Withdrawn; however may be applied on special agreement !

EUROMAP 15

PROTOCOL FOR COMMUNICATION BETWEEN INJECTION MOULDING MACHINES AND A CENTRAL COMPUTER

Part 5

PROCESS DATA TRANSFER FOR STATISTICAL PROCESS CONTROL (SPC)

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This recommendation was prepared by the Working Group "Electronic Control of Injection Moulding Machines" of EUROMAP.

It is part of the complete EUROMAP 15 recommendation.

Contents

1. Introduction

Part 5 of the EUROMAP 15 recommendation, process data transfer for statistical process control (SPC), defines the telegrams and data structures necessary to collect process data from the machine controller required to perform statistical process control or any other data evaluation on the central computer.

EUROMAP does not define a method to SPC in the machine controller, it defines only a means to transfer SPC related data from the machine controller to the central computer. In addition to the implementation of EUROMAP 15 part 5 any machine controller may or may not contain an internal manufacturer specific SPC system.

The telegrams are universally defined to allow collecting any kind of process related data such as temperatures, times, forces, positions, speeds, pressures, powers, part quality data, part counter, date and time as well as manufacturer specific parameters. The central computer can perform any data evaluation of interest going beyond SPC.

2. Types of Telegrams

2.1 Definition of Telegrams from the Central Computer

Telegram 200: SET DATA COLLECTION MODE

Byte	cont.	Description
05..06	-N02-	sample size ("01" to "99")
07..08	-N02-	sample interval for data acquisition ("00" means consecutive cycles)
09	-N01-	polling mode; automatic generation of standard answer with "204" if buffered data available
	"0"	- disabled
	"1"	- enabled
10	-N01-	sampling mode; start of sample is
	"1"	- on cycle number
	"2"	- on time
	"3"	- at end of previous sample
	"4"	- on request from the central computer
11..16	-N06-	number of cycles between start of samples; only used if sampling mode = 1
17..22	-N06-	time delay between start of samples in seconds; only used if sampling mode = 2

Telegram 201: **SELECT PARAMETERS**

Byte	cont.	Description
05	-N01-	number of the parameter group ("0", "1" or "2")
06	" "	(ASCII-blank)
07..08	-N02-	definition of parameter 1
09	" "	(ASCII-blank)
10..11	-N02-	definition of parameter 2
12	" "	(ASCII-blank)
13..14	-N02-	definition of parameter 3
15	" "	(ASCII-blank)
16..17	-N02-	definition of parameter 4
18	" "	(ASCII-blank)
19..20	-N02-	definition of parameter 5
21	" "	(ASCII-blank)
22..23	-N02-	definition of parameter 6
24	" "	(ASCII-blank)
		select a group of 6 parameters to be stored for reference from the central computer; group 0, 1 or 2 are possible; group 0 has a fixed set of parameters (see telegram "304"); if group 0 is selected, the definition of the parameters must be " " (2 ASCII blanks); parameter number according to SPC-parameter list; parameters 50 ... 99 is manufacturer specific; " " (2 ASCII blanks) means not used

Remark: Definitions are cleared by sending telegram "202" with byte 05 = "4".

Telegram 202: **REMOTE CONTROL OF SAMPLING PROCESS AT MACHINE**

Byte	cont.	Description
05	-N01-	remote control command
	"1"	- start
	"2"	- suspend
	"3"	- continue
	"4"	- stop (reset and clear parameter definitions)
06..08	-N03-	delay until start (cycles); only valid if byte 05 is "1" or "3" and sampling mode is not equal to 4

Telegram 203: **TAKE SAMPLE (REQUEST FROM CENTRAL COMPUTER)**
contains no data bytes

Remark: This telegram is only used if sampling mode = 4.

