SK 4
Process Monitoring System
with force and acoustic sensing

Valid as of software version 1.6.0
Technical Details Subject to Modification
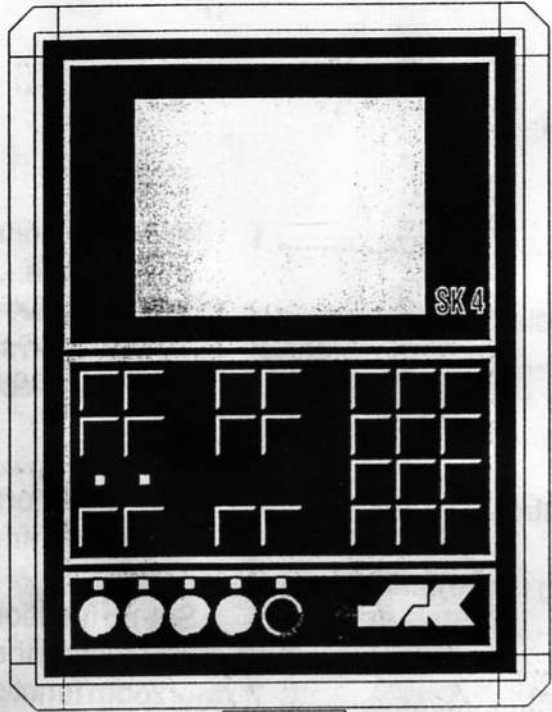
Contents

SK 4
display unit.

Mounting on
pedestal or on
swivel arm carrier
suspension system.

data cable

110/230V

Separate
control buttons
for MAN and
AUTO mode
(DUPLO)

MAN AUTO
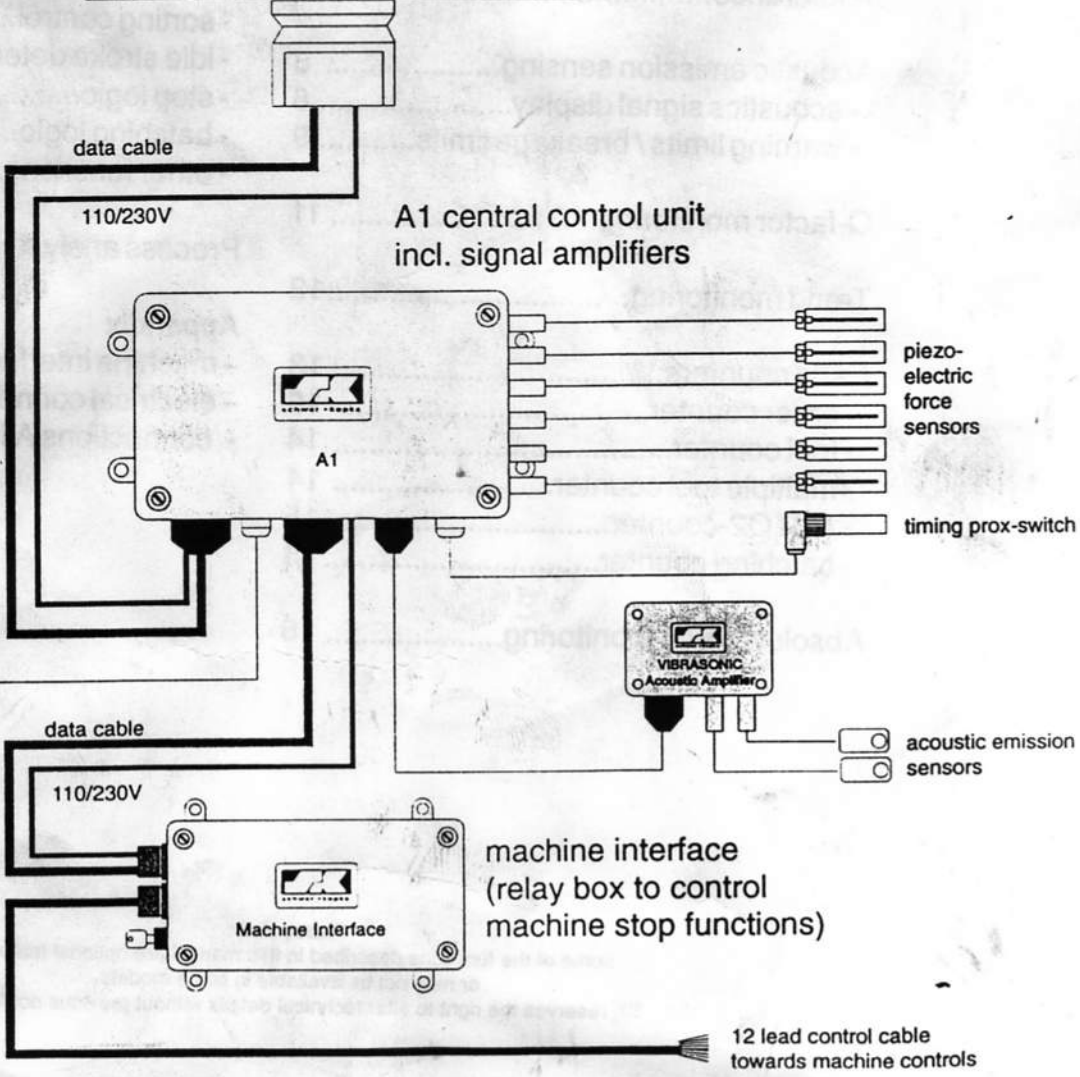
A1 central control unit
incl. signal amplifiers

A1

piezo-
electric
force
sensors

timing prox-switch

VIBRASONIC
Acoustic Amplifier

acoustic emission
sensors

data cable

110/230V

Machine Interface

machine interface
(relay box to control
machine stop functions)

12 lead control cable
towards machine controls

front panel

Adjusting display brightness
(models 420 and 440):
1. Press the key
"Process Monitoring"
2. Press "E" to increase
brightness
3. Press "C" to decrease
brightness

SK 4

1. LCD-display (color oder b/w)
2. force curve display with envelopes
3. force values / sensitivity / tolerance
4. Q-factor monitoring
5. trend monitoring
6. timing cyle lights 1 and 2
7. network key
8. acoustic emission values / sensitivity
   tolerance
9. acoustic emission signal display
10. menu- key
11. operating mode keys with LED:
   •MAN-mode (set-up)

   • AUTO 1 - mode (regular shift)
   • AUTO 2 - mode (unmanned shift)
   • STOP (machine is stopped)
12. bypas-key
13. part counters
   • C1: order size counter
   • C2: tool life counter
   • C3: AUTO2-counter
   • ⬛ : batching counter
14. numerical keys 0 - 9
15. ENTER-key (E-key)
16. C-key (clear / delete / mode change)

rear panel

25

20

Printer   Serial

21

22

CE

Type			
Ser. No.			
V / Hz / A	V	Hz /	A

24

schwer +kopka

23

```
1
0
```

dimensions:
325W x 415H x 120D mm
(without suspension coupling)

26

20. printer port
21. serial data port RS 232
    (e.g. for TELESERVICE)
22. model identification plate
23. ON/OFF switch

24. lock to open rear door
25. suspension coupling from top
26. suspension coupling from bottom,
    or for pedestal mounting
    (cable routing through suspension tubes)

Selecting operation modes

The different operation modes are selected via the mode keys on the front panel, or via the supplementary MAN and AUTO buttons provided by the DUPLO remote control box. The operation modes include functions such as set-up mode or automatic mode for regular or unmanned shifts. The LED's above each mode key indicate which mode is currently running.

MAN mode (set-up)
MAN mode is not actively monitoring the process. However, the unit is registering and displaying the forces and the acoustic signals in order to assist the operator in setting up the machine.The MAN key must be pushed after every STOP and after switching the unit on in order to free the STOP-mode. Running time in MAN mode is limited to an adjustable number of strokes after which the unit will switch into AUTO mode all by itself (adjustment is carried within the set-up menu).

AUTO1 mode
Pushing the AUTO 1 key will start the monitoring mode. The unit is immediately active after pressing the key. The monitoring limits (force and acoustic envelopes) are dynamically updated and matched with the process' variation. Counting of good parts made starts also. Every impermissible deviation of the force or acoustic signal will cause the unit to react.

AUTO2 mode
Automatic mode used when running unmanned shifts. Offers the same functions as AUTO 1. In addition, the AUTO2 parts counter is started to provide a separate count for parts made during AUTO2 mode. When stopping the machine during AUTO2, the unit fires the separate EMERGENCY-STOP relay in order to switch off the machine entirely (AUTO1 mode will only fire the MOTOR-STOP relay).

STOP
The STOP light comes on every time the unit has switched off the machine. In addition, a machine stop can be initiated by pushing the STOP key manually. The unit always will prompt a plain language stop message on the display to identify the reason for switching the machine off.

BYPASS key switch
Pushing the key button and entering an access code number will put the monitoring system into bypass-mode. The unit itself still runs in AUTO but will not release any stop signals towards the machine interface (ATTENTION: machine now runs without surveillance!). Bypass mode is typically indicated by a flashing message on the display and by the flashing light at the STOP button.
A separate key switch located on the machine interface allows the complete electrical disconnection of the monitoring system from the machine controls

Envelope monitoring

The envelope monitoring technique scans the entire force wave form from start to finish. Each point scanned is compared to a previously memorized "good parts wave form" by using the upper and lower envelope threshold curves. These are automatically established by the monitoring system each time it is put into AUTO-mode. The envelope curves are calculated such that they always provide a perfect fit around the current variation of the process. Thus, a calm and stable process will be monitored with fairly tight envelopes, while an unstable process will run with wider envelopes. Depending upon the stability of each segment of the process curve, the envelope width may well be different at each point of the wave from.

Envelope display

Pressing the curve-key will display the force wave form together with the envelopes. Channel selection is made by simply pressing the number of the channel you wish to see. The display will immediately switch to the selected channel. Pressing the C-key changes the presentation of the wave form from refresh-mode to overwrite-mode. Overwrite mode gives a good image of the process variation.

The numbers displayed in the "process deviation" boxes indicate if and how much of the current force curve is leaving the envelope band upwards and/or downwards. The picture below shows that the machine has been stopped due to a low load in channel 2. The number "66" shown in the downward box says that 66 % of the force curve has dropped below the lower envelope. The stop reason is shown in plain language as "Lower envelope channel 2" along with date and time the stop occurred.

