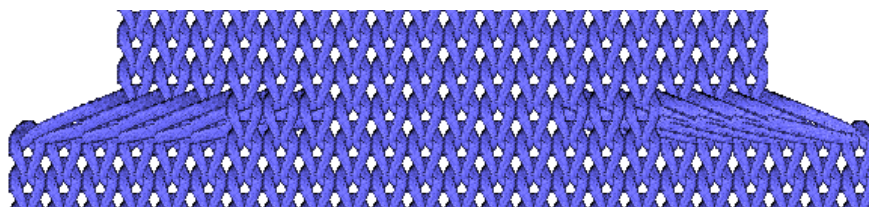
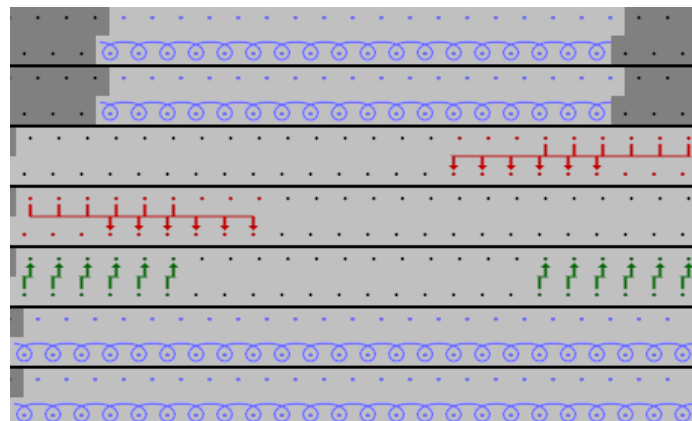


10 Classification of the knitting patterns

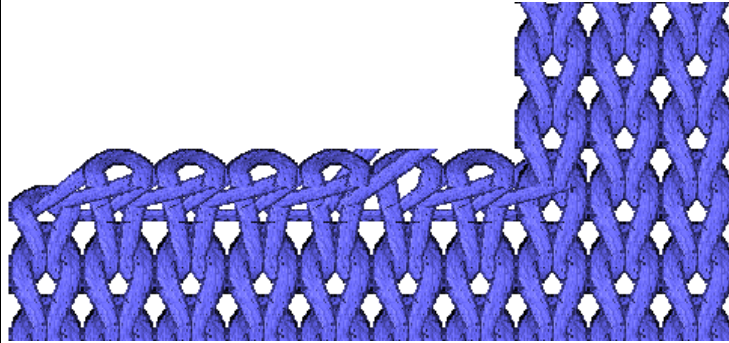
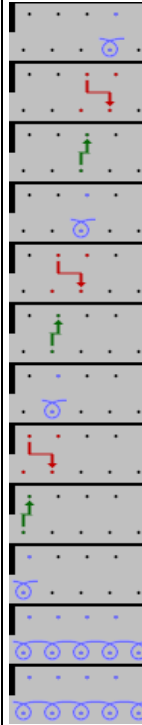
2 needles narrowing underneath



3 needles narrowing underneath

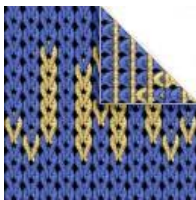


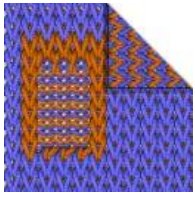
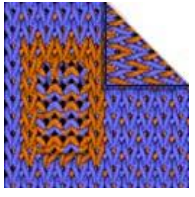
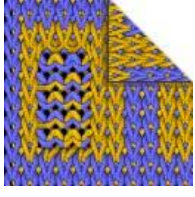
Binding-off (to the right >>)



11 More Knitting Techniques

11.1 Knitting Technique: Jacquard

Knitting technique Jacquard		
Continuous Jacquards produce a picture (picture side) on the fabric front, whereby the fabric back is needed to knit the used colors.		
1: Up to 6 colors per jacquard area can be knitted.		
Possible jacquard backs:		
Float Jacquard (single jersey fabric)		On the fabric back the colors are not knit, but instead they are guided from A to B by floats.
Jacquard with stripe back (Double jersey fabric)		Each jacquard color is worked on all needles on the rear needle bed.
Jacquard with twill back (Double jersey fabric)		The jacquard colors are knitted racked in 1x1 on the rear needle bed.