Telegram 204: REQUEST FOR SAMPLED PARAMETERS

Byte	cont.	Description
05	-N01-	identification of required parameter group
	"0"	- fixed group with date/time/part counter
	"1"	- user definable group no. 1
	"2"	- user definable group no. 2 (if present)
		if a parameter group is requested which is not existing or not definied, then telegram "305" with byte 05 = "5" is transferred
06..07	-A02-	identification of required cycle within sample
	" M"	- mean value
	" R"	- range
	" S"	- standard deviation
	"01"	- actual value of parameters of first cycle in the buffer
	"02"	- of second cycle
	"99"	- of cycle nr. 99 (if present)
		only the number of cycles defined by telegram 200 can be requested; if a higher number than the buffer length is requested, telegram "305" with byte 05 = "4" is transferred; if byte 05 = "0" then byte 06 to 07 have to be "00"
08	"0"	- not last request from this sample
	"1"	- last request; increment read pointer and clear memory for all selected goups after the "304" is sent

Telegram 206: REQUEST FOR INFORMATION ABOUT DATA COLLECTION MODE

contains no data bytes

Telegram 207: REQUEST FOR INFORMATION ABOUT SELECTED PARAMETERS

Byte	cont.	Description
05	-N01-	number of the parameter group

2.2 Extension of the List with Standard Answers

Telegram 100: STANDARD ANSWER

Byte	cont.	Description
05..07	-N03-	request number
	"204"	- request for sampled parameters

2.3 Definition of Telegrams from the Machine Controller

Telegram 300: SPECIFICATION OF DATA COLLECTION MODE

Byte	cont.	Description
05..06	-N02-	sample size ("01" to "99")
07..08	-N02-	cycle interval for data acquisition ("00" means consecutive cycles)
09	-N01-	polling mode
	"0"	- disabled
	"1"	- enabled
10	-N01-	sampling mode
	"1"	- on cycle number
	"2"	- on time
	"3"	- at end of previous sample
	"4"	- on request from the central computer
11..16	-N06-	number of cycles between start of samples; only used if sampling mode = 1
17..22	-N06-	time delay between start of samples in seconds; only used if sampling mode = 2

Remark: If a the sample size, cycle interval, number of cycles between start of samples and time delay set by telegram "200" is above the limits of the machine controller the max. value is set and transferred.

Telegram 301: SPECIFICATION OF SELECTED PARAMETERS

Byte	cont.	Description
05	-N01-	number of parameter group
06	-N01-	status of the group:
	"0"	- group not available
	"1"	- group with selectable parameters
	"2"	- group with fixed parameters
07..08	-N02-	definition of parameter 1
09	-N01-	status of parameter 1
	"0"	- parameter not available
	"1"	- parameter selected
10..11	-N02-	definition of parameter 2
12	-N01-	status of parameter 2
13..14	-N02-	definition of parameter 3
15	-N01-	status of parameter 3
16..17	-N02-	definition of parameter 4
18	-N01-	status of parameter 4
19..20	-N02-	definition of parameter 5
21	-N01-	status of parameter 5
22..23	-N02-	definition of parameter 6
24	-N01-	status of parameter 6
		specification of selected parameters in one group parameter number according to SPC - parameter - list; " " (2 ASCII blanks) means not selected

Remark: If group 0 is selected, the definition and the status of the parameters must be filled with ASCII blanks.

Telegram 302: ANSWER TO "202"

Byte	cont.	Description
05	-N01-	acknowledge
	"0"	- not possible, no reason specified
	"1"	- positive acknowledge
	"2"	- start command neglected (already running)
	"3"	- not possible to continue (not suspended)
	"4"	- not possible to suspend (already suspended)
	"5"	- not possible to suspend (not started)
	"6"	- not possible to start (not initialized)

Remark: In case any other nack reason is not applicable, the "0" can be used.