Process monitoring values / Sensitivity /Tolerance

This screen shows the actual and average forming force values and the related settings of sensitivity and tolerance for each channel. The actual and average numbers indicate the maximum forces during the forming stroke. These numbers can be relative or absolute, depending upon the selected display mode.

```
              Process Monitoring
  Stat.     Actual        Average       Tol.        Sens.
    1         127           127           1      [████      ]
                                                 0   3   6   9
    2         395           395           2      [██████    ]
                                                 0   3   6   9
    3          35            35           1      [███       ]
                                                 0   3   6   9
    4         127           127           1      [██        ]
                                                 0   3   6   9
    5         337           337           2      [███████   ]
                                                 0   3   6   9

   240 /Min                                         62:17
```

RPM-indicator

**Remaining run time before
one of the part counters is down**

Pressing the key a second time will switch the unit into data entry mode. The first entry box (tolerance of channel 1) will change its color to indicate entry mode. Enter the new number and confirm by pressing the E-key, or move the colored box with the E-key to the next position. Before confirming a new entry, the numbers may be corrected by using the backspace function of the C-key. After each entry, the colored box moves on.

Sensitivity

The sensitivity setting determines if the envelope curves will adjust quickly to changing force curves (coarse setting), or if they behave rather rock solid (fine setting). Sensitivity can be set in steps from 1 (coarse) to 9 (fine):

    1 : the envelopes quickly adjust to force variations (coarse setting)
    9 : the envelopes do not adjust to force variations (fine setting)

A sensitivity setting of "0" will switch the respective channel off (ATTENTION: this channel is not being monitored!). The sensitivity box will change its color to red. This feature, however, can be locked for security reasons (see set-up section).
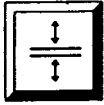
Tolerance

The tolerance setting will allow minor deviations of the current force signal from the envelopes without stoping the machine immediately. The tolerance values can be set between 0 and 99:

- 0: no deviation allowed; machine will be switched off immediately at the first deviation from the force curve envelopes
- 99: machine only switches off after a significant number of subsequent deviations have occurred

> Please note: typical setting for tolerance is 1 or 2.

Attention: Extremely high force curves (Crash) will directly switch the machine off irrespective of any tolerance numbers that may have been set. The Crash limits which determine how big an overload is considered a Crash can be programmed in the set-up section.

The tolerance setting is typically used to compensate random process variations in order to avoid nuisance machine shut downs. It is recommended, however, to not use tolerances higher than 1 or 2. If a process tends to vary more than others, this is already acounted for by the dynamic envelope setting. It is mostly not necessary to increase the tolerance.

When using the monitor on progressive multi-die machines it is advisable to stop the machine even with minor variations. A small fault can cause major carry-over damage in other stations if the machine keeps on running. Tolerance on these machines is typically set to 0.

**Tolerance and sorting function**

When using the sorting function the monitoring unit will activate the sort relay each time it detects a non-allowed process deviation. The tolerance setting now has the function to limit the number of consecutively sorted bad parts. If more parts are sorted than the preset tolerance value allows, the machine will be switched off.

VIBRASONIC° acoustic emission monitoring

The VIBRASONIC acoustic emission monitoring is used in addition to the proven force envelope technique in order to detect special types of faults such as cracks or tool chips. The ACOUTRONIC sensors measure the acoustic emission of the process during the forming stroke. The acoustic emission during regular production (defect-free running) is often neglectible or minute. When cracks or chips occurr, however, they can produce a significant and intense acoustical signal. If the signals exceed the preset limits, the machine can be stopped, or a warning signal is given.

Acoustic signal display

Pressing the acoustic-key will show the acoustic emission signal and the respective limits. The monitored section of the signal is marked with a gray shade. It is possible to have more than one section marked at the same time.The white lines show the "breakage limits" and the doted lines represent the "warning limits". Faulty acoustical curves will be shown in red, and the stop reason is prompted in plain language.
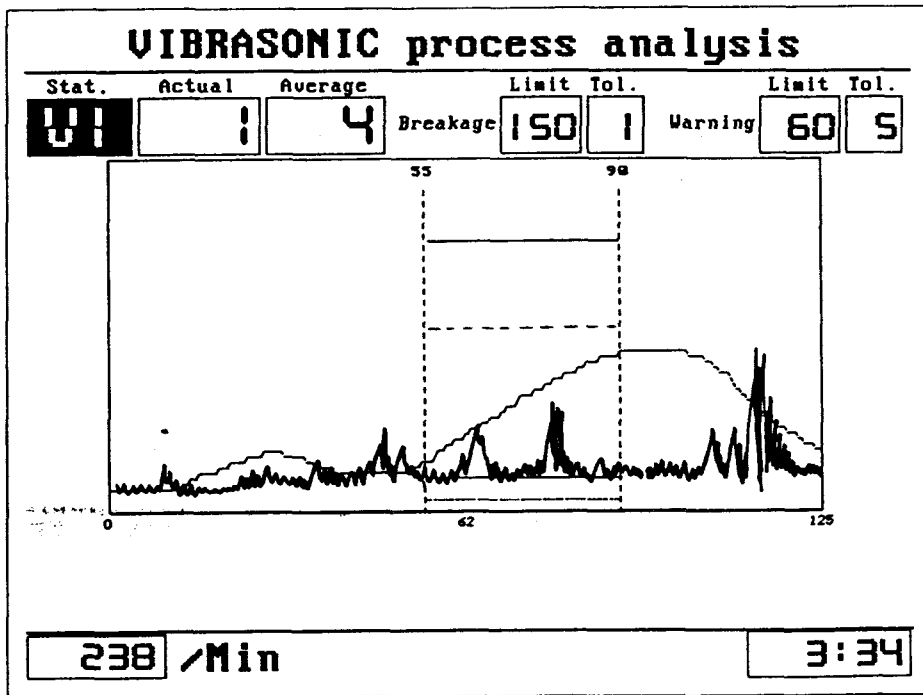
Pressing the C-key will underlay the force curve of that channel that has been used tc set the timing windows for the acoustical signal. If your machine is equipped with more than one acoustical sensor, you can callup the respective channel (V1, V2, etc.) by pressing its number.

More details on how to use the VIBRASONIC system are included in the separate VIBRASONIC manual.

Actual and average / warning limits / breakage limits
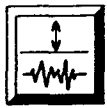
Pressing the limit key (see left) brings up the "VIBRASONIC Process Monitoring" screen which shows the actual and average acoustic values as well as the current monitoring limits.

Actual: indicates the highest peak value of the acoustic emission signal within the shown measuring windows

Average: represents the average value of the peak values over a number of machine strokes

Pressing the key a second time switches into entry mode. The box of the first limit value changes its color to indicate this. Enter a new limit value, if desired, and confirm by pressing the E-key. The colored box moves to the next possible entry. The following limits can be set:

Warning limit: is calculated from the actual value plus the set limit value.
               example: actual 620 + limit 200 = warning limit 820

Breakage limit: is calculated from the actual value plus the set limit value.
               example: actual 620 + limit 310 = breakage limit 930.

The tolerance for the warning limit is typically set to a value bigger than "0" such that the machine only stops after the warning limit has been exceeded several times. Setting the warning limit to e.g. "3" will require four times exceeding the limit before the machine is stopped. The breakage tolerance is normally set to "0" such that an immediate reaction is given in case of large signal changes (e.g. punch breakage). Depending upon the settings made in the "stop logic" section (see set-up) the unit will either stop the machine, or start flashing the warning light to alert the operator.

VIBRASONIC Process Monitoring						
		Envelope		Breakage		Warning
Stat.		Actual	Average	Limit	Tol.	Limit	Tol.
V1	envel.	6 19	620	3 10	0	200	3
V2	envel.	0	0	230	1	175	4

| 238 | /Min | | 3:34 |
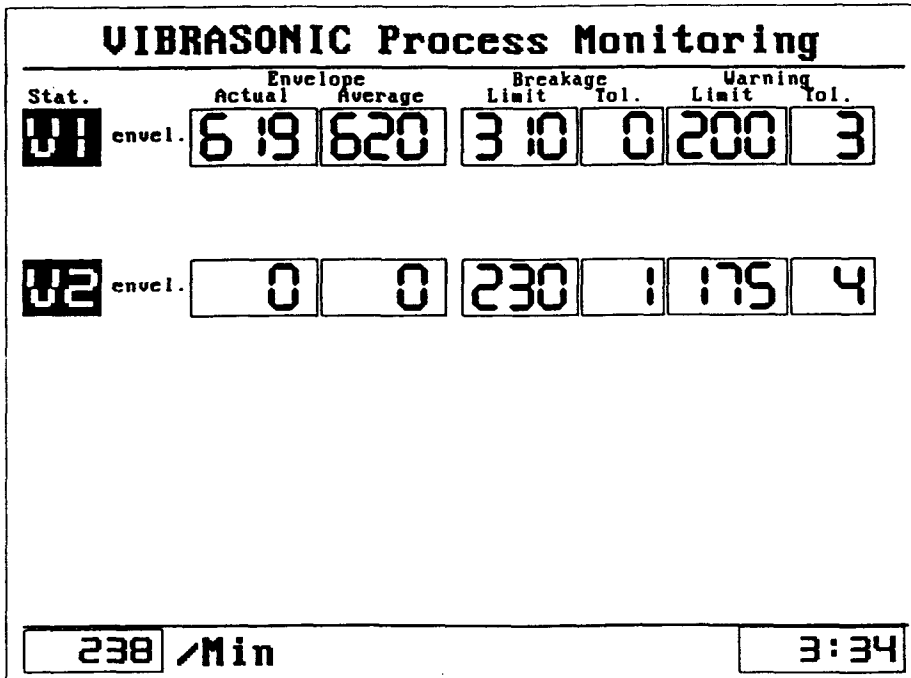
Parameter setting

The various set-up parameters for the acoustic emission monitoring are included in a separate menu section which is accessible by pushing the M-key and selecting #7:

```
              Vibrasonic 1
   _____

   ┌─────────────────────────────────┐
   │ 1 Code                       No │
   │ 2 Synchronisation               │
   │ 3 Monitoring strategy           │
   │ 4 Stop logic                    │
   │ 5 Warning                    No │
   └─────────────────────────────────┘
```

For further details on this, please refer to the separate VIBRASONIC® manuals.