Jacquard with ladder back (Double jersey fabric)	full		Jacquard with 2 colors = cross-tubular i: The fabric has two picture sides with exchanged colors.
	1x1		On the rear needle bed the jacquard back will be knitted as twill on every second needle. i: Appropriate back when using 4 and more colors.
	1x2		On the rear needle bed the jacquard back will be knitted as twill on every 3rd needle. i: Appropriate back when using 4 and more colors.
	1x3		On the rear needle bed the jacquard back will be knitted as twill on every 4th needle. i: Appropriate back when using 4 and more colors.
Jacquard relief (transfer) (Double jersey fabric)			
with stripe back			On the picture side (front) reverse jersey will be visible in one area (= jacquard color) This jacquard color is used for transferring and will not be knitted anymore. i: Number of jacquard colors minus 1 = actual number of jacquard colors
with twill back			
with ladder back full			

Examples



i

Intarsia with positioned jacquard back

In case of multicolored intarsia motifs jacquards are also used, which will be positioned only in the area of the motif.

11.2 Knitting Technique: Intarsia

Intarsia knitting technique

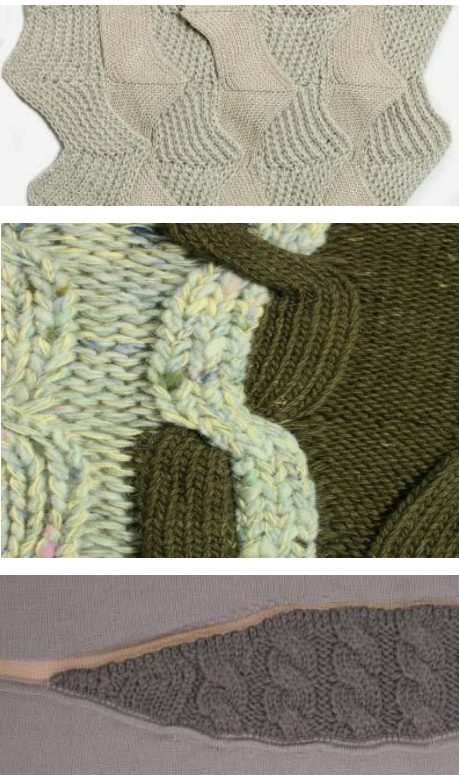


Intarsia patterns are generally single jersey, multicolored fabrics. According to its structure technique, the color areas are connected for example with a tuck since each area is knitted with a separate yarn carrier (= intarsia yarn carrier).

i: A maximum of 31 colors in each pattern row is possible!



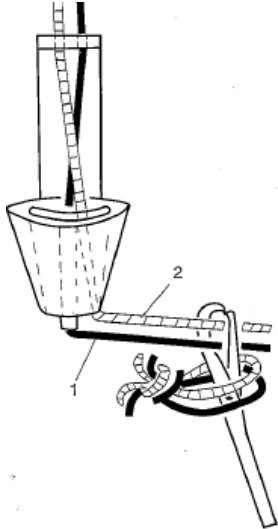
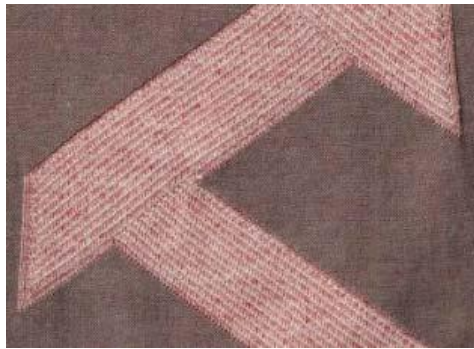
11.3 Knitting Technique: multi gauge

multi gauge	
With the multi gauge gauges (e.g. E 5.2, E 6.2, etc.) one can: ♦ cover different gauge ranges (= Flexible Gauge) ♦ achieve different looks (fine / coarse) within one pattern row (= multi gauge) based on intarsia	
	Flexible Use: This means that it is possible to produce fabrics with a look from fine up to coarse with one machine. 1: A complete stitch row is knitted with one look.
	multi gauge knitting technique This technique is based on intarsia knitting technique for what the use of intarsia yarn carriers is necessary. 1: Different gauges (visual effects) are knitted within one pattern row.