Telegram 303: ANSWER TO "203", TAKE SAMPLE

Byte	cont.	Description
05	-N01-	acknowledge
	"1"	- ok, sample started
	"2"	- sample start not possible (buffer full)
	"3"	- sample start not possible (wrong mode)
	"4"	- sampling in progress, sample start not possible

Telegram 304: SAMPLED PARAMETERS

Byte	cont.	Description
05	-N01	identification of parameter group
06..07	-A02-	identification of cycle
	" M"	- mean
	" R"	- range
	" S"	- standard deviation
	"01"	- actual value of parameters of first cycle in the buffer
	"02"	- actual value from second cycle etc.
08..13	-N06-	value of parameter 1
14..19	-N06-	value of parameter 2
20..25	-N06-	value of parameter 3
26..29	-N06-	value of parameter 4
32..37	-N06-	value of parameter 5
38..43	-N06-	value of parameter 6

Remark: If parameter group 0 is requested, then the selection of the parameters is fixed. Bytes 06 to 07 have to contain "00", otherwise "305" with "4" is sent.
parameter 1 = no. of lots completed (6 MSD's)
parameter 2 = no. of lots completed (6 LSD's)
parameter 3 = actual no. of parts within last lot (6 MSD's)
parameter 4 = actual no. of parts wthin last lot (6 LSD's)
parameter 5 = date (ddmmyy)
parameter 6 = time (hhmmss)

Remark: Values for unused parameters are filled with ASCII blank.

Remark: Not consistent value of parameter is filled with ######.

Remark: If the sample size = 1 and the central computer asks for mean, range or standard deviation, an error message ("305" with "4") is sent.

Telegram 305: ANSWER TO TELEGRAM "204" (NACK)

Byte	cont.	Description
05	-N01-	acknowledge
	"0"	- not possible, no reason specified
	"1"	- system not initialized
	"2"	- sampling process not running
	"3"	- sample buffer empty
	"4"	- requested parameters not available
	"5"	- requested parameter group not stored

Remark: In case any other nack reason is not applicable, the "0" can be used.

Telegram 306: ANSWER TO TELEGRAMS "200" AND "201" (NACK)

Byte	cont.	Description
05	-N01-	acknowledge
	"0"	- not possible, no reason specified
	"1"	- not possible, system is already running

Remark: In case any other nack reason is not applicable, the "0" can be used.

3. Communication Flow

3.1 Initialize SPC system in the Machine Controller

Telegram No.	Description
"200"+spec.	set data collection mode
"300"+spec.	receive actual mode from the machine; the actual selection may be different from the request, because a mode may not be implemented

Remark: The data collection mode can only be set once. Before new setting of data collection mode the telegram "202" with byte 05 = "4" must be sent.

"201"+spec.	set parameter selection in one group
"301"+spec.+stat.	receive actual selection from the machine; the actual selection may be different from the request, because parameters may be fixed or not available

Remark: Eventually another telegram "201" may be sent to define another group of parameters.
Only defined groups are stored in the buffer.
Data for group 0 is stored by defining group 0 as:
"201"+"0"+" " (19 ASCII blanks).

Before sending another telegram "201" for the same parameter group, telegram "202" with byte 05 = "4" must be sent. This resets the data acquisition.

"202"+"1"	start sampling process and take first sample
"302"+"1"	sampling proces started see 3.3 and 3.4 for a description of the sampling process.

3.2 Ask Information on the SPC system from the Machine

Telegram No.	Description
"206"	request for data collection mode
"300"+spec.	receive actual mode
"207"+spec.	request for parameter selection
"301"+spec.+stat.	receive actual selection from the machine

Remark: Eventually a second "207" telegram may be sent to request a second group of 6 parameters.

3.3 Take Sample and Receive Parameters from the Machine

(polling mode 1)

Telegram No.	Description
"000"	standard question
Wait for:	
"100"+"204"	standard answer
"204"+"000"+"0"	request for part counter, time and date of sample
"304"+"000"+data	part counter, time and date of sample
"204"+"101"+"0"	request for group 1 parameters of first cycle
"304"+"101"+data	receive values
"204"+"201"+"0"	request for group 2 parameters of first cycle
"304"+"201"+data	receive values
"204"+"1"+" M"+"0"	request for mean values of group 1 parameters
"304"+"1"+" M"+data	receive mean values
"204"+"2"+" M"+"0"	request for mean values of group 2 parameters
"304"+"2"+" M"+data	receive mean values
"204"+"1"+" R"+"0"	request for range values of group 1 parameters
"304"+"1"+" R"+data	receive range values
"204"+"2"+" R"+"1"	request for range values of group 2 parameters (this is the last request from this sample)
"304"+"2"+" R"+data	receive range values

Remark: Group 2 is optional.