Q-factor (process stability / process quality)

Q

The Q-factor is an indicator which expresses the stability or repeatability of the forming process from stroke to stroke as a percentage number. A low Q-factor (e.g. less than 80%) would result from a very unstable process where the forming force curves are changing significantly from part to part. As a consequence, this would lead to fairly wide envelopes with little sensitivity. On the other side, a calm and stable process with high Q-readings (e.g. 98% or better) will be monitored very closely with tight envelope curves.

Pressing the Q-key displays the Q-factors for all monitored channels. In addition, a Q-limit is shown which allows to set a required minimum Q-reading for each channel. If the current Q-factor drops below the required minimum because of an unstable forming process, the machine can be stopped.

Setting Q-limits

Press the Q-key a second time to activate entry mode (first channel's Q-limit box changes color). Enter your desired limit and confirm with the E-key. The colored box moves on to the next channel. Entering a Q-limit of "0" will switch the Q-monitoring off for this channel.

The entry mode can be locked in order to prevent unauthorized changes of the Q-limits (see set-up section).

Q-Factor

Stat.	Actual Q	Q-Limit
1	95	80
2	91	90
3	98	90
4	95	75
5	91	75

| 238 /Min | | 3:33 |

The trending feature allows to visualize and to monitor gradual changes in your forming process such as a steady but slow rise or fall of the forming load. Trending can be activated individually for each channel.

Trend monitoring in model 420

Pressing the T-key diplays for each channel the current average force value and the related lower (LL) and upper trend limits (UL). Pressing the T-key a second time calls up the entry mode (limit box changes color). Enter your desired limits and confrim with pressing the E-key. If the average force values exceeds the upper trend limit, or drops below the lower trende limit, the machine will be stopped (if trending has been activated for this channel).

Graphic trend display with Stop/Go in model 440

The model 440 offers graphic trending on its color display. The presentation includes the flow of the average force over time, the selected trend limits, and any machine stops in between. The time frame shown on one screen can be set to cover between 15 min. and 8.5 hours. Press the T-key a second time to do so. The time frame box changes color. Enter the desired time frame and confirm with the E-key.

To adjust the trend limits, press the E-key first. A window pops up asking for the upper trend limit. Confirm your entry with the E-key. Next, a second window for the lower limit will show up. Enter the limit and confirm. The trend limit lines on the display will now reset to the new values.

Peak Trend
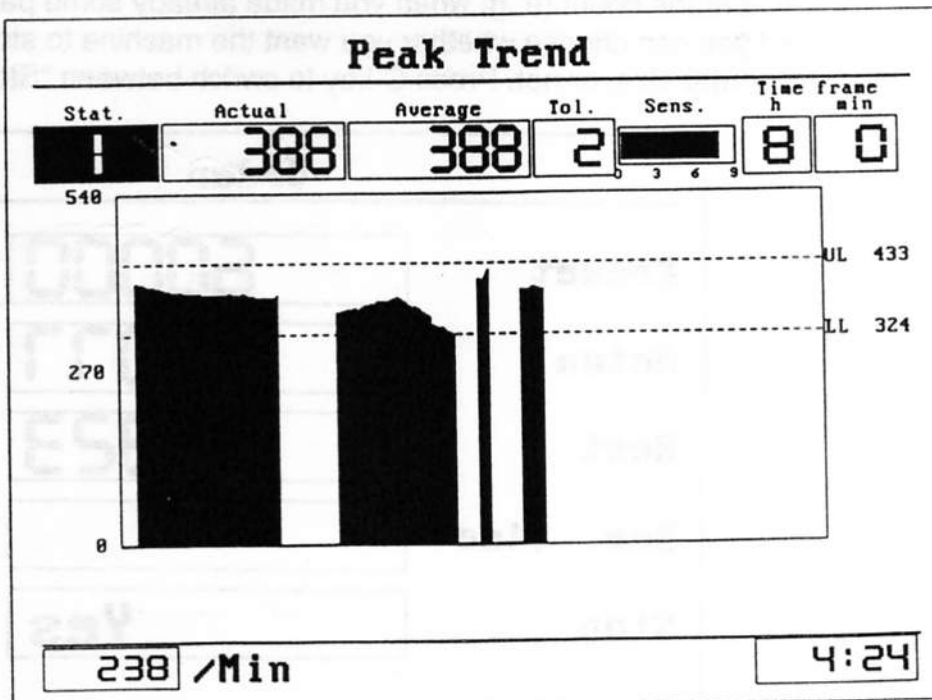
The SK monitoring system provides four (4) different part counters for order size, tool life, unmanned shift (AUTO2-mode) and batching. Each counter can be directly called up on the display through its own function key (C1, C2,...). An additional production stastistics counter is available in the unit's menu-section (press M-key to acces this), which will give you total counts over a period of time..

Order size counter (C1)

C1

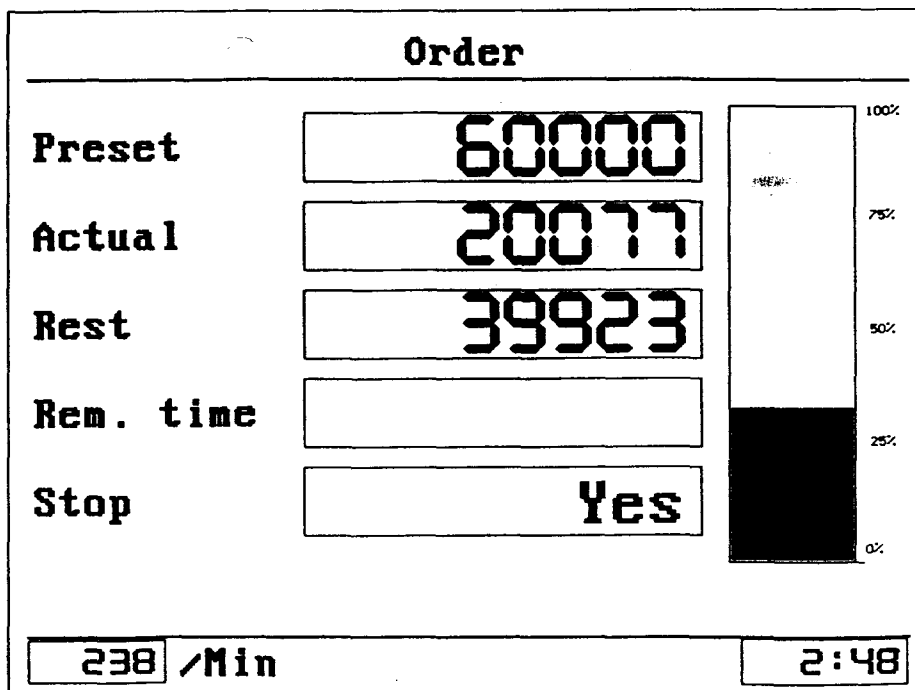The order size counter counts all good parts produced while running in AUTO1 or AUTO2 operation mode. If desired you can also add all parts made during MAN-mode to the order size count (see set-up section for programming this). When the current count reaches the preset order size, the machine can be stopped in order to prevent over runs.

The display shows the preset order size, the number of parts already made, the re-maining quantity, and the remaining running time needed to reach the target count (provided the machine keeps on running at current speed). The bar graph on the right side of the display tells you how much of the order has been completed already.

Pressing the C1-key a second time will switch into entry mode (color of the order size box changes). Enter the new quantity, check the display to be sure you have typed in the correct number, and confirm with the E-key. The made-count automatically resets to zero, and the bar drops down to zero %. You can also use the E-key to move the colored box to the made count and to the "Stop Yes/No" selection. This allows you to preset a made count (e. g. when you made already some parts of this order previous-ly),and you can choose whether you want the machine to stop upon reaching the preset order size, or not. Press C-key to switch between "Stop Yes" and "Stop No").

```
                        Order
    _____
                                                    100%
    Preset        |   60000   |
                                                    75%
    Actual        |   20077   |

    Rest          |   39923   |                     50%

    Rem. time     |           |
                                                    25%
    Stop          |       Yes |
                                                    0%
    _____

    | 238 | /Min                        | 2:48 |
```

C2

Tool life counter (C2)

The tool life counter is used exactly like the order size counter described on the previous page. It counts all parts being made during MAN, AUTO1, and AUTO2 mode. The tool life counter is typically used to stop the machine at regular intervals for tool changes or other inspections (e.g. periodic adjustments, inspections, maintenance, etc.).

C2

Multiple tool counter

Some models of the SK4-series feature an optional tool counter for up to 36 different tools which allows to keep track of the performance of individual parts of the tool set. The regular tool counter with presettable break count is not available when using the multiple counter. The 36 single counters are listed on 3 pages:
- page 1 counters 1-1 to 2-6
- page 2 counters 3-1 to 4-6
- page 3 counters 5-1 to 6-6

Change from page to page by pressing the C-key. Each individual counter can be reset back to zero in case of a tool change in order to show the exact number of parts made.

To do this, press the C2-key a second time, and the first counter box changes color to indicate that you're in entry mode. Use the E-key to move the colored box to the counter you want to zero. Enter "0" and confirm by pressing the E-key again. Instead of zeroing the counter, you can also enter any other count e.g. if that tool has already been used before.

Tool			
1-1	10032	2-1	26113
1-2	5032	2-2	32
1-3	32	2-3	32
1-4	32	2-4	32
1-5	50032	2-5	25032
1-6	100032	2-6	25032

238 /Min		6:18

C3

AUTO2-counter (C3)

The AUTO2-counter works just like the previously described order size and tool life counters. It counts all parts made while the unit runs in AUTO2 mode. This is in addition to the counts taken by the order size and tool life counters. The AUTO2 counter is typically used to count production and /or to limit running time for unattended shifts.

Batching counter

The batching counter is designed to control the function of an external batching unit. Such units are used to distribute the total production into several, consecutive containers. After a presettable number of parts, the SK system will give out a signal to move the batching unit to the next fresh container. When all available containers are filled, the motor stop relay is fired to switch the machine off. The display indicates how many containers are filled already, and to what percentage the current container is filled. The remaining run time shows how much time is needed to fill all containers.

