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KROHNE

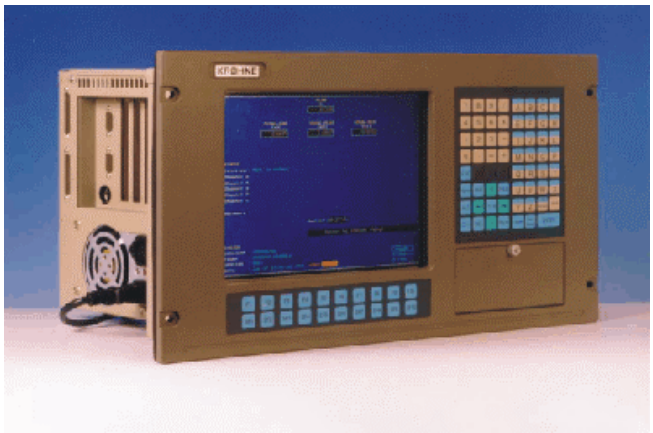
Ultrasonic
Flowmeters

ALTOSONIC V

Reference Guide

Operating manual

Ultrasonic Flow Processor (UFP-V)



Applicable for software version 0300

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INTRODUCTION

This manual describes the operation of the ALTOSONIC-V ultrasonic flow-meter system and the handling of the data-files.

Also, in this manual you will find a description of the computer that is used, its data-acquisition and control cards, the software, possible errors and recommendations.

Note that in this manual all, standard and optional, specifications of the ALTOSONIC V are described

The manual is divided into two parts**. Basic Operations and Extended Operations.**

Product Liability and warranty

Responsibility for suitability and intented use of these ultrasonic flowmeters rests solely with the operator.

Improper installation and operation of the flowmeters (systems) may lead to loss of warranty.

In addition, the “General conditions of sale” forming the basis of the purchase contract are applicable.

1 Basic and Extended operations

The first part of this manual will describe the Basic Operations.
The second part of this manual (Chapter 10) will describe the Extended Operations.

Basic Operations:

- Start up
- Alarming
- Description of all windows
- Description of Standard volume to API2540
- Batching
- UFP Hardware description

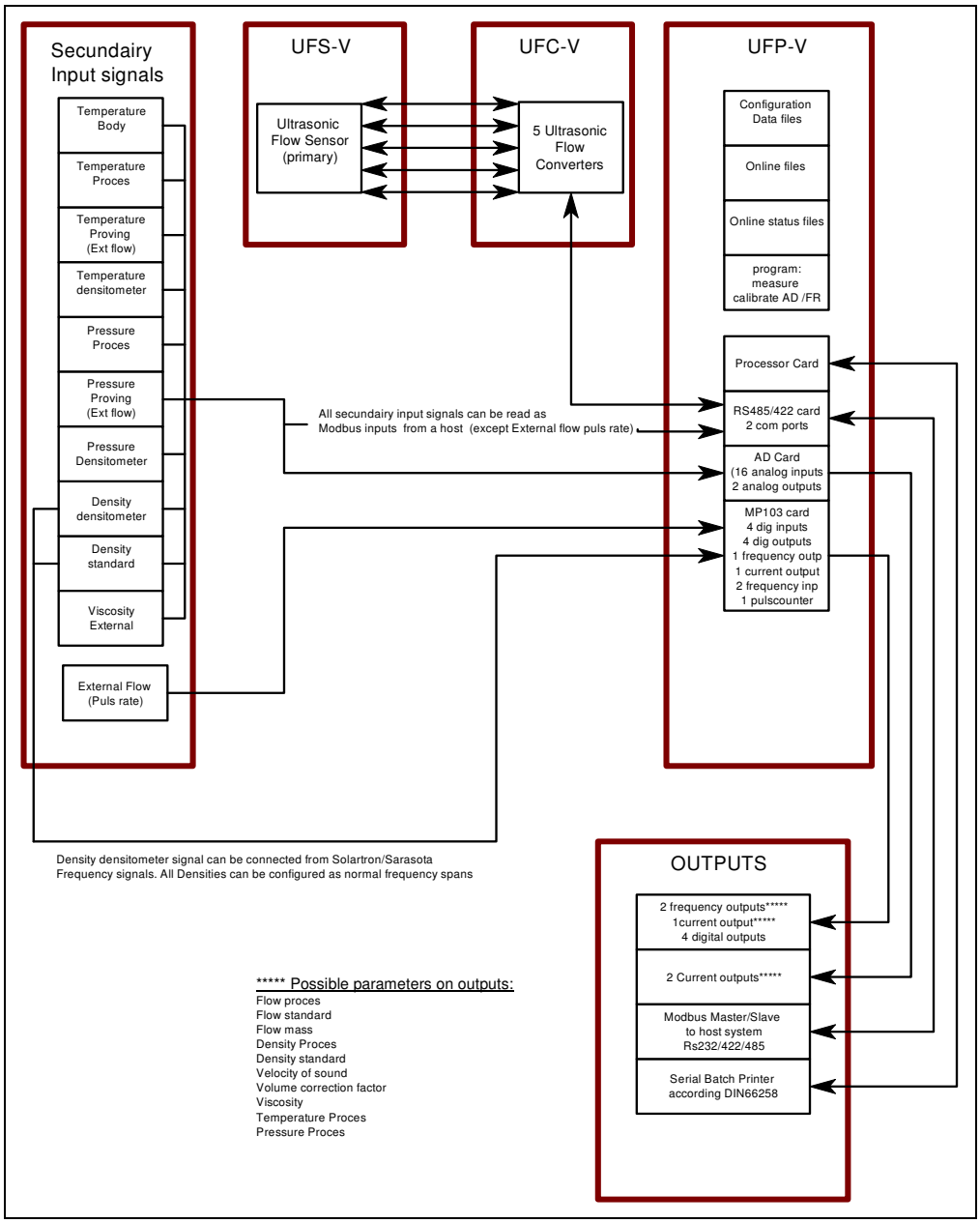
Extended Operations:

- External Flowmeter setup (master duty)
- Base Sediment and water
- Other Standard Volume standards than API2540
- Extra batching functions
- Simulated Frequency on failure
- Meter factor adjustment through Modbus
- Reynolds Warning function

2 SYSTEM CONFIGURATION

2.1 Hardware configuration

The flow chart below includes all hardware specifications of the ALTOSONIC V regarding the flow measurement.



From this point on, in this manual the following abbreviations will be used

UFS-V	: Ultrasonic Flow Sensor (primary flow-meter body)
UFC-V	: Ultrasonic Flow Converter (5 converters)
UFP-V	: Ultrasonic Flow Processor
UFP-Program	: Software program running on the UFP-V for measuring the flow.

2.2 UFP-Program

The operating system is DOS 6.22 for its proven reliability using real time data processing.
The UFP-Program is controlled by initialisation data files and on-line configurable data files.

2.2.1 Initialisation data files

These files can be accessed by a DOS-editor when the UFP-Program is not running.
The Initialisation data files are divided into 3 groups:

UFS files	: Calibration data regarding the Ultrasonic Flow Sensor (primary)
UFP files	: Calibration and configuration data on the hardware set up within the UFP (cards etc)
DAT files	: Client configuration data regarding the set up of communication and signal IO.

2.2.2 On-line configurable data files

These files are binary and only accessible when the UFP-program is on-line.

API.bin	: API settings on standard volume correction
DENSITOx.bin	: 4 files for calibration data on densitometer cells Solartron 1 & 2, Sarasota 1 & 2
OVERRIDE.bin	: Override value settings

2.2.3 Functionality

The functionality can be divided into primary and secondary functions

Primary functions:

- Monitor data- and system integrity
- Data acquisition: data of five converters and optional data such as temperatures, pressures, densities, control bits, etc.
- Check the measured data from the five converters and handle errors, if necessary.
- Calculate the proces volumetric flow in the primary head from the measured data.
- Calculate the standard volumetric flow (e.g. 15 °C, 1.01325 bar), if installed. Standard temperature can be set in the range 0-30°C.
- Totalise proces and standard flow as measured volumes
- Flow weighted averages on batching (temperature, pressure, density etc).
- Resetable and non resetable totalisers
- Output of calculated data and errors through: frequency output, analog outputs, digital outputs and Modbus communication.
- Possibility to override the input values (Temperatures, Pressures, Densities etc on line). Override is signalled as an alarm.
- Printing of tickets for batch functions such as Off Loading and Continuous Pipeline Measurement

Secondary functions:

- Statistics
- Back-up history such as totalisers, averages and alarms.
- Various screen functions for real-time monitoring.

2.3 Features

Data measured

RS485	UFC-V ↔ UFP-V (data communication connection between UFC-V and UFP-V):	
	Flow velocity	-five times (as a percentage)
	Transit time	-five times
	Status UFC-V	-out of range, path failure, communication failure
Analog in	Temperature	: body, proces, densitometer*
	Pressure	: proces*, densitometer*
	Density	: proces*, standard*, densitometer*
Digital in	Start /Stop signals calibration (KROHNE used), or switch Densitometer calibration data	
	Reset volumes and errors	
	Reset errors	

Data processed for output to user

Flow	: proces flow, standard flow*, mass flow*
Sound velocity	: five channel values, mean value
Resetable Totals	: proces volume, standard volume*, mass*. All forward, reverse, total.
Non resetable Totals	: proces volume, standard volume*, mass*. All forward, reverse, total.
API Density	: proces, standard*, densitometer*
Analog in Temperature	: body, proces*, densitometer*
Analog in Pressure	: proces*, densitometer*
Analog in Density	: densitometer*, standard*
Flow weight averages	: Temperature (body, proces*, Proving external*, standard*, densitometer*)
	Pressure (proces*, densitometer*)
	Density (proces*, standard*, densitometer*)
	Corrections (Ctl & Cpl values*)
	[2 sets averages (= made in two time intervals*)]
Batch ticket print	: All output values can be printed by free definable layout configuration

Data integrity

Alarms on flow data
Alarms on system
Alarms on Low/High Analog inputs*

Data corrections under normal conditions

Reynolds correction
Body expansion correction for temperature and pressure
Standard volume correction according to API 2540* standard

Data corrections under alarm conditions

Real time profile correction on channel failure
On-line override values on analog inputs*
Filtering of measured data*

Service values on Modbus (measured by UFP but not used for calculation directly)

All temperatures, pressures, densities and Viscosity

* = Optional

Secondary input	Function
Temperature body	For correction of the expansion of the UFS, resulting in a correction factor K_b on the measured flow
Temperature proces*	For standard volume correction Resulting in a correction factor $C_{tl\ 15\ to\ proces}$ on the measured flow
Temperature proces**	For correction on standard calibration volume (Factory use only). Function is only applicable when the calibration is not only monitored by the calibration facility but also, with a digital start/stop signal, by the UFP. The standard calibration volume is the volume measured at a standard temperature
Temperature densitometer*	For standard volume correction Resulting in a correction factor $C_{tl\ 15\ to\ densito}$ on the measured flow
Pressure proces*	For standard volume correction Resulting in a correction factor $C_{pl\ proces}$ on the measured flow
Pressure densitometer*	For standard volume correction Resulting in a correction factor $C_{pl\ densito}$ on the measured flow
Densitometer density*	The density measured by the densito meter
Density standard*	The density standard with at predefined standard temperature

* = Optional
**= KROHNE Altometer calibration use only

3 UFP-V START UP

When the UFP is powered, the UFP-Program starts automatically.
To prevent unattended changes to the initialisation files the data is protected at start-up by:

- **Calculation CRC checksum**
- **Check data from files on input range limits**
- **Password**

3.1 Calculation CRC checksum

Each file has a CRC checksum. When anything changes in the file, the CRC-checksum will also change.
At the start-up of the UFP-V the CRC checksums are calculated and checked:

Start-up:

```
CRC-CHECKSUM FOR DATA FILES:
    -------------------------
    flow0300.ufs: CRC correct
    reyn0300.ufs: CRC correct
    swrl0300.ufs: CRC correct
    crc_date.ufs: CRC correct
    crc_norm.ufs: CRC correct
    -------------------------
    hset0300.ufp: CRC correct
    adca0300.ufp: CRC correct
    mpca0300.ufp: CRC correct
       defad.ufp: CRC correct
       defmp.ufp: CRC correct
    crc_date.ufp: CRC correct
    crc_norm.ufp: CRC correct
    -------------------------
    coms0300.dat: CRC correct
    syst0300.dat: CRC correct
    clnt0300.dat: CRC correct
    tick0300.dat: CRC correct
    crc_date.dat: CRC correct
    writ0300.dat: CRC correct
    crc_norm.dat: CRC correct
    -------------------------
```

