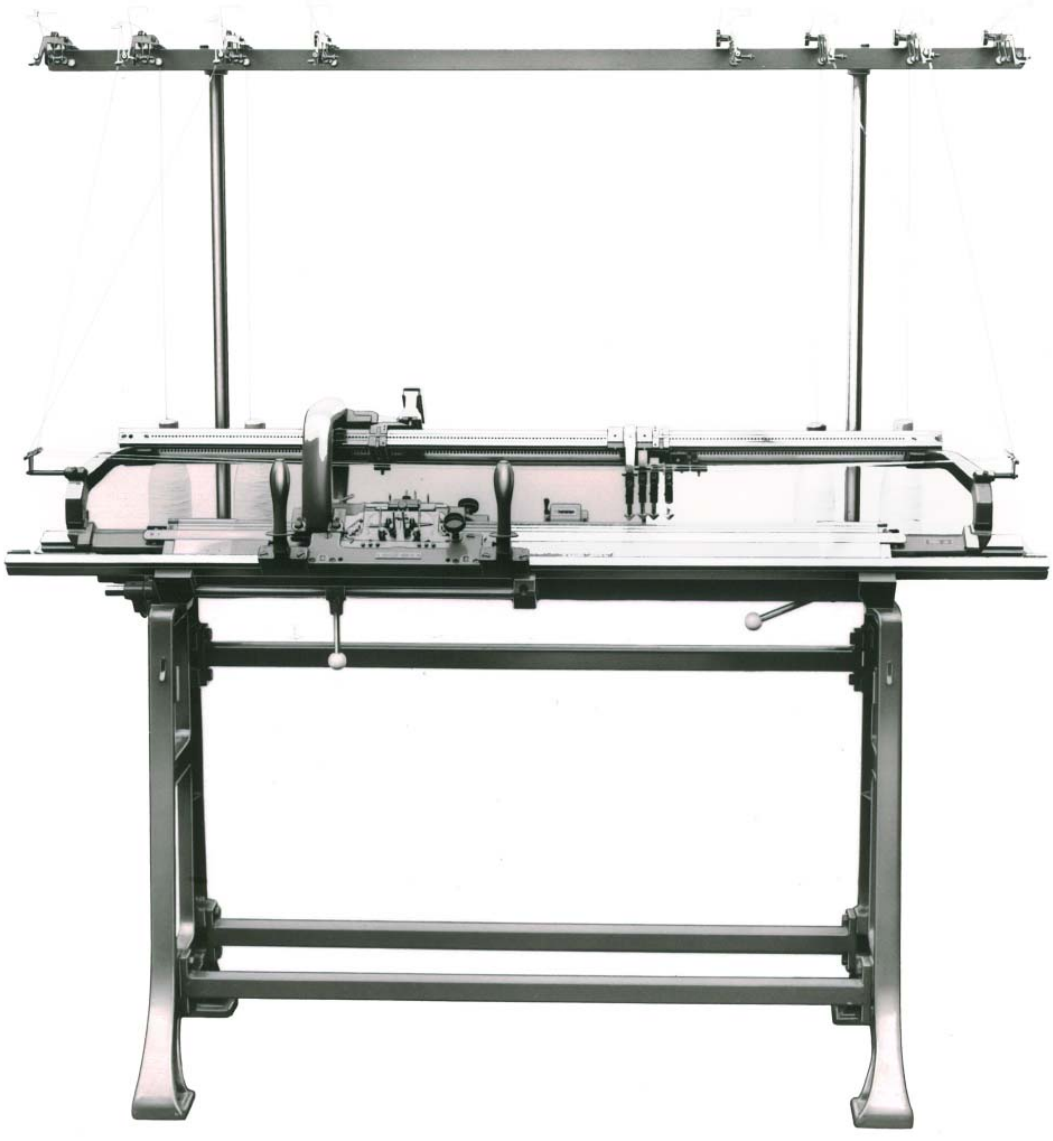
STOLL

KNIT AHEAD

Stoll Training

Manual Flat Knitting Machine



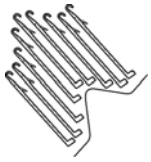
Ident-No. 223 788_01 EN

Date: 17/01/2013

H.Stoll GmbH&Co. KG, Reutlingen

Content

1 Classification of Stitch Forming Machines

<table>
<tr><td colspan="6">Knitting machines
(Knitwear / Weft Knit)</td><td colspan="3">Warp Knitting Machines
(Warp Knit / Weft Knit)</td></tr>
<tr><td colspan="6">◆ individually driven needles
  </td><td colspan="3">◆ jointly driven needles
  </td></tr>
<tr><td colspan="6">↙ ↘</td><td colspan="3">↓</td></tr>
<tr><td colspan="6">Single thread knitting machine
(knitting machine)
Thread feed crosswise ——</td><td>Warp knitting machine
Warp thread feed lengthwise
||||</td><td colspan="2">Single thread warp knitting machines
(Weft knitting machine)
Thread feed crosswise ——</td></tr>
<tr><td colspan="2">↙</td><td colspan="4">↘</td><td>currently no construction type</td><td colspan="2">↓</td></tr>
<tr><td colspan="2">Flat knitting machine
▭</td><td colspan="4">Circular knitting machine
○</td><td rowspan="3"></td><td colspan="2">Cotton machine
▭</td></tr>
<tr><td>↙</td><td>↓</td><td>↘</td><td>↙</td><td>↓</td><td>↘</td><td>↙</td><td>↘</td></tr>
<tr><td>SJ</td><td>D J</td><td>LL</td><td>SJ</td><td>DJ</td><td>LL</td><td>Single Jersey</td><td>Double Jersey</td></tr>
<tr><td rowspan="5"></td><td rowspan="5">↓</td><td rowspan="5"></td><td rowspan="5">↓</td><td rowspan="5">↓</td><td>↓</td><td rowspan="2">↓</td><td rowspan="3"></td></tr>
<tr><td colspan="3">◆ Small circular knitting machine
(Ø < 165 mm)</td><td colspan="2">◆ flat weft knitting machine
(Cotton system)
◆ i: Production of
– Cut goods
– Fully Fashion</td></tr>
<tr><td colspan="4">◆ Small circular knitting machine
◆ Large circular knitting machine (Ø > 165 mm)
(rib and interlock machines)</td></tr>
<tr><td colspan="4">◆ Small circular knitting machine
i: Production of stockings, socks, technical items)
◆ Large circular knitting machine
i: Production of cut goods (e.g. underwear, outer clothing)</td></tr>
<tr><td colspan="7">◆ 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</td></tr>
</table>

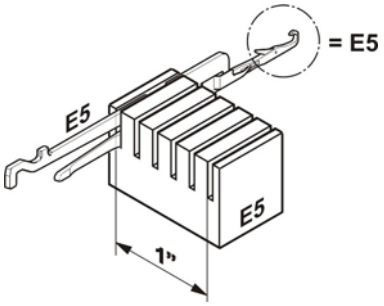
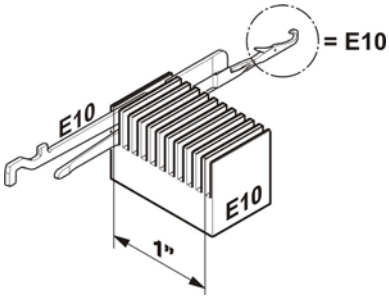
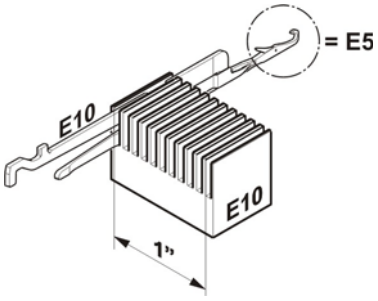
i	In the classification the construction types of the warp machines are not considered in detail.

2 Terms and description of the machine

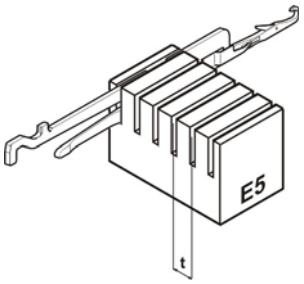
2.1 Terms: Gauge and nominal width

Terms

- Gauge

<table>
<tr><td>Terms</td><td colspan="2">Meaning</td></tr>
<tr><td rowspan="4">Gauge E</td><td colspan="2">Number of needles per 1 English inch (= 2,54 cm) in one needle bed.</td></tr>
<tr><td>Needle bed gauge</td><td>Number of needle bed tricks (= needles) per 1 English inch (= 25,4 mm)</td></tr>
<tr><td>Needle hook gauge</td><td>= needle hook size in E</td></tr>
<tr><td colspan="2">i: For the 'standard' gauges the needle bed gauge = needle hook gauge.</td></tr>
<tr><td colspan="3">Examples</td></tr>
<tr><td colspan="2">Gauge E 5</td><td>Gauge E 10</td></tr>
<tr><td colspan="2"> 
</td><td> 
</td></tr>
<tr><td colspan="2">Gauge E 5.2
(Multi-Gauge gauge)</td><td> 
</td></tr>
</table>

- Gauge

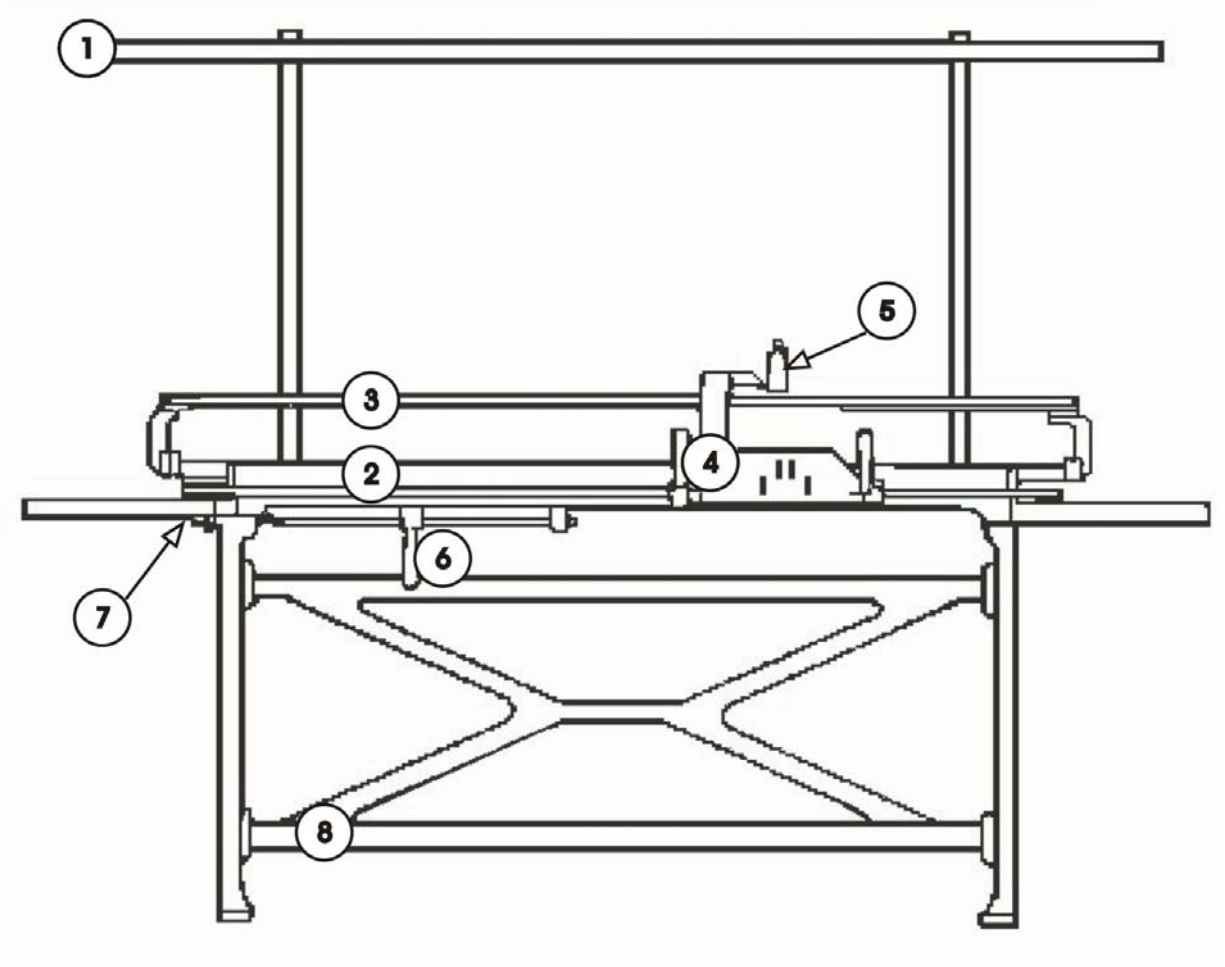
Terms	Meaning
Gauge t	Distance [mm] between two needle tricks (grooves) **Calculation with the formula:** **t** = 25,4 mm / E
	

- 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:



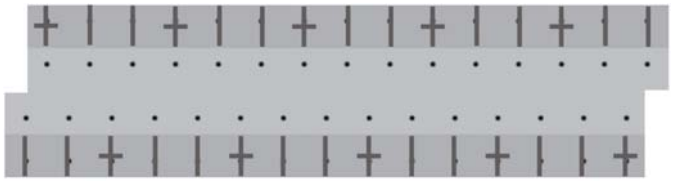
No.	Label
1	
2	
3	
4	
5	
6	
7	
8	

2.3 Racking, needle classification in the racking

I. Explanation to racking:

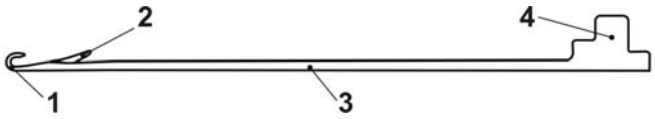
Term	Meaning
Racking V	Move the rear needle bed to another position.
V0	Racking home position **0** – 1 – 2 – 3 – 4 – 5 - 6
V>1	Racking by one needle to the right
V<1	Racking one needle to the left

II. Needle classification in the racking home position V0:



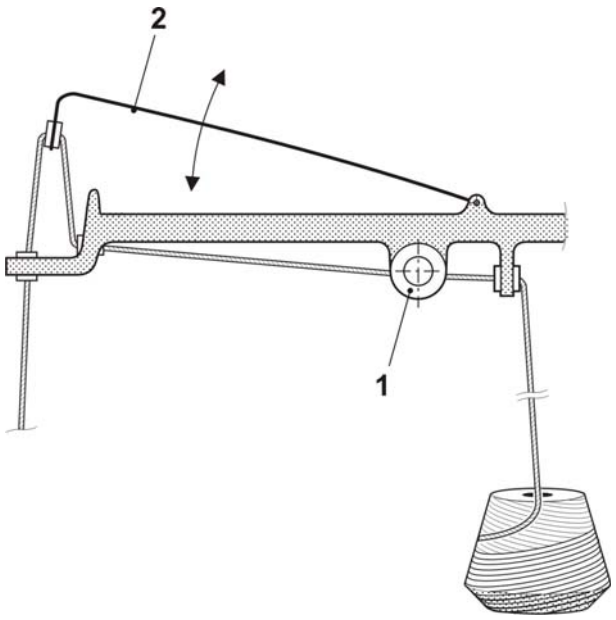
Symbols	Meaning
	
	

III. Elements of the needle:



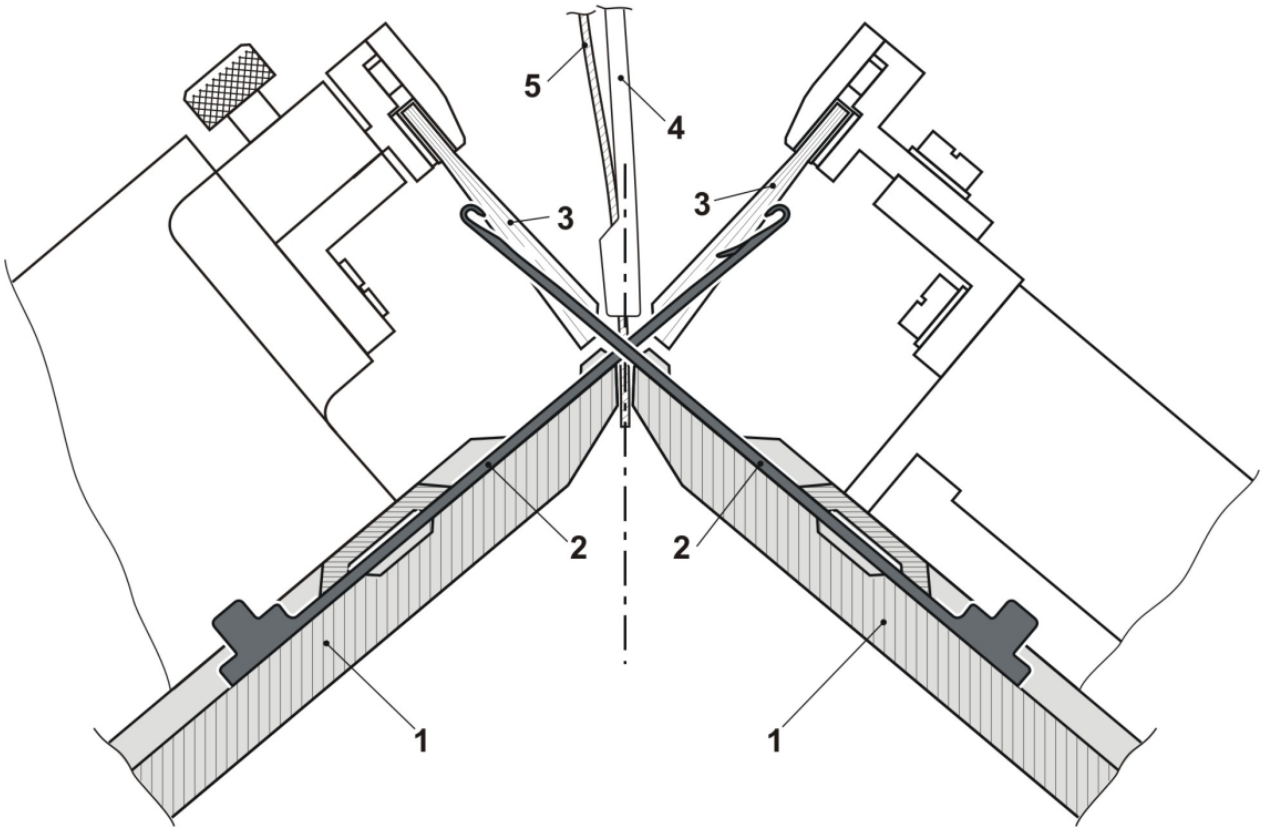
No.	Label
1	
2	
3	
4	◆ . ◆ .