Pressing the batching-key a second time switches into entry mode ("preset" box changes color). Enter desired quantity per container and confirm with the E-key. Then enter the number of containers available on your batching unit (up to 15 possible). Confirm again with the E-key. If you set the number of containers to "0" a batching signal is given continuously after every container without stopping the machine. The batching function is switched off when both, the preset quantity and the number of containers, are set to "0".

```
                        Batching

  Preset              9000          100%

  Containers             8          75%

  Rem. time                         50%

  ▮▮▮ ▮▮▮ ▯▯▯ ▯▯▯ ▯▯▯                25%
  ▯▯▯ ▯▯▯ ▯▯▯                       0%

  238 /Min                    2:45
```
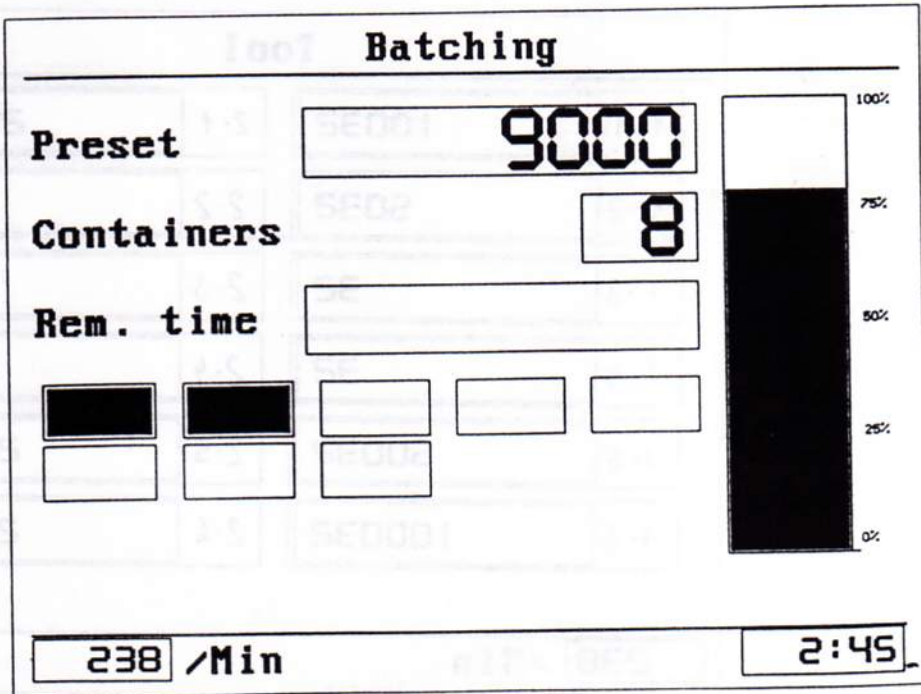
Absolute force display

All SK process monitors offer the possibility to display force readings in absolute numbers. When this function is activated, the "Process Monitoring " screen will show the force values in "kN" (kilo Newton).

Process Monitoring

Stat.	Actual (KN)	Average (KN)	Tol.	Sens.
1	1833	1833	2	
2	1502	1502	1	
3	659	659	2	
4	2357	2357	2	
5	974	974	1	

238 /Min   2:42
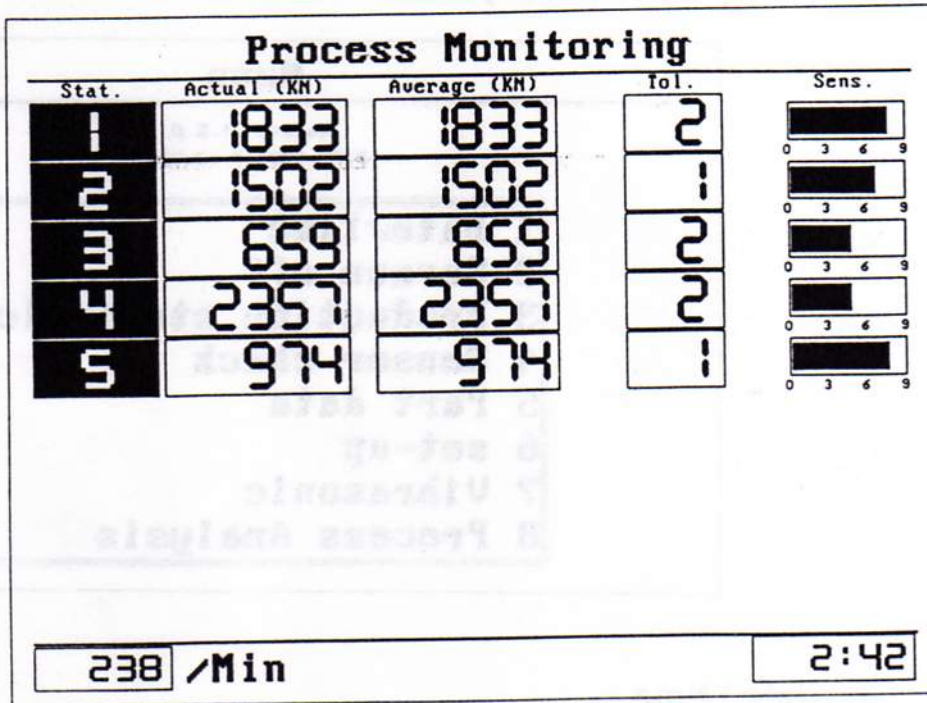
Calibration

In order to calibrate the absolute force display, it is of course necessary to know the exact absolute tonnages of each channel's forming load. This can be accomplished for example by calculating the forming forces for a known process, or to use a reference load cell and measure actual tonnages. The results are then simply entered into the calibration menu of the SK monitoring system with the machine running. The calibration menu is situated in an access-protected area of the set-up section in order to prevent unauthorized or accidental changes.

Adjust calibration

Stat.	KN	Volts
1	1750	3.874
2	1500	3.337
3	629	1.029
4	2249	3.869
5	980	2.854
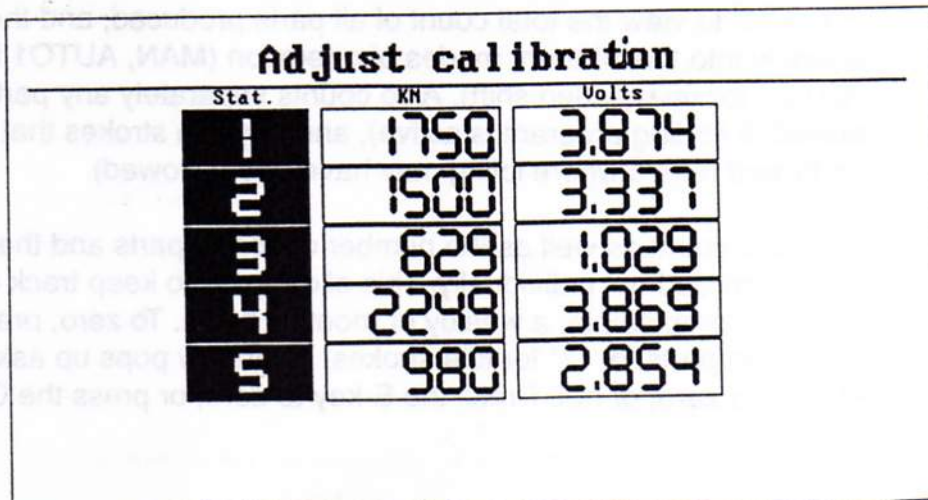
M

Press the M-key to call up the menu section which includes some additional functions, and the set-up section with a number of important parameter settings. To enter the set-up section, you will have to know a 4-digit access code before being allowed to enter this section. The different menu functions are called up by pressing the number (1 to 7) of the function you want to use.

```
                        Menu
                    _____
                     Version 1.6.0
                   12.02.1991 / 12.02.91

        ┌──────────────────────────────┐
        │ 1 Date/Time               .   │
        │ 2 Screen off                  │
        │ 3 Production statistics       │
        │ 4 Sensor check                │
        │ 5 Part data                   │
        │ 6 set-up                      │
        │ 7 Vibrasonic                  │
        │ 8 Process Analysis            │
        └──────────────────────────────┘
```
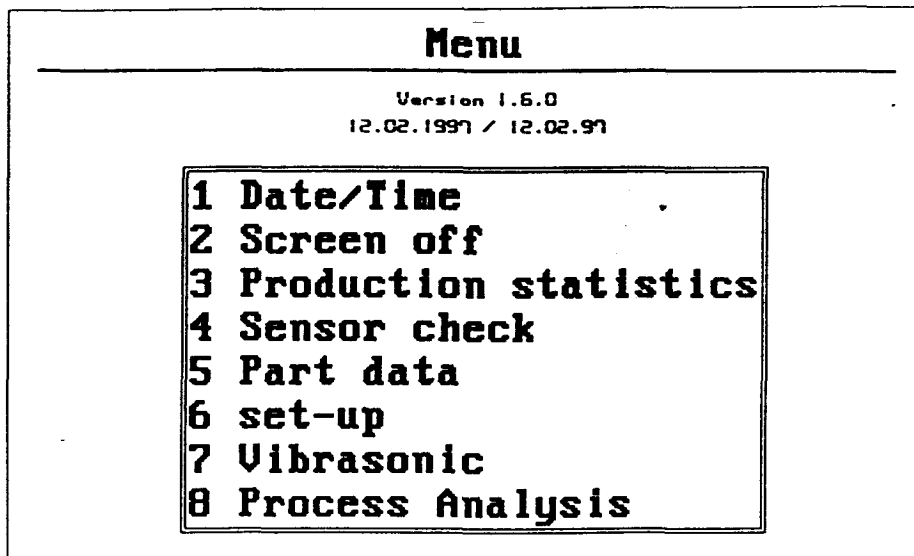
1. Date / time
Select this function if you want to to set or to correct date and time. Press "1" for time, or "2" for date, enter the new time or date, and confirm with the E-key.

2. Screen saver control
Press "2" to activate the screen saver. The LCD-display will turn dark to reduce burn-in of the display, and to potentially increase it's life. The unit itself remains fully working. Press any of the unit's function keys to bring the display back to life.

3. Production statistics
Press "3" to view the total count of all parts produced, and the breakdown of that quantity into the different modes of operation (MAN, AUTO1 for regular shift, and AUTO2 for unattended shift). Also counts separately any parts that may have been sorted (if sorting program is active), and any idle strokes that may have occurred (e.g. on thread rollers where idling may have been allowed).