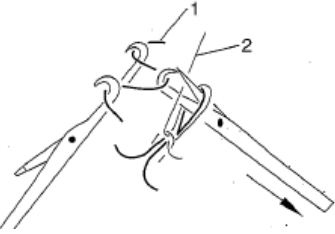
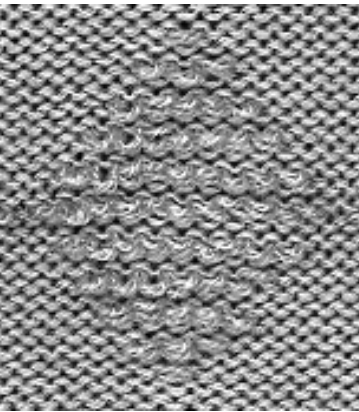
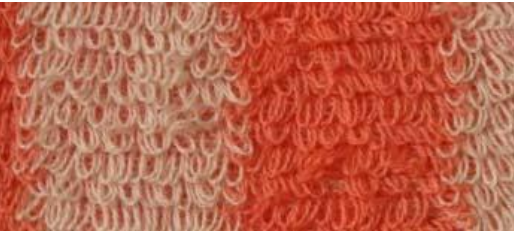
11.4 Knitting Technique: Knit and wear

Knitting technique Knit and Wear	
According to its knitting technique, front, back and sleeves are knitted (manufactured ready to wear) on the machine => no make-up necessary	
	♦ Minor finishing necessary ♦ Then generally finishing (washing) needed
	♦ With intarsia ♦ Further Possibilities: – With pockets – Different neckline solutions – Structures

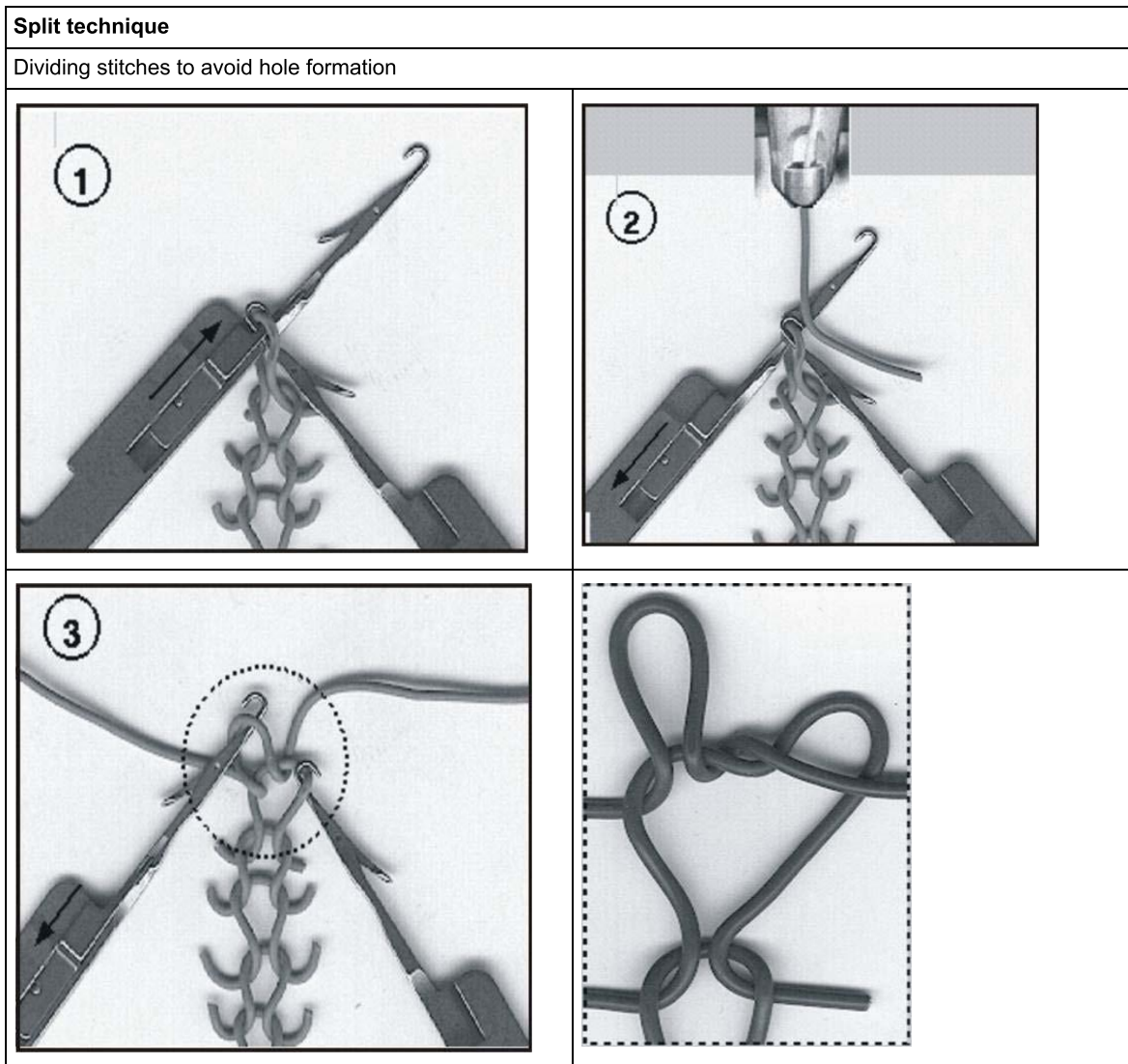
11.5 Knitting Technique: Plating

Plating technique When plating two threads are inserted in the needle hook. Types of plating: ♦ Color plating: Patterning effect ♦ Elastane plating: Manufacturing elastic fabrics	
	1 Plating yarn 2 Basic yarn
Color Plating	
	