2.4 Yarn Tensioner



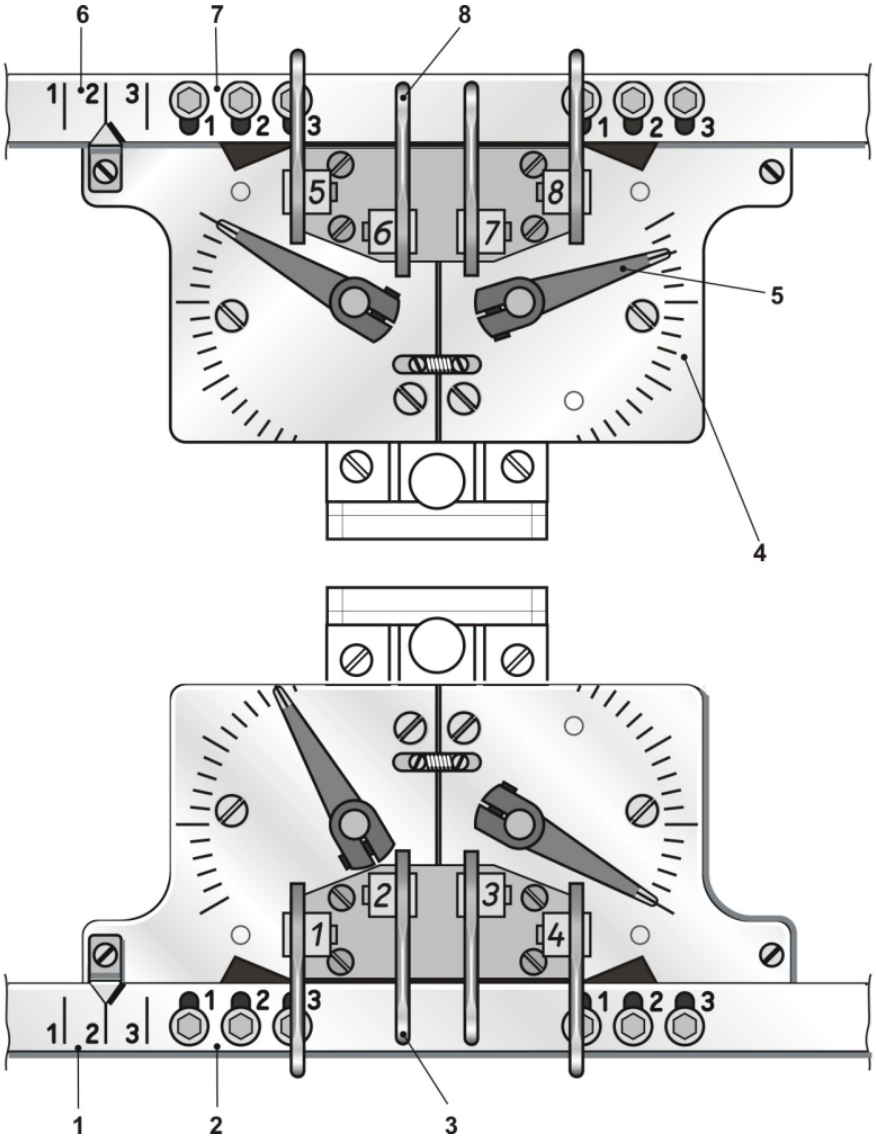
No.	Label
1	
2	

2.5 Sideview of the Needle Beds



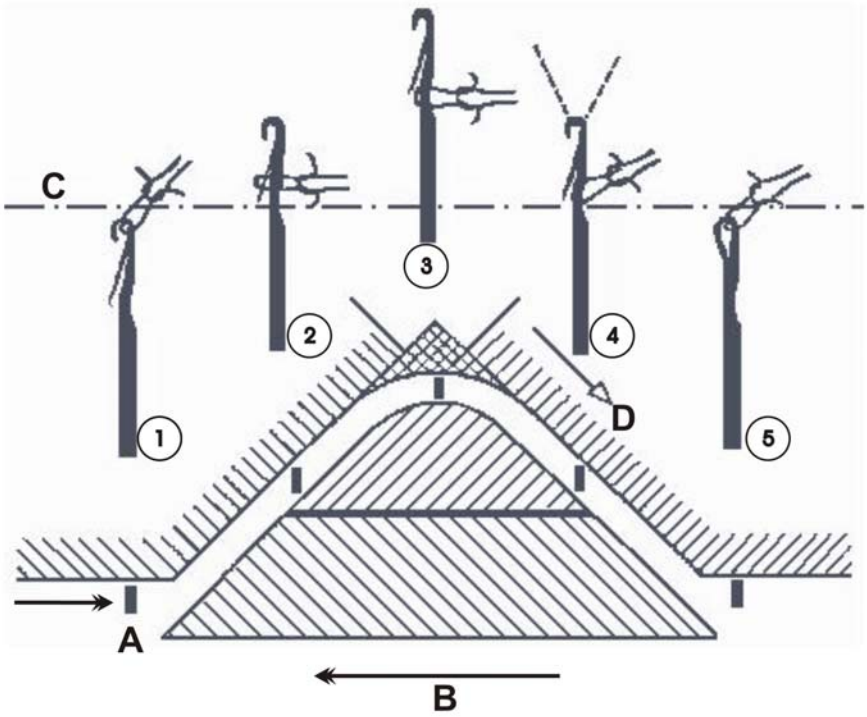
No.	Meaning
1	
2	
3	**i**: For opening the latches.
4	
5	

2.6 Setting the Stitch Cams



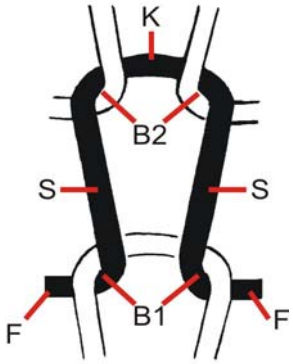
No.	Meaning
1	**N**adelsenker (stitch cam)**P**ositions for the front needle bed (**NP**)
2	Set screw for adjusting the stitch cam positions of the front needle bed
3	Lever (1-4) for the cams for the front needle bed
4	Value scale for the stitch cam positions
5	Indicator for the stitch tension
6	**N**adelsenker **P**ositionen (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



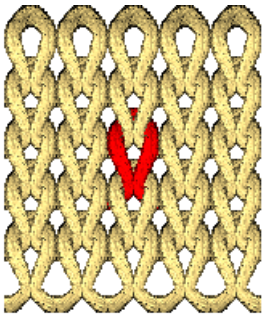
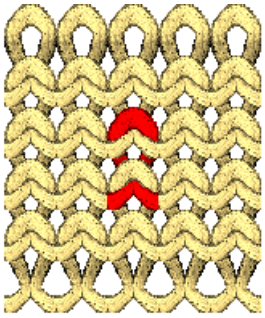
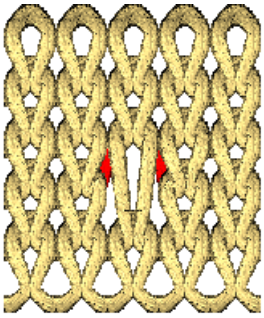
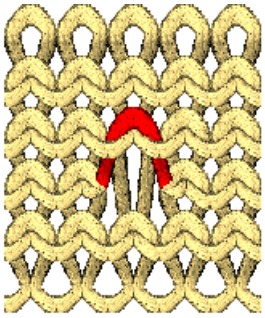
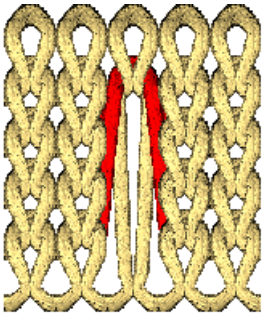
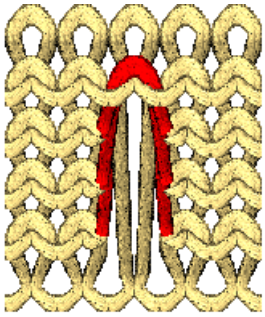
No.	Meaning
A	
B	
C	
D	
1	
2	
3	
4	
5	

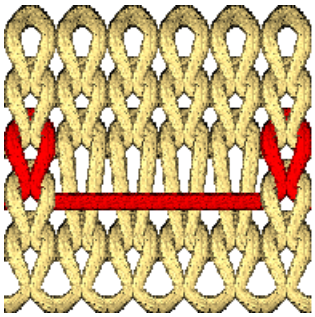
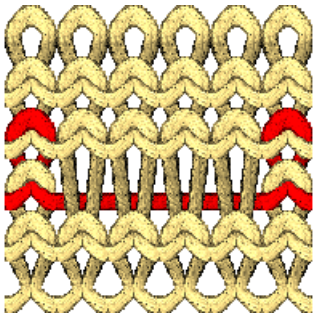
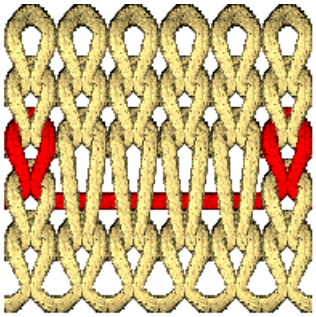
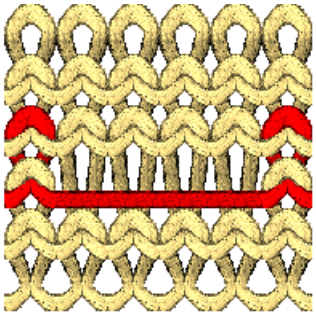
3.1 Elements of the Stitch



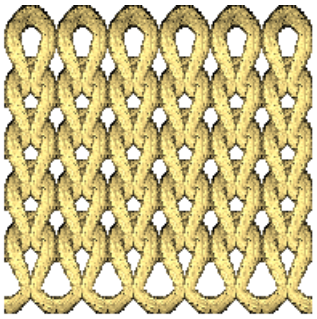
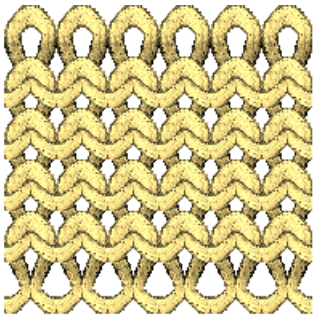
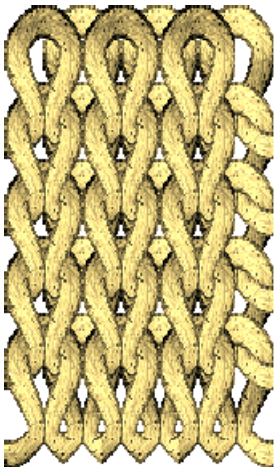
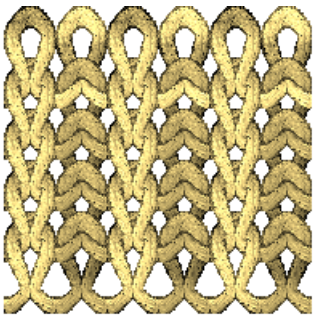
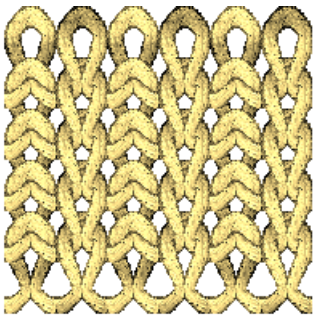
K	
S	
F	
B1	
B2	

3.2 Binding Elements

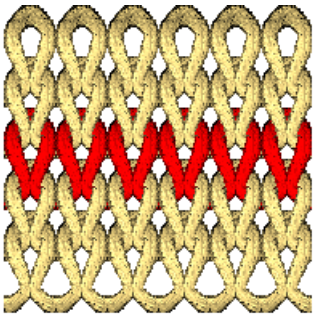
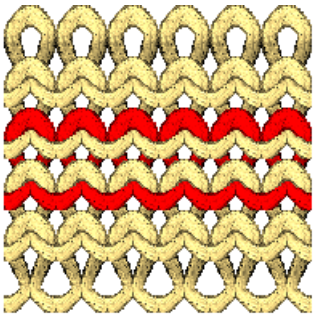
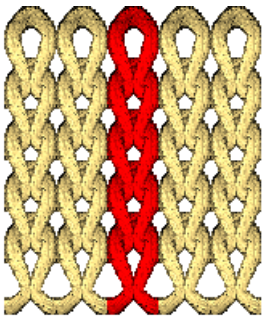
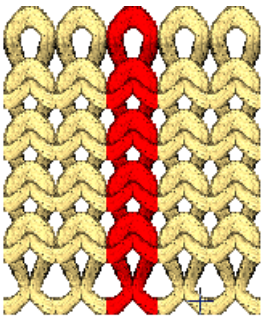
Jersey stitch		
	Technologically right fabric side	
		
Reverse jersey		
	Technologically reverse fabric side	
		
Tuck		
	Technologically right fabric side	Technologically reverse fabric side
Tuck on a needle in the front needle bed		
3x tuck on a needle in the front needle bed		

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

4 Single Jersey / Double Jersey

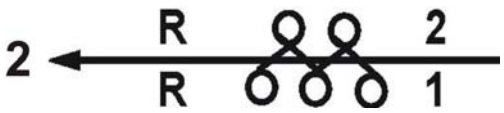
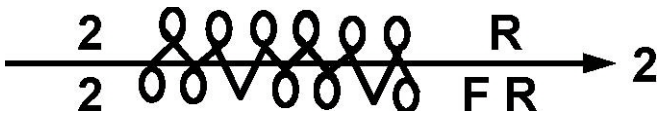
Single jersey fabric (RL)		
	Technologically right fabric side	Technologically reverse fabric side
Single-bed fabric = single jersey fabric		
All needle knit fabric (DJ)		
Double-bed fabric = Double jersey fabric (without elongation)		
Double-bed fabric = Double jersey fabric (with elongation)		

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

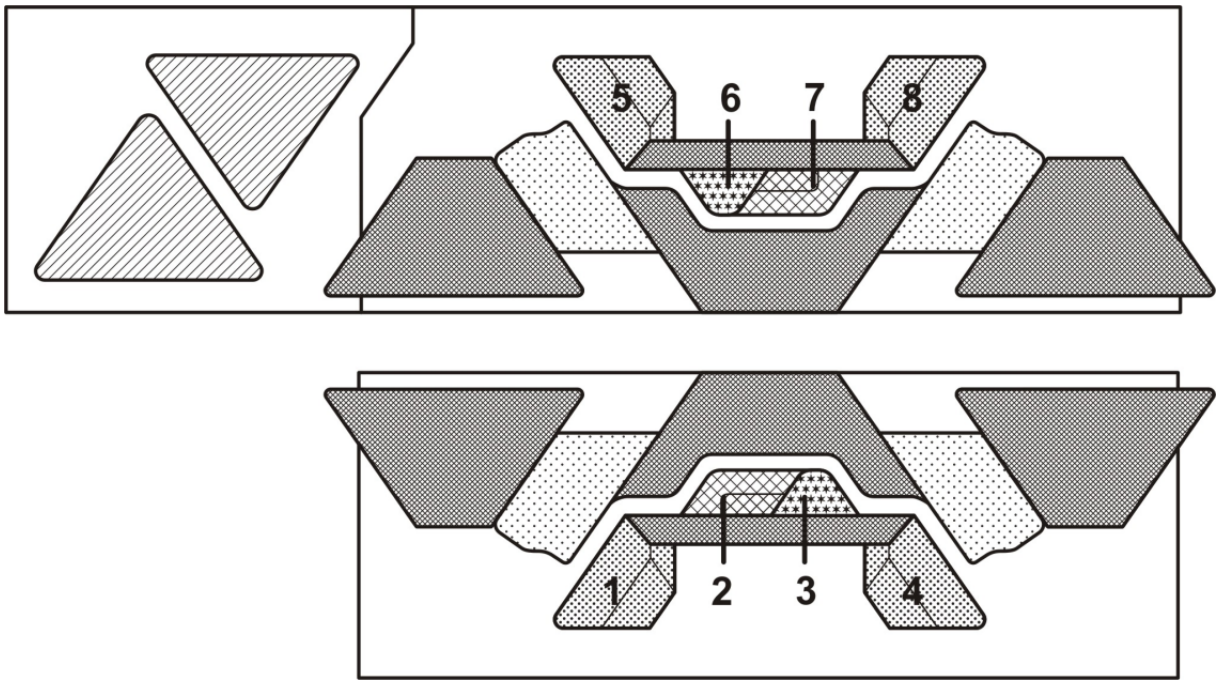
Knitting specifications for the carriage stroke from right to left	
	
Sintral command	`<< S: R – R;  Y: 2;  NP 1 – 2  S1`
Knitting specifications for the carriage stroke from left to right	
	