The total count as well as the number of sorted parts and the number of idle strokes can be zeroed out individually. This allows you to keep track of your production numbers on, for example, a weekly or monthly basis. To zero, press "1" for total count, "2" for sorted parts, or "3" for idle strokes. A window pops up asking you whether you really wish to zero, or not. Press the E-key to zero, or press the C-key to skip this.

3. Production statistics

The production statistics counter as shown on the display:

```
        Production Statistics

  1 Total                          33090

      Auto 1                       32330

      Auto 2                         523

        MAN                         237

  2 Parts sorted                      7

  3 Idle strokes                      0


    654 /Min                      1:23
```

4. Sensor check

Press "4" to call up the sensor check feature which allows a fast and simple control of correct sensor functioning. A sensor is only operable and working if it produces an usable output signal. A value of e.g. 0.00 Volts may be related to an extremely low forming load, but may also be caused by a broken sensor wire, or a misaligned timing switch (force signal is no longer seen in the current timing window).

```
           Sensor check

     Stat.          Volts

       1            4.055

       2            3.337

       3            1.073

       4            4.050

       5            3.176
```

Part data memory

Thememory function of the SK 4 system allows to store important information relative to the setting parameters such as sensitivities, tolerances, timing windows, zoom channels etc. under the part number, and re-use them for repeat jobs. If your monitor is also equipped with the optional "process analysis feature", the unit will also memorize the target force wave forms and the machine loading profile.

Memorizing part data (store parameters)

M

5

1

Press "M", "5" and "1" to access the entry section for part data. A qestion box shows up asking whether you are memorizing data for a new part (press "E") orif you want to refresh data for an existing part (press "C"). If you choose "new part", you will need to enter the part number and confirm with "E". If you choose "overwrite existing part", the screen will show a listing of the part numbers already in memory. Pick the part number you wish to overwrite by moving the red selection bar with the "2" and/or the "5" key to the desired position. Confirm your choice with the "E"-key. Next, you can select which parameters you wish to store for that part. Make your choice. Pressing the "C"-key allows you to leave the entry screens at any time.

```
1 Force parameters        Yes
2 Vibra parameters         No
3 General parameters       No
4 Infobox
5 Target curve            Yes
6 Distribution profile    Yes
7 Store
```

1 "Force parameters" memorizes all force related settings
2 "Vibra parameters" memorizes all acoustic related settings
3 "General parameters" memorizes all other settings (sort, idle strokes, stop logic,..)
4 "Info box" allows you to memorize under 10 consecutive numbers any numerical information you wish to store along with this part (e.g. thicknesses of filler pieces, settings or lengths of ejector pins, etc.) for future reference.
5 "Target curve" will store the envelope band for each force sensor at that time
6 "Loading profile" will store the loading across all sensors at that time

Please select "Yes" or "No" for each heading ("Yes", if you want to memorize that data for the part, "No", if you don't). Once you've made your selection, it will automatically be proposed again when you memorize data for another part.

Press "7" for storing the data. You will be asked one more time if you really want to store. Answer "E" for yes, or "C" for no.

M

5

2

Recall part data (recall parameters)

Press "M", "5" and "2" to access the recall section for part data. A listing will appear with all the part numbers for which information is stored. Pick the part number you wish to recall by moving the red/dark selection bar with the "2"-key downwards or the "5"-key upwards to the desired position. Confirm your choice with the "E"-key. Next, you can select which parameters you wish to recall for that part. If any parameter says "No", there is no information in memory for this particular parameter. Any information stored in the "Info box" for this part can be viewed in the "Process analysis" section (see page 29, #7).

Press "5" to recall the memorized data, and to re-activate them as the current monitoring settings (before this, you will see another safety question, whether you really want to recall the data, or not).

```
1 Force parameters       Yes
2 Vibra parameters        No
3 General parameters     Yes
4 Infobox
5 Recall
```

All memorized parameters such as sensitivity, tolerance, timing windows, zoom channels etc now will automatically be re-activated. If your unit is equipped with the optional "Process analysis" feature, you can also view the target curves and the loading profile for this part in comparison to the current force curves and loads (go to "process analysis" in the menu section ti do so.

Delete a part

Memorized part numbers can be deleted from the memory within the **Set-Up** section (this section is normally protecetd by a 4-digit code). Enter the code and call up page 1-3, and go to "Delete part".

Select the part you wish to delete by moving the red/dark selection bar to the desired part number and press "C" to delete. As a precaution, you will be asked if you really want to delete this part (press "E") or not (press"C"). If you choose "Yes", any data for this part data will be deleted.

M	
6	
9	
1	

6. Set-up section

The set-up section of the SK process monitor contains many of the important parameters which are needed to match the unit with the type of machine it is going to work on. The most important parameters are explained in the following (please remember you will need an access code to enter this):

Timing system (adjust the timing window)

Press 9 for page 2 of the set-up, then press 1 to access "timing system". Each channel has it's own individual timing window based upon crank angles of the machine's main shaft. The timing window defines the area of the machine rotation where the forming process takes place. This ensures that the actual forming force signal is always shown in optimum scale on the display. Select "timing system" in set-up 1, page 2 to obtain the currently set timing window for channel 1. If the machine runs, you will see a force curve provided the window is set to a position where forming occurs. If you wish to view the timing window of another channel simply press it's number .
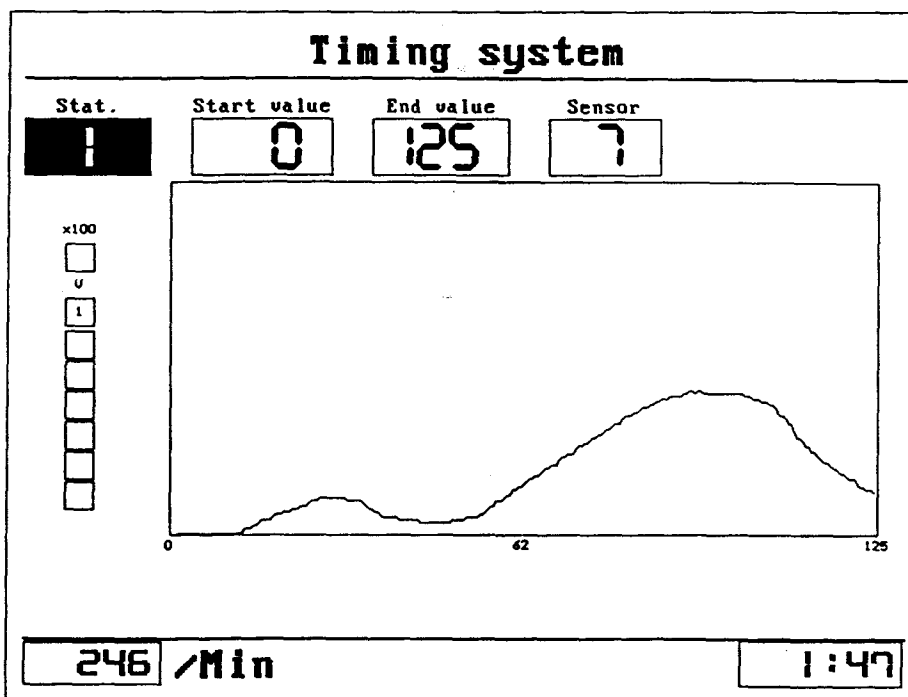
The example above shows the force curve in channel 1 with a set window of 0 to 125 degrees. Channel 1 looks at sensor input #7. The zero degree position is determined by the location of the prox-switch installed at the machine's main shaft.

The timing window can only be modified if the SK unit is put in MAN- or STOP-mode. Press the C-key once to obtain the colored entry box for "Start value". Enter your new number, and confirm with the E-key. Next, enter the "End value" and confirm again. Now, you may also change the sensor input if you want this channel to look at another sensor input signal. Confirm your choice again with the E-key. The timing window now changes to the new settings, and the scale of the force curve adjusts.

Zoom function

The SK process monitoring units feature the unique zoom function which is a simple yet effective way to significantly enhance the system's fault detection capabilities. The zoom function looks just like a magnifying glass at those sections of the forming force curve which are particularly relevant to certain types of faults, and monitors that segment as a separate channel. It is possible to have more than one zoom window opened on one sensor, or to have zoom channels activated for several sensors. The number of zoom channels is limited, and depends on the type of unit you have.

Open a zoom channel

NOTE: Zoom channels can only be opened while the units is in MAN or STOP.

To open a zoom channel, press the curve key and call up the channel you wish to zoom on. Press the curve key again. The two dotted lines on the left and right side of the screen can be moved to mark the desired zoom window. Press "3" to move the line to to the right, and "1" to move it to the left. You can switch from one line to the other line by pressing the "C" key. When you have marked your desired zoom window, press "E" to confirm. The zoom channel now will be automatically generated. If you press any other number than "1" or "3" while moving the lines, a window pops up which allows you to enter the start and end values of the desired zoom window by their number (in degrees), and you can set your own sensitivity and tolerance for the zoom channel.

Each entry is confirmed by the "E" key. The zoom channel is generated automatically, and the respective area is shown in shaded gray on the force wave form of this channel.