Elastane plating	
♦ Use in the start: more elastic rib ♦ Use in complete article: for fashionable, tight fitting fabrics	

11.6 Knitting Technique: Plush

Plush = formation of thread loops  i: For knitting plush special cams are to be assembled in the CMS.	
	◆ Complete piece in plush ◆ Plush placed according to the pattern ◆ Plush with intarsia knitting technique ◆ Plush with multi gauge (coarse and fine areas with plush look)
	
	

11.7 Knitting Technique: Split



	♦ With Jacquards close the start stitch with transfer (relief)
	♦ Close the hole (pointelle) in case of inclined running stitch groups
	

11.8 Knitting Technique: Applications

Applications	
♦ Open / closed waves ♦ Knops ♦ All sorts of pockets	
	
	
	

11.9 Knitting Technique: Gore Technique

Gore technique

Knitting wedges (gores) and counter-wedges, whereby the structure in between runs inclined then.



12 Yarn

Definition of the concept:

Yarn = single yarn

Linear formation, which is produced from textile fibrous material (spinning fiber, filaments or tape).



Single yarn

This concept is used to describe a yarn without plying or twisting.

12.1 Natural Fibers

Vegetable fiber (plant fiber) cellulosic fiber materials			
Seed fibers	Cotton	CO	
	Kapok	KP	
Bast fibers	Linen (flax)	LI	
	Hemp	CA	
	Jute	JU	
	Ramie	RA	
Hard fibers	Sisal	SI	
	Manila (Abaca)	AB	
	Coconut	CC	
Animal fibers - protein fibres			
Wool	Wool	WO	
	Fleece wool (lamb's wool)	WV	
Fine animal hairs	Alpaca	WP	
	Llama	WL	
	Vicuna	WG	

	Camel	WK	
	Angora	WA	
	Mohair	WM	
	Cashmere	WS	
	Guanaco	WU	
	Yak	WY	

12 Yarn

Coarse animal hair	Bovine	HR	
	Horsehair	HS	
	Goat	HZ	
Silk	Silk (cultivated silk)	SE	
	Tussah silk (wild silk)	ST	
Mineral fibres			
derived from rocks	Asbestos	AS	
	Glass fiber	GL	

12.2 Synthetic Fibers

Chemical fibers from natural raw material			
Cellulose Fibers	Rayon		
	Viscose	VI	
	Modal	MD / CMD	
	Lyocell	CLY	
	Cupro fibers	CU / CUP	
	Acetate fibers	CA / AC	
	Bamboo		
Alignate fibers		ALG	
Caoutchouc		LA	

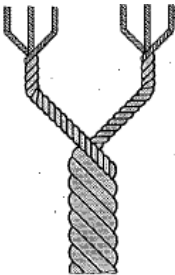
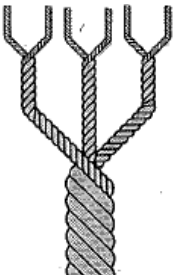
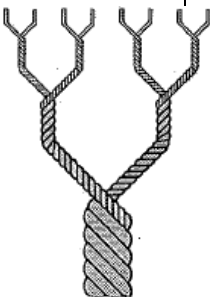
Synthetic fibers of man made raw materials (Synthetics)			
Acrylic	Dralon	PC	
	Dorlan		
	Dunova		
Polyamide	Nylon	PA	
	Perlon		
	Tactel		
	Meryl		
	Aramid	AR	
Polyurethane	Elasthan	PU	
	Lycra		
	Dorlastan		
	Creora		
Polychloride		CLF	
Polyvinyl chloride	Leavil	PVC	
	Clevyl		
	Rhovyl		
Polyester	Trevira	PES	
	Diolen		
	Elite (elastic)	PBT	
Polyolefin	Polypropylene ♦ Meraklon ♦ Vegon	PP	
	Polyethylene ♦ Vestolan	PE	