Sintral command	`>> S: FR – R;  Y: 2;  NP 2 – 2  S1`

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

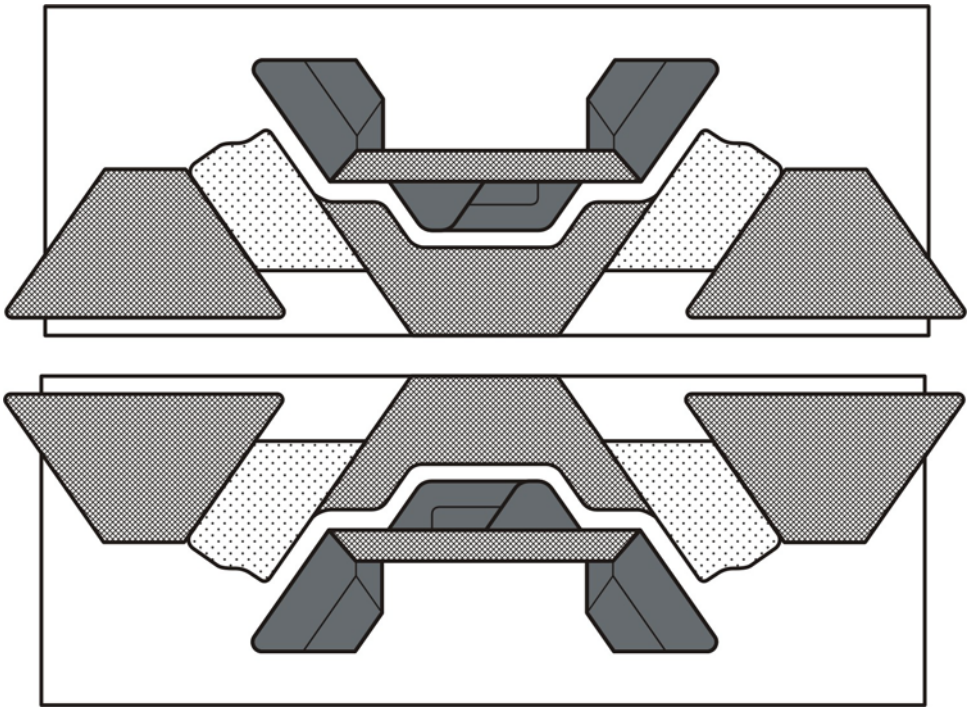


Front cam plate

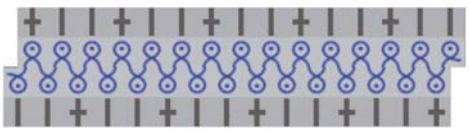
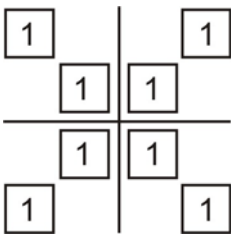
Designation of the cams

	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	

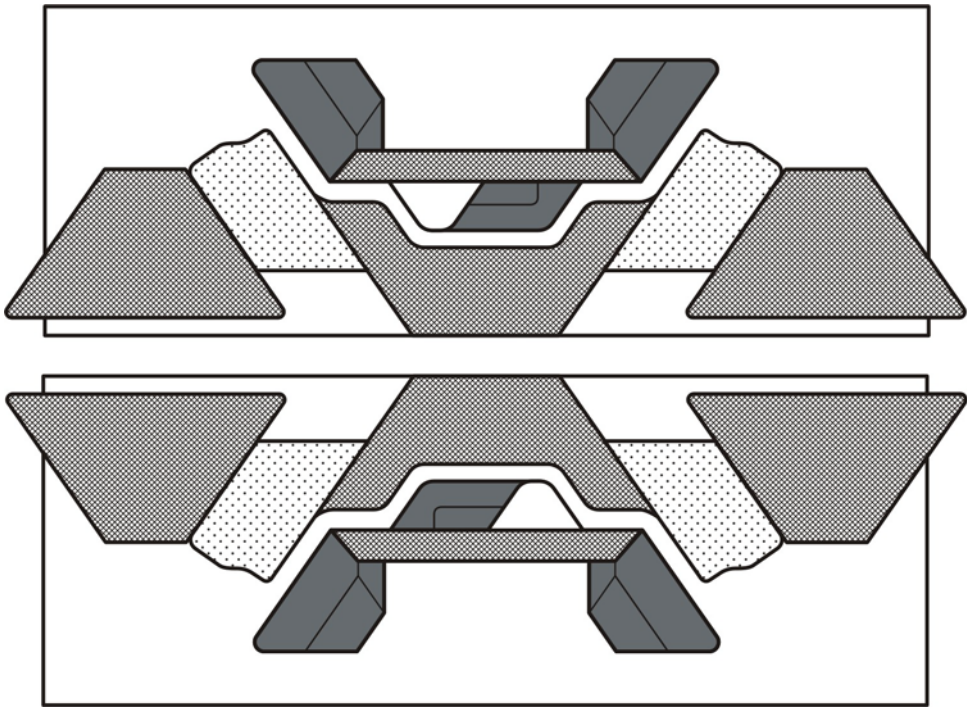
6.1 Setting Example 1



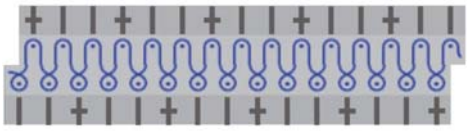
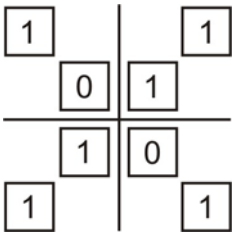
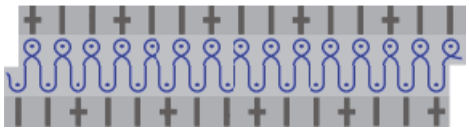
Legend		
	1	Down lever (on)
	1/2	Halfway up lever
	0	Up lever (off)

Stitch line	Sintral command	Lever position
	**< > S: R – R;**	

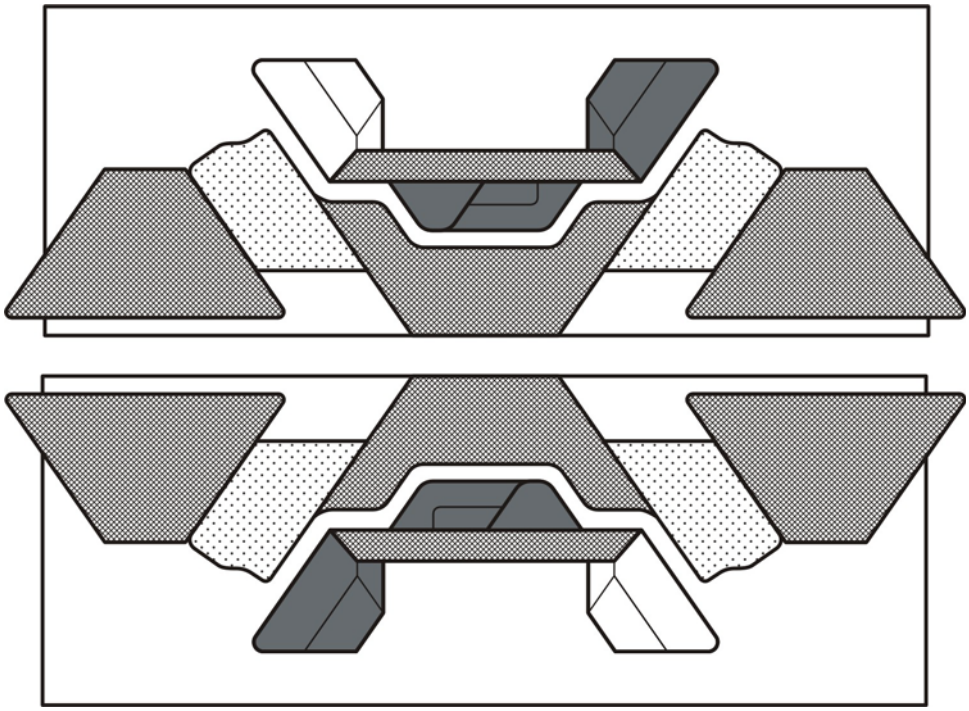
6.2 Setting Example 2



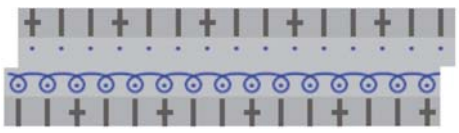
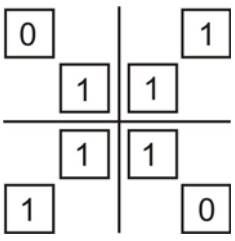
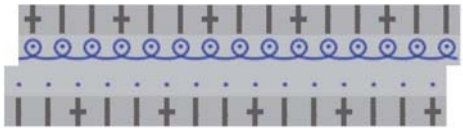
Legend		
	1	Down lever (on)
	1/2	Halfway up lever
	0	Up lever (off)

Stitch line	Sintral command	Lever position
	**<< S: R – F;**	
	**>> S: F – R;**	

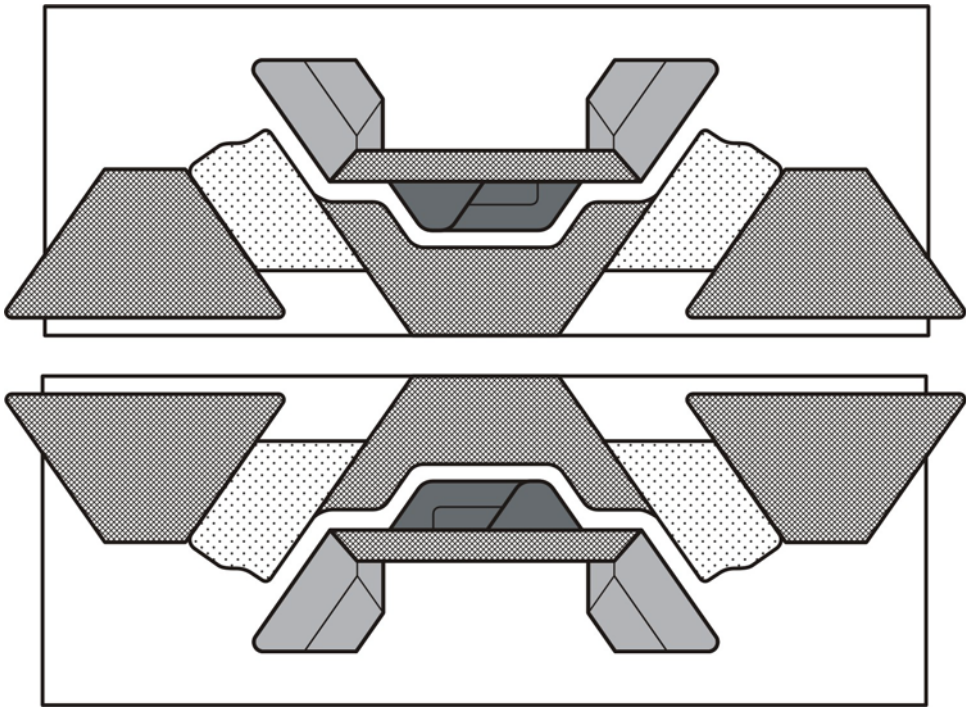
6.3 Setting Example 3



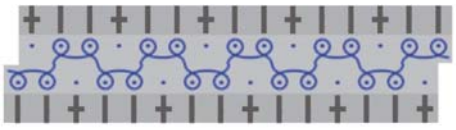
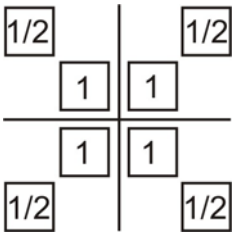
Legend		
	1	Down lever (on)
	1/2	Halfway up lever
	0	Up lever (off)

Stitch line	Sintral command	Lever position
	**<< S: R – 0;**	
	**>> S: 0 – R;**	

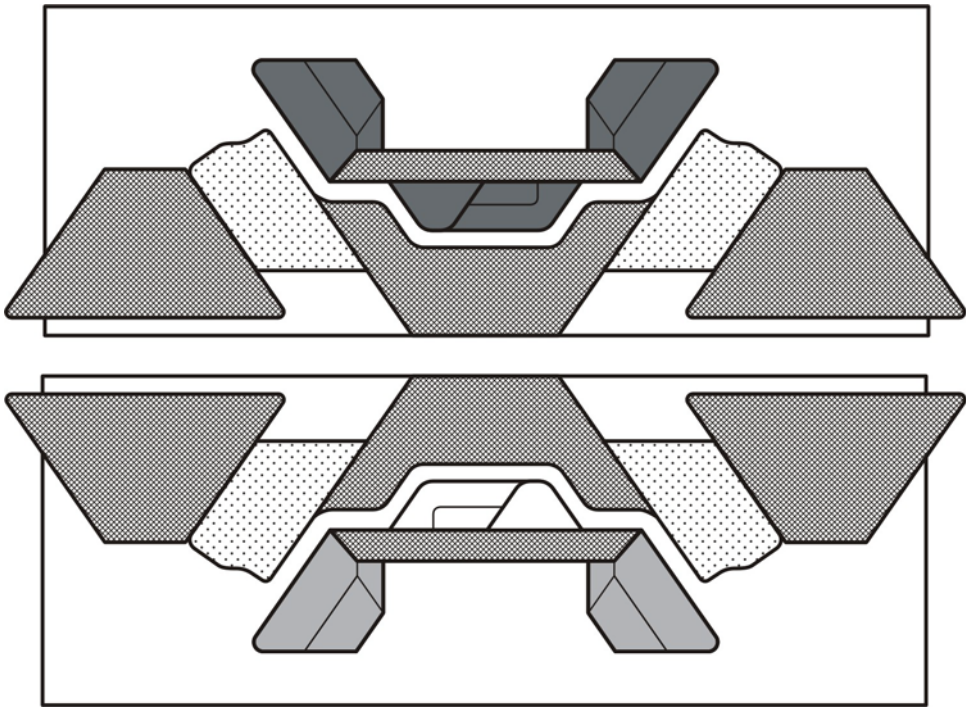
6.4 Setting Example 4



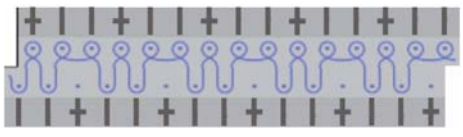
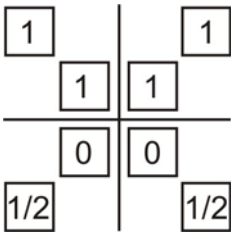
Legend		
	1	Down lever (on)
	1/2	Halfway up lever
	0	Up lever (off)

Stitch line	Sintral command	Lever position
	**<> S: RH – RH;**	

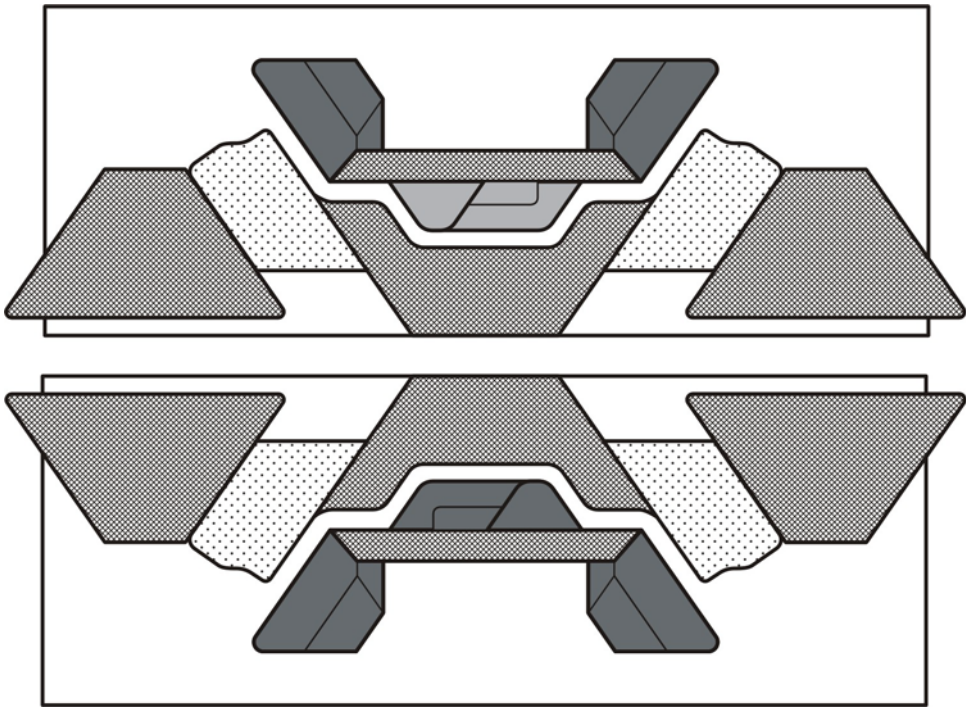
6.5 Setting Example 5



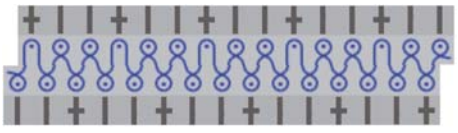
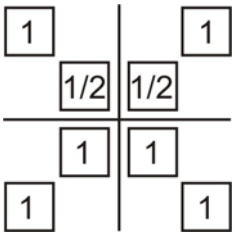
Legend		
	1	Down lever (on)
	1/2	Halfway up lever
	0	Up lever (off)