Process Analysis

Stat.	Process deviation downwards	Process deviation upwards	Q-Factor	Tol.	Sens.
I	0	0	99	I	0 3 6 9

zoomed area

x100

8   60   120

Order-No.	Tool-No.	Part-No.
		4712

272 /Min   4:56
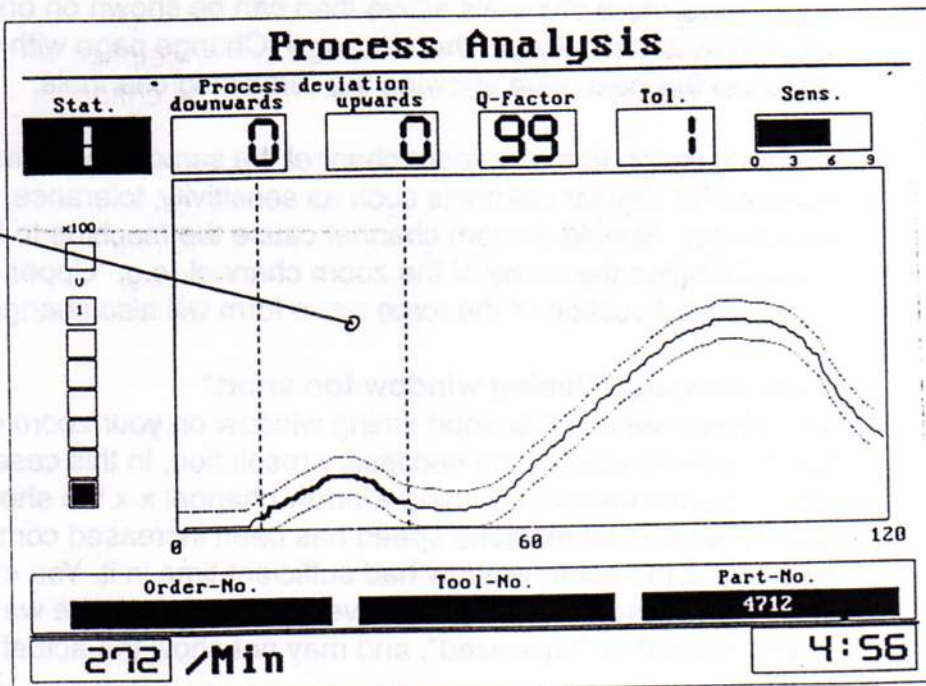
All zoom channels are listed on the "Process Monitoring" screen just like the regular channels, however, they use their owning numbering system. This number includes the regular channel they are based on, and which zoom channel they are. The example below shows 5 regular channels numbered 1 through 5, and two zoom channels which are both looking at regular channel 1. The zoom channels thus are called 1-1 and 1-2.

Process Monitoring

Stat.	Actual	Average	Tol.	Sens.
1	345	345	2	
2	312	312	1	
3	92	92	2	
4	345	345	2	
5	267	267	1	
1-1	92	92	2	
1-2	287	287	2	

247 /Min   1:04

If you have more channels active than can be shown on one page of the screen, you will automatically get the message "Change page with 0". Press the "0" to switch to the next page showing the remaining channels.

You can assign to every zoom channel the same specific monitoring techniques and limits as for regular channels such as sensitivity, tolerance, trending, idle stroke detection, etc. Should a zoom channel cause the machine to be stopped, the fault message identifies the name of the zoom channel (e.g. "Upper envelope channel 1-2"). The zoomed scetion of the force wave form will also change it's color (red or dark).

Error message "timing window too short"
If you have set a rather short timing window on your zoom channel the system may not be able to work at the necessary resolution. In this case, you will be notified by a flashing error message "timing window channel x-x too short". A reason for this could also be that machine speed has been increased compared to the previous part where the zoom window had sufficient time in it. You may run the system with the error message flashing, however, some of the force wave forms may appear "compressed" or "squeezed", and may not show the actual progression of the forces.

If you have selected the timing window too short already during initial zoom set up, you will obtain the following message window:

```
+-------------------------------------------+
|        Your selected timing window        |
|                is too short.              |
|            Adjust automatically?          |
|  +--------------------+------------------+ |
|  |        No          |       Yes        | |
|  +--------------------+------------------+ |
+-------------------------------------------+
```

If you choose "No" (press the "C"-key), your too short timing window will be accepted. The error message keeps on flashing, but be aware of possible falsifications.

If you choose "Yes" (press the "E"-key), the system will automatically adjust the window to the closest possible setting by maintaining your initial start value.

Add/change/delete a zoom channel
Call up the channel or the zoom channel you wish to work on by pressing the curve key, and press this key again (Note: unit must be in MAN or STOP mode). The following window pops up:

```
+-------------------------------------------+
|  Select zoom function                     |
| ----------------------------------------- |
|  1  Add zoom window                       |
|  2  Change zoom window                    |
|  3  Delete zoom window                    |
+-------------------------------------------+
```

Press "1" to **add** another zoom channel to this sensor. If you still have open zoom channels left, you will obtain another set of dotted lines which you can move to the desired positions by using the "3" and "1" keys as described above. If there is no further zoom channel available an error message will be shown.

Press "2" to **change** an existing zoom channel. Again, use the "3" and "1" keys to move the dotted lines one after the other to their new positions. Confirm the new zoom window by pressing the "E" key.

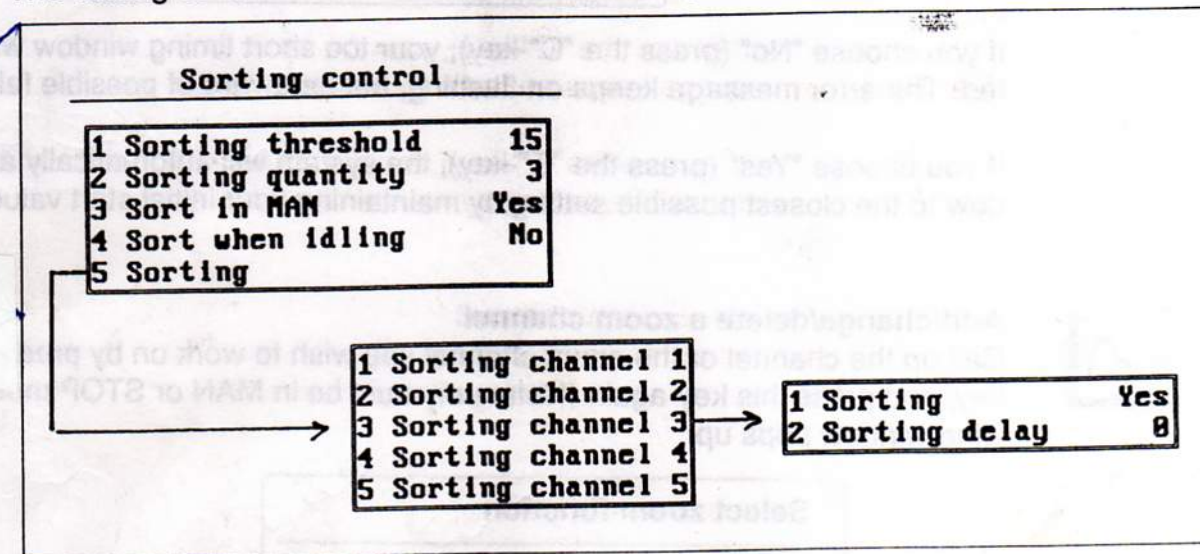If, during adding or changing a zoom window, you press any other number key than "3" or "1", the numerical entry window pops up where you can define start and end value of the zoom window through their numbers.

Press "3" to **delete** an open zoom channel. Answer the following safety question "Delete zoom channel?" with "Yes" and this channel will be deleted. A deleted zoom channel can be re-used immediately.

Setting the sorting control parameters

The SK process monitoring systems are designed to operate in conjunction with suitable parts separation systems such as gates or traps in order to separate any detected faulty parts from the previous good parts production. The SK unit will give a sort signal via it's sort relay to open and close such device. The machine is allowed to carry on producing. It will only be stopped by the process monitor if too many consecutive bad parts are made (adjustable via "Tolerance" setting, see page 07).
The sorting control section includes the following parameters:

```
┌──────────────────────────────────┐
│  Sorting control                 │
│                                  │
│  1 Sorting threshold        15   │
│  2 Sorting quantity          3   │
│  3 Sort in MAN             Yes   │
│  4 Sort when idling         No   │
│  5 Sorting                       │
└──────────────────────────────────┘

        ┌──────────────────────────┐      ┌──────────────────────────┐
        │ 1 Sorting channel 1      │      │ 1 Sorting          Yes   │
        │ 2 Sorting channel 2      │      │ 2 Sorting delay      0   │
        │ 3 Sorting channel 3  ──→ │      └──────────────────────────┘
        │ 4 Sorting channel 4      │
        │ 5 Sorting channel 5      │
        └──────────────────────────┘
```

1 Sorting threshold
Determines which size of fault will be sorted (the process deviation which is shown in the force curve display must be greater than the threshold value set here).

2 Sorting quantity
Defines the number of machine cycles or strokes for which the sort signal will be given. Ensures that the faulty part has really passed the gate position.

3 Sort in MAN
When set to "Yes" the sort signal will be activated as long as the SK unit runs in MAN-mode. Any set-up pieces are now sorted as well, if desired.

4 Sort when idling
When set to "Yes", the sort signal will be activated every time the process monitor detects an idle stroke. On some machines such as thread rollers, certain faults have very low force readings and, thus, may look like an idle stroke which typically is allowed on these machines. In such a case, the sort gate can be activated for safety reasons every time an idle stroke or a "would-be idle stroke" is detected.

5 Sorting
Allows to select which channel(s) will trip a sort pulse, and the number of strokes for delaying the sort pulse (this option can minimize the number of good parts which normally are sorted along with the bad one).

M

6

6

Adjusting idle stroke parameters

Certain types of machines, such as thread rollers for instance, have the tendancy to produce idle stroke at regular intervals due to problems in feeding the blanks at the desired rates. Normally, the process monitor would consider an idle stroke to be a "defect", and, consequently stop the machine. To avoid this, the SK unit can be set to tell the difference between idles strokes and "real faults"; and to tolerate a certain number of idle running. Only if idle running continues over longer periods of time (e.g. when raw material stock or blanks are finished) the machine will be stopped. The following parameters must be set for this function:

```
          Idle stroke detection
     ┌──────────────────────────────────┐
     │1 Idle stroke detect.             │
     │2 Idling threshold           15   │
     │3 Idle strokes allowed      500   │
     └──────────────────────────────────┘

              ┌──────────────────────────────────┐
              │1 Idle stroke channel 1      No   │
              │2 Idle stroke channel 2      No   │
              │3 Idle stroke channel 3      No   │
              │4 Idle stroke channel 4      No   │
              │5 Idle stroke channel 5      Yes  │
              └──────────────────────────────────┘
```

1 idle stroke detection
You choose in which channels you want to allow idle strokes to occurr without stopping the machine. After pressing "1" the screen switches to your channel selection. Switch those channels to "Yes" where you want to allow idle strokes (press the number of the respective channel to change from "No" to "Yes"). Press the E-key to return to the previous page.

2 Idling threshold
Determines the limit for idle strokes as a percentage of the normal peak load. If a force reading is below the limit this stroke will be considered an idle stroke. The example above will see idle stroke if forces are less than 15% of the normal load.