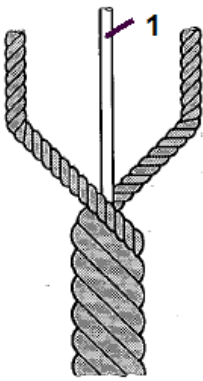
Inorganic textile fabrics			
Glass			
Carbon fibers		CF	
Metal fibers		ME / MTF	Lurex
	Gold		
	Silver		
	Stainless steel		

12.3 Classification of Yarns

Yarns		
Single yarns 	Plied yarns 	Twisted yarns = plied yarn 
i: Yarn without plying or twisting	i: At least two yarns that are wound together but not twisted together.	i: All linear textile formations produced by twisting (twining) together at least two yarns.
Spun fiber yarns i: These yarns result twisting together staple fibres (spinning) by mechanic means.  Staple fibers from: ♦ Cotton / linen ♦ Wool ♦ Florette silk / Bourette silk ♦ Broken / cut synthetic fibers	Filament yarns i: Filament yarns are yarns from continuous fibers (filaments) that are spun by the silkworm or by chemical technical means. ♦ Monofilament = one filament  ♦ Multifilament: – Twistless multifilament  – Twisted multifilament 	

12.4 Classification of Plied Yarns

Plied Yarns				
All linear textile formations that are produced by twisting together (plying) at least two single yarns. Properties: ♦ Higher tensile strength ♦ Homogeneity in the cross section				
↙		↘		
Folded yarn		Cabled yarn		
♦ Production with one plying process		♦ Production out of at least two plying processes ♦ Consisting of folded and/or cabled yarns ⓘ: Single yarns can also be used.		
↙		↓		
Two-ply yarn		↓		
Folded yarn from two single yarns		↓		
↘		2-cabled yarn		
		4 ply yarn 	6 ply yarn 	6 ply yarn 
Three ply yarn 		Three ply cable		
Four ply yarn 		8 ply 		

Core spun yarn (special yarns)	
 The diagram illustrates the production of core spun yarn. It shows a central vertical line representing the core yarn, labeled with a '1'. Two other lines, representing cover yarns, are shown crossing the core yarn at different points. The resulting yarn is depicted as a twisted structure where the cover yarns are spun around the central core yarn.	Core spun yarn results by spinning around (twining) a core yarn (1) (core) with fibers / yarns. ♦ Production of elastic fabric from cover spun plied yarn with elastic core (Elastane)

12.5 Yarn Structure

The structure of the yarn is defined by:

- ♦ Count
- ♦ Number of filaments
- ♦ Twisting direction
- ♦ Twist
- ♦ Plying

I. Count:

Quotient resulting from mass / length of a yarn

- ♦ By Length = count
 - **Nm**
 - **Ne**
- ♦ By Weight
 - **tex / dtex**
 - **den**

II. Number of filaments:

Identification f = number of single filaments in a filament yarn

Example: dtex 24 f 12

1: The yarn consists of 12 single fibers which together have the yarn gauge of **24 dtex**.

The result is that the fiber gauge (single titer) is **2 dtex**.

Formula: Yarn count / Number of single filaments = gauge of the single filaments

III. Twisting direction

Label		Meaning
Z-twist		Individual spinning fibers or filaments in a vertically held yarn appear to cross in the direction as the diagonal of a letter Z (= clockwise twisted). Valid also for: ♦ single yarns / pre-plies in the plied yarn ♦ single or plied yarns ♦ plied yarns in the over-ply yarn
S-twist		Individual spinning fibers or filaments in a vertically held yarn appear to cross in the direction as the diagonal of a letter S (= counter-clockwise twisted). ♦ Valid also for: ♦ single yarns / pre-plies in the plied yarn ♦ single or plied yarns ♦ plied yarns in the over-ply yarn

IV. Twist:

Number of twists of a single yarn (plied yarn) in relation to 1 m length.

Marking t = twists per 1 m



Yarns (plied yarns) in the flat knitting domain almost have a low number of twists:
(300 up to **600/m** max.)
Exceptions: Special / effect plied yarn, e.g. slub, knop or loop yarn

V. Plying:

At least two or more single or plied yarns are feeded together, but not twisted (= twined).

12.6 Yarn Count

Yarn classification = yarn identification depending on its thickness			
↙		↘	
by length = count		by weight = titer	
i: Reference value is a permanent weight.		i: Reference value is a permanent length.	
Formula:	Yarn number = length / weight	Formula:	Titer = weight in grams multiplied by determined length / length in meters
i: The higher the number, the finer the yarn.		i: The higher the number, the thicker the yarn.	