CRC checksum:

All data files have a CRC checksum

CRC checksums are saved in file:
CRC_NORM.ufs
CRC_NORM.ufp
CRC_NORM.dat

Back-up of all data files in:
CRC_FILE.ufs
CRC_FILE.ufp
CRC_FILE.dat

CRC checksums and length of each file is saved in:
CRC_BACK.ufs
CRC_BACK.ufp
CRC_BACK.dat
(CRC checksums of these files are within the file)

If the checksum of a file is not identical to the one saved at the previous start-up in the CRC_NORM file, the program switches to fail mode.

```
CRC checksum not OKEE!!!

Errornumber = 25

                Communication with flowconverters active
                Modbus driver active.

               Stop by pincode..(4dig)

               Errortime:  00:00:18.72
```

Fail mode:

Possible cause:
Change of data in file

Only breakable by pin code:
1357

CRC checksum error

If the fail mode is caused by a CRC-checksum error, there are three options:

1. Calculate a new CRC-checksum. The calculation is protected by password.
2. Load the backup file
3. Escape

```
CRC INCORRECT:make new CRCchecksumfile,  hit key (1)
              retrieve backup datafiles, hit key (2)
              escape,                    hit key (3)

YOUR CHOICE IS:
```

Causes:
1 Change made in data file
2 sudden checksum error (not likely to happen)

Possible actions:
1 new crc-checksum.
2 Load backup file:
If crc checksum of backup files also fail, backup file not loaded. Check parameter file
3. Escape

Make new CRC checksum

```
Make new CRCfile, type password (=max 10 characters)

        Enter current password   :   **
```

Making the new crc file:
1 Type the password
On delivery the password is 7531
2 Enter

When more than 30 characters are typed during input of the password the UFP-Program terminates and the UFP-Program must be restarted to make the new crc-file

To make a new CRC-checksum and to start the measure mode follow these steps:

1.	MEAS [enter]	(Batch file to start the measure mode)
2.	1357	(Pin code to stop the fail mode)
3.	1	(Choice to make a new CRC-checksum)
4.	“Your password”	(Pin code to make the new CRC checksum)
5.	MEAS [enter]	(Batch file to start the measure mode)

Note that the password can only be changed when the UFP-Program is running.
To change it:

- Go to the Main Window
- Type code : PSSWRD
- Follow the directions in the window
- After the password is saved, the program automatically shuts down and a new CRC-checksum must be created. Start the UFP-Program and make the new CRC-checksum by using your new password.

3.2 Reading initialisation files on input range

Each parameter is checked for its input range.

```
Out of range in clnt0300.dat:
Freq_max=3000.000000 , must be 1.000000 .. 2000.000000

Errornumber = 24

Communication with flowconverters active
Modbus driver active.

Stop by pincode..(4dig)

Errortime:  00:00:09.59
```

1. If a parameter is out of range, the software switches to fail-mode.
   (Only breakable by pin code 1357)

2. In fail mode a system set-up Error Code is given.
   The parameter and its input range are printed on screen. If the Modbus communication is active the set-up Error Code is also available on this output.

3. If there are no problems at start-up, the software checks whether the CRC-checked data files correspond with the backup file BACK0300.bin.
   This backup file also has a CRC-checksum. Only when the data files do not correspond or the backup checksum gives an error, a new backup file and checksum are made.

3.3 Batch commands for configuration change and program start up

The following batch commands can be used in DOS mode:

No	Name	Description
1	MEAS	Start measure program to measure flow
2	AD	Start calibrate-verify AD card IO (AD-812)
3	FR	Start calibrate-verify Frequency card IO (MP103)
4	CLNT	Edit parameters on IO, Spans etc
5	COMS	Edit communication setup (Modbus, Batchprinter etc)
6	SYST	Edit the system file (syst0300.ufs)
7	TICK	Edit ticket (BOL) layout file
8	HSET	Edit parameters on hardware settings of the UFP
9	SECU	Secure all (configuration, programs, operating system)
10	BACKALL	Make a backup to an empty floppy of flow configuration and OS
11	BACKFLOW	Make a backup to an empty floppy of flow configuration only
12	BACKOS	Make a backup to an empty floppy of Operating System OS only
13	BACKZIP	Make a backup to empty floppy (zipped)
14	FLOW	Edit the flow calibration file
15	REYN	Edit the reynolds calibration file
16	SWRL	Edit the swirl calibration file

Note that these files are custody transfer configurations and a password is required to enable the changes for the measurement program.

3.4 Start up: system set-up errors

The system SET-UP ERRORS are caused by an improper initialisation such as data–change etc.

If the UFP-V identifies a system set-up error, it switches to fail-mode.
The fail-mode shows the found error and the elapsed proces error time. The mode can only be stopped by pin code 1357.

Identified set-up errors are:

Error No.	Function	Problem	How to solve
1	CRC	Error opening: file(filename) to check on CRC	Try to load backup (CRC-function)
2	CRC	Error closing: file(filename) to check on CRC	Try to load backup (CRC-function)
3	CRC	Error opening: CRC-code file(filename)	Try to load backup (CRC-function)
4	CRC	Error closing: CRC-code file(filename)	Try to load backup (CRC-function)
5	CRC	Error length: CRC-code file(filename)	Make new CRC checksum
6	Common, opening file	Error in path: file(filename) not found	Try to load back-up (CRC-function)
7	Not in use	Not in use in this version	
8	Common, read in table	File(filename), maximum rows exceeded	Put in less data points
9	Common, closing file	Error read in file(filename)	Try to load backup (CRC-function)
10	Common, closing file	Error write in file(filename)	Try to load backup (CRC-function)
11	Read in profiles	Error in file(filename): a parameter <|0.01|	Try to load backup (CRC-function)
12	Not in use	Not in use in this version	
13	Check on serial numbers	Serial numbers in parameter files do not correspond	Check the serial number in files
14	Initialising Graph driver	Graphics error	Is egavga.bgi file in directory ASV0300?
15	File location	Error in finding disk	Check the file locations in HSET0300.ufp
16	Frequency set-up	Error in set-up frequency output	Follow instructions on screen
17	Common, read in parameter	Error in a parameter file, bad up-dating, make sure that '#' is first	Check your last updated file or load backup (CRC function)
18	Common, read in parameter	Error in a parameter file, number too large (more then x characters)	Check your last updated file or load backup (CRC function)
19	Factory use only		
20	Factory use only		
21	Not in use		
22	Check location executable	Error in LOCATION_EXE, proces location is disk x	Change LOCATION_EXE in HSET0300.ufp
23	Not in use		
24	Check parameters on range	Out of range in file(filename), parameter(name)=x, Must be in range x1…x2	Follow the instructions on screen
25	CRC-checksum outcome	CRC checksum not correct!	Make a new checksum or if not certain about the data, load the backup (CRC-function)
26	Not in use		
27	CRC-checksum	CRC backup-files checksum not correct	Fill in the correct data in actual files Backup
28	Batch status files	When the batch mode is enabled and the batch status files are not found at start-up.	After breaking the fail mode follow the instruction on screen to insert your last ticket number
29	Initialisation Printer	When the batch mode is enabled, the printer software is initialised. On error of initialisation	Check the COMS0300.dat file for errors in Printer set-up
30	Password	If for any reason the password is lost	Try to load backup (CRC-function)

The errors, which may occur during the initialisation of the Modbus Driver and the initialisation of the driver for the communication with the ultrasonic converters, are listed below.

- See for the communication system set-up errors also the **ALTOSONIC V ModBus Manual.**

Returned error numbers:

Error No.	Problem	How to solve
1001	Modbus driver: Requested interrupt not supported	Make sure MODBUS_UART_INTERRUPT is within the limits (3 or 4)
1002	Modbus driver: Requested baud rate is not supported	Make sure MODBUS_UART_BAUDRATE is within the limits (1200,2400,4800,9600,19200)
1003	Modbus driver: Parity setting error	Make sure MODBUS_UART_PARITY is within the limits (0,1,2)
1004	Modbus driver: Stop bit error	Make sure MODBUS_UART_N_STOPBITS is within the limits (1,2)
1005	Modbus driver: RTS_MODE not supported	Make sure MODBUS_UART_RTS_MODE is within the limits (0 or 1)
1006	Modbus driver: Number of bits not supported	Make sure MODBUS_UART_N_DATABITS is within the limits (7 or 8)
1007	UFC driver: UART_init parameters error	Make sure Setting for the UFC communication are correct
1008	Modbus driver: too many pollblocks installed	Make sure NUMBER_OF_POLLBLOCKS_TO_USE is not larger than 20
1009	Modbus driver: function 6 only supports integer types in modicon compatible mode	When using the Modbus master mode in modicon compatible mode, function 6 only support integer types. When Other types (float, double…) are necessary use function 16.
1010	Modbus driver: Slave ID not in range of 0…247	The Slave ID in a pollblock request must be between 1 and 247 or in case of a broadcast 0.
1011	Modbus driver: Broadcast not allowed for this function (pollblock x)	Use a valid Slave ID to access only 1 slave.
1012	Modbus driver: Function 5 and 6 can only handle 1 point (pollblock x)	When using function 5 or 6, make use the number of points is 1, these functions can handle only one point.
1013	Modbus driver: Minimum number of points to request is 1 (pollblock x).	Make sure that at least 1 point is used for this action.
1014	Modbus driver: data type not allowed (pollblock x)	The data type of the pollblock is not the same as the data type in the Modbus mapping
1015	Modbus driver: unsupported data address, or request number of points out of range	The requested points must be in the available Modbus mapping.
1016	Modbus driver: Data type / function mismatch	Make sure the Modbus function and the allowed data type do match
1017	Modbus driver: Too many points requested	Make sure the Modbus message length is not exceeded, request fewer points.
1018	General: unable to open the communication set-up file	Make sure the COMS0300.DAT file exists in this directory
1019	General: unable to close the communication set-up file	Make sure the Drive is still powered.
1020	General: error reading communication set-up file in parameter x	A parameter was expected but could not be read, make sure all the variables start with a **#**
1021	General: error reading communication set-up file in parameter x, parameter out of range	A parameter was read, but not within the expected limits.
1022	General: PC timer initialisation failed.	Try to restart the flow computer (cold start) else contact KROHNE

3.5 System set-up warning

The system set-up warnings (SSW) are caused by:

- Insufficient statistical data during set-up (file REAL.BIN was not found)
  Default data is used until sufficient statistical information is recorded (under normal conditions within 3 minutes under normal flowing conditions). In this case the warning is self-resolving.
- Improper initialisation of the Modbus driver
  Modbus will not be accessible. In this case the warning remains active.

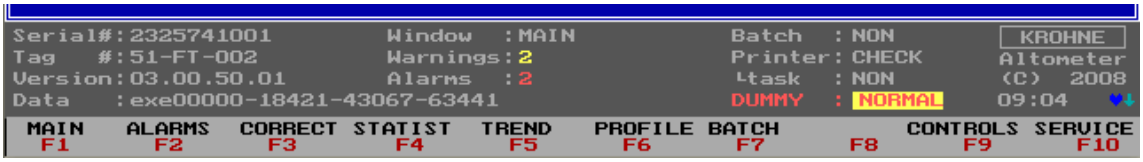
4 RUNTIME USER WINDOWS

In measure mode the screen is always divided into two parts.

- The Status Window at the bottom of the screen
- The Runtime User Window which is above the Status Window

Function keys control the Runtime User Windows. At the bottom of the Status Window the possible functions are showed for the particular Runtime User Window.