3 Idle strokes allowed
Determines the maximum number of the allowed consecutive idle strokes before the machine is switched off. During this time, the warning light on the top of the SK unit will flash to alert the machine operator of an unproductive machine condition.

M

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7

Setting the stop logic

The different parameters of the "stop logic" section allow you to customize the stop reactions of the SK monitor to the particular needs of your machine.

```
                        Stop  logic
_____



             ┌──────────────────────────────┐
             │ 1 Trend Stop           Yes │
             │ 2 Tool C. Stop          No │
             │ 3 Order C. Stop         No │
             │ 4 Q-Limit Stop         Yes │
             │ 5 Flash cycles         500 │
             │ 6 Soft Stop             No │
             └──────────────────────────────┘
```

1 - 4 Selecting your stop logic

It may not be desirable in every case to stop the machine right away for non-critical reasons that do not necessitate immediate reaction. It could make more sense to just inform the machine operator by a flashing warning light and a message on the display that his attention may be needed. Only if he has not attended to the problem within a certain period of time, the machine will stop. Such a stop reaction can be programmed for "Trend limits", "Tool counter", "Order counter" and "Q-limit" as follows:

Stop = Yes :   immediate stop as usual
Stop = No: delayed stop, first flashing of the warning light

5 Flash cycles (sec)

Programs the duration of the warning action in seconds. After this, the machine will be switched off. Flash cycles can be set between "1" and "9999". If set to "0", this would again mean immediate stopping.

6 Soft Stop

You can also activate our "Soft Stop" function for the above described non-critical stop reasons (set "Soft Stop" to Yes). The machine will then be stopped as follows:

- first, the "Wire" relay inside the machine interface (see appendix INTF) is fired to disrupt further material feeding
- the machine will run a few more strokes to empty all stations (number of strokes is automatically calculated from the number of channels respectively dies).
- now, the "Motor Stop" relay will fire to finally stop the machine

When "Soft Stop" is activated, it will be effected for all of the above stop reasons, be it direct stop, or stop after warning.

M

6

8

Setting the batching logic
SK's unique batching logic allows you to customize the batching functions to the particular requirements of your machine, your quality control procedures, and your batching system.

```
            Batching  logic

  1 Bat.. AUTO   -> STOP      Yes
  2 Bat. STOP    -> MAN       Yes
  3 Bat. MAN     -> AUTO 1    No
  4 Bat. MAN     -> AUTO 2    No
  5 Bat. AUTO 1-> AUTO 2      No
  6 Containers AUTO 2         12
  7 Delay                      2
```

1 - 5 Batching signal when changing operation mode
You may wish to have a batching signal given each time there is a change in the SK unit's operation mode (set the respective mode change to "Yes"). It may make sense, for instance, to move your batching unit to the next empty container when the machine is stopped for a fault such that tha faulty part does not contaminate the previous container with the good parts. To do this, set menu point 1 (Bat. AUTO->STOP) to "Yes". Accordingly, the batching signal can be initiated for all other changes in the mode of operation.

6 Containers AUTO2
Filled batching containers are typically emptied during normal shifts (AUTO1 mode) by the operating personnel, and the batching function is set to permanent mode without final stop (number of containers in the batching counter, see page SK4-15, is set to "0"). When running unattended shifts in AUTO2, however, you just have a limited number of containers available after which you would like to stop the machine. You can enter this number here, and it will be automatically programmed into the batching counter as soon as you start AUTO2-mode. When going back to AUTO1 mode, the setting will be again the standard "0".

7 Delay
The batching signal can be delayed by a presettable number of machine strokes. This function can be helpful in cases where a conveyor is used between the machine exit chute and the batching unit which will delay the bad part's arrival. Using the delay function minimizes the number of good parts filled with the bad one into the next container.

M

6

Set-Up 1-1 (page 1)

1. Code
Determines whether you want to protect the set-up section by a 4-digit code or not.

2. Envelope distance
The minimum width of the envelope limits can be set here for every channel. The number is in percent. The smaller your number, the closer the envelope is trying to fit around the current variation of the force wave form.

3. Trend setting
The trending feature can be activated separately for each channel (if set to "Yes", the trend limits are active). Furthermore, you can lock the trend limits such that they are no longer adjustable from the trending screen (prevents unauthorized changes).

4. Crash limit
You can set for each channel which size of fault shall be treated as CRASH. A Crash signal will override any "Tolerance" settings and stop the machine immediately.

5. Sorting control
6. Idle stroke detection
(see description on pages 22 and 23).

7. Printer setting
(see descroption on page 19).

Set-Up 1-2 (page 2)

3. Tolerance
This option locks the possibility to change "Tolerance" setting when set to "No".

4. Q limit
This option locks the possibility to change "Q limit" settings when set to "No".

5. Absolute display (scale 100)
When set to "Yes", the display of all force readings (peak value) will be scaled to a value of 100. The standard setting is "No", which will show the force readings on a fixed scale proportional to the true sensor input signal.

6. Count in MAN
When set to "Yes", the order size counter will also count all parts made during MAN-mode. If set to "No", it counts only the parts made during AUTO modes.

M

6

7. Strokes in MAN
Sets the number of machine strokes after which you want the SK unit to change automatically from MAN into AUTO mode. This feature eliminates the risk that the machine is being run without monitoring (often, people just forget to push the AUTO button to start the automatic monitoring mode).

Set-Up 1-4 (page 3)

1. Calibration
This option allows to enter calibration values relating to the absolute force monitoring feature (please see page 16).

2. Teleservice
Used to activate the Telservice feature. Switch **Tele diagnosis** to "Yes" with the modem connected to the unit's serial port to properly initialize the modem for Teleservice. If your unit is equipped with an integrated modem, use #2 to change between the different types of modem.

3. Delete part
Used to delete any part data from the memory (see also page 19/2).

NOTE:
When your unit is equipped with the optional "print-out" function, it will take a little more time than usual to switch from one page of the set-up to the other. As explained earlier, the print-out function is started with a double-pressing the "9". Since the "9" is also used to change.pages, there is a short time delay built in before a single "9" becomes valid.

M

8

2. Load distribution profile

This screen shows the distribution of the current peak force reading (blue bar on right side) in comparison to a previously memorized reference profile (green bars on left side) for the same part. This allows to see if there are major differences between the current and the previous load distribution, and to identify under- or overloading.

```
         Load distribution profile

    182  128  149  101  83  128  80  128  63  102


current─

target─



Stat.    1       2       3       4       5
Memorized on  3.01.97, 11:32h

   Order-No.          Tool-No.          Part-No.
                                          4712
```
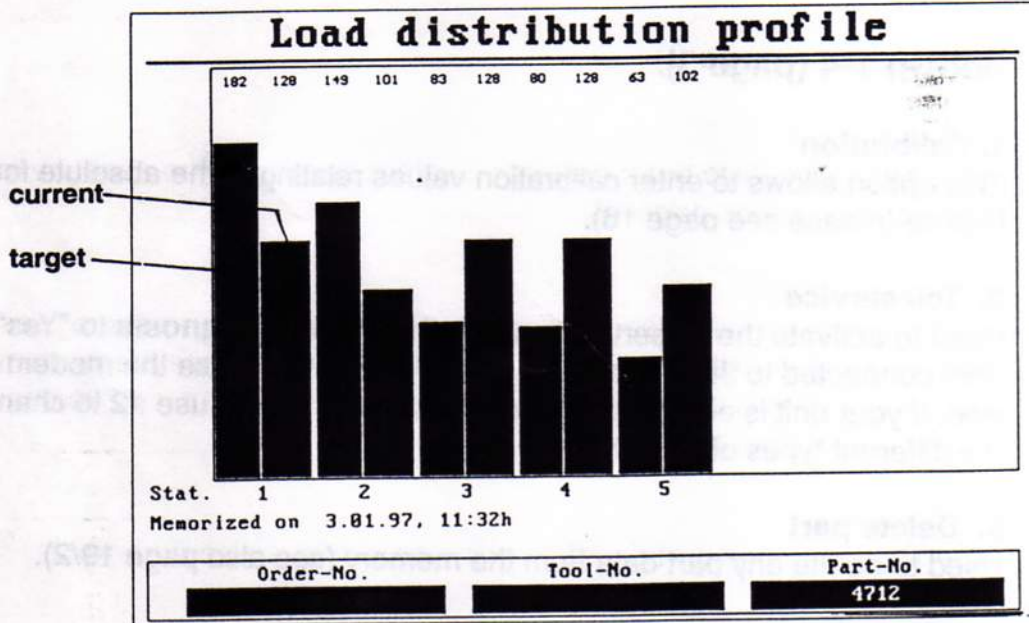
3. Failure curves

The SK unit always keeps the last 100 failure curves in memory. The failure curves can be called up for analysis purposes. Use the "1" and the "3" keys to page up and down through the list of the memorized curves. Each failure curve is exactly identified by a running number, the error message, and time and date of the recording.

```
                  Failure curves

              Process deviation
        Stat. downwards  upwards  Q-Factor  Tol.   Sens.
         4       0        69        99       1
                                                   0  3  6  9

        x100
                                                          Upper/
error─                                                    lower
curve                                                     envelope
         1




         0              60                    120

Curve    2 of   12   (14.09.96, 13:35h)
Crash channel 4
```
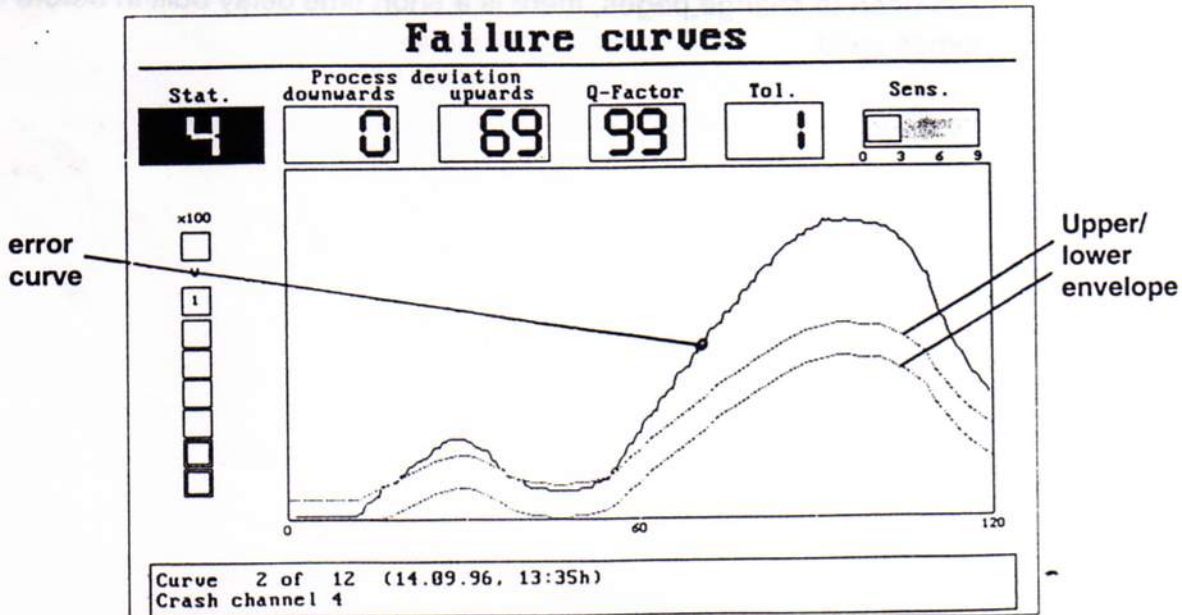
M