12.6.1 By Length = count

By length = count:

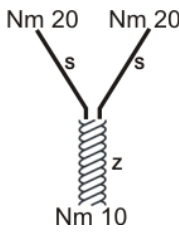
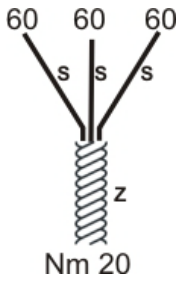


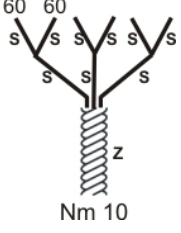
The yarn gauge is determined by the number of length units per weight unit.

- ♦ Metric number **Nm**:
Nm = Length in meters per **1g**
- ♦ English Cotton count **Ne** / **NeC**:
(Number english Cotton)
Ne = Length in meters x 453,59 / weight in Grams x 768,10

Label	Meaning
NeC	English Cotton count: = Ne  : Standard commercial designation for handicraft yarns and sewing threads.
NeW	Worsted count (English Wool count) extension W (worsted wool)  : Outdated additional specification, in case of likelihood of confusion.
NeL	Lea count (English Linen count)  : Outdated additional specification, in case of likelihood of confusion.

Example for the designation of the yarns:

Yarn Type	Presentation	Designation of the yarns Example	Abbreviated designation (Final count)
Single yarns (Spinning fibers)		Nm 24 Z 660 ♦ Nm = Metric number ♦ 24 = weigh 24 meter of yarn 1g ♦ Twisting single yarn with Z-twist ♦ 660 = number of twists in 1m	Nm 24
Plied yarns		1. Same yarns: 2 x Nm 50 S 900 ♦ 2 x = two yarns are processed parallel together ♦ Twisting single yarn with S-twist	2 x Nm 50 (Nm 25)
		Different yarns: Nm 40 S 800 + Nm 50 Z 900 ♦ + = Connection of the two specifications of the respective single yarns	Nm 40 + Nm 50 (Nm 22)
Folded yarns		Same yarns: Nm 20 S 800 /2 Z 600 ♦ /2 = two plied yarns are twisted together – each initial plied yarn has Nm 20 with S twist – the final plied yarn has Nm 20/2 = Nm10 with Z twist	Nm 20 /2 (Nm 10)
		Same yarns: Nm 60 S 800 /3 Z 600 ♦ /3 = three plied yarns are twisted together – each initial plied yarn has Nm 60 with S-twist – the final plied yarn has Nm 60/3 = Nm 20 with Z-twist	Nm 60/3 (Nm 20)
		i: The twisting direction of the final plied yarn is normally opposite to the twisting direction of the single yarns or of the initial plied yarn.	

Yarn Type	Presentation	Designation of the yarns Example	Abbreviated designation (Final count)
Cabled yarns	Two ply cable 	Same yarns: Nm 60 S 700 /2 S 500/3 Z 200 ◆ Specification of the initial plied yarn before the first cabling step – Nm 60 S 700 /2 = Yarn thickness of the two initially plied yarns with S-twist and the twisting number ◆ Specification of the plied yarns before the 2nd cabling step – S 500/3 = three plied yarns with S-twist with the twisting number ◆ Specification for final plied yarn – Z 200 = Final plied yarns with S-twist with the twisting number	Nm 60 / 2 / 3 (Nm 10)



The gauge of the plied yarns are specified **without** taking into account the **twist contraction**.

12.6.2 By Weight

By Weight = Titer:

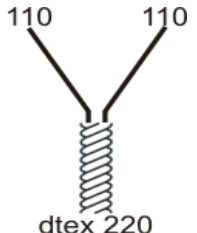
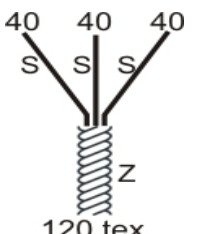
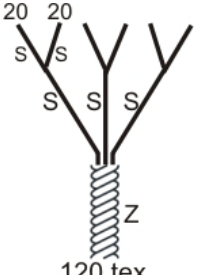


The yarn gauge is determined by the number of weight units per length unit.