"000"	send standard question again (redo from start)

3.4 Take Sample and Receive Parameters from the Machine

(polling mode 0)

"204"+"000"+"0"	request for part counter, time and date of sample
"305"+"3"	sample buffer empty
Poll until:	
"204"+"000"+"0"	request for part counter, time and date of sample
"304"+"000"+data	part counter, time and date of sample
	rest of the data flow same as in polling mode 1

3.5 Transfer Parameters from each Cycle

(example for minimum overhead)

To minimize data flow in a small system, time (hhmmss), part counter (6 LSD's) and cycle counter (6 digits) are included in the parameter list. This saves the transmission of "304", group 0 if only time or one of the counters is needed. Sending
"201"+"0"+" " (19 blanks) in the initialization phase selects group 0 parameters.

Telegram No.	Description
"200"+spec.	set data collection mode sample size = 01 interval = 00 polling mode = 1 sampling mode = 3
"300"+spec.	receive actual mode from the machine
"201"+spec.	set parameter selection in one group
"301"+spec.+stat.	receive actual selection from the machine
"202"+"1"	start sampling process
"302"+"1"	sampling proces started

Remark: At this moment the sampling process starts and will not stop until "202" with byte 05 = "2" or "4" is received. The buffer is filled automatically and can be read out by the following sequence:

"000"	standard question
Wait for:	
"100"+"204"	standard answer
"204"+"101"+"1"	request for group 1 parameters (last request)
"304"+"101"+data	receive values
"000"	send standard question again

3.6 Take Sample on Request from Central Computer

Telegram No.	Description
"200"+spec.	set data collection mode, sampling mode = 4
"201"+spec.	set parameter selection in one group
"202"+"1"	remote control of sampling process at machine : start
"203"	take sample (request from central computer)
.	
.	
.	
.	
"203"	take sample (request from central computer)
"202"+"4"	remote control of sampling process at machine: stop (reset and clear parameter definitions).