Stitch line	Sintral command	Lever position
	**<> S: FH – R;**	

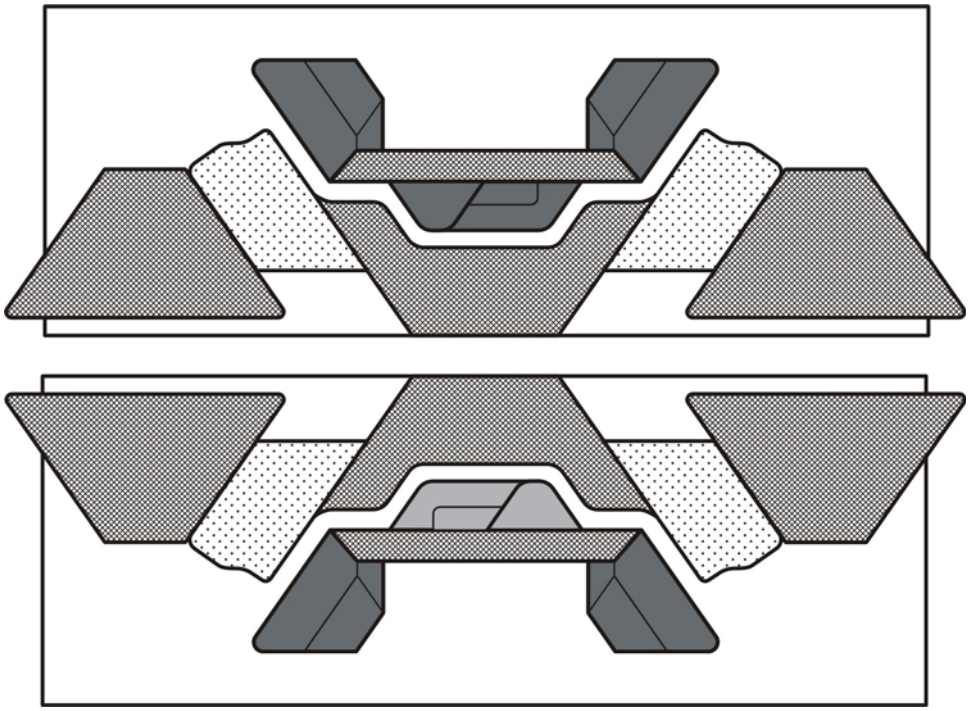
6.6 Setting Example 6



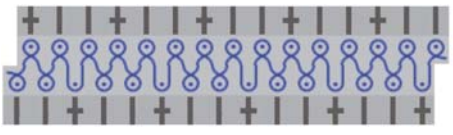
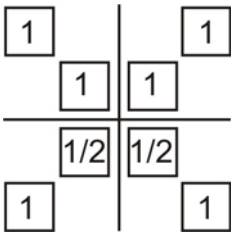
Legend		
	1	Down lever (on)
	1/2	Halfway up lever
	0	Up lever (off)

Stitch line	Sintral command	Lever position
	**<> S: R – FR;**	

6.7 Setting Example 7

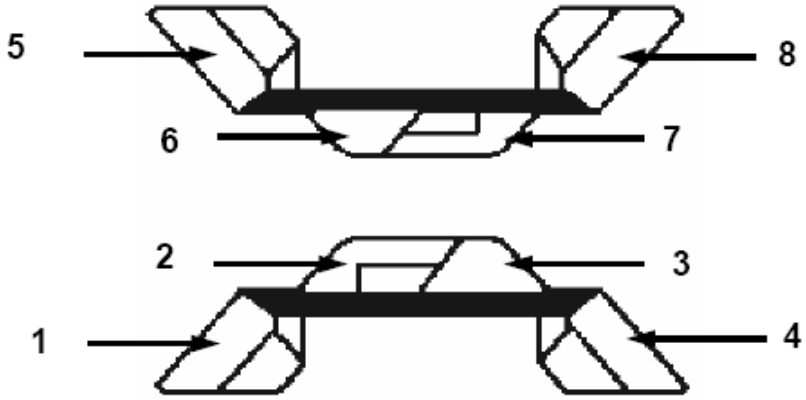


Legend		
	1	Down lever (on)
	1/2	Halfway up lever
	0	Up lever (off)

Stitch line	Sintral command	Lever position
	**<> S: FR – R;**	

6.8 Overview of Setting Options

Cam box view:



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	**i**: 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	**i**: 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	**i**: 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

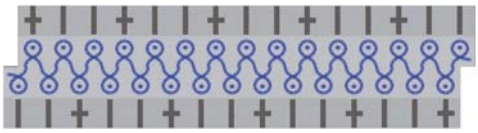
Knitting mode	
Combinations of double jersey, tuck and single jersey	
All racking patterns	
Net row	Start with comb

Stitch cam position 3 (NP3): loose

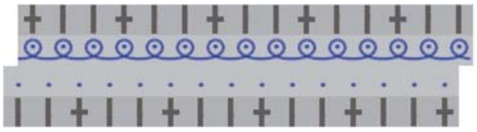
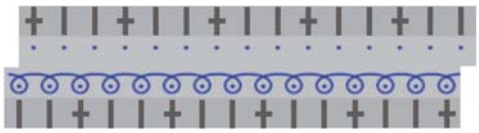
Knitting mode	
Single jersey rows	Not all the needles knit
Tubular	

8 Start with Comb

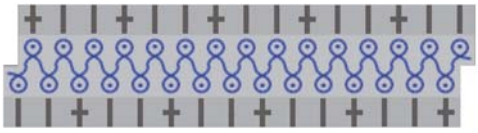
1) Stop carriage on the right at the reversion.
2) Select the desired yarn carrier (e.g. yarn carrier 1).
3) Activate all cams (= all levers 1-8 down) and set stitch cam position **NP** 2 - 2.
4) Move the carriage from right to left.

<< S: R – R;	

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:

>> S: 0 – R;	
<< S: R – 0;	

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.

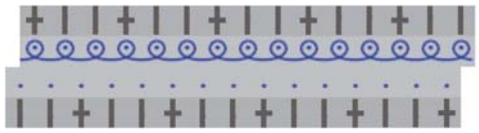
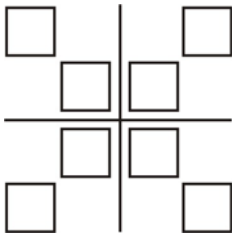
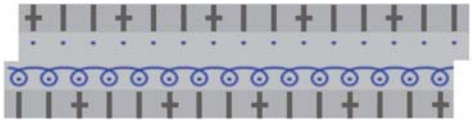
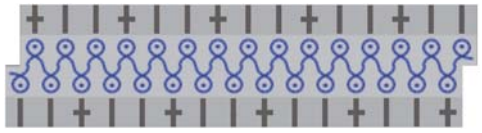
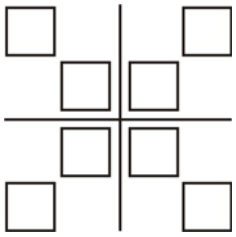
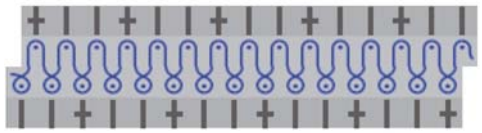
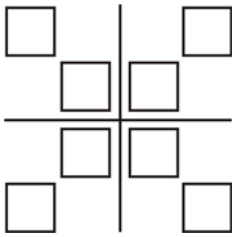
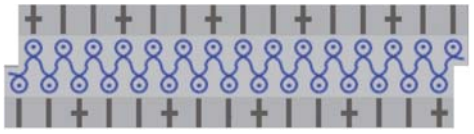
>> S: R – R;	

11) Carry on with the desired basic structure.

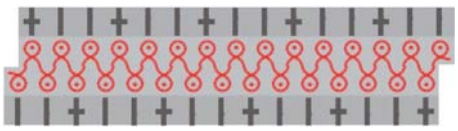
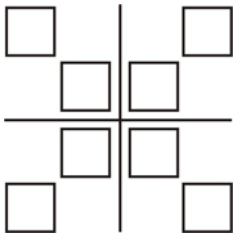
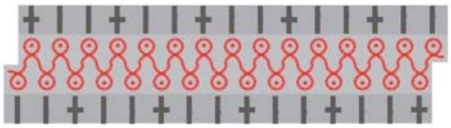
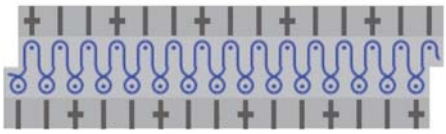
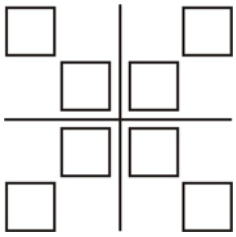
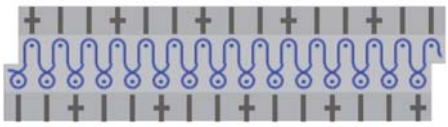
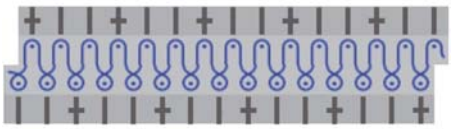
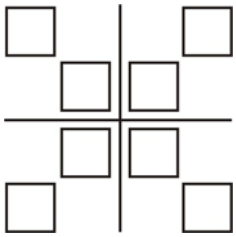
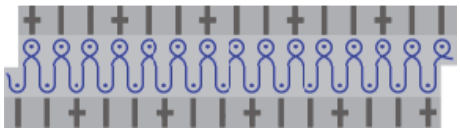
9 Overview of Basic Knitting Modes

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	**Heringbone**
14	**Milano Rib**

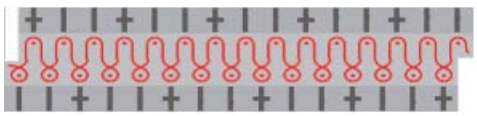
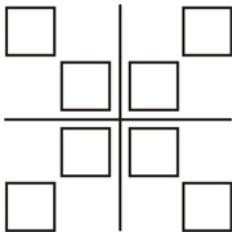
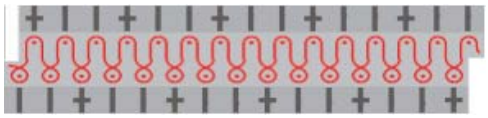
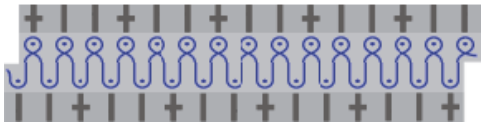
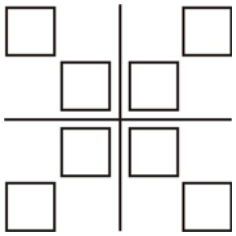
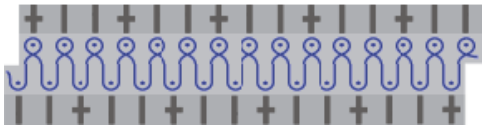
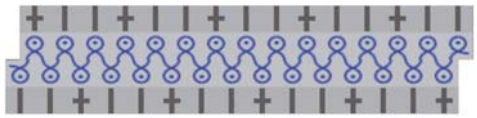
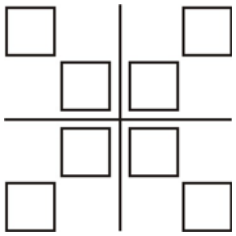
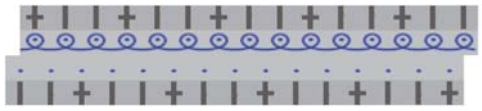
9.1 Tubular / DJ / half cardigan

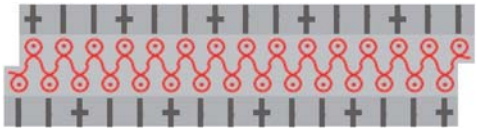
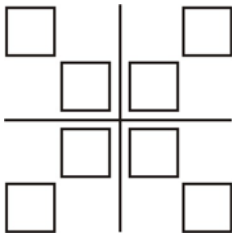
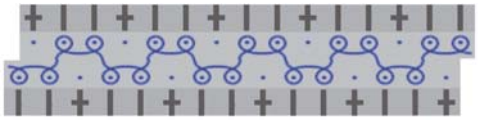
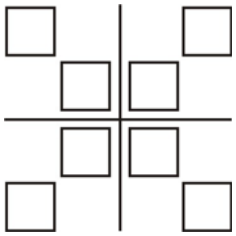
Tubular				
<< S: 0 – R;	**Y:1;**	**NP 3 - 3**		
>> S: R – 0;				
Double Jersey (DJ)				
<> S: R – R;	**Y:1;**	**NP 1 - 1**		
Half Cardigan				
<< S: R – F;	**Y:1;**	**NP 2 - 1**		
>> S: R – R;				

9.2 Double Half Cardigan / Full Cardigan

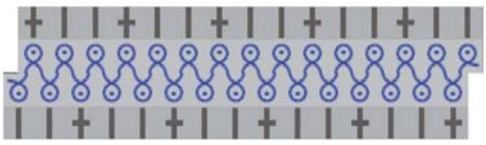
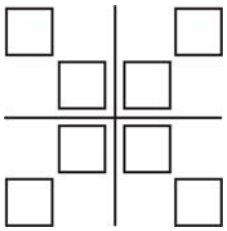
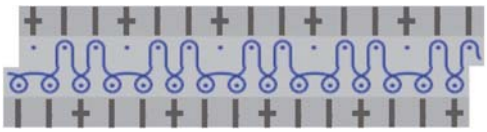
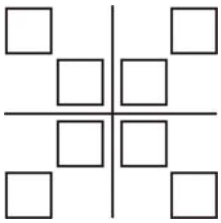
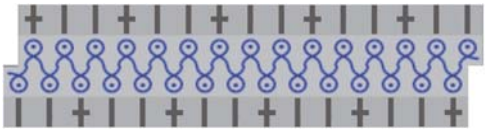
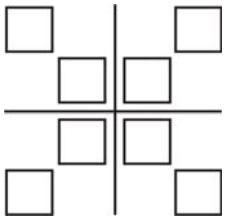
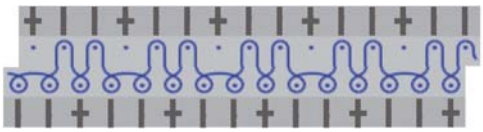
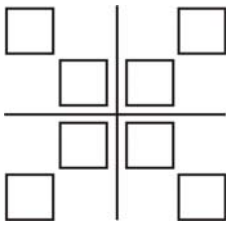
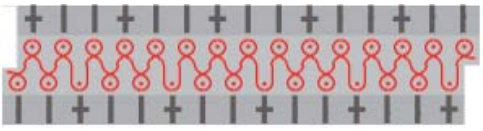
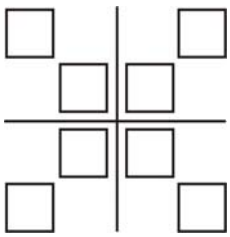
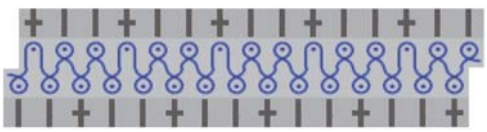
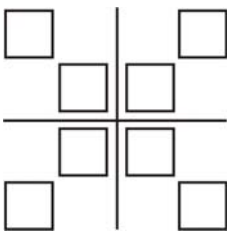
Double Half Cardigan				
<< S: R – R;	**Y:1;**	**NP 2 - 1**		
>> S: R – R;				
<< S: R – F;	**Y:2;**			
>> S: R – F;				
Full Cardigan / tuck				
<< S: R – F;	**Y:1;**	**NP 1 -1**		
>> S: F – R;				

9.3 Double Full Cardigan / Half Milano / Colorful pattern

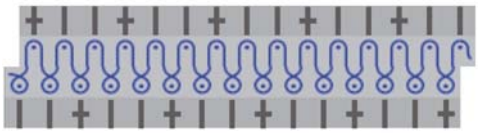
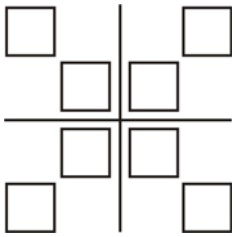
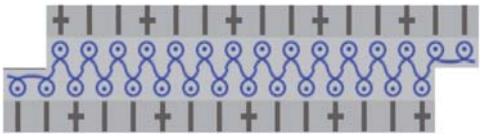
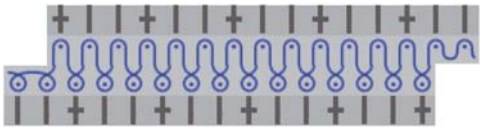
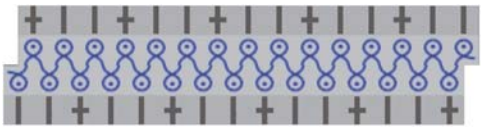
Double Full Cardigan				
<< S: R – F;	**Y:1;**	**NP 1 - 1**		
>> S: R – F;				
<< S: F – R;	**Y:2;**			
>> S: F – R;				
Half Milano / Half Tubular				
<< S: R – R;	**Y:1;**	**NP 2 - 2**		
>> S: 0 – R;				

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

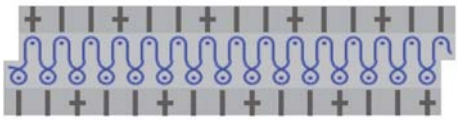
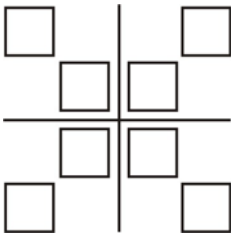
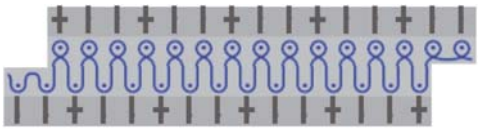
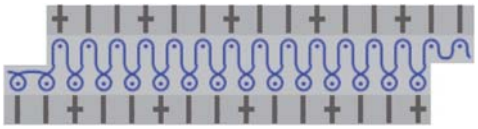
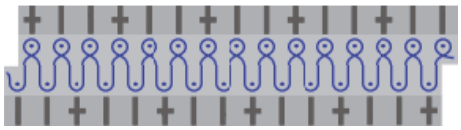
9.4 Knop / Tuck Pattern

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;**			

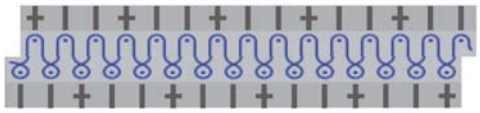
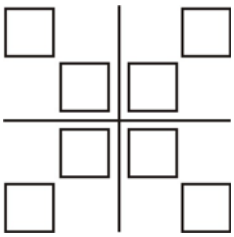
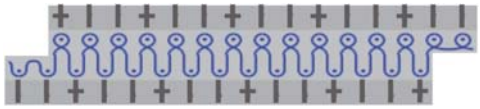
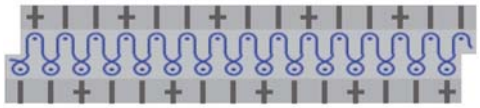
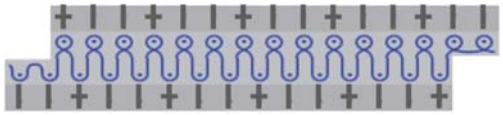
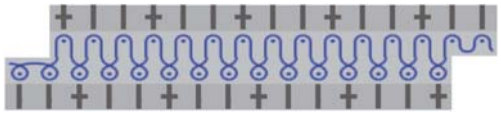
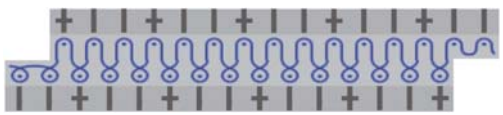
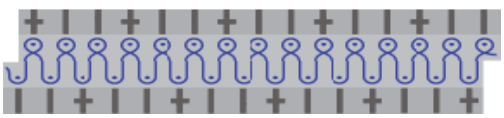
9.5 Half Cardigan Racked