- ♦ New system **tex (Tt)**
tex = Weight in Grams per 1000m (1km)
- ♦ **Decitex (dtex)**
dtex = Weight in Grams per 10.000m
 dtex = 1/10 tex
- ♦ International silk titer **Denier (den)**:
Titer den = Weight in Grams per 9000m

Example for the designation of the yarns:

Yarn Type	Presentation	Designation of the yarns Examples	Abbreviated designation (Final count)
Single yarns	Spinning fibers 	40 tex Z 660 ♦ 40 = 1000 meter yarn weigh 40g ♦ tex = Gauge (length related mass) ♦ Twisting of the single yarn with Z-twist ♦ 660 = Number of twists in 1m	40 tex
	Filaments 	140 dtex f40 S 1000 ♦ 140 dtex = 10.000 m yarn weigh 140g ♦ f40 = 40 single filaments are in the filament ♦ S 1000 = Filament with S-twist and 1000 twists in 1m	140 dtex (Single titer = 3,5 dtex)
Plied yarns		1. Same yarns: 40 dtex S 115 x 2 t0 ♦ 40 dtex = 10,000 meter yarn weigh 40g ♦ S 115 = Single yarn with S-twist and number of twists in 1m ♦ x2 = two yarns will be knit together (plied, not twisted) ♦ t0 = Specification in case of plied yarns or filaments without specification of the twisting direction.	40 dtex x 2 t0 (80 dtex = 8 tex)

Yarn Type	Presentation	Designation of the yarns Examples	Abbreviated designation (Final count)
Folded yarns	 110 110 dtex 220	Same yarns: 110 dtex S 117 x2 Z 670 ♦ 110 dtex = 10.000m yarn weigh 110g ♦ S 117 x2 = Single yarn / initial plied yarn have every one 110 dtex with S-twist and 117 twists in 1m ♦ Z 670 = Final plied yarn has 220 dtex = 22 tex with Z-twist and 670 twists in 1m	110 dtex x2 (220 dtex = 22 tex)
	 40 40 40 S S S Z 120 tex	Same yarns: 40 tex S 600 x3 Z 400 ♦ x3 = three plied yarns are twisted together – each initial plied yarn has 40 tex with S-twist and 600 twists – Final plied yarn has 40 tex x3 = 120 tex with Z-twist and 400 twists	40 tex x3 (120 tex)
		i: The twisting direction of the final plied yarn is normally opposite to the twisting direction of the single yarns or of the initial plied yarn.	
Cabled yarns	 20 20 S S S S S Z 120 tex	Same yarns: 20 tex S 700 x2 S 500 x3 Z 200 ♦ Specification of the initial plied yarn before the 1st cabling step – 20 tex S 700 x2 = Yarn thickness of the two initially plied yarns with S-twist and the twisting number ♦ Specification of the plied yarns before the 2nd cabling step – S 500 x3 = three plied yarns with S-twist and the twisting number ♦ Specification for final plied yarn – Z 200 = Final plied yarns with S-twist and the twisting number	20 tex x2 x3 (120 tex)

i

The gauge of the plied yarns are specified **without** taking into account the **twist contraction**.

If the twist contraction is taken into account this is called **Resulting gauge** In front of the yarn designation the specification **R** is added.

Example: Folded yarn **110 dtex x2**, the resulting gauge **R 225 dtex /2**.

12.6.3 Conversion Formulas

I. Conversion from ,Nm' or ,Ne' to ,tex':

- ♦ $\text{tex} = 1000 / \text{Nm}$
- ♦ $\text{Nm} = 1000 / \text{tex}$
- ♦ $\text{tex} = 590 / \text{Ne}$

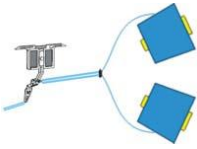
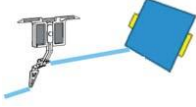
II. I. Conversion from ,dtex' to ,den':

- ♦ $\text{den} = \text{Grams (g)} / 9000\text{m}$
- ♦ $\text{dtex} = \text{Grams (g)} / 10000\text{m}$
- ♦ $\text{dtex} = 10 / 9 \text{ den}$
- ♦ $\text{den} = 9 / 10 \text{ dtex}$

12.7 Yarn Table

The specified values serve as a guideline. The quality and the specific weight of a yarn must also be taken into account. Instead of a simple yarn, we recommend twisted yarn. With coarser machines it is advisable to use several twisted threads.