The status window:



It shows:

- Serial # : Serial number assigned by KROHNE Altometer
- Tag # : Tag number that can be defined by the user
- Version : Software version number
- Data : CRC-checksum for the executable and of the 3 data sets (UFS, UFP, and DAT).
  This can be a first check for the data integrity (every change in a data set changes the checksum of that data set).
  If the CRC-checksum of the executable (program) is 00000 as above the executable is either not certified or the data integrity is corrupted. Either way it is advised to load a new program executable.
  Details can be found under F10 Service, F9 CRC-Data
- Window : The name of the Runtime window showing above
- Warnings : Number of actual warnings, details can be found in the Alarms window (F2)
- Alarms : Number of actual alarms, details can be found in the Alarms window (F2)

The following items are only shown if the batch mode is enabled in the initialisation file CLNT0300.dat

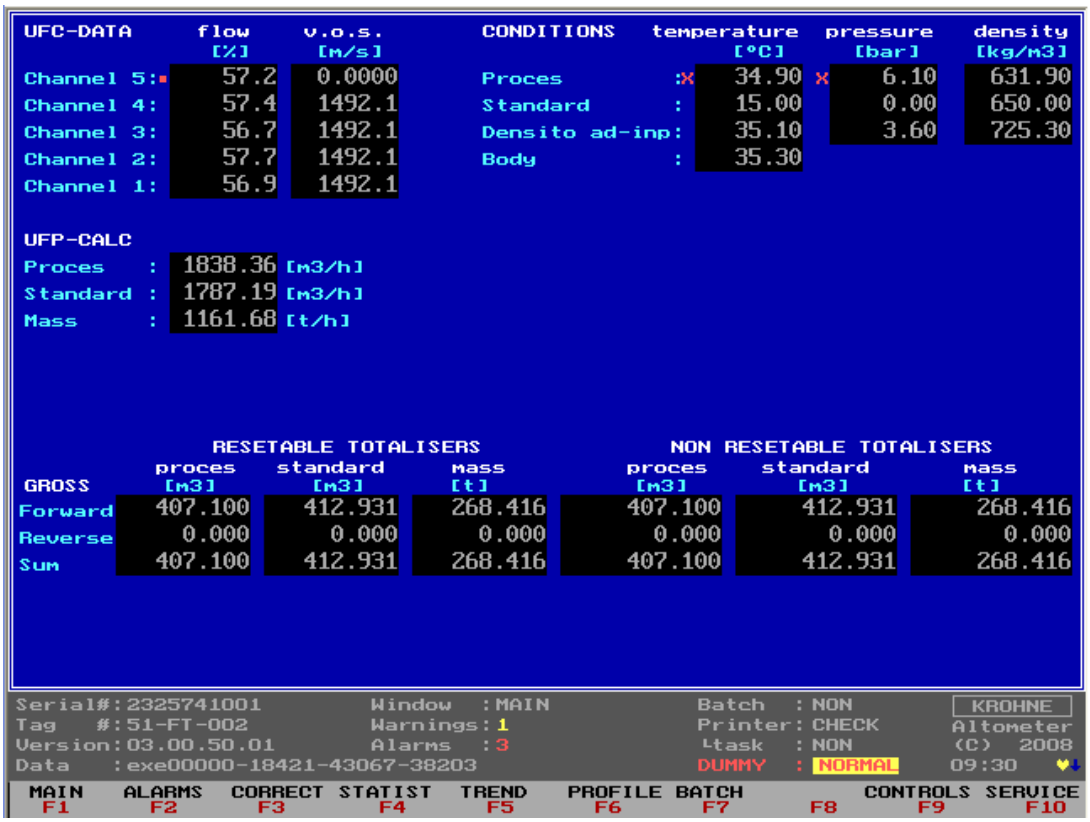
- Batch : Batch status
- Printer : Printer status
- Task : Print task

For more details on Batch mode see chapter 6.

On the bottom the F1…F10 keys represent the possible options available by using these function keys

4.1 Main menu: F1 Main window

The Main window is the default start-up window. This window shows an overview of the system and can always be accessed by function key F1.



Explanation of the Main window layout:

UFC-DATA shows:

- Raw data of the 5 channels regarding flow % and Velocity Of Sound (V.O.S.)
- A red marker (▪) per channel shows an active channel failure, a green marker (▪) shows a previously occurred channel failure

CONDITIONS show:

- Temperatures, pressures and densities measured or calculated for the conditions of Proces, Standard, Densitometer. Body temperature is also included.
- A red marker (**X**) in front of a parameter shows an alarm for out of range or manual on-line override, a green marker (**X**) shows a previously occurred alarm

UFP-CALC shows:

- Flow rates at Proces conditions, Standard conditions and Mass

.

RESETABLE TOTALISERS shows:

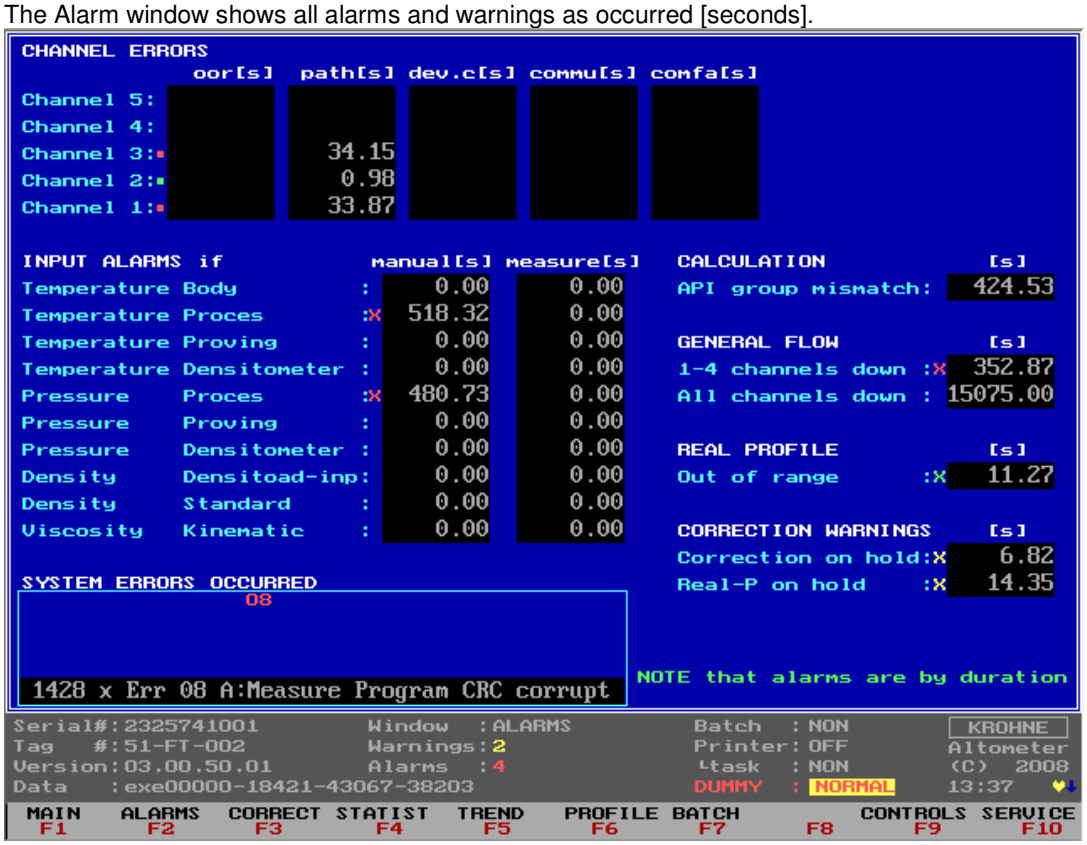
- The forward, reverse and summation of the Totaliser values at Proces conditions, Standard conditions and Mass.
- The resetable totalisers can be reset in the Control menu (through F9 in main): F8 RES-TOT. It is also possible to reset the totalisers by digital input signal or Modbus boolean.

NON RESETABLE TOTALISERS shows:

- The forward, reverse and summation of the Totaliser values at Proces conditions, Standard conditions and Mass.

4.2 Main menu: F2 Alarms window

The Alarm window shows all alarms and warnings as occurred [seconds].



Explanation of the Alarms window layout:

<u>CHANNEL ERROR shows:</u>

There are 5 types of errors

1. **OOR,** Out Of Range, flow data from the UFC is out of the limits – 125...+125% flow rate.
   Possible causes are:
   - Flow out of range
   - Empty pipe
   - Problem with sensor
   - Problem with converter

   Common check is: Value of the proces flowrate

2. PATH, Path failure. The transmitted signal from one sensor in the path is not correctly received by the other sensor in the path..
   Possible causes are:
   - Empty pipe
   - Particles or solids in the fluid
   - Cavitation due to low proces pressure resulting in gas bubbles
   - Problem with converter

   Common checks are:
   - Proces pressure
   - Value of the proces flow rate

3. **DEV.C,** Deviation in sound velocity
   The UFP calculates the mean sound velocity out of the three most nearby channel values (5 times) and then checks all channels on their deviation to this mean value

Deviation limit is set default to –0.5…+0.5 % of mean V.O.S.
Possible causes are:
- Local density variations due to sludge, mixtures or temperature variations
- Empty pipe
- Problem with converter
- Problem with sensor

Common checks are:
- Flow and sound velocity per channel

4. **COMMU**, Communication failure between UFP and UFC (rs485).
The communication is checked on communication errors. The incoming RS485 data is checked on validity. Single errors are skipped (COMFA's) but if there are more than 120 consecutive requests failing this alarm is raised.
Possible causes are:
- if all channels fail there is probably no power supply to the UFC
- if all channels fail it is probably caused by a malfunction of the connection between UFP and UFC
- if some channels fail the problem is in the specific converter of the UFC
- The specific converter is in it's configuration menu
- The specific converter is not configured properly

Common checks are:
- Power supply UFC
- Converter displays
- If a new converter is installed, check the configuration
- Cable
- Connections
- Check the converter by exchanging the connections of a good converter for a probably bad converter. Note that the channel number is configured in the converter

5. **COMMFA,** single communication failures until COMMU is reached

Channel error types 1 to 4 are used to make the General Flow alarms. On General Flow alarm the REAL profile is used to correct the failing channels.
If COMFA's occur then the previous measurement on that channel is used for calculation.

Possible causes are:
- Multiple rapid window changes on slower CPU's
- EMC distortion through poorly connected wiring.

<u>INPUT ALARMS shows:</u>
Each parameter as stated below INPUT ALARMS has alarm settings in the CLNT0300.dat file.
If the alarm is enabled and the parameter is used in the calculation then on alarm the time of occurrence is counted.
When the parameter is in manual override, the time of occurred manual override is counted.

<u>CALCULATION shows:</u>
When using the calculation for the standard volume by API standards the alarm is on if the density is out of range for the API group that is used (see chapter 5).

<u>GENERAL FLOW shows:</u>
The combined channel errors give an alarm on "1-4 channels" down and "all channels down" in time of occurrence.
If the UFP has a power failure then the time between start up and program running is calculated and added at start up of the UFP-Program.

REAL PROFILE:
On GENERAL FLOW error "1-4 channels down" the REAL profile is used to correct the channels with errors. The real profile is sampled at a certain flow rate.

- The REAL-profile correction has a limited validity.
  When the actual profile changes too much, the previously sampled REAL-profile might not be reliable anymore. The check for profile changes is done through flow-rate difference.
- When the sampled REAL-profile flow rate differs too much from the actual flow-rate during REAL-profile correction this is shown as a warning.

CORRECTION WARNINGS shows:

- If there is too much flow variation for corrections, the corrections go on hold. When the corrections are on hold the real time profile is used as a standard for correcting the flow.
- If there are too much flow variations or channels failing, the sampling of the REAL profile goes on hold. On release the sampling is started at maximum time for sampling a profile.