4. Structure of Internal Buffers

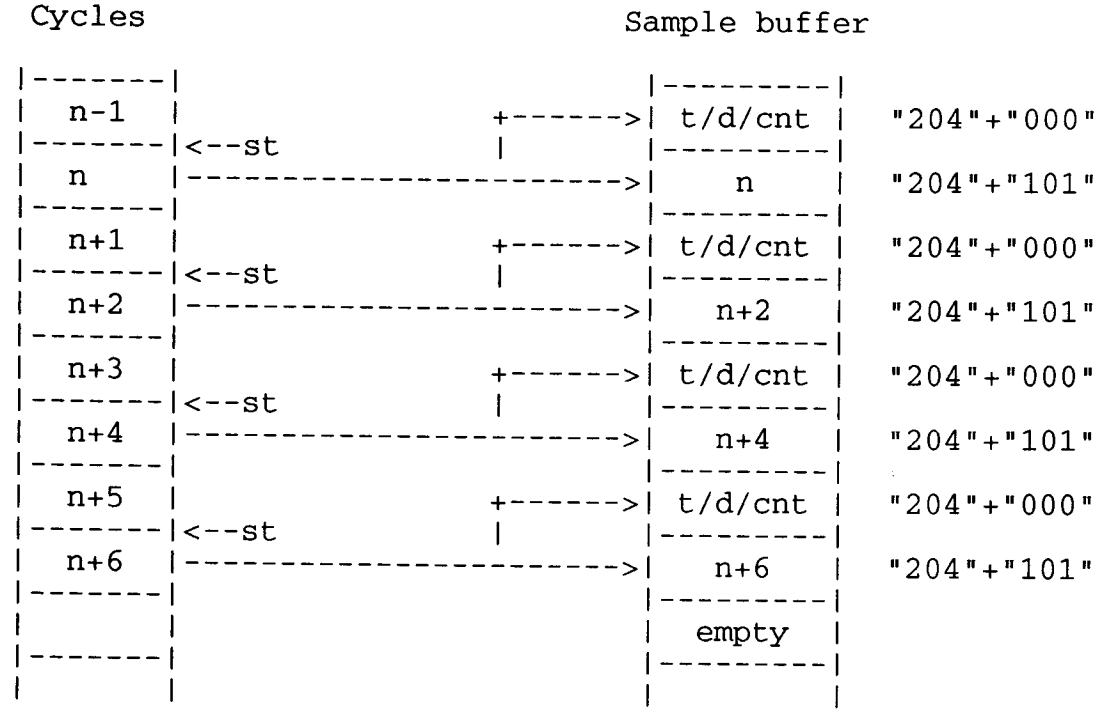
4.1 Description

For reading and writing of the (cyclic) sample buffer there are two pointers: the read pointer (rp) and the write pointer (wp). The rp is incremented if "204" is received with byte 08 = "1", the wp at the start of a new sample. In this way the sampling process (the writing of data into the buffer) and the reading of the buffer by the central computer have become independant (as long as this buffer is big enough). If at sample start wp+size > rp then buffer overflow would occur. See chapter 5. If rp = wp then the buffer is empty. In this situation reception of a "204" would result in an error message ("305" with "3").