8

4. Stop code analysis

Displays the distribution of the last 100 stop codes as they were determined by the SK unit (technological stop code analysis). The numbers in brackets ( ) indicate how often that particular code occurred.

```
                 Stop-Code-Analysis

  Stop-button pushed (8)
  Tool counter preset quantity (3)
  Crash channel 1 (3)
  All batching container are filled (3)
  Upper envelope channel 2  (2)
  Order counter preset quantity (2)
  Q-Limit channel 1 (2)
  Lower envelope channel 1  (2)
  Q-Limit channel 2 (1)
  Proximity signal missing (1)

  0       2       4       6       8      10
                                    No. stops

  Order-No.          Tool-No.          Part-No.
                                         4712

     272 /Min                          43:49
```
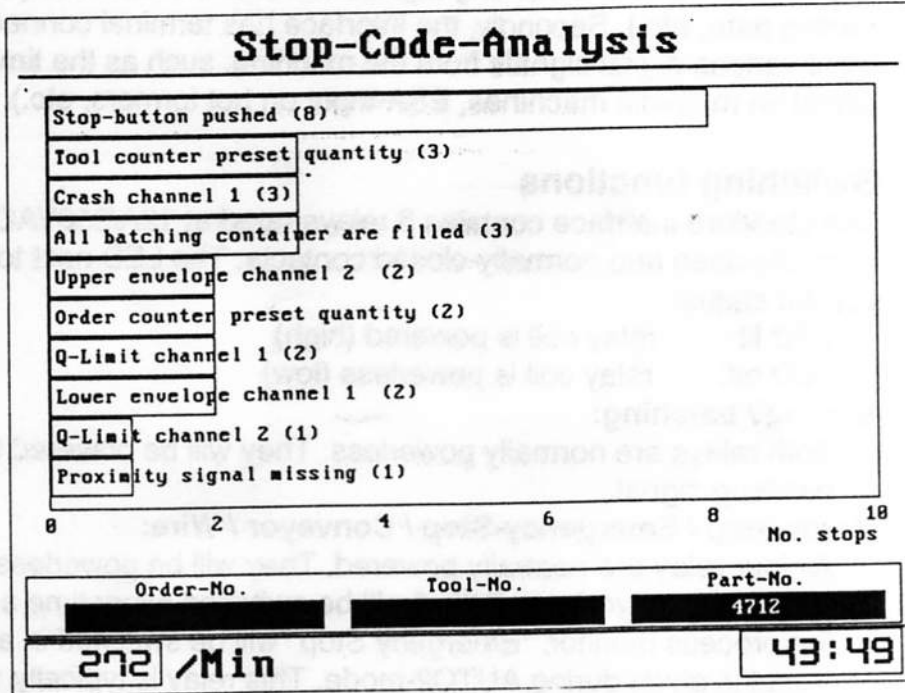
5. Down time reporting

Fucntion not available.

6. Machine running time

Function not available.

7. Info box

If a previously memorized part number has been recalled, the info box here will show any information that was recorded with that part number (see also page 19/1).

General description

The machine interface serves as connection between the SK process monitoring systems and the machine controls. Firstly, the interface contains a set of relays which are used to transfer switching signals towards the machine (e.g. stop machine, flip sorting gate, etc.). Secondly, the interface has terminal connectors which are used to input various digital signals from the machine, such as the timing signal, finger-open signal on multi-die machines, ESA-input on hot formers, etc.).

Switching functions

The standard interface contains 6 relays rated at 12A/250VAC. Each relay offers normally-open and normally-closed contacts. The LED next to the relay shows it's current status:

    LED lit: relay coil is powered (high)
    LED off: relay coil is powerless (low)

Sorting / batching:

    Both relays are normally powerless. They will be powered to give the sorting or batching signal.

Motor-Stop / Emergency-Stop / Conveyor / Wire:

    All four relay are normally powered. They will be powerless for switching. "Motor Stop", "Conveyor" and "Wire" will be switched every time a stop signal is given by the process monitor. "Emergeny Stop" will be switched in addition when a stop signal is given during AUTO2-mode. This relay is typically used to switch off every electrical component on the machine when it is stopped during unmanned shifts. As an option, the "Emergency Stop" relay can be switched with a 5 min time delay to let the machine slow down and cool off before power is cut completely.

By-Pass key switch

The by-pass key switch located on the outside of the interface box will force all relays to stay in their normal position. The process monitoring system can now be removed from the machine, and the machine is able to run without the monitor.

Good-part-made pulse output

The good-parts-made output pulses a short signal for every good part made when the machine is running. Some data networking systems require such a signal to tell if the machine is running or not. No output signal is given in case of machine downtime, or when the machine runs idle.

Digital inputs

The following digital inputs are reserved for fixed functions:

    IN 0:   Input of the ESA-signal (used when monitoring hot forging machines)
    IN 1:   Input of "transfer finger open" signal (used e.g. on presses which can actively dropwire cut-offs or material blanks, to put the monitor into by-pass)
    The other inputs are reserved for future functions.

3 x 1.0 mm² cable to A1 control unit and to SK4/SK8

230 VAC

100 mA T
100 mA T

1
230 VAC
2
Earth

GND
Good part
Cycle
Collector
+12 V

Socket for connection towards processor board

1

34

34-lead data cable to the A1 control unit

max. contact rating:
12A / 250VAC

5	1		
11	2	Sorting	
	3		Rotary decoder
9	4		
10	5	Batching	
	6		
7	7		key switch
8	8	Motor Stop	
	9		
3	10		digital inputs
4	11	Emergency Stop	
	12		
	13		
	14	Conveyor	digital inputs
	15		
	16		
	17	Wire	
6 (free)	18		
	19		digital inputs
	20	Reserve 1	
	21		
	22		
	23	Reserve 2	
	24		digital inputs

Rotary decoder:
+ 12V
+ 5V
0
A
B
GND

key switch:
GND
Bypass

digital inputs:
+ 12V
IN 7
IN 6
GND

digital inputs:
+ 12V
IN 5
IN 4
GND

digital inputs:
+ 12V
IN 3
IN 2
GND

digital inputs:
+ 12V
IN 1
IN 0
GND

All relays shown in powerless condition

12-lead cable towards machine controls

by-pass key switch

Modified version!

GND
Good part
Cycle
Collector
+12 V

Earth

1
110/230 VAC   2

Fuse
Fuse
230 VAC: 5 A slow blow
110 VAC: 10 A slow blow

110/
230 VAC

**3 x 1.0 mm² cable
to A1 control unit
and to SK4/SK8**

Socket for connection
towards processor
board

1

34

**34-lead
data cable to the
A1 control unit**

max. contact rating:
12A / 250VAC

Relay		Label		Signal
5	1			+12V
11	2	Sorting	Rotary	+5V
	3		decoder	0
9	4			A
10	5	Batching		B
	6			GND
7	7		key	GND
8	8	Motor Stop	switch	Bypass
	9			+12V
3	10		digital	IN 7
4	11	Emergency	inputs	IN 6
	12	Stop		GND
	13			+12V
	14	Conveyor		IN 5
	15		digital	IN 4
	16		inputs	GND
	17	Wire		+12V
6 (free)	18		digital	IN 3
	19		inputs	IN 2
	20	Reserve 1		GND
	21			+12V
	22		digital	IN 1
	23	Reserve 2	inputs	IN 0
	24			GND

All relays shown
in powerless
condition

**12-lead cable towards
machine controls**

by-pass
key switch

Status: 150297/Kp

Terminal board

rotary decoder

- GND
- A
- B
- 0
- + 5V
- + 12V

digital inputs

- GND
- IN 7
- IN 6
- + 12V

digital inputs

- GND
- IN 5
- IN 4
- + 12V

20   1
to processor board

Timing signals (prox-switch)

- GND
- Takt 2
- Takt 1
- + 12V

digital inputs

- GND
- IN 3
- IN 2
- + 12V

- GND
- IN 1
- IN 0
- + 12V

microprocessor board

power supply

RS 232 PC-unit
1   10

Amplifier 1
1   16

towards machine interface
1   34

keyboard PC-unit
1   14

Amplifier 2
1   16

to terminal board
1   20

DUPLO remote keys
1   14

+ 5V
+ 12V
JUMPER

Switching
Pull Up + 5V/+12V

Pull Up
Pull Down
JUMPER

- 0
- A
- B
- IN 0
- IN 1
- IN 2
- IN 3
- IN 4
- IN 5
- IN 6
- IN 7
- Takt 1 (prox 1)
- Takt 2 (prox 2)

Jumper position for contacts IN0 - IN7:
- 12V-signal on relay contact: **Pull-Up**.
  Input is high when the contact is closed.
- GND-signal on relay contact: **Pull-Down**.
  Input is high when contact is open.

Jumper position for contacts Takt 1/Takt 2:
- P-type prox switch: **Pull-Down**.
- N-type prox switch: **Pull-Up**.
Set the non-used prox input (typically #2) to Pull-Up.