SYSTEM ERRORS shows:
The status of the system is divided into:

- System Runtime Warnings. These are caused by system failures. These failures will not influence the flow measurement.
- System Runtime Alarms. These are caused by system failures. These failures might influence the flow measurement.
  Identified System Runtime Errors are numbered 1 to 60 are:

4.2.1 SYSTEM ERRORS

Identified System Runtime Errors are numbered 1 to 60, A = alarm, W = warning:

Error no.	In function	Problem	Consequence
A : 1	Get RS485 data from converters	Overrun, missed data	Missed data, message
A : 2	Self test	Error in memory self-test	Non-reliable memory
A : 3	Batch start / stop	Error during saving files of start or stop	File lost but ticket is made
A : 4	Profile correction (REAL)	Error in state_correction	Attempt divide to by zero
W: 5	Read Backup all files	Error in reading backup file	Possible loss of backup file
W: 6	Switching disk	Error in finding a drive	Message
W: 7	System time	A notice that the system time was adjusted manually or by Modbus.	No consequence for totalisers or proces time, only on ticket time
A: 8	General program exectutable certification	CRC of the executable is not correct executable file is corrupted.	Load a new executable file. Contact KROHNE service for help
A: 9	Batch status backup	Status file corrupt	Possible loss of batch status
W: 10	Override values files	Error in opening/closing override value file	Override values not stored but still in use
A: 11	Batch totaliser backup	Totaliser backup-file corrupt	File lost , message
A: 12	Batch average backup	Average backup-file corrupt	File lost, message
A: 13	Batch ticket create	Error in creating batch ticket file	Ticket itself is made for printing but lost during saving
W: 14	Opening file (for update)	Error in opening REAL file	File lost, message
W: 15	Closing file (for update)	Error in closing REAL file	File lost, message
W: 16	API settings	Error in file, defaults are loaded and saved	Old settings lost
W: 17	Batch 2	A alarm on batch 2 file (Batch 2 is only used through Modbus with a Scada system)	File lost, message
W: 18	Check free disk-space	Error dos_getdiskfree() call	Time-out function 30 s
W: 19	Check free disk-space	Low on disk-space	Time-out function 30 s
W: 20	Ad card overrun	The requested AD card is not noticed	Solve the problem
W: 21	Opening file (for update)	Error opening API table file	File lost, message
W: 22	Value check	1 or more API values defaulted	Check the installed parameters
W: 23	Opening file (for update)	Error opening external flow meter file	File lost, message
W: 24	Value check	Default external flow meter K-factor	Check the installed K-factor
W: 25	Counter input	Unable to read Counter value	Read on next entry
A : 26	Calibration MP103 card	MPCA File corrupt	Install backup

A : 27	Calibration AD card	File corrupt	Install backup
A : 28	Calibration data Densito Cells	File corrupt	Automatic install of default values Set the correct values on-line
A : 29	Batch ticket currently saved	A Requested batch ticket not available for printing	A ticket by that name was not saved or had a previous save error
A : 30	Batch ticket	CRC error in a Batch ticket	A ticket was not saved correctly or was changed manually
W: 31	Read batch ticket previously saved	A Requested batch ticket not available for printing	A ticket by that name was not saved or had a previous save error
W : 32	Batch ticket close file	Error in closing a ticket file	Ticket file not closed , probably because it could not be opened

See for the communication runtime errors also the **ALTOSONIC V ModBus Manual.**

Err no.	In function	Problem	Consequence
W: 33	Modbus master	Poll block not send due to transmit error	
W: 34	Modbus master	Poll block response time-out occurred	
W: 35	Modbus master	Invalid Slave ID in response	
W: 36	Modbus master	Invalid function in response	
W: 37	Modbus master	Response not correct	
W: 38	Modbus master	Error handling function 1,2	
W: 39	Modbus master	Error handling function 3,4	
W: 40	Modbus master	Error handling function 5	
W: 41	Modbus master	Error handling function 6	
W: 42	Modbus master	Error handling function 15	
W: 43	Modbus master	Error handling function 16	
W: 44	Modbus master	Exception received	
W: 45	Modbus master	Error unpacking Boolean data	
W: 46	Modbus master	Error unpacking integer data	
W: 47	Modbus master	Error unpacking long integer data	
W: 48	Modbus master	Error unpacking float data	
W: 49	Modbus master	Error unpacking double data	
W: 50	Modbus master/slave	Error incorrect message length	
W: 51	Modbus master/slave	Invalid CRC or LRC received	
W: 52	Modbus master/slave	Error receive buffer saturated	
W: 53	Modbus master/slave	UART error (parity, framing, overrun)	
W: 54	Modbus master/slave	Transmit buffer not empty for new transmission	
W: 55	Modbus slave	Unsupported function requested	
W: 56	Modbus slave	Unsupported register(s) requested	
W: 57	Modbus slave	Requested data Level and function mismatch	
W: 58	Modbus slave	Too many data point (registers) requested	
W: 59	Modbus slave	Error unpacking received data	
W: 60	Modbus slave	Broadcast not allowed	

Note: Occurred and disappeared alarms and warnings can be reset in the Control menu: F7 RES-ERR. It is also possible to reset by digital input signal or Modbus Boolean.

4.3 Main menu: F3 Corrections window

The Corrections window monitors the corrections.

Explanation of the Corrections window layout:

<u>REAL-P shows:</u>

- The previously sampled profile.
- The remaining update time to make the new REAL profile.
- The sampling goes on hold if:
  - Channel errors occur
  - Less than 5% flow rate
  This will show in yellow colour as HOLD.
- The validity range in flow rate percentage of the sampled REAL profile. Out of this range an alarm condition is activated

<u>CORRECTION REYNOLDS:</u>

There are three methods in using the Reynolds correction (method 1 is normally used).

1. Through ratio measured numbers AL and BL the profile belonging to a certain Reynolds Number and its correction factor Kr is recognized in a calibrated lookup table. This the default used method
2. The kynematic viscosity is measured and the Reynolds number is calculated from F(Viscosity, Diameter, Velocity). By a calibrated Reynolds table the correction factor Kr is found. Note that Viscosity needs to be measured by the UFP or inputted by Modbus communication for this method.
3. Input the Viscosity under reference conditions and the UFP corrects the viscosity for temperature proces condition. Possible to have up to 6 liquids with choice by measured sound velocity. This method is normally not used.

See the configuration file Reyn0300.ufs for further details.

In the picture method 1 is in light-blue meaning this method is used to make the Reynolds correction factor Kr.
In the picture method 2 and 3 is in grey meaning this method is not used to make the Reynolds correction factor Kr.

The green arrow ►at the Kr location shows that this Kr factor is used in the flow calculation. No arrow means: Not used.
When the correction is on hold due to flow variations this is shown in yellow as HOLD at the Kr location. During the hold period the corrections are done with the REAL-profile as a reference.

The "Dev AB %" shows the percentage of deviation between measured AL BL pair and closest interpolated match to AL BL the lookup table. The smaller the deviation the higher the quality of the Reynolds Correction normally is.

SWIRL shows:
In version 03005000 and later the previous used Swirl Number is replaced by the Swirl% and Skewness%.as quality parameters on the measured flow profile.

The Swirl % is an indication for the found swirl. A normal value is -3.5%…+3.5%.
Out of this range the swirl is considered to have a influence on the flow measurement accuracy.
The Skewness % an indication for the skewness of the measured flow profile. As Skewness can come in many different shapes (symmetrical, and assymetrical) it is difficult to put a limit on the allowed percentage. Skewness is installation specific and can come in many different shapes (symmetrical and asymmetrical). Determination of a limit should be based on installation experience. Registration of skewness during start up or during the first few weeks of installation will give insight in the installation specific limits

It is strongly recommended to avoid swirl by using a flowstraighting device. In the situation whereby flow straigtners can not be used or are insufficient for the high levels of swirl can not be elimimated the A-V has option to use a swirl correction factor because swirl influences the profile and as such the used correction based A and B needs to be compensated for this the swirl correction table can be used. This correction value if possible should be avoided. Hoewever if swirl is present the result will be much better neverthelees the accuracy of the A-V will be lowered and as such the A-V may operate outside its spec.
By default the swirl correction factor is not used.
Only if there is physically no way to correct a swirl it is used to make a more reasonable flow value but this value is inaccurate. As such the ALTOSONIC V may operate outside its specification to be within specs of the ALTOSONIC V because of possible uncalibrated swirl intensities and viscosities.

- The green arrow ► at the Ks location shows that the factor is used in the flow calculation.
  No arrow means: Not used in the flow calculation.
- If the correction is on hold due to flow variations, this is shown in yellow as HOLD at the Ks location. During the hold period the corrections are performed with the REAL-profile as a reference.

BODY EXPANSION shows:
The **temperature expansion correction** is done with the measured Body(Primary) temperature.
The correction factor is Kb. The green arrow ► at the Kb location shows that the factor is used in the flow calculation. No arrow means: Not used.
The correction for body thermal expansion is as follows:

$$K_b = 1 + 3 \cdot \alpha \cdot (T_{body} - T_{ref})$$

K_b : Correction factor used for the body thermal expansion
α : Lineair thermal correction factor [℃ $^{-1}$], depending on the type of metal material.
T_{body} : Temperature body [℃]
T_{ref} : Temperature reference [℃]

The Kb factor is implement as a normal kfactor to correct the measured volume for thermal body expansion.

Another option to use (by default disabled) is the **pressure expansion correction.** Only applicable for high process pressures. The correction factor is Kbp. The green arrow ► at the Kbp location shows

that the factor is used in the flow calculation. The correction is lineair and depends on meter construction.
For example correction per 100 Bar difference for:

- a certain ALTOSONIC V 6 inch construction is about +0.04%
- a certain ALTOSONIC V 10 inch construction is about +0.045%

As this is a linear function the correction at 50 Bar difference would be half the value (0.02%).
This was calculated using the standard: ISO/CD 17089/1

The correction is described in different standards. To be compliant with these different standards KROHNE as made the choice to put the correction in a general formula:

$$K_{pb} = 1 + \frac{C_{pb}}{100} \cdot (P_{proces} - P_{ref})$$

K_{bp} : Correction factor used for the pressure expansion
C_{bp} : Lineair pressure correction factor [%/bar], depending on the construction and used standard.
P_{proces} : Pressure proces[bar]
P_{ref} : Pressure reference [bar],
Note that P expansion correction is disabled at that time, or used pressure is low.

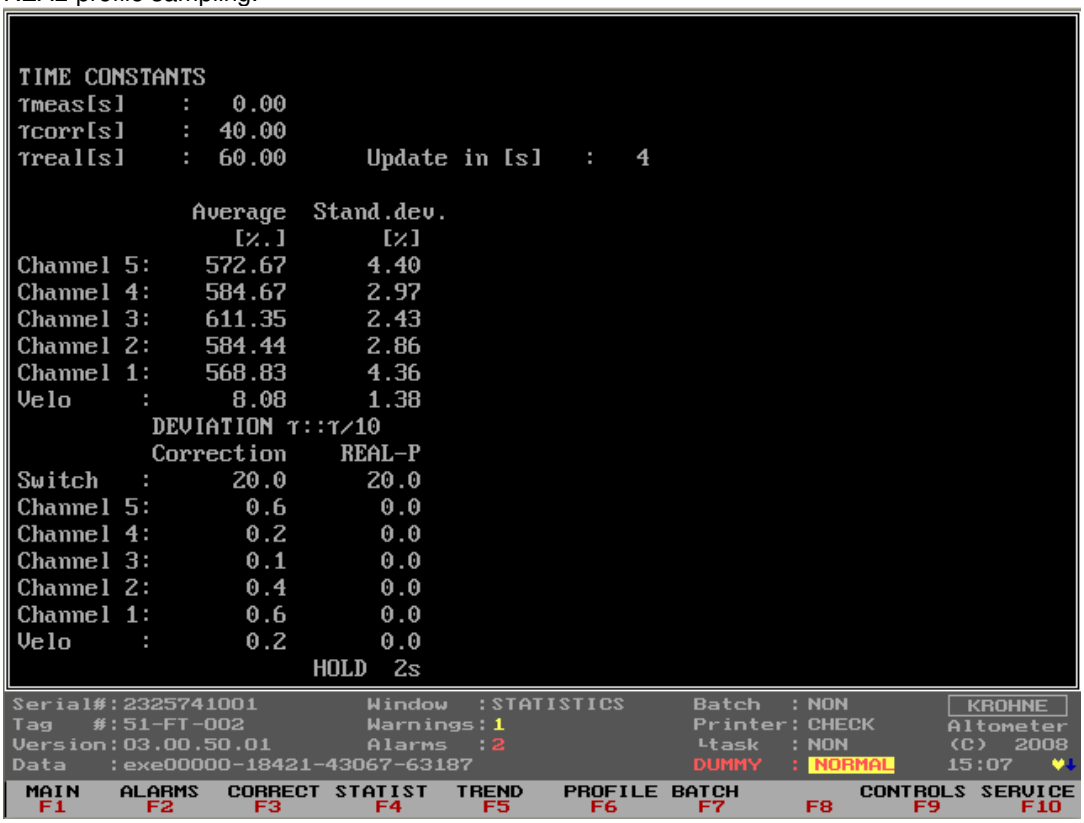
<u>STANDARD VOLUME CORRECTIONS shows:</u>

- The temperatures, pressures and densities at proces, standard, densitometer and optional external flow meter conditions in relation to the correction factors Ctl and Cpl
- The correction factors Ctl (temperature correction to 15°C) and Cpl (pressure correction to 1.01325 bar, or 0 barg)

See chapter 5 for more information on the Standard Volume correction

4.4 Main menu: F4 Statistics window

The Statistics window shows the statistics and monitors the flow variations for the corrections and REAL-profile sampling.



Explanation of the Statistics window layout:

TIME CONSTANTS:

- Tmeas gives the time-constant in seconds as used for the incoming 5 measuring paths flow percentages. Default the time-constant is 0 sec.
- Tcorr gives the time-constant in seconds as used for the Reynolds and Swirl corrections. Default the time-constant is 40 sec.
- Treal gives the time-constant that is used for sampling the REAL-profile. Default the time-constant is 60 sec. After 3 times Treal (180 seconds) the sampled REAL profile is used for possible correction.