The start point (st) of a sample depends on the sampling mode.
1 - a specified number of cycles after the previous sample start
2 - a specified time after the previous sample start
3 - immediately after the previous one,
4 - after a request from the central computer using telegram "203".
(It is only allowed to send telegram "203" if sampling mode=4; In other cases the answer "303" contains "3" instead of "1").

4.2 Example 1 (get the parameters of every second cycle)

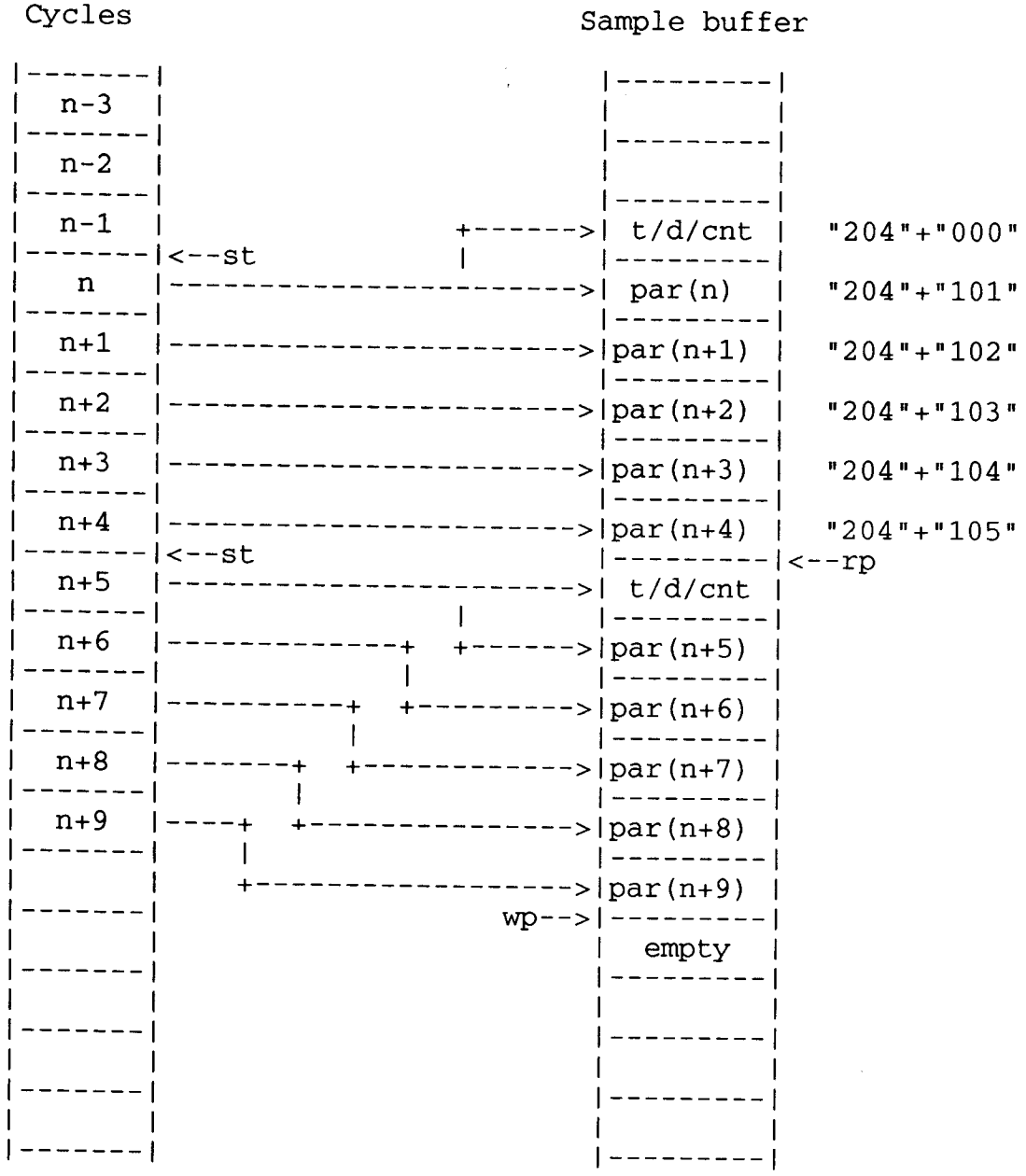
Sample size = 1
Interval within samples = 1
Sampling mode = 3 (no delay).