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;				

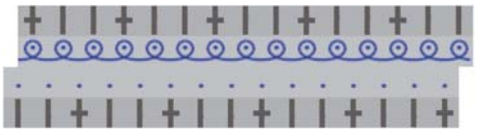
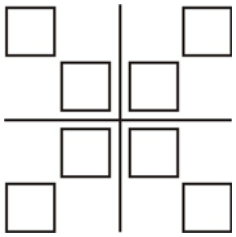
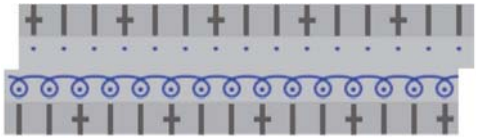
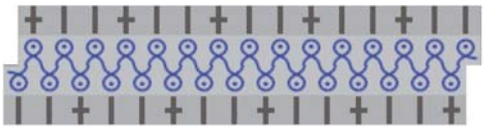
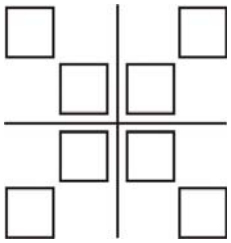
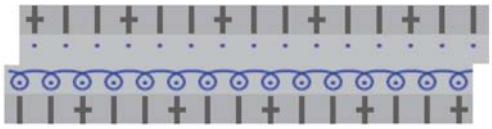
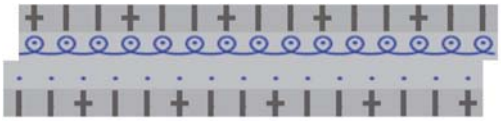
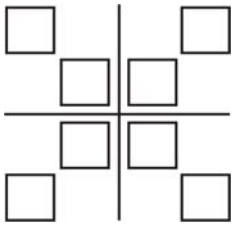
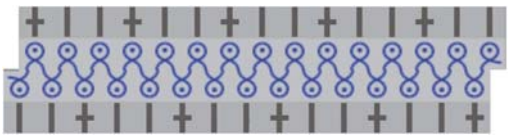
9.6 Full Cardigan Racked

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 Heringbone

Heringbone				
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

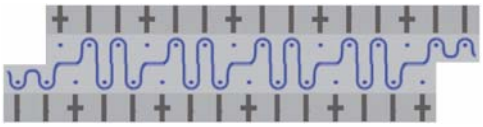
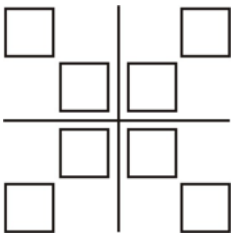
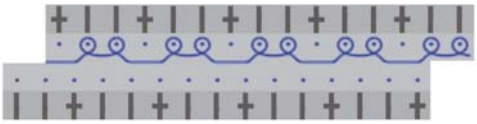
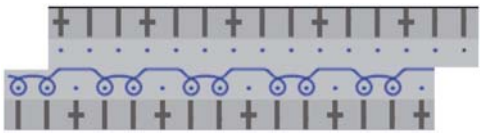
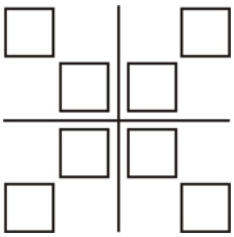
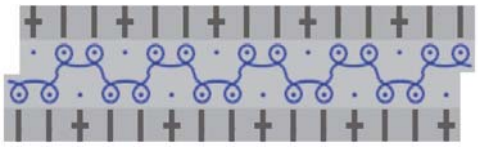
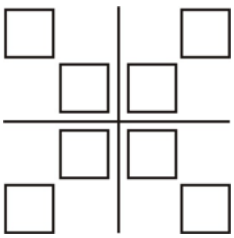
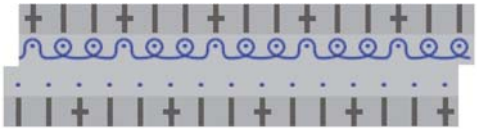
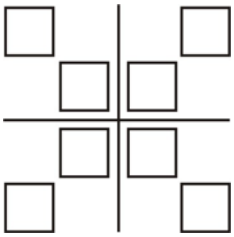
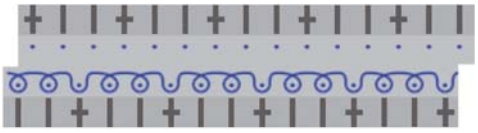
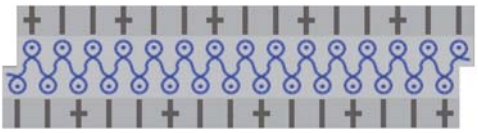
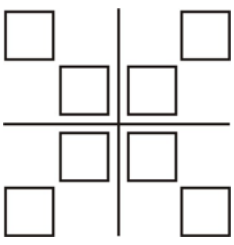
Group	Contents
I	All patterns (basic structures) without special characteristics.
II	Racking pattern without and with missing needle
III	Missing needle pattern
IV	Pattern combinations
V	Casting-off pattern
VI	Cable
VII	Pointelle
VIII	Fully Fashion

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

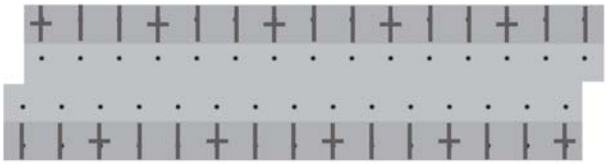
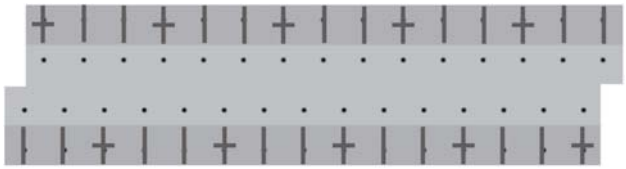
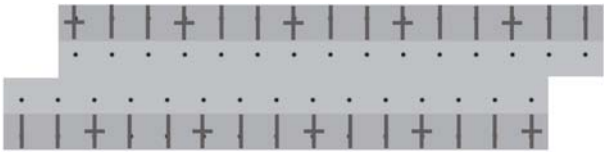
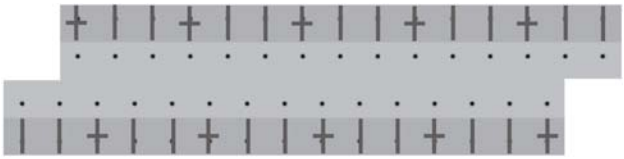
The basic structures can be knitted with plain color or with color change.

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;				

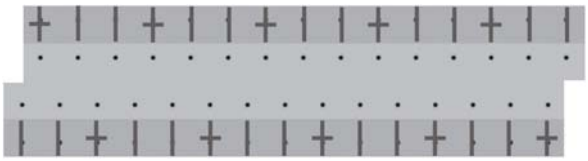
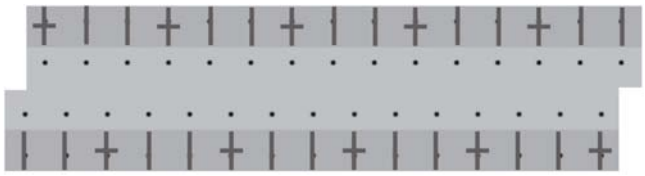
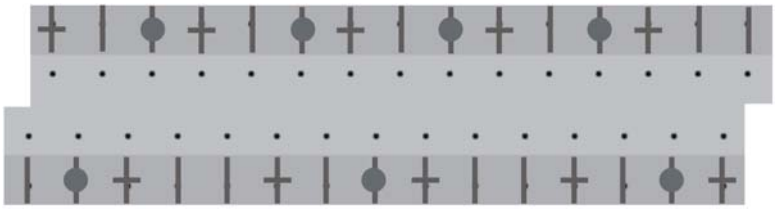
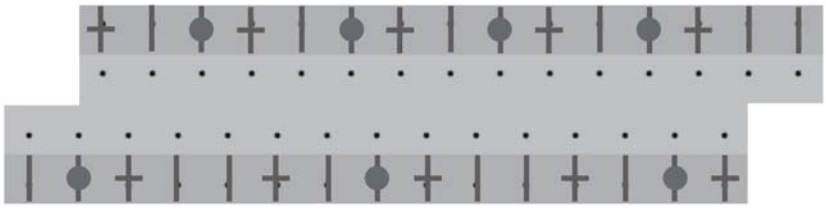
10.3 Group II: Racking pattern

Without missing needle:

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

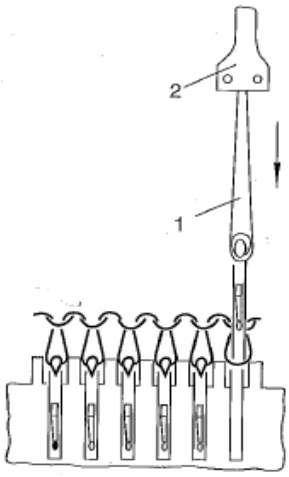
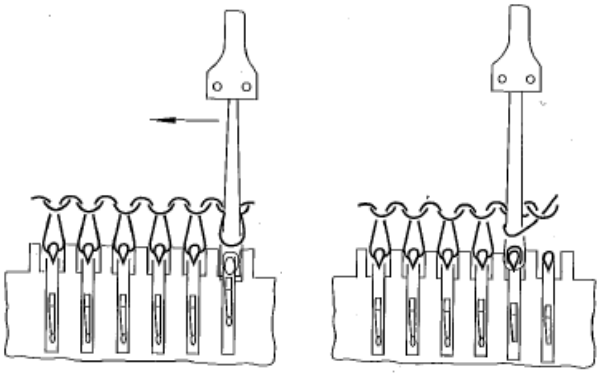
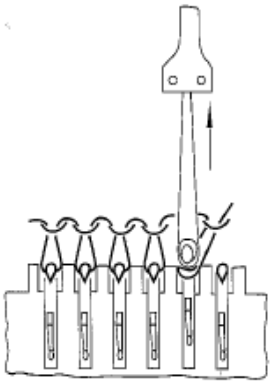
Course-related racking	Row-related racking
Meaning:	
Racking after every 2 stitch rows.	Racking after every stitch row.
=>	=>
Related basic structures:	
◆ ◆	

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:	
 **= missing needle**	
	
Rack the rear needle bed by one position **V>1**	
	

10.4 Procedure when transferring stitches

> **i** 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

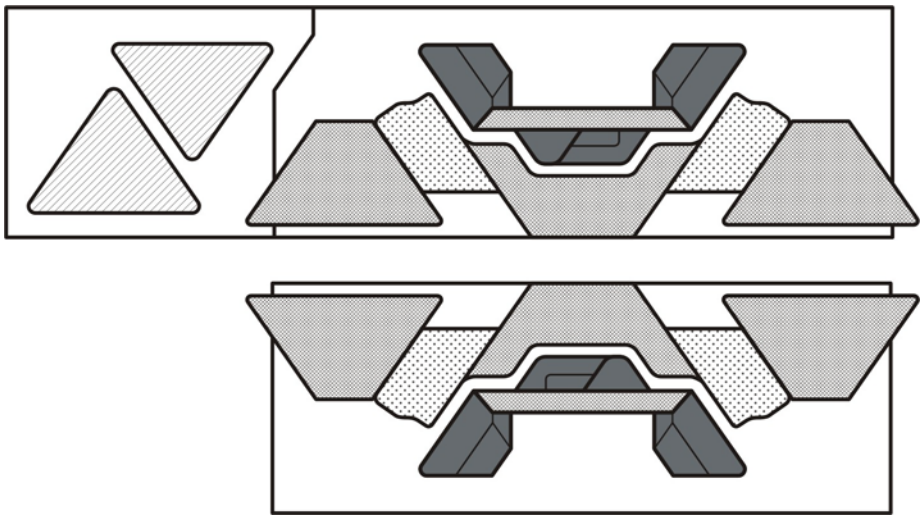
Needle classification	Used needle types	
Needle classification with only one needle type	◆ = High butt needle ◆  = missing needle	i: From a knitting technique point of view there is no difference between high and low butt needles.
Needle classification with two needle types	◆ = High butt needle ◆  =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

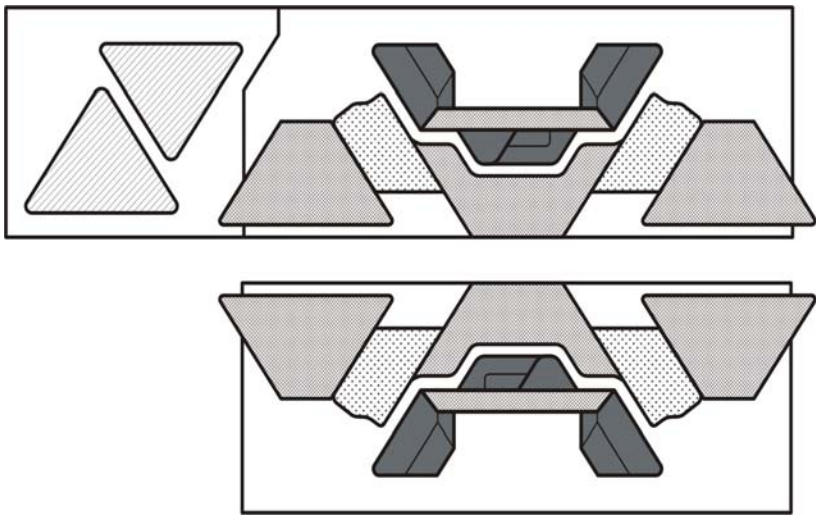
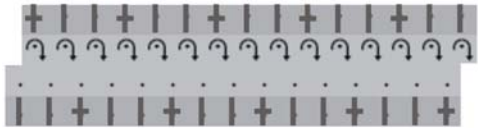
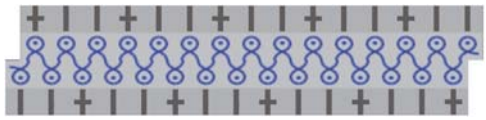
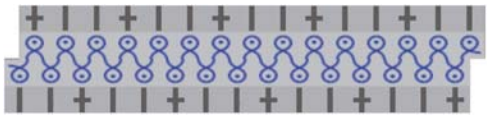
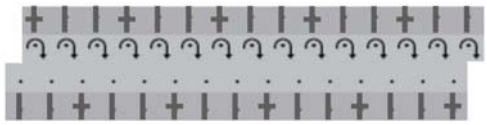
10.7 Group V: Casting-off pattern

> **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).

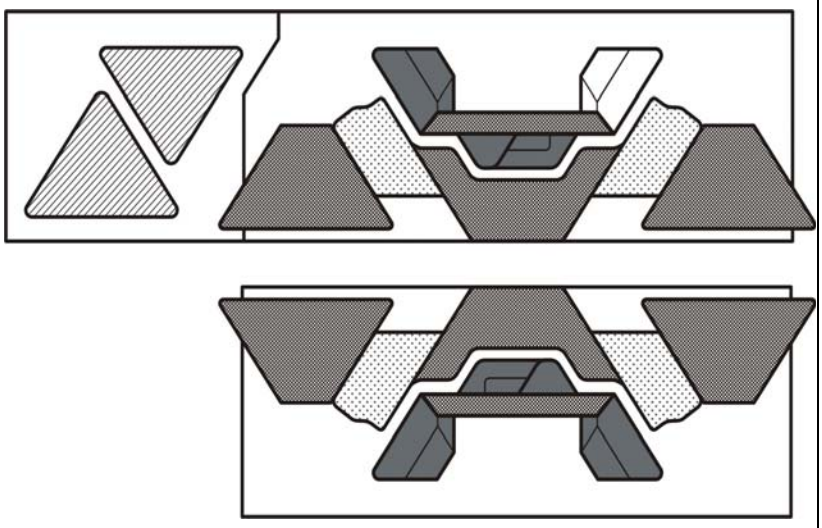
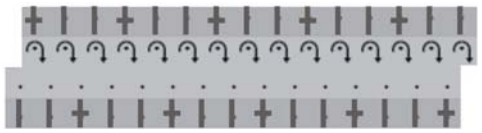
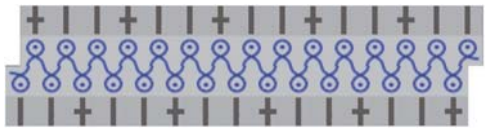
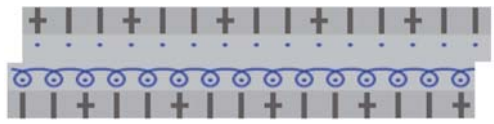
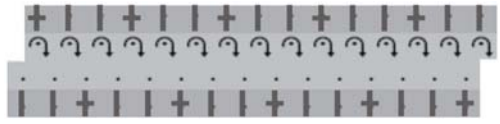