STATISTICS:

- The average and relative standard deviation of the 5 channels and the calculated velocity is calculated over 200 (default) measurements (about 7 seconds).
  So every 7 seconds there is an update on these standard deviation values.
- The average for the channels is presented as flow-rate promillage (-1250…+1250), especially practical to measure the zero point deviation per channel at zero flow rate. Note that there will be temperature differences in the proces liquid causing local flows at zero flow.
- Normal is that channels 1 and 5 have a larger standard deviation then channels 2, 3 and 4. For ALTOSONIC V ‘s without straightener the shown readings for the standard deviation are normal. With a flow straightener build-in these values can be reduced by approximately a factor 2.

DEVIATION:

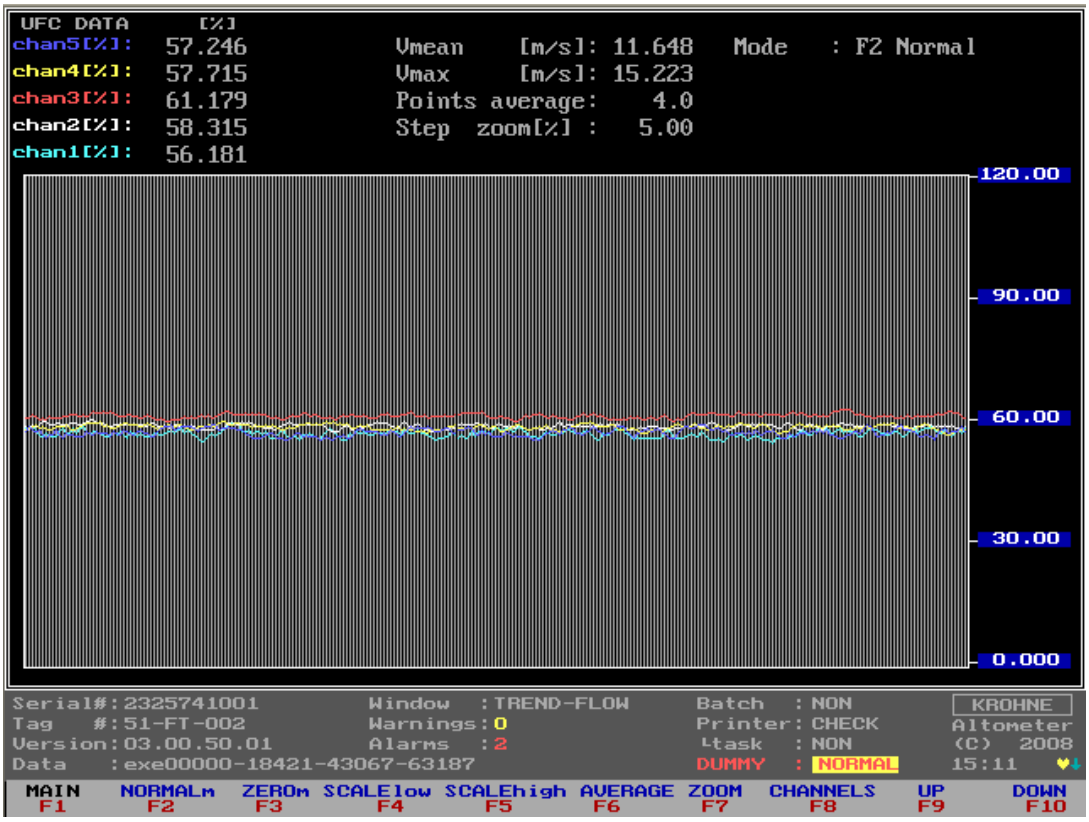
The flow variations for the corrections and REAL-profile are monitored as described below:

- All channels and calculated velocity are monitored with the normally used time-constant and with the normal time-constant divided by 10. If the difference between those two time-constants is more

than the switch value (default 20%) for one of the channels or the velocity the corrections go on hold. When everything is normal again, they are released again and used in the normal way.

4.5 Main menu: F5 Trend-flow window

The Trend-flow window shows the Raw UFC flow percentage as a trend over 10 seconds.
This makes flow variations per channel visible in a graphic.



Each channel has is own colour.

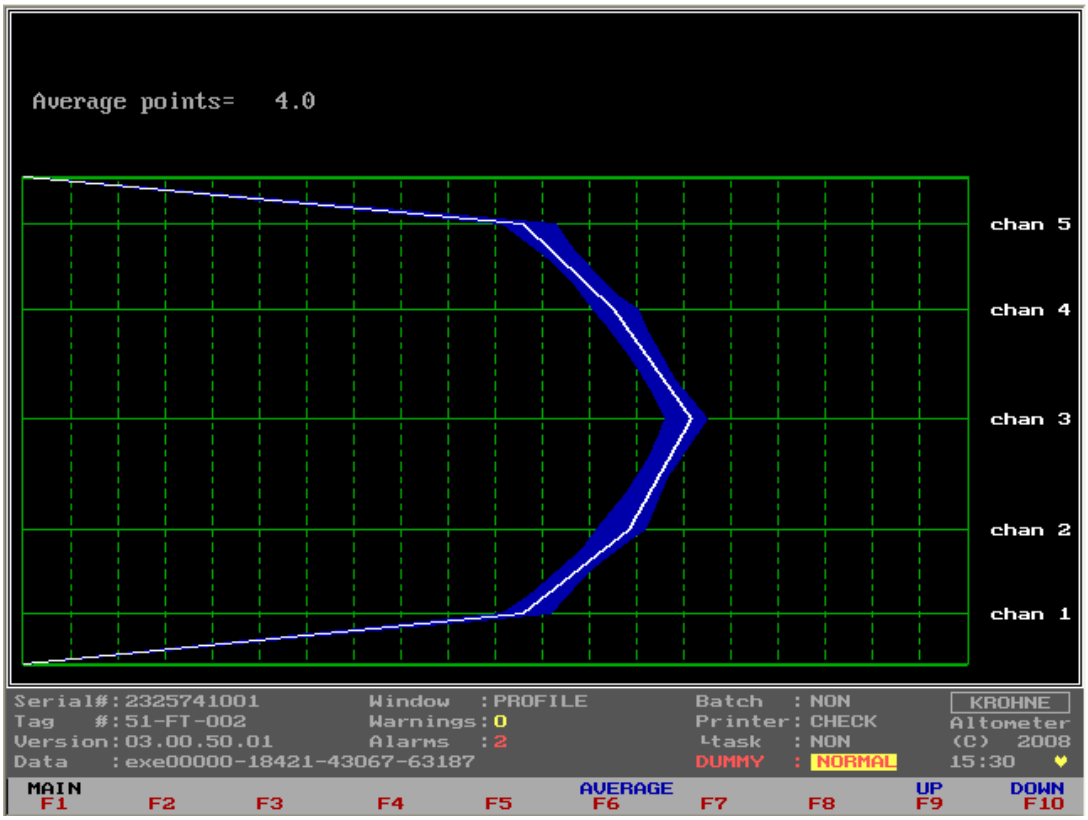
Function keys do the controls of this window, therefore it is only possible to go back to the Main window.

F1 : Back to Main window
F2 : To default normal Y scale (0…120%)
F3 : To zero flow Y scale (-0.5 … +0.5%)
F4 : To change low value Y scale, control by F9 and F10
F5 : To change high value Y scale, control by F9 and F10
F6 : To change points of average (default over 4 measurements), control by F9 and F10
F7 : To change step [%] for UP and DOWN scaling
F8 : To rule out channels, to get a better view over the remaining channels, type <C1>,<C2>,<C3>,<C4>,<C5> to enable and disable channels
F9 : Up scaling for function F4, F5, F6, F7
F10 : Down scaling for function F4, F5, F6, F7

Note that there is <u>no influence on the normal flow measurements</u>.

4.6 Main Menu: F6 Profile window

The Profile window shows the profile of the flow that in the measuring section of the flowmeter and is therefore a good graphical display of the measured profile. Swirl or bend profiles can be easily detected by this graph.

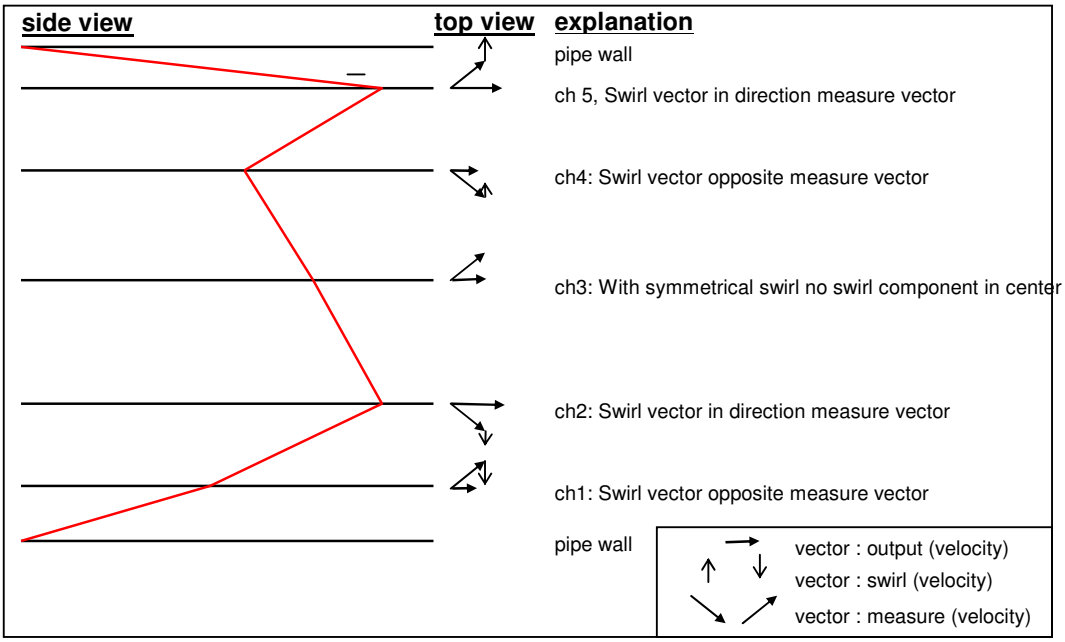


F6 : To change points of average (default over 4 measurements), control by F9 and F10
F9 : Up scaling for function F6
F10 : Down scaling for function F6, F7

A typical low Reynolds number profile is shown above. The blue surface is the noise band on the flow measurement.

Note that anything that is done in this window by using function keys causes <u>no interference with the normal flow measurements</u>.

For example a symmetrical swirl profile would look like this:

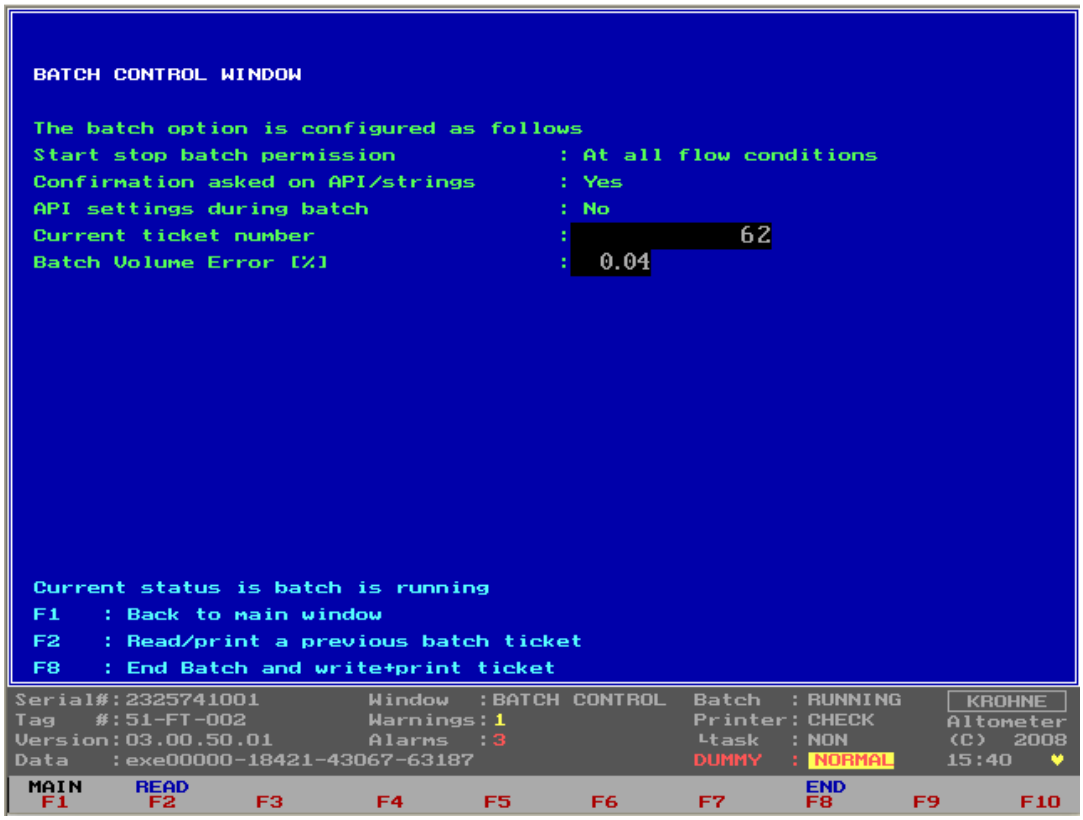


For this example in relation to normal: ch5 larger, ch1 smaller, ch4 smaller, ch2 larger, and ch3 close to normal.