4.3 Example 2 (get the parameters of 5 consecutive cycles)

Take consecutive samples of 5 consecutive cycles. From each sample the central computer could for instance read only the mean values of the parameters by sending "204"+"M".

Sample size = 5
Interval within samples= 0
Sampling mode = 3 (no delay).

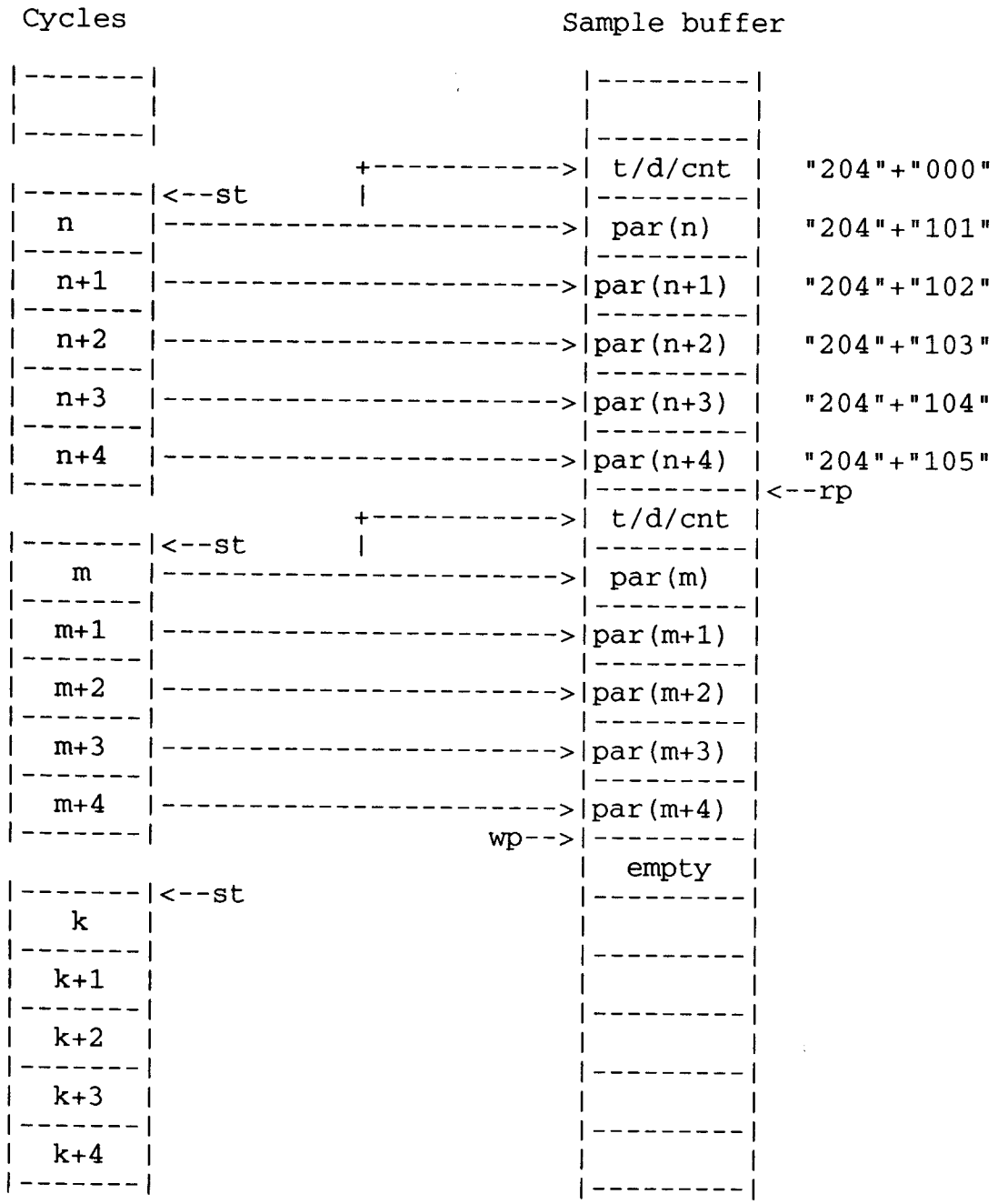


t/d/cnt means time + date + counters (lots and parts)
par(x) means parameters from cycle number x.

4.4 Example 3 (sampling process for SPC)

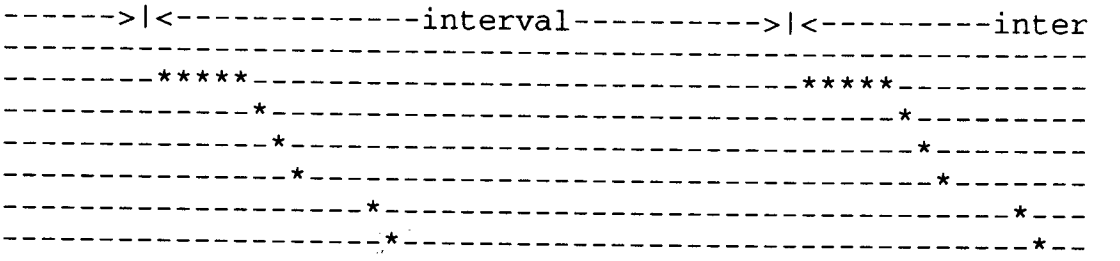
Take samples of 5 consecutive cycles. Start next sample on time, part counter or request from the central computer. This is an example how an SPC system would request its data from the machine.

Sample size = 5
Interval within samples= 0
Sampling mode = 1, 2 or 4 (cycle number, time or request).



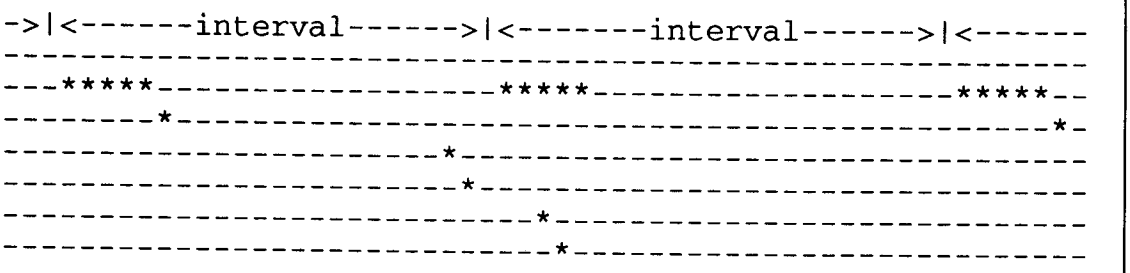
5. Timing

5.1 The Central Computer is Fast Enough to Handle All Samples



In this case the central computer is fast enough to read data before a buffer overflow in the machine controller occurs. Because the buffer can contain multiple samples, this does not mean, that the central computer has to handle a sample before the start of the next one.