	Casting-off cams	
	0	Standard position: Casting-off cams are up **i**: Needles do not run through the casting-off cam
	1	Casting-off cams are down **i**: High butt / low butt needles run through the casting-off cam
	1/2	Casting-off cams are halfway up **i**: ◆ High butt needles run through the casting-off 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)					
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 – 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:

i	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

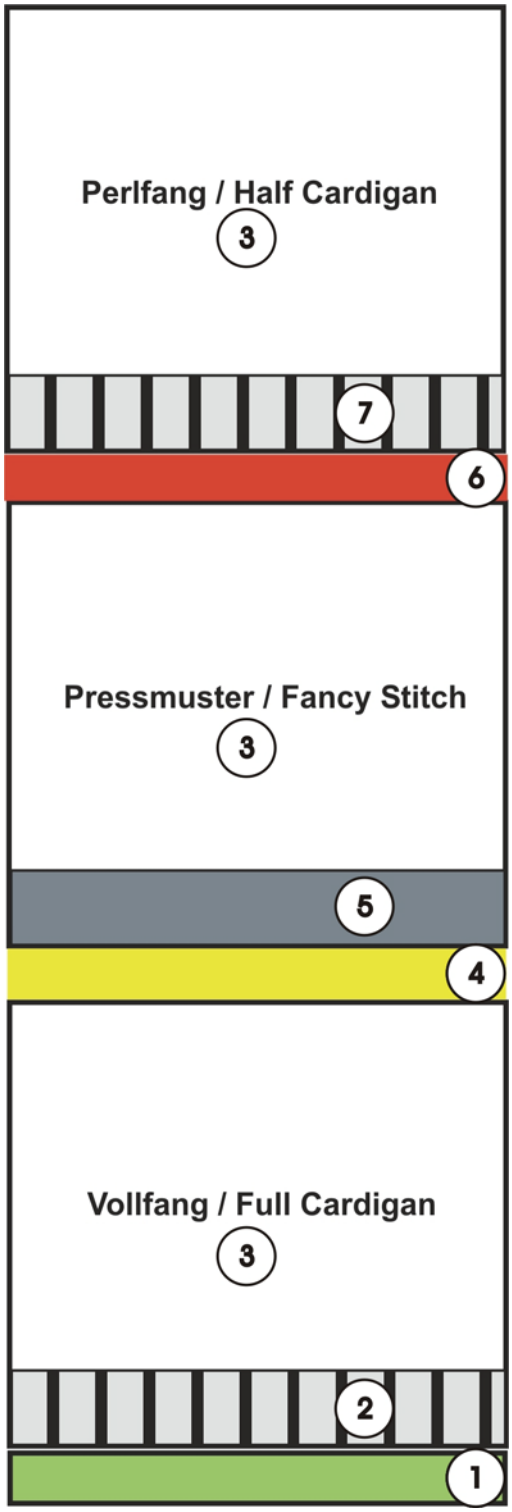
i: The thread will be pulled out after finishing

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

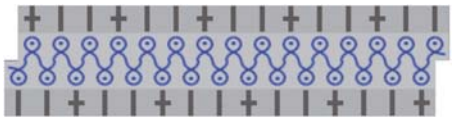
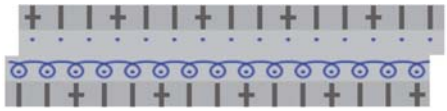
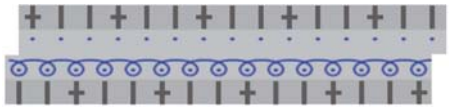
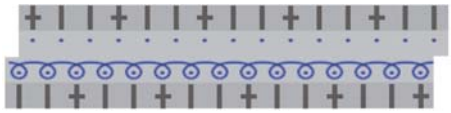
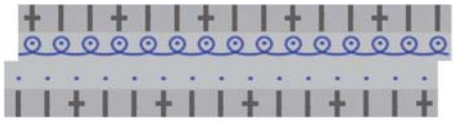
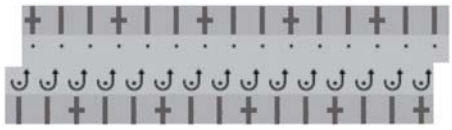
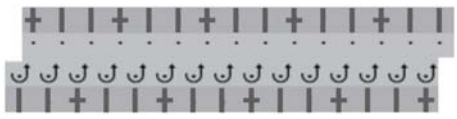
i: The thread is dissolved when damping the fabrics. Leaves residues.

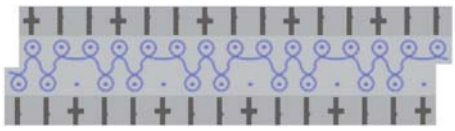
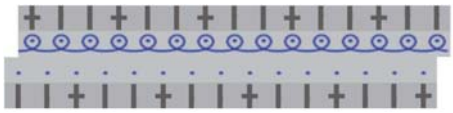
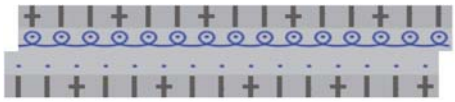
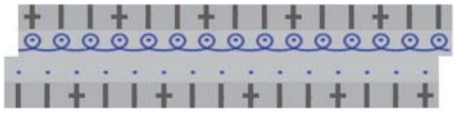
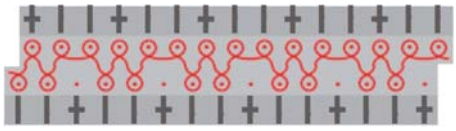
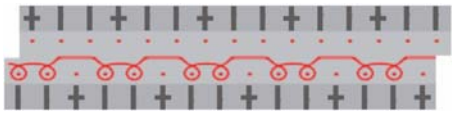
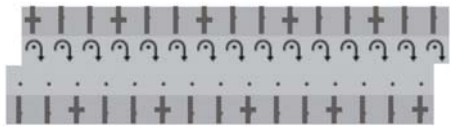
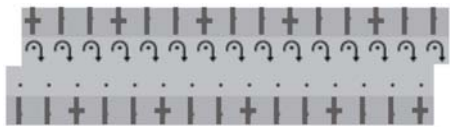
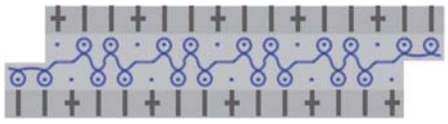
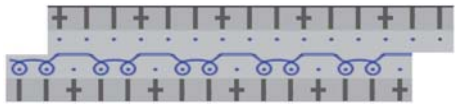
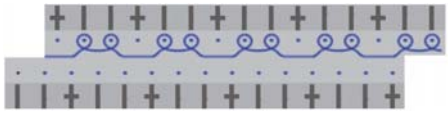
- Metal draw thread
  - Use in the area of technical textiles (e.g. Kevlar, glass fiber)

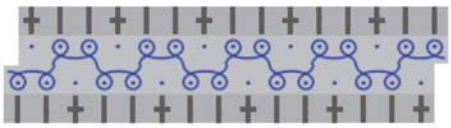
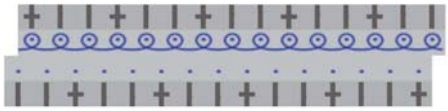
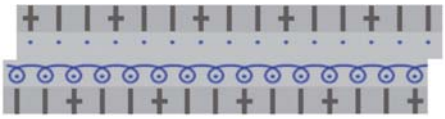
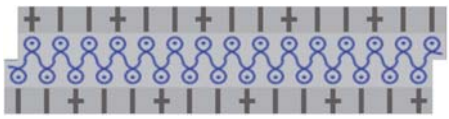
Pattern examples for the manual flat knitting machine

Graphic presentation	No.	Knitting sequence
	**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

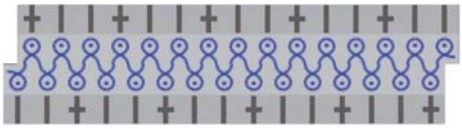
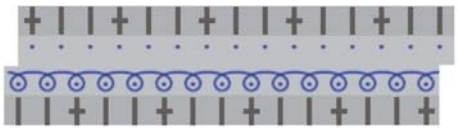
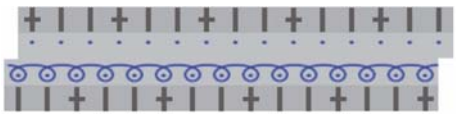
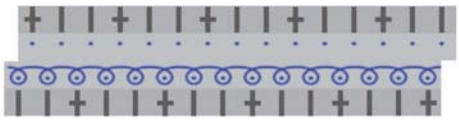
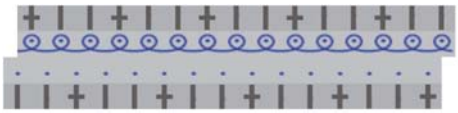
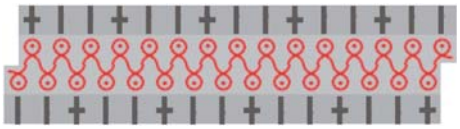
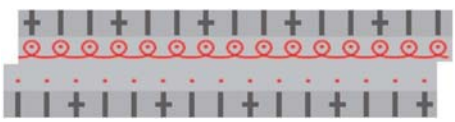
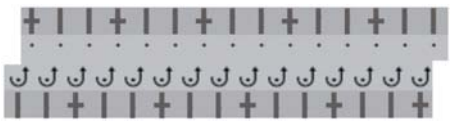
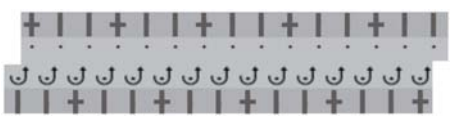
10.8.1 Transition with Draw Thread for 2x1 Start

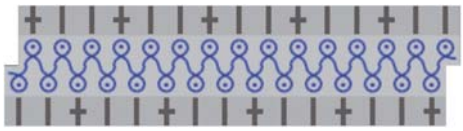
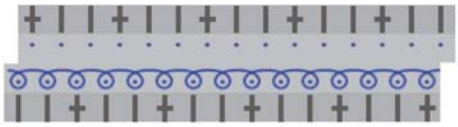
Last row of the previous fabric				
>> S: R – R;	**Y:1;**	**NP 2 - 2**		
<< S: R – 0;		**NP 3 - 2**		Protective rows in the front needle bed **i**: After casting-off the stitches this prevents ladders
>> S: R – 0;				
<< S: R – 0;				
>> S: 0 – R;		**NP 2 – 2**		
<< S: R – 0;	**Y:0;**	**NP 2 - 2**		Casting-off 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;				

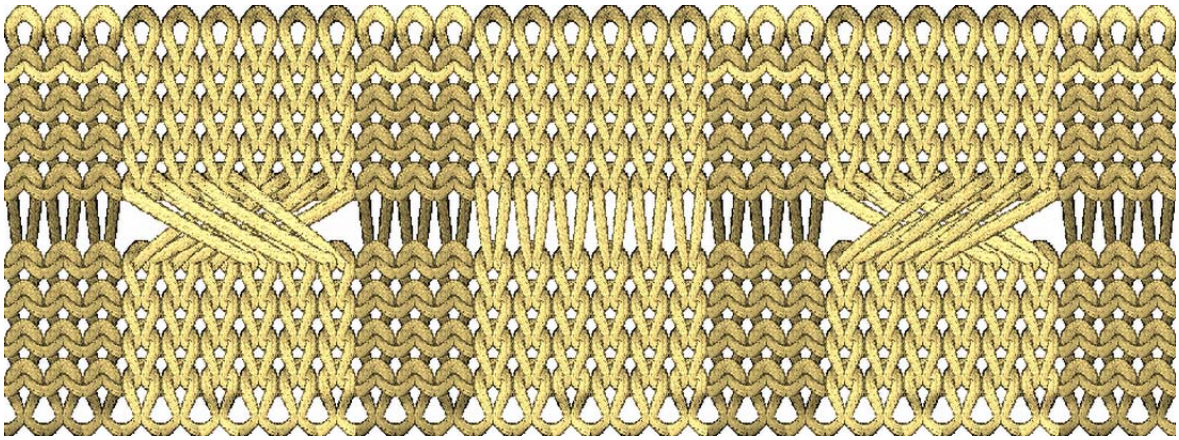
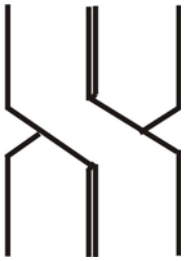
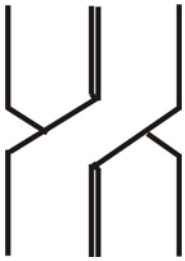
10.8.2 Transition with Draw Thread for DJ Start and Tubular Start

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;				

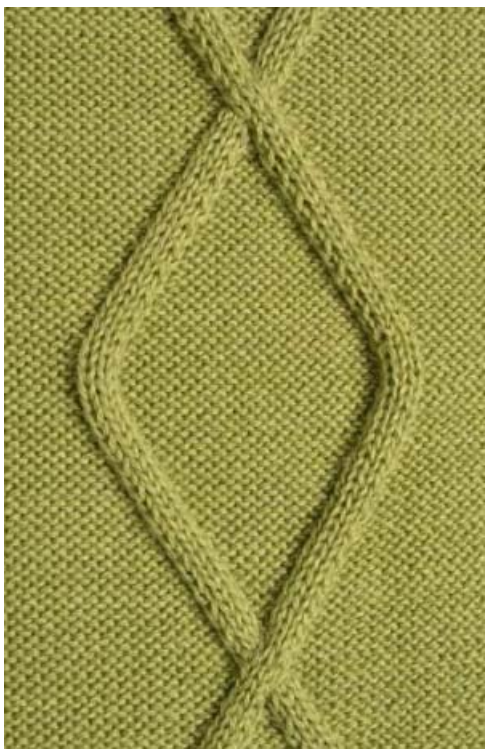
<< S: R – R;	**Y:1:**	**NP 1 - 1**		**i**: Net row of the new fabric
>> S: R - 0;		**NP 2 - 2**		
Carry on in the cycle of the desired start!				

10.9 Group VI: Cable

Knitting technique with cable stitch:
Cable stitch cross-overs are achieved by transferring stitches.

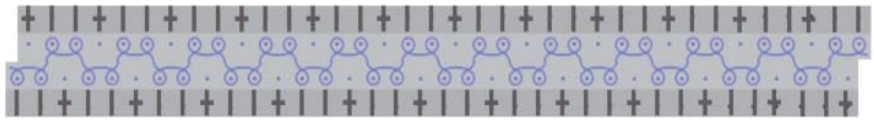
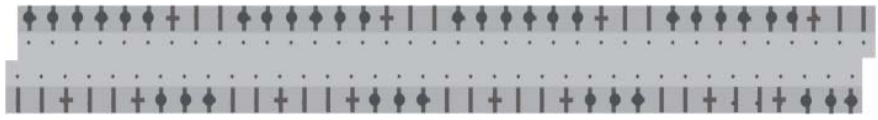
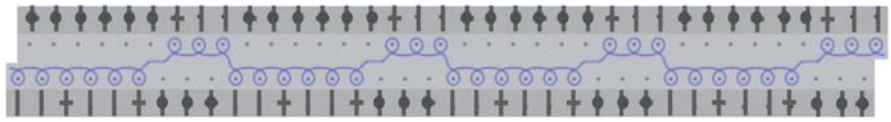
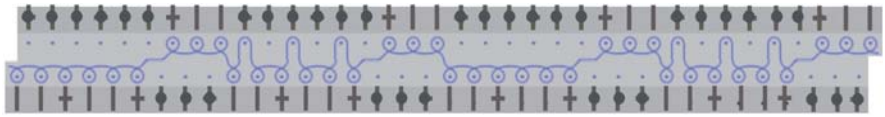
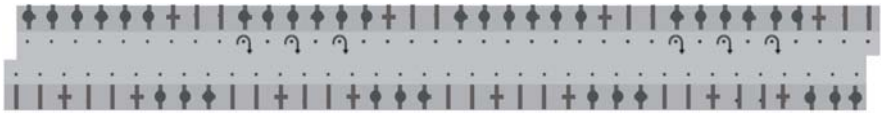
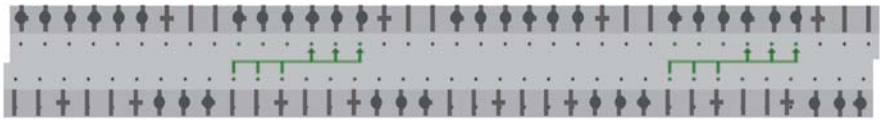
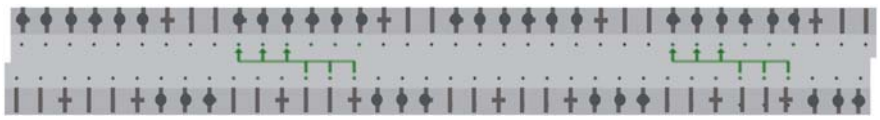
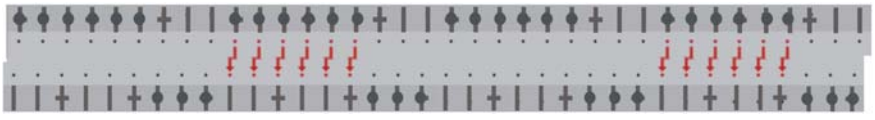
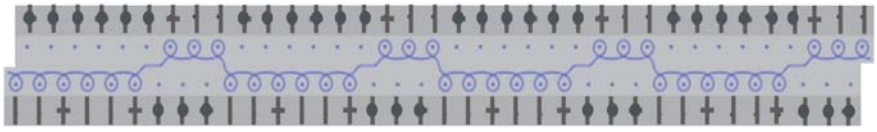
Cable stitch cross-over to the left (crossed to the left)	Cable stitch cross-over to the right (crossed to the right)
	
	

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

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

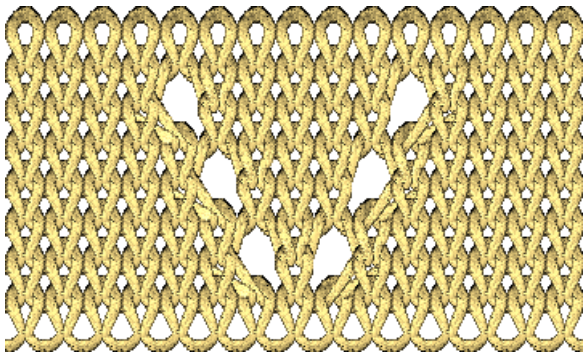
Cable examples	
Cable + Aran structure 	Aran structure 
3x3 cable with spread needle 	2x1 Aran 