The above profile would lead to about 20% Swirl and would have a large influence on the flow measurement.

4.7 Main Menu: F7 Batch window

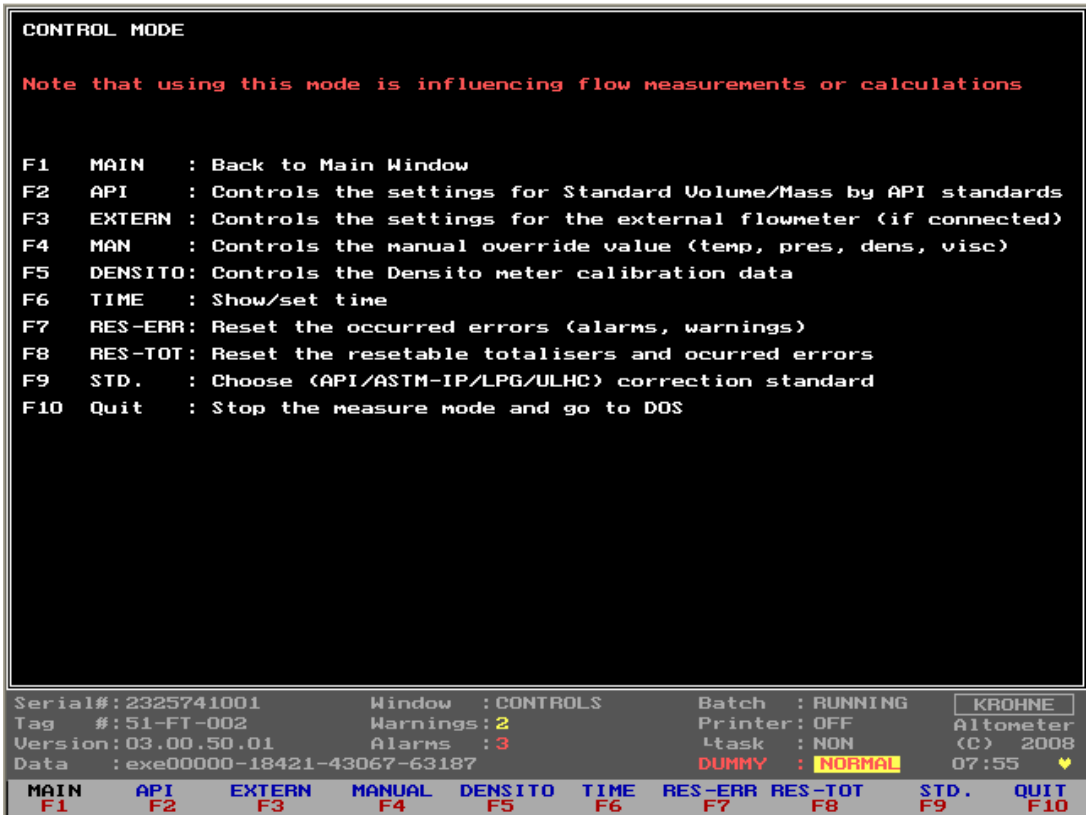
This window is only visible when batch mode is enabled in de initialisation file CLNT0300.dat.
Below is only the window as showed when no batch is running.
For more details on batch mode see chapter 6 BATCH MODE.



New since software version 03.00.50.01 is the option to view, during the batch, the worst case batch Volume Error % estimate due to batch alarms such as path failures, input signals alarms etc etc

4.8 Main menu: F9 Controls window

This is the start window for the controls where a description is given of the types of controls possible.

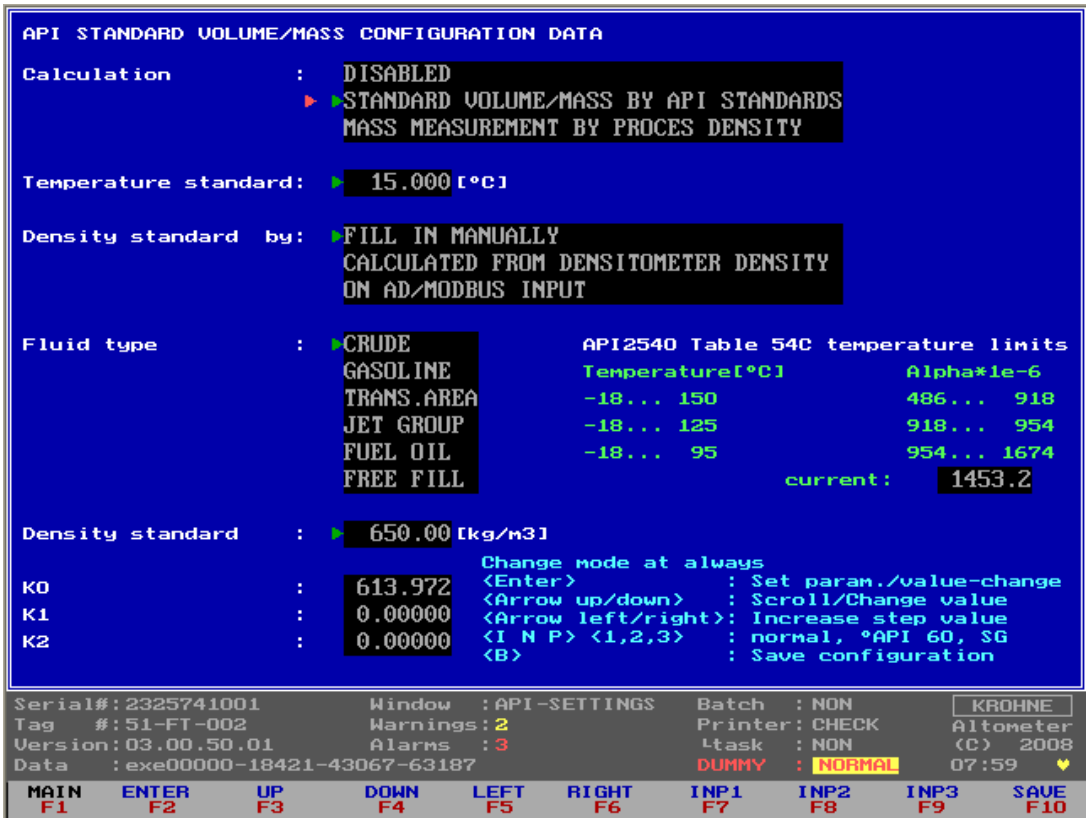


IMPORTANT:

- Using this mode (CONTROLS) is influencing flow measurements or calculations (except for function F6).
- When Batch mode is enabled it is possible that certain controls are not accessible due to the batch mode configuration. See chapter 5 BATCH MODE for more details.

4.8.1 Controls menu: F2 API settings window

In this window the configuration can be made for calculating the standard volume /mass.
The green arrows ► represent the current settings per option. The red arrow ►is the option cursor.



CALCULATION option is configurable:

1. *Disable*, no standard volume or mass is calculated
2. *Standard volume/mass by API standards*
3. *Mass measurement by input of proces density.*

TEMPERATURE STANDARD:

When the CALCULATION option is 2, the used temperature standard is selectable between 0-30℃ or equivalent in ℉. If the temperature standard is changed, the input limits for the density standard per fluid type also change to default and have to be configured as desired.

DENSITY STANDARD BY:

When the CALCULATION option is 2 then the method to establish the density standard is configurable:

1. *Fill in manually* value for the density standard manually in this window. Additional only proces temperature and pressure must be measured.
2. *Calculated from Densitometer density.* The density standard is calculated by iteration of the measured density (on frequency or AD input). Additional proces and densitometer temperatures and pressures must be measured.
3. *On AD input.* Density standard on an AD input. Additional only proces temperature and pressure must be measured and the temperature standard must be set according to input density standard.

FLUID TYPE:

When the CALCULATION option is 2 then the used fluid type is configurable. Each fluid type has its own density standard limits.

DENSITY STANDARD:
When the CALCULATION option is 2 and the DENSITY STANDARD BY is fill in manually, the density standard value is selectable within the limits of the chosen FLUID TYPE.
Note that there are different options for how to input the density, i.e. as mass/volume, °API60 or SG (Configurable by Function key F7, F8, F9)

K0, K1, K2:
When the CALCULATION option is 2 and the FLUID TYPE is Freefill then the correction factors K0, K1 and K2 can be configured.

API2540 table 54C temperature limits:
The correction according to API2540 table 54C is valid within temperature and calculated Alpha limits as shown in above window.
The reading "current" is the calculated Alpha. If the Alpha or a used temperature is out of limits then the API correction is out of limits and the alarm API GROUP MISMATCH is raised.

Description of the controls in this window:
Function keys do the controls of this window, therefore it is only possible to go back to the Main window. For practical use also normal keys have the same functionality.

F1	: Go back to Main window
F2 (or <ENTER>)	: Set a parameter or disable/enable value change
F3 (or <arrow up>)	: Scroll up with red cursor. Or if value change is enabled(F2) increase value
F4 (or <arrow down>)	: Scroll down with red cursor. Or if value change is enabled (F2), decrease value
F5 (or <arrow left>)	: If value change is enabled(F2) increase step value of change(F3,F4)
F6 (or <arrow right>)	: If value change is enabled(F2) decrease step value of change(F3,F4)
F7 (or <INP1>)	: Normal density standard manually input
F8 (or <INP2>)	: Density standard manually input as °API 60
F9 (or <INP3>)	: Density standard manually input as SG
F10(or <s>)	: Save configuration

Note:
Make sure you save the data after the changes are made as desired.
It is also possible to make the configuration by Modbus communication

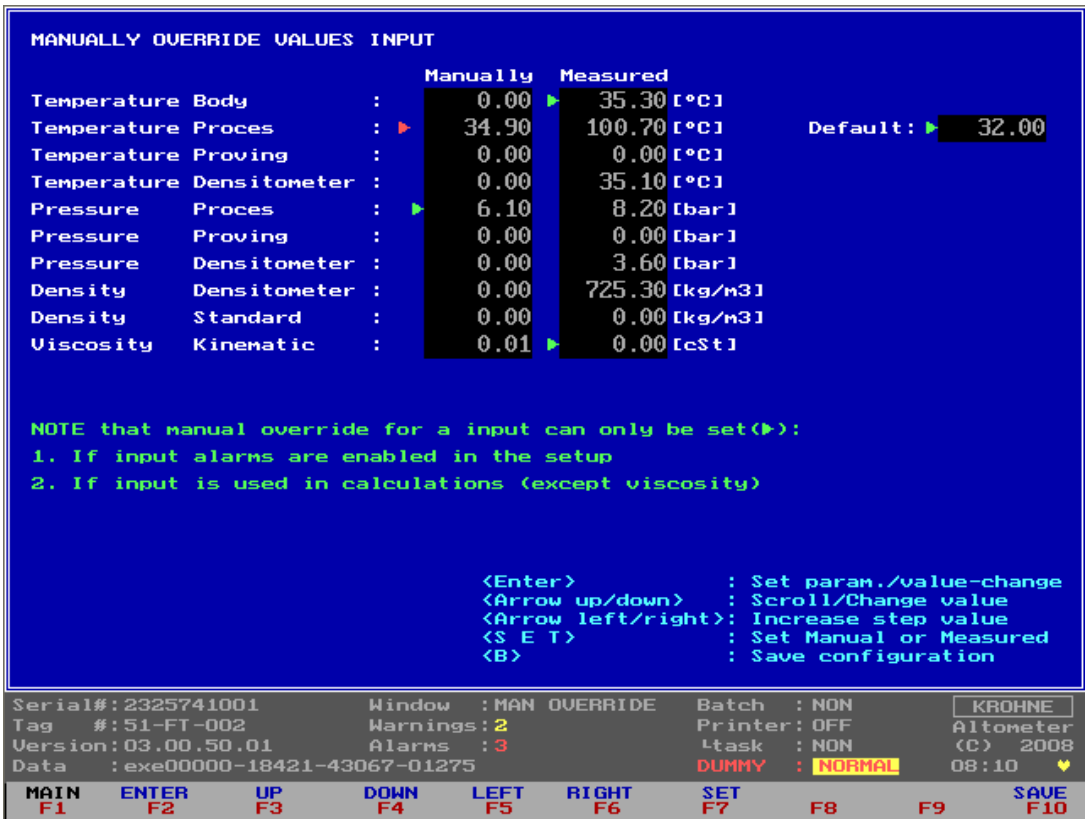
Additional information about the used API standards etc can be found in: chapter 4 CALCULATION OF STANDARD VOLUME AND MASS

4.8.2 Controls menu: F3 External-flow meter window

External Flow meter is described in the Extended Operations section of this manual

4.8.3 Controls menu: F4 Manual override window

In this window a manual override can be made on several input parameters.