Yarn table: Allocation of machine gauge and yarn thickness

Gauge	assembled processing [Nm]	Final count [Nm]
	 Several fine threads are assembled and fed as a thick yarn to the yarn carrier.	 Yarn thickness of the assembled threads Example: $6 \times 16/2$ $16/2=8$ $8:6=1,33$
2	6 x 16/2	1,2 - 1,4
2.5	6 x 18/2	1,3 - 1,6
3	5 x 18/2	1 - 2
3 m.3L	15 x 20/2	0,65 - 1
3.5	6 x 24/2	1,4 - 2,5
4	5 x 24/2 6 x 34/2	1,4 - 3
5	4 x 24/2 4 x 34/2	3 - 4,5
7	2 x 22/2 2 x 28/2	4,5 - 7
8	2 x 24/2 2 x 34/2	6 - 8
10	2 x 36/2 1 x 24/2	8 - 12
12	1 x 24/2 2 x 44/2	10 - 18
14	1 x 28/2 2 x 40/1	14 - 20
16	1 x 48/2 1 x 54/2 1 x 60/2	20 - 30
18	1 x 54/2 1 x 60/2 1 x 80/2	20 - 40
20	1 x 80/2	20 - 40

Gauge	assembled processing [Nm]	Final count [Nm]
2,5.2 (all needles)	3 x 28/2 2 x 14/2	3 - 4,5
2,5.2 m.4L	All needles: 3 x 28/2 Nm	3 – 4,5
	Every 2nd needle: 8 x 28/2 Nm	1,3 - 2
	Every 2nd needle with cast-off technique: maximum 13 x 28/2 Nm	1,1
2,5.2 (CMS 830 C) (each 2nd needle)	3 x 14/2 6 x 14/2	1 - 2
2,5.2 (each 2nd needle)	3 x 14/2 4 x 14/2	1,3 - 2
3,5.2 (all needles)	2 x 28/2 3 x 28/2	4,5 - 7
3,5.2 (each 2nd needle)	3 x 14/2 7 x 28/2	1,5 - 2,5
3,5.2 m.4L	All needles: 3 x 28/2 Nm	4,5 – 7
	Every 2nd needle: 7 x 28/2 Nm	1,5 – 2,5
	Every 2nd needle with cast-off technique: maximum 9 x 28/2 Nm	1,5
5.2 (all needles)	1 x 20/2 2 x 28/2	8 - 12
5.2 (each 2nd needle)	3 x 28/2 4 x 28/2	3 - 4,5
6.2 (all needles)	2 x 44/2 1 x 28/2	10 - 16
6.2 (each 2nd needle)	2 x 28/2 3 x 28/2	4,5 - 7
7.2 (all needles)	1 x 28/2 1 x 30/2	14 - 20
7.2 (each 2nd needle)	2 x 28/2 2 x 30/2	6 - 8
8.2 (all needles)	1 x 50/2 2 x 60/2	15 - 25
8.2 (each 2nd needle)	2 x 50/2 3 x 60/2	10 - 12
9.2 (all needles)	1 x 40/2 1 x 60/2	20 - 30
9.2 (each 2nd needle)	2 x 40/2 2 x 44/2 2 x 60/2 3 x 60/2	10 - 16

12.8 Bobbin Types

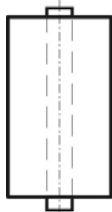


Well wound is half the knitting!

When is rewinding necessary?

- ♦ Quality is not enough for effective further processing
- ♦ Quality is not enough for the quality of the final result
- ♦ The bobbin type does not correspond to the requirements of further processing

Appropriate bobbin types: Cross-wound bobbin with cross winding

Bobbin Types		
Conical cross-wound bobbin	Cylindrical cross-wound bobbin	
		
	Front side straight	Front side at an angle
		
♦ Yarn unwinding direction to the top => The bobbin does not rotate	♦ Yarn unwinding direction to the top possible but not optimal => The bobbin does not rotate  When unwinding, the thread is "plucked" => Yarn breakage! ♦ Recommendation: Rewind on conical cross-wound bobbins.	
Advantages:		
♦ high unwinding speeds are possible (ballooning) ♦ great capacity (bobbin size) possible ♦ Winding density decreases from inside out ♦ Overhead yarn unwinding => no additional friction (friction should be even)		
Disadvantages		
♦ Due to the winding around the bobbin when unwinding, the yarns lose their torsion => the yarn gets untwisted ♦ The yarn unwinding force increases as the unwinding process empties the bobbin => consequence on the dimensions of the fabrics (smaller)		

Winding modes for cross-wound bobbins

	Random winding (uncontrolled winding)	Precision winding
	The random winding has the same crossing angle with all bobbin diameters. The winding number decreases as the bobbin diameter increases. With an increasing bobbin diameter the distances between the windings get narrower and overlap (ribbon winding), then they get wider and again narrower.	In case of the precision winding the crossing angle gets smaller as the bobbin diameter increases. The winding number remains constant.
Advantages:	♦ well dyeable ♦ Winding process less costly (cost-effective)	♦ good unwinding
Disadvantages	♦ poor unwinding	♦ Winding process more costly (expensive)