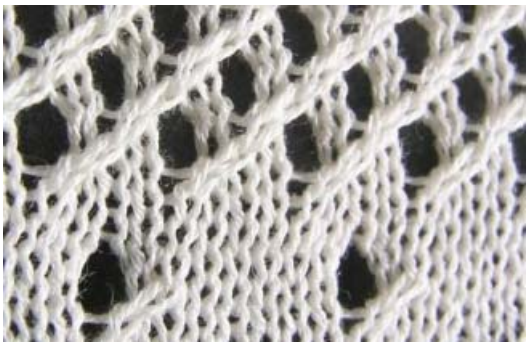
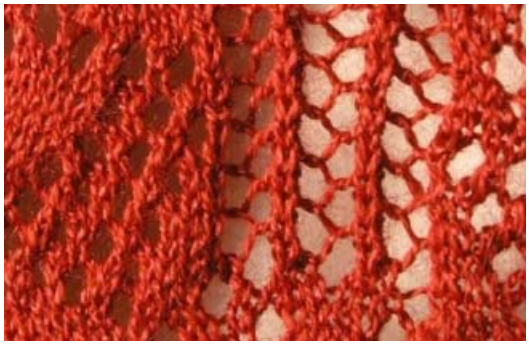
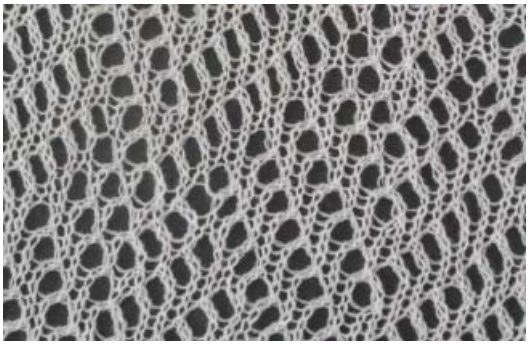
10.9.1 Stitch Line of 3x3< Cable

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			

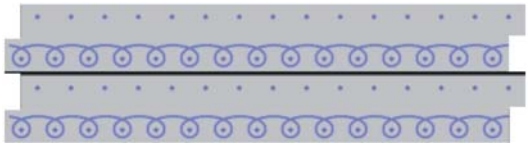
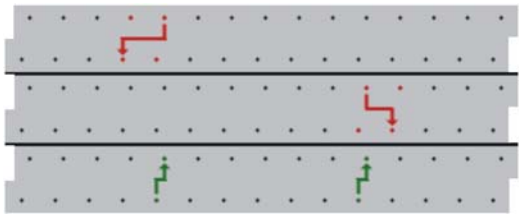
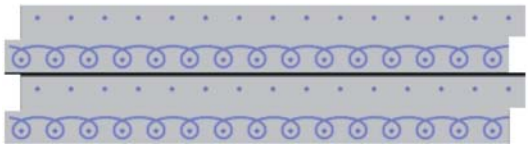
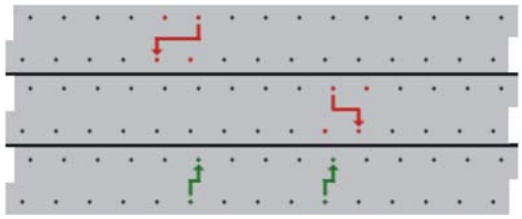
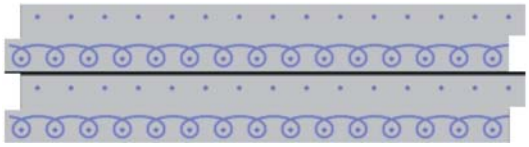
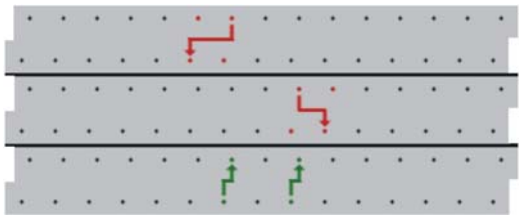
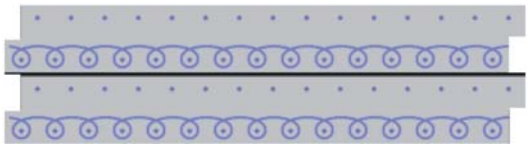
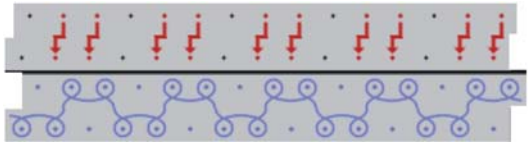
10.10 Group VII: Pointelle

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

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

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 selvedges.
Fixed edges are the result where no stitches can run.

Standard shapes

Raglan	
Saddle shoulder	
Inserted sleeve	
French Shoulder	

Components of a pullover

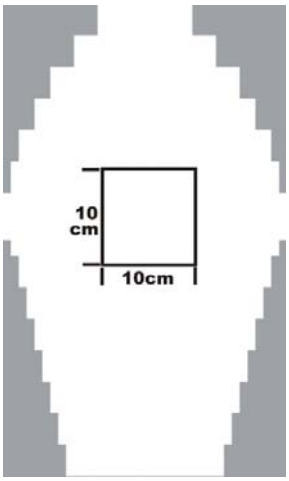
	**Front piece**	Without neckline	The collar will be sewed on ◆ Stand-up collar ◆ Turtleneck, etc. ◆ i: If necessary a gore will be knitted in the front.
		With neckline	◆ V-neck ◆ Round neck neckline ◆ Boat neck neckline ◆ Other neckline variants
	Back piece	i: If necessary a gore will be knitted in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

10.11.1 Stitch Ratio

> **i** 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**:



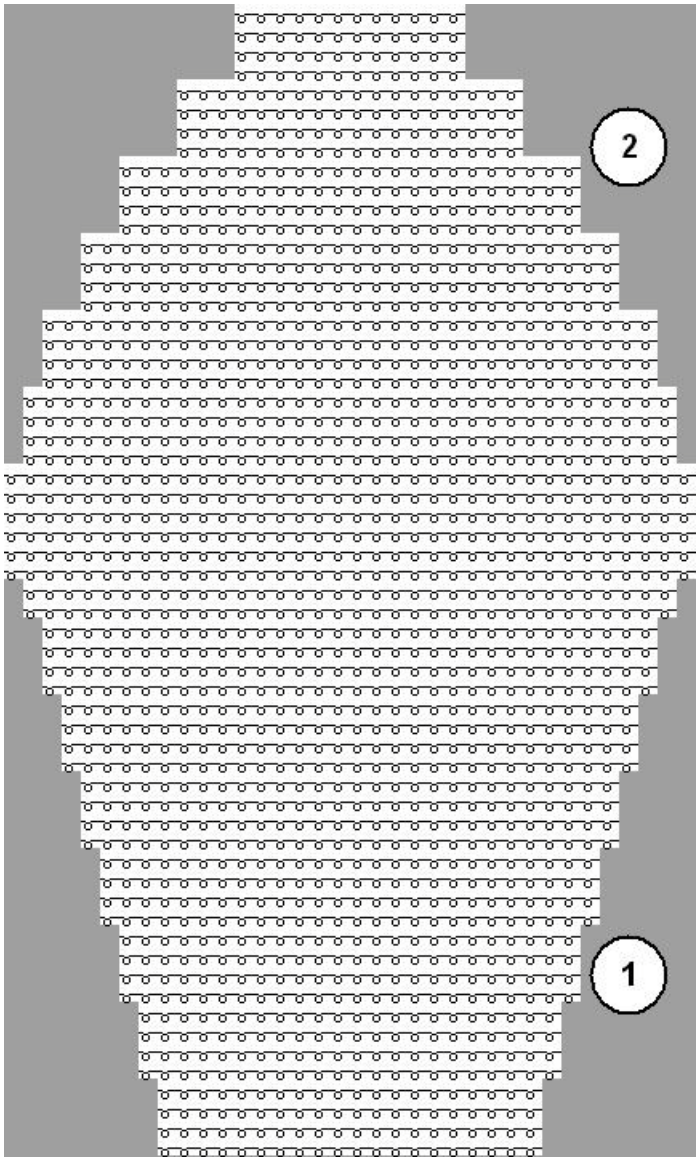
  - In the test fabric mark an area with the desired measure unit (**mm** / **cm** / inch).
  - In this area count the number of stitches in terms of width and height (rows)

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 height:**
  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

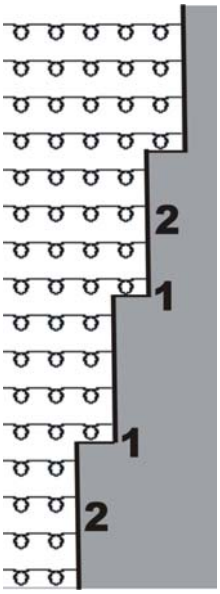
Shaping by widening / narrowing



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

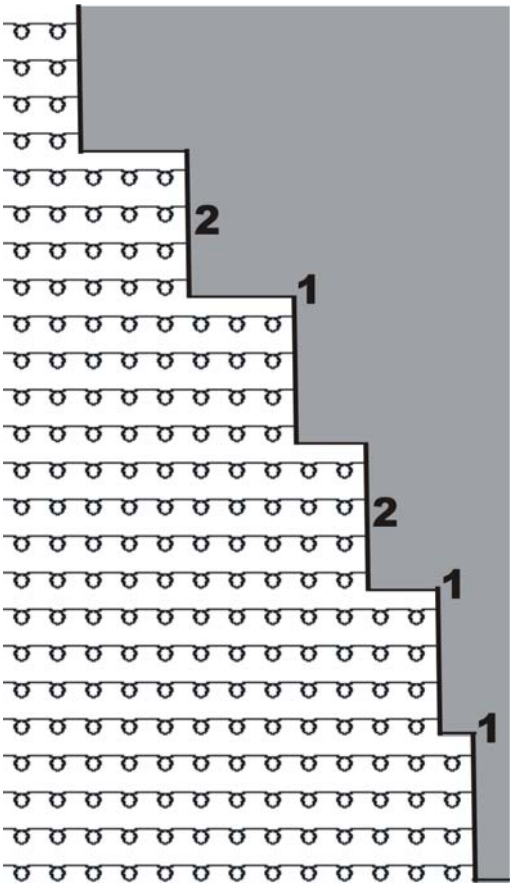
Step height and step width when widening / narrowing

Widening



1	**Step width** i: Widening always only 1 needle
2	**Step height** = Number of rows between two widenings i: Step height is as desired

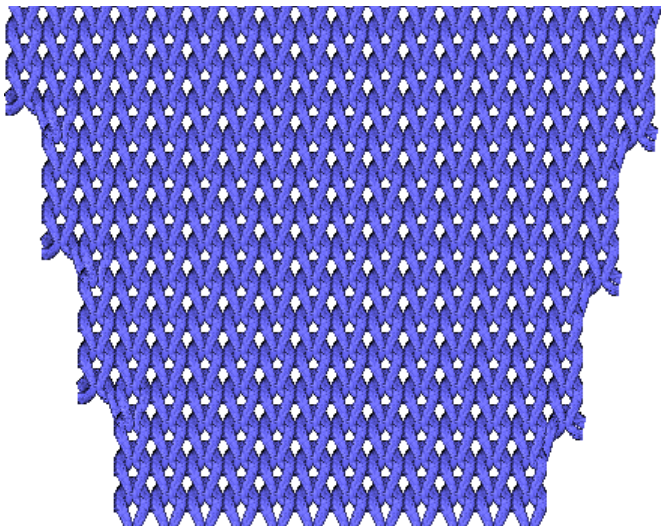
Narrowing

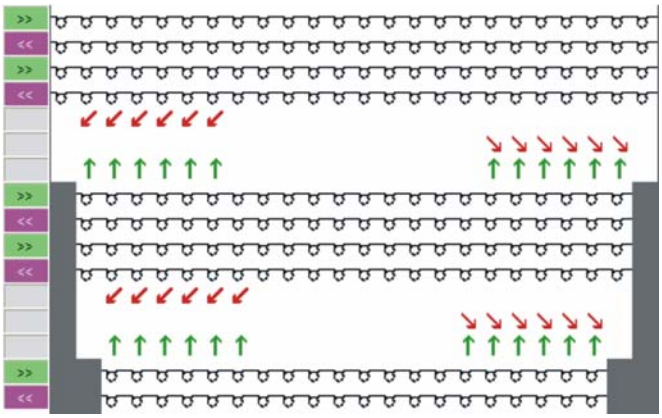
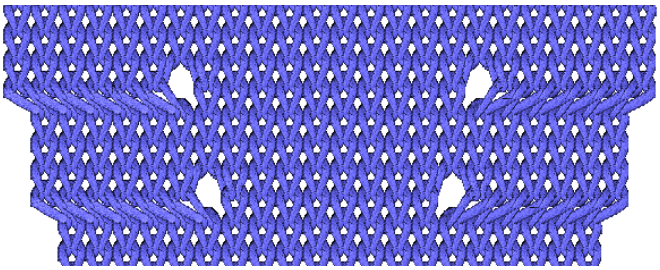


1	**Step width** ◆ 1 needle narrowing ◆ 2 needle narrowing ◆ 3 needle narrowing i: Step widths of more than 3 stitches are bind-off.
2	**Step height** = Number of rows between two narrowings i: Step height is as desired

10.11.3 Widening Procedure by the Example of Single Jersey fabric

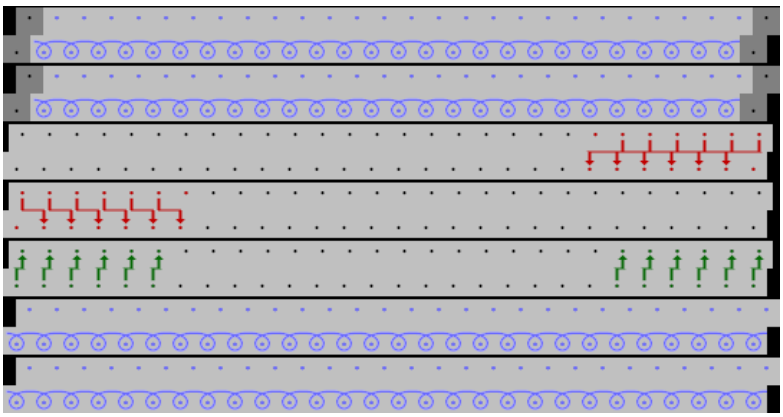
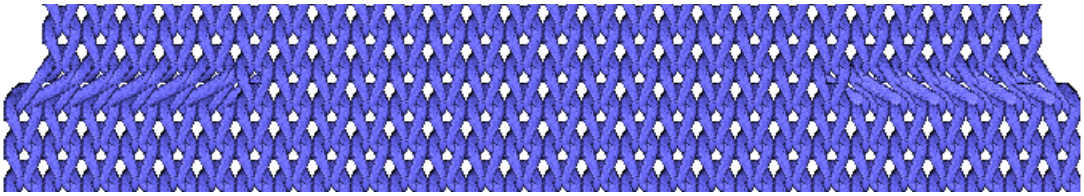
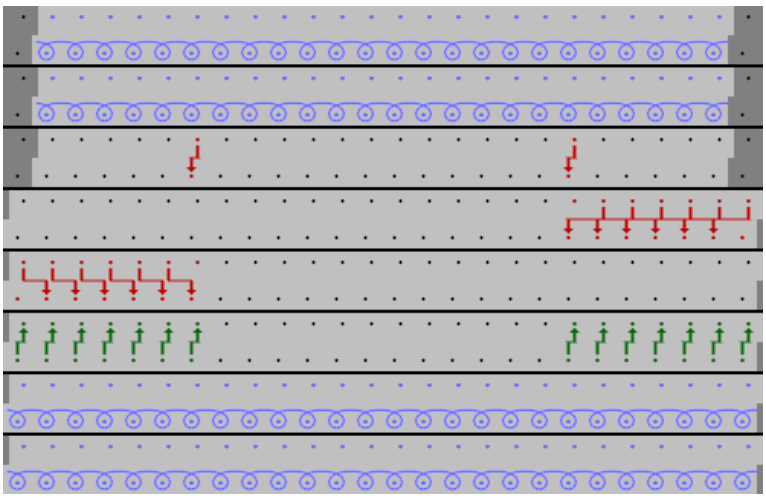
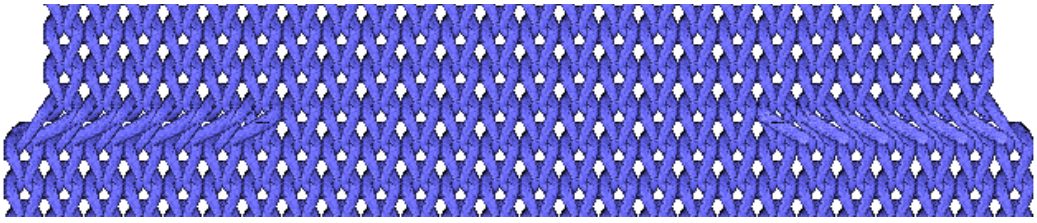
Widening

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-depending and therefore the yarn insertion (=tuck) is more secure.
	