Note that a manual override for an input:

- Can only be set if the input alarms are enabled in the initialisation
- Can only be set if the input is used in calculations (except for the viscosity)
- Sets the alarm for the parameter that is in manual override, but the alarm time is counted separately. See Alarms window

The green arrows ▶ represent the current settings per parameter. No green arrow ▶ means that it is not possible to set that parameter because of the above restrictions.
The red arrow is the scrollable cursor position

- Manually : The override value is set manually, this always causes an alarm condition
- Measured : Value as measured on AD/Modbus/Frequency input
- Default : The default override value on first occurrence of active alarm.

The default override value on first occurrence active can be configured in the initialisation file CLNT0300.dat section 9.

Example Temperature proces parameter:

```
TEMPERATURE PROCES
9.8  MODE                =#1     //Use input:0=disable, 1=AD-input, 2=Modbus
9.9  MODBUS_SERVICE      =#0     //Service input:0=disable, 1=AD-input
9.10 Alarm_out           =#1     //disable=0, enable=1  alarm to output
9.11 alarmLow            =#0     //Low alarm  below this value [øC]
9.12 alarmHigh           =#100   //High alarm above this value [øC]
9.13 Override            =#20    //Default static override value [øC] on alarm
9.14 Override_code       =#2     //0=disable override value, 1=use default override
                                 //2=use default batch average as override
```

The OVERRIDE_CODE (9.14) makes it possible on first occurrence of active alarm to have:

- (0) No override value, measurement value is used for calculations
- (1) Use the default static override value OVERRIDE (9.13) .
- (2) Use the batch average value of the parameter as calculated up to first occurrence of active alarm

Description of the controls in this window:

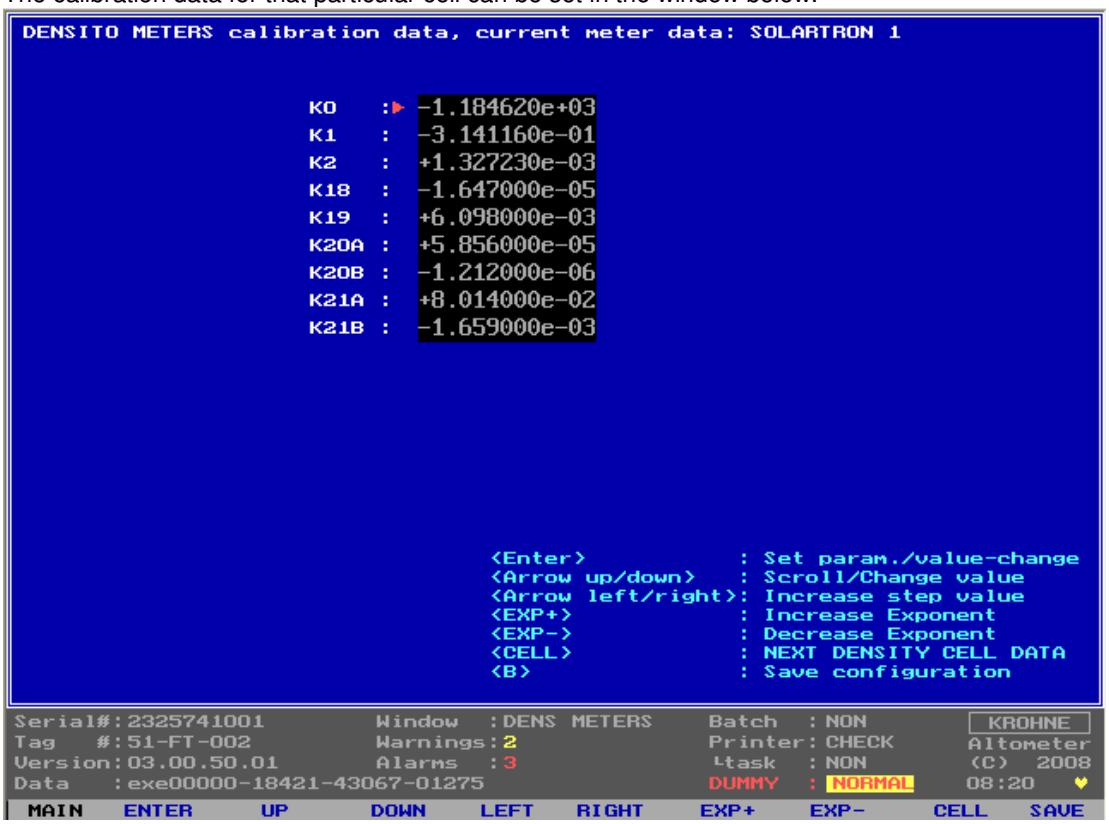
The red arrow ► is the scrollable cursor position

Function keys do the controls of this window, therefore it is only possible to go back to the Main window.

F1	: Go back to Main window
F2 (or <ENTER>)	: Set a parameter or disable/enable value change
F3 (or <arrow up>)	: Scroll up with red cursor ►. Or if value change is enabled (F2) increase value
F4 (or <arrow down>)	: Scroll down with red cursor ►. Or if value change is enabled (F2), decrease value
F5 (or <arrow left>)	: If value change is enabled (F2) increase step value of change (F3, F4)
F6 (or <arrow right>)	: If value change is enabled (F2) decrease step value of change (F3,F4)
F7 (or <SET>)	: Set as manual override or measured input
F10 (or <B>)	: Save configuration

4.8.4 Controls menu: F5 Density cell window

When a density cell is used to measure the density for Standard Volume calculation then the hardware configuration must be made in the initialisation files HSET0300.ufp and CLNT0300.dat.
The calibration data for that particular cell can be set in the window below.



Description of the controls in this window:

Function keys do the controls of this window, therefore it is only possible to go back to the Main window.

F1 : Go back to Main window
F2 (or <ENTER>) : Set a parameter or disable/enable value change
F3 (or <arrow up>) : Scroll up with red cursor. Or if value change is enabled (F2) increase value
F4 (or <arrow down>) : Scroll down with red cursor. Or if value change is enabled (F2), decrease value
F5 (or <arrow left>) : If value change is enabled (F2) increase step value of change (F3, F4)
F6 (or <arrow right>) : If value change is enabled (F2) decrease step value of change(F3, F4)
F7 (or <EXP+>) : Increase the exponential value, when value change is enabled (F2)
F8 (or <EXP->): Decrease the exponential value, when value change is enabled (F2)
F9 (or <CELL>) : Scroll the data set, possible to scroll between:
SOLARTRON 1
SOLARTRON 2
SARASOTA 1
SARASOTA 2
F10(or <B>) : Save configuration

4.8.5 Controls menu: F6 Time window

The system time can be set in this window.

Note:

- The system time is not the time used for making the totalisers. The time used by the totalisers is the proces time. This time is calibrated together with the frequency output because the frequency output uses the same processor timer in the UFP.
- The Set Time can have a maximum deviation to System Time of ± 2 hours in one saving.
- For very large deviation settings it is better to do the setting under DOS by commands TIME and DATE.
- It is also possible to set the time through Modbus controls.

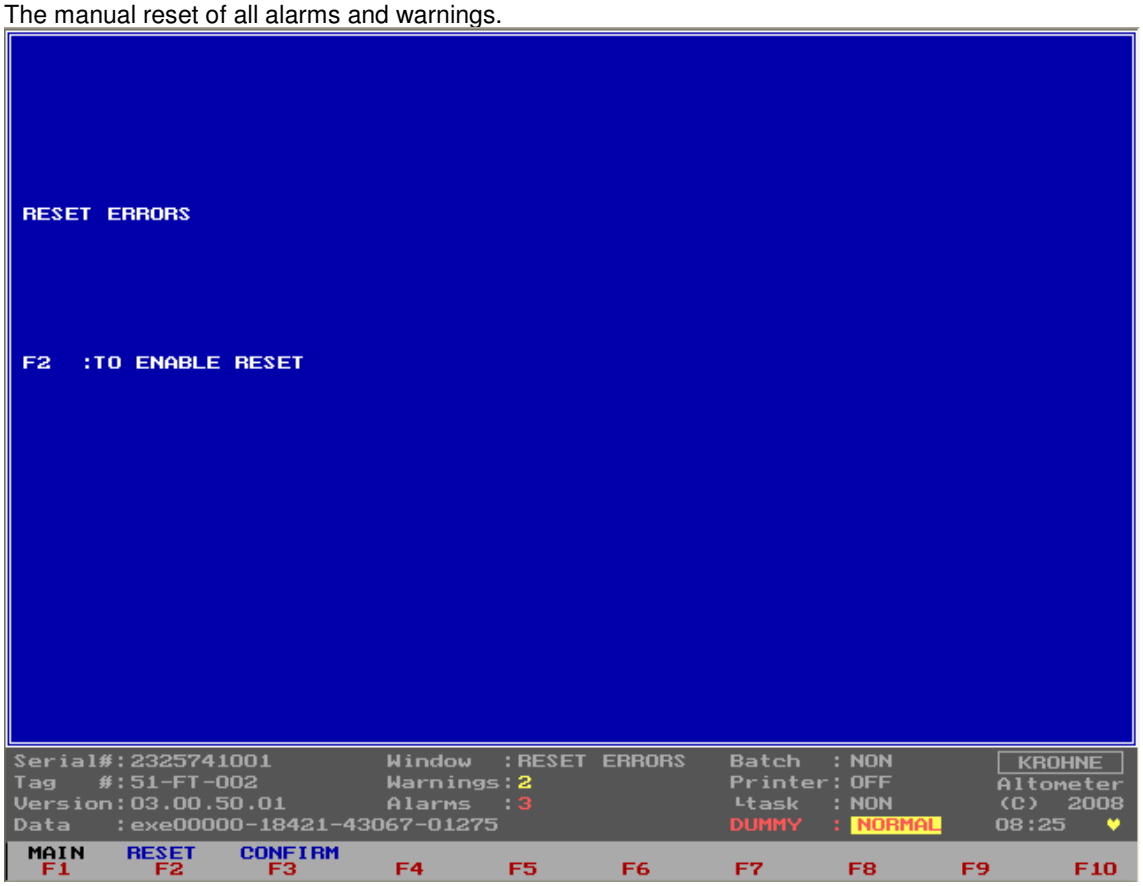
Description of the controls in this window:

Function keys do the controls of this window, therefore it is only possible to go back to the Main window.

F1	: Go back to Main window
F3	: Scroll up in value at the red cursor position value
F4	: Scroll down in value at the read cursor position
F5	: Change cursor position to the left
F6	: Change cursor position to the right
F10	: Save configuration (set the desired time)

4.8.6 Controls menu: F7 Reset Errors window

The manual reset of all alarms and warnings.