5.2 The Central Computer is Too Slow



In this case samples are skipped if there is no space in the buffer. As soon as the next start moment is reached the system tries again to start a sample. Samples will be lost if there is no buffer space.
If sampling mode = 3 there is no interval. Sampling starts as soon as possible.
If sampling mode = 4 an error message ("303" with "2") is sent and the sample is not started at all (the central computer has to retry).

6. SPC Parameter List

6.1 Temperatures

parameter number of 2 decimal digits (e.g. 01 for melt temperature)

01. melt temperature, °C
maximum value in the nozzle during injection

02. mould temperature at moving platen, °C
value measured at start of injection

03. mould temperature at fixed platen, °C
value measured at start of injection

6.2 Times

04. filling time, s
time from start of injection until start of holding pressure

05. plasticizing time, s
time during plasticizing without decompression before or after plasticizing

06. machine cycle time, s
overall cycle time without idle time; start of cycle with mould closing

6.3 Force

07. clamp force, KN
maximum value from start of mould closing until start of mould opening

6.4 Positions

08. melt cushion, mm
minimum value from injection until end of holding pressure

09. switch over position, mm
screw position at switch over to holding pressure

10. plasticizing position, mm
screw position after plasticizing without decompression

6.5 Speeds

11. maximum injection speed, mm/s
    maximum value during injection

12. average injection speed, mm/s
    average value during injection

13. maximum screw rotation, rpm
    maximum screw rotation during plasticizing

14. average screw rotation, rpm
    average screw rotation including profiles

6.6 Pressures

15. maximum hydraulic injection pressure, bar
    maximum value during injection and holding pressure

16. hydraulic injection pressure at switch over, bar
    value at switch over to holding pressure

17. maximum back pressure, bar
    maximum back pressure during plasticizing

18. average back pressure, bar
    average back pressure including profiles

19. maximum cavity pressure, bar
    maximum value during injection and holding pressure

20. cavity pressure at switch over, bar
    value at switch over to holding pressure

6.7 Powers

21. injection power, kNm
    integral of melt pressure from start of injection until start of holding pressure over stroke times screw area

22. hydraulic injection power, kNm
    integral of hydraulic pressure from selectable start position until start of holding pressure over stroke times hydraulic cylinder area,
    default value for start position is start of injection

6.8 Part Quality Data

23. weight, g
    weight of shot or moulded part / parts
24. additional quality parameter 1
25. additional quality parameter 2
26. additional quality parameter 3
27. additional quality parameter 4
28. additional quality parameter 5
29. additional quality parameter 6
30. additional quality parameter 7
31. additional quality parameter 8

6.9 Manufacturer Specific Parameters

50 ... 89

6.10 Reserved Parameters for EUROMAP

90 ... 99

90. no. of lots completed (6 MSD's)
91. no. of lots completed (6 LSD's)
92. actual no. of parts within last lot (6 MSD's)
93. actual no. of parts within last lot (6 LSD's)
94. cycle counter since start of job (6 MSD's)
95. cycle counter since start of job (6 LSD's)
96. time (hhmmss)
97. date (ddmmyy)

7. Data Format

A fixed data format of 6 characters is used. There is no space allowed. The decimal point can also be transferred. Negative numbers are transferred with a minus sign instead of the decimal point. If no decimal point and no minus sign is used, it is a positive integer number.

e. g.	+5.3	5.3000
		05.300
		005.30
		0005.3
	-5.3	5-3000
		05-300
		005-30
		0005-3
	1500	001500

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