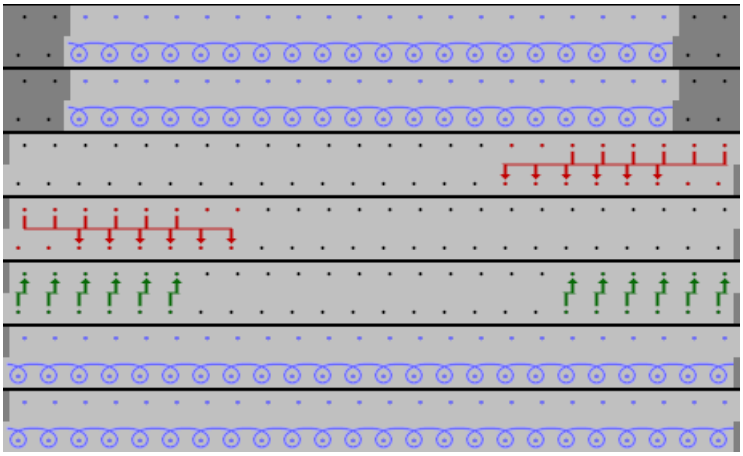
Widening by transferring stitches by one needle outward = pointelle (without closing)	
 	i: The hole (=pointelle) that resulted from transferring stitches outward (stitch group = widening width) can also be closed by knitting + transferring a tuck. (= Widening with Closing-Stitch)

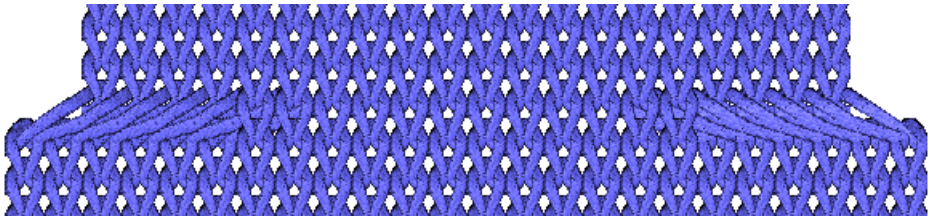
10.11.4 Narrowing Procedure by the Example of Single Jersey

Narrowing

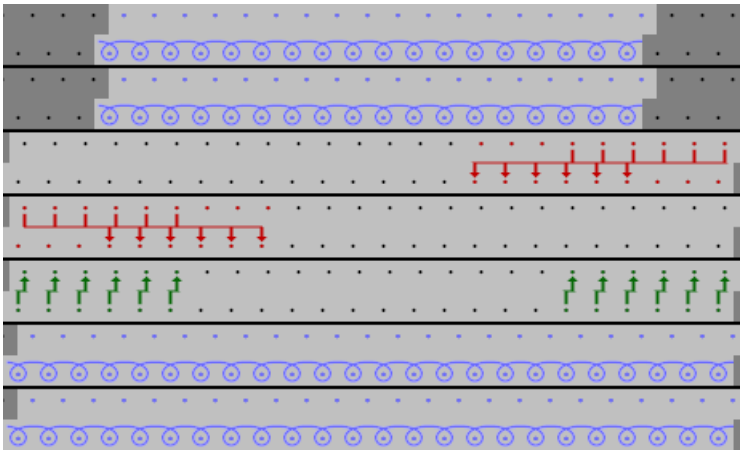
1 needle narrowing underneath


1 needle narrowing above



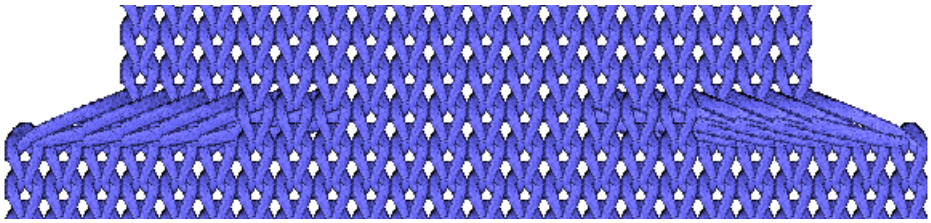
2 needles narrowing underneath

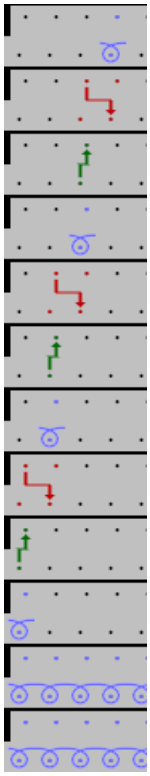
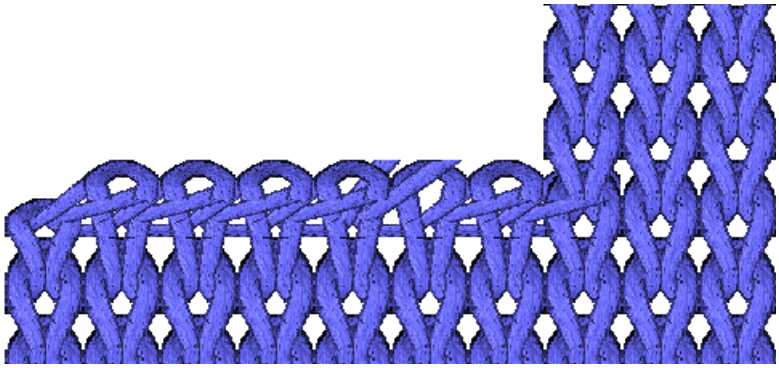




3 needles narrowing underneath



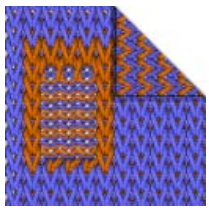
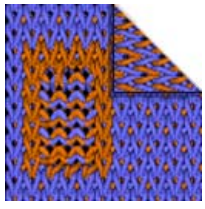
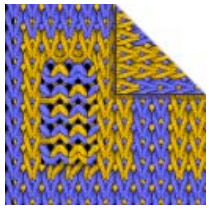


Binding-off (to the right >>)	
	

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. i: 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	
	

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.

i: 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.

i: Different gauges (visual effects) are knitted within one pattern row.

11.4 Knitting Technique: Knit and wear

<table>
<tr><th colspan="2">Knitting technique Knit and Wear</th></tr>
<tr><td colspan="2">According to its knitting technique, front, back and sleeves are knitted (manufactured ready to wear) on the machine => no make-up necessary</td></tr>
<tr><td>  </td><td>◆ Minor finishing necessary
◆ Then generally finishing (washing) needed</td></tr>
<tr><td> 
</td><td>◆ With intarsia
◆ Further Possibilities:
– With pockets
– Different neckline solutions
– Structures</td></tr>
</table>

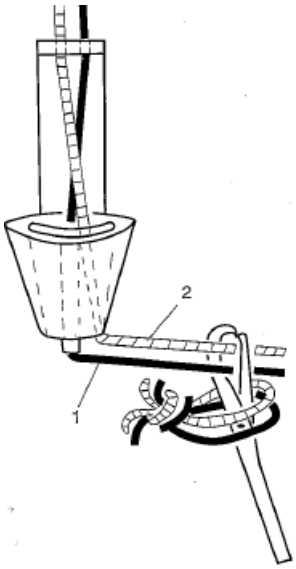
11.5 Knitting Technique: Plating

Plating technique

When plating two threads are inserted in the needle hook.

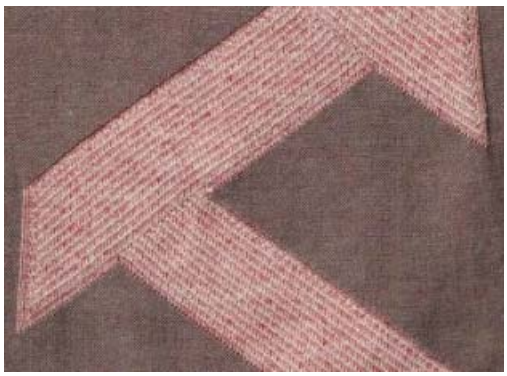
Types of plating:

- Color plating: Patterning effect
- Elastane plating: Manufacturing elastic fabrics



1 Plating yarn
2 Basic yarn

Color Plating



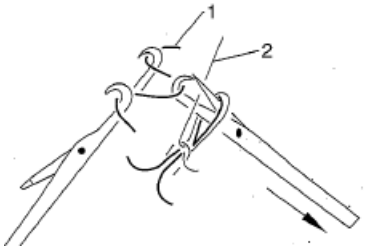
Elastane plating

- Use in the start: more elastic rib
- Use in complete article: for fashionable, tight fitting fabrics

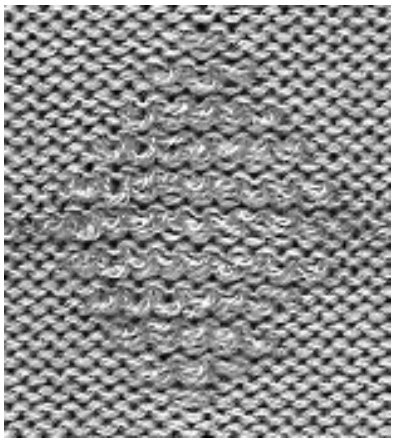
11.6 Knitting Technique: Plush

Plush

= formation of thread loops

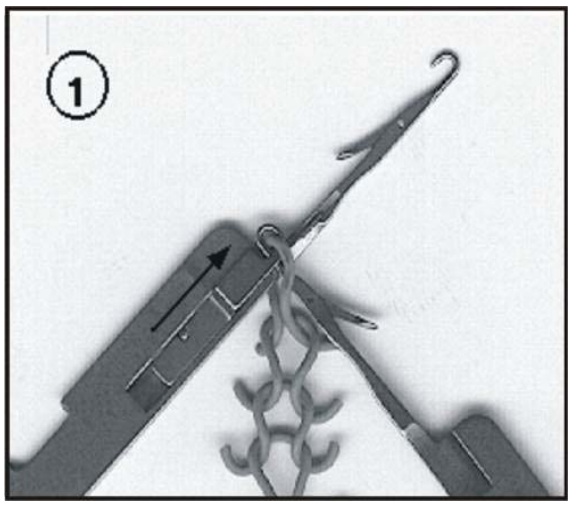
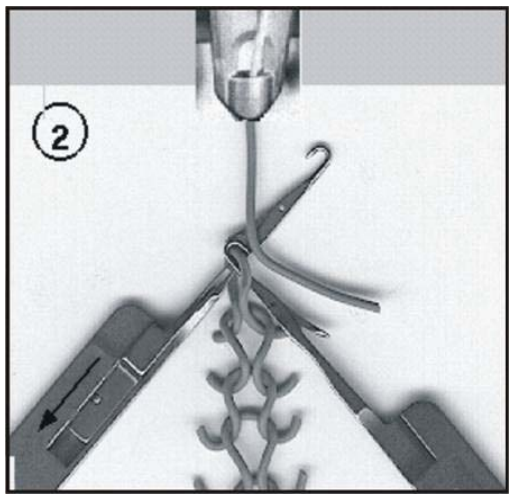
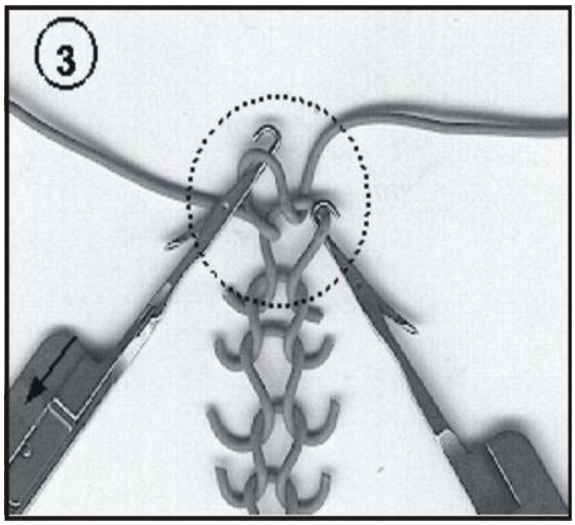
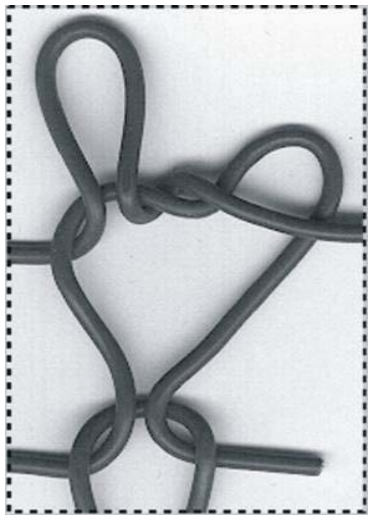


i: For knitting plush special cams are to be assembled in the CMS.



- 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

Split technique	
Dividing stitches to avoid hole formation	
	
	

	◆ 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

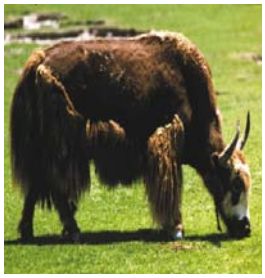
Definition of the concept:
Yarn = single yarn

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**	

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

<table>
<tr><th colspan="4">Yarns</th></tr>
<tr><td colspan="2">Single yarns
</td><td>Plied yarns
  </td><td>Twisted yarns
= plied yarn
  </td></tr>
<tr><td colspan="2">i:
Yarn without plying or twisting</td><td rowspan="2">i:
At least two yarns that are wound together but not twisted together.</td><td rowspan="2">i:
All linear textile formations produced by twisting (twining) together at least two yarns.</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>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</td><td>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
  </td><td colspan="2"></td></tr>
</table>

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

- Production with one plying process

Two-ply yarn

Folded yarn from two single yarns

Multiple-ply yarn

All folded yarns from more than two single yarns.

Three ply yarn

Four ply yarn

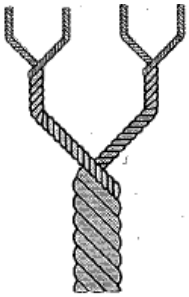
Cabled yarn

- Production out of at least two plying processes
- Consisting of folded and/or cabled yarns

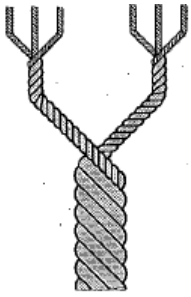
i: Single yarns can also be used.

2-cabled yarn

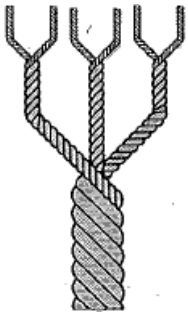
4 ply yarn



6 ply yarn

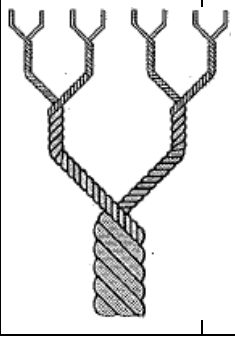


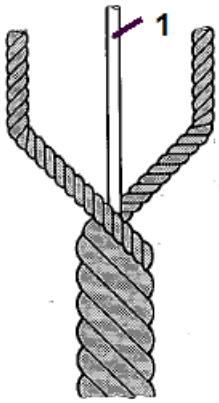
6 ply yarn



Three ply cable

8 ply



Core spun yarn (special yarns)	
	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

i: 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

> **i** 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

<table>
<tr><td colspan="4">Yarn classification
= yarn identification depending on its thickness</td></tr>
<tr><td colspan="2">↙</td><td colspan="2">↘</td></tr>
<tr><td colspan="2">by length = count</td><td colspan="2">by weight = titer</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">i: Reference value is a permanent weight.</td><td colspan="2">i: Reference value is a permanent length.</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Formula:</td><td>Yarn number = length / weight</td><td>Formula:</td><td>Titer = weight in grams multiplied by determined length / length in meters</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">i: The higher the number, the finer the yarn.</td><td colspan="2">i: The higher the number, the thicker the yarn.</td></tr>
</table>

12.6.1 By Length = count

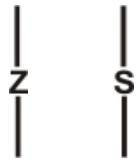
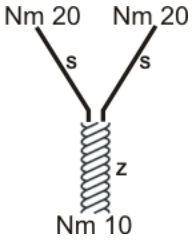
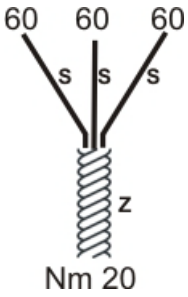
By length = count:

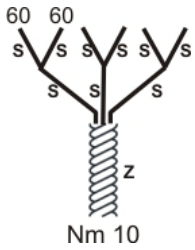
> The yarn gauge is determined by the number of length units per weight unit.

- 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** i: Standard commercial designation for handicraft yarns and sewing threads.
NeW	Worsted count (English Wool count) extension **W** (**w**orsted wool) i: Outdated additional specification, in case of likelihood of confusion.
NeL	Lea count (English Linen count) i: 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)**

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

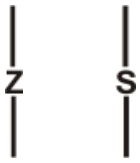
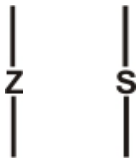
12.6.2 By Weight

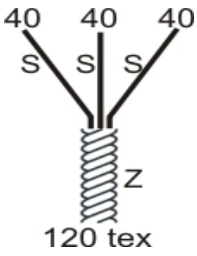
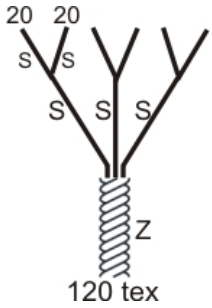
By Weight = Titer:

> 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		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)**
		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	Two ply cable 	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':

- **tex = 1000 / Nm**
- **Nm = 1000 / tex**
- **tex = 590 / Ne**

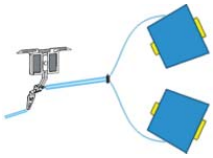
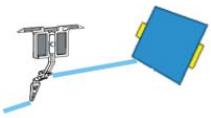
II. I. Conversion from ‚dtex' to ‚den':

- **den** = Grams (g) / 9000m
- **dtex** = Grams (g) / 10000m
- **dtex** = 10 / 9 den
- **den** = 9 / 10 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 x 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**

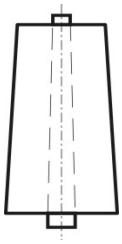
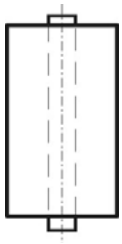
12.8 Bobbin Types

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

<table>
<tr><td colspan="3">Bobbin Types</td></tr>
<tr><td>Conical cross-wound bobbin
  </td><td colspan="2">Cylindrical cross-wound bobbin
  </td></tr>
<tr><td></td><td>Front side straight</td><td>Front side at an angle</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>◆ Yarn unwinding direction to the top
=> The bobbin does not rotate</td><td colspan="2">◆ Yarn unwinding direction to the top possible but not optimal
=> The bobbin does not rotate
i: When unwinding, the thread is "plucked" => Yarn breakage!
◆ Recommendation: Rewind on conical cross-wound bobbins.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Advantages:</td></tr>
<tr><td colspan="3">◆ 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)</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Disadvantages</td></tr>
<tr><td colspan="3">◆ Due to the winding around the bobbin when unwinding, the yarns looses 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)</td></tr>
</table>

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)