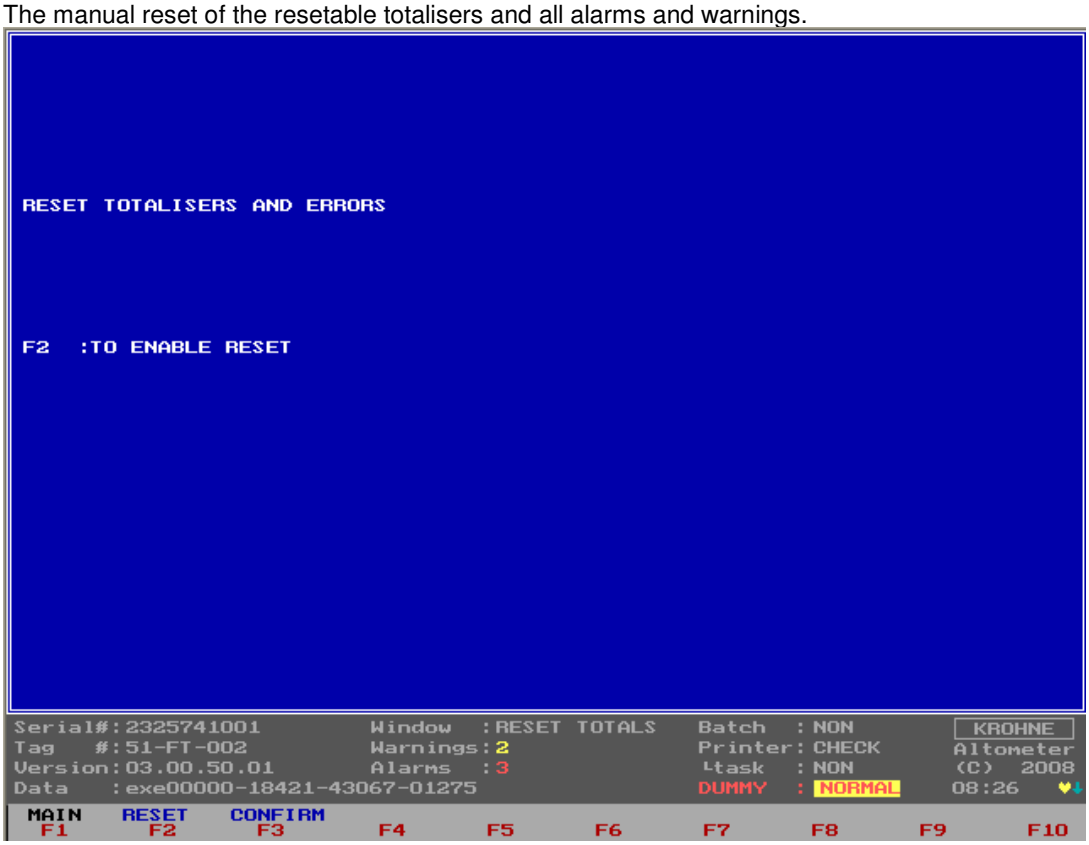
Reset sequence:

- Enable the reset by function key F2
- Confirm to reset by function key F3

It is also possible to reset by digital input signal or Modbus boolean.

4.8.7 Controls menu: F8 Reset Totalisers window

The manual reset of the resetable totalisers and all alarms and warnings.



Reset sequence:

- Enable the reset by function key F2
- Confirm to reset by function key F3

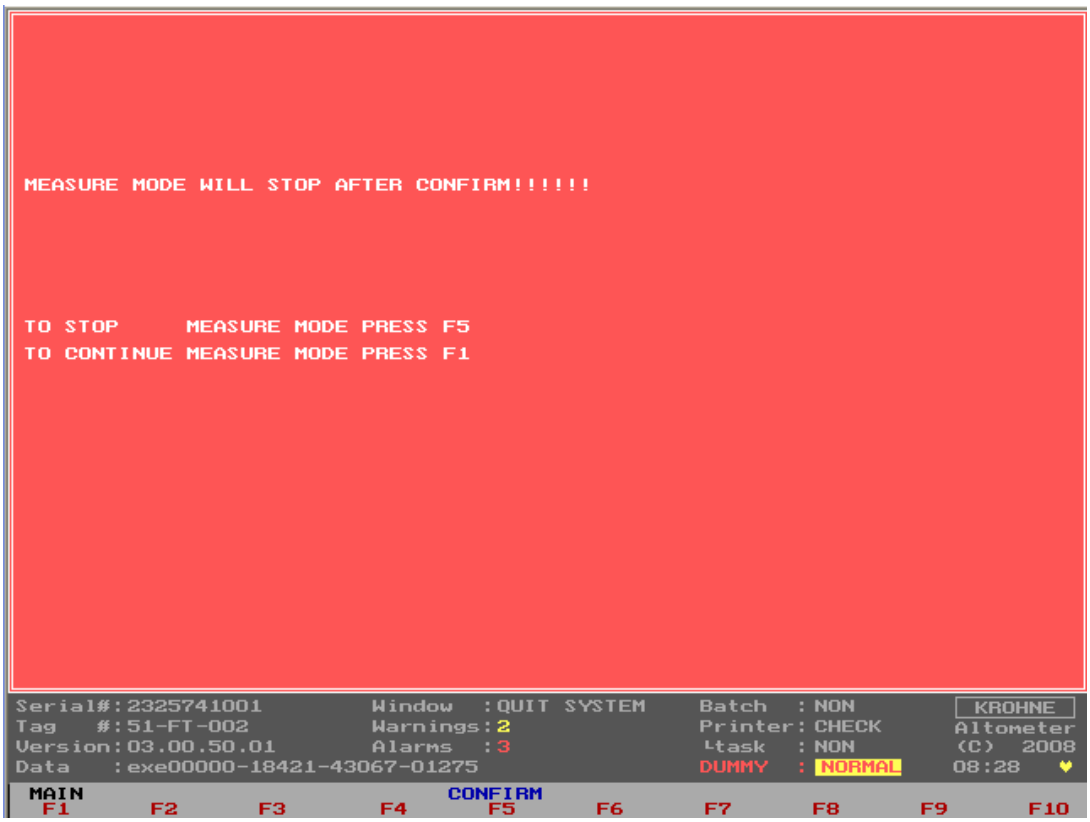
It is also possible to reset by digital input signal or Modbus boolean.

4.8.8 Controls menu: F9 Standard Volume choice in used standard

This window entry can be blocked in the configuration file CLNT0300.DAT, for custody transfer regulations that can differ by country/region
This window is described in the Extended Operations section of this manual.

4.8.9 Controls menu: F10 Quit measure mode window

Window to terminate the measure mode and go to DOS mode.



Quit sequence:

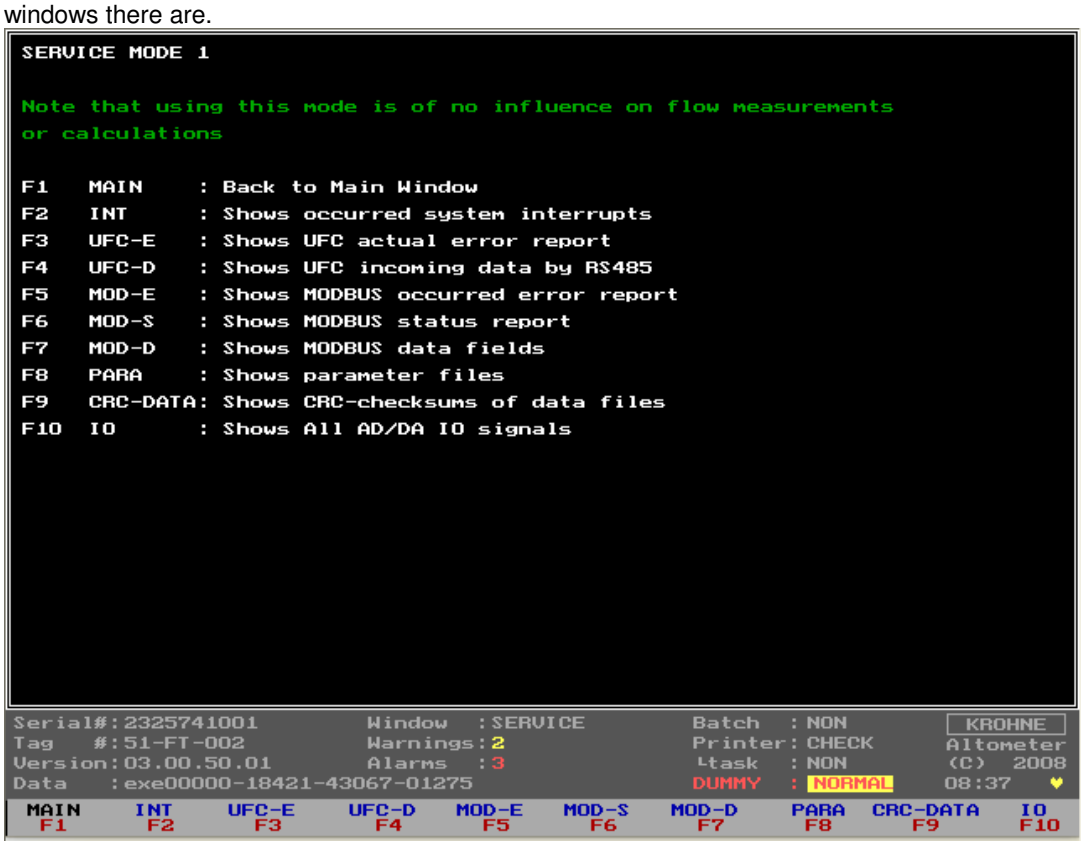
- Confirm to quit function key F5

To proceed use function key F1

IMPORTANT: If the UFP-Program is stopped. No flow measurements/calculations are performed anymore.

4.9 Main menu: F10 Service window

This is the start window for the Service windows where a description is given of the types of Service windows there are.

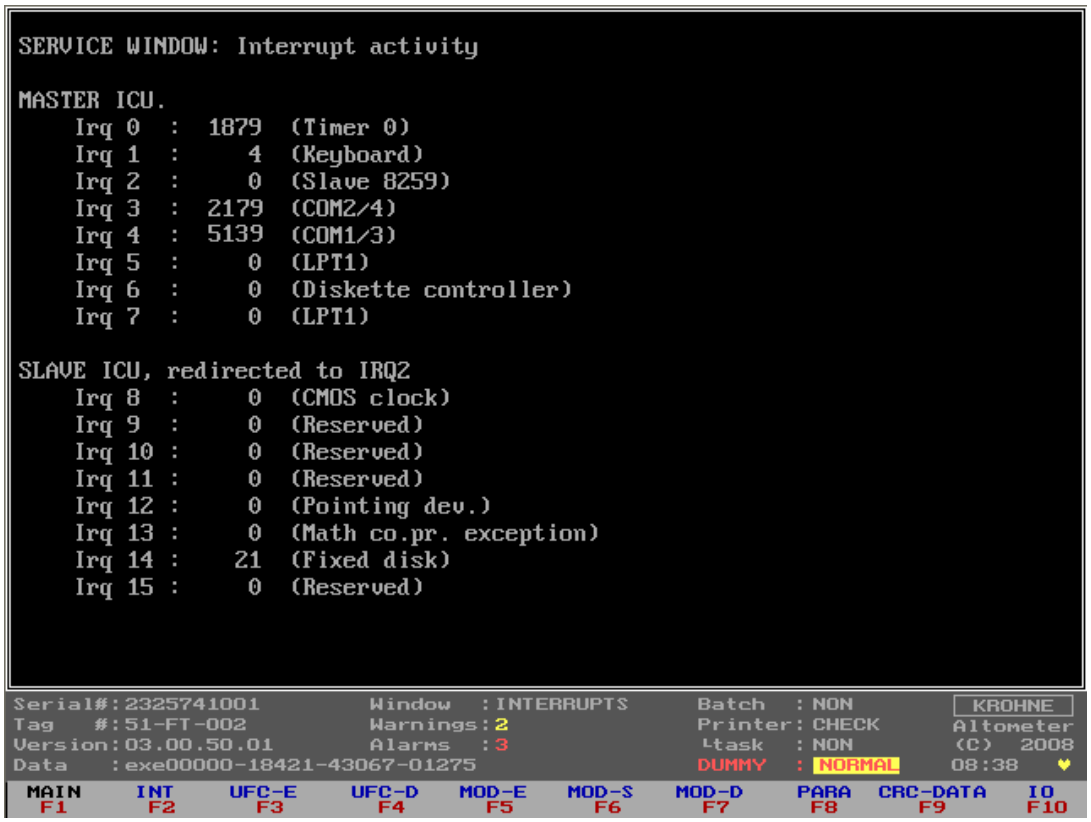


Note that using this mode (SERVICE) is of no influence on flow measurements or calculations

These Service windows are especially practical for debugging errors when an ALTOSONIC V system is set-up for Modbus and I/O signals (AD/DA).

4.9.1 Service menu: F2 Interrupts window

Under normal circumstances it is not necessary to view this window.



The Interrupt window is the lowest level PC activity monitor.

The serviced interrupts are counted per source. Therefore, the activity on for example a COM port for Modbus can easily be monitored for any signals coming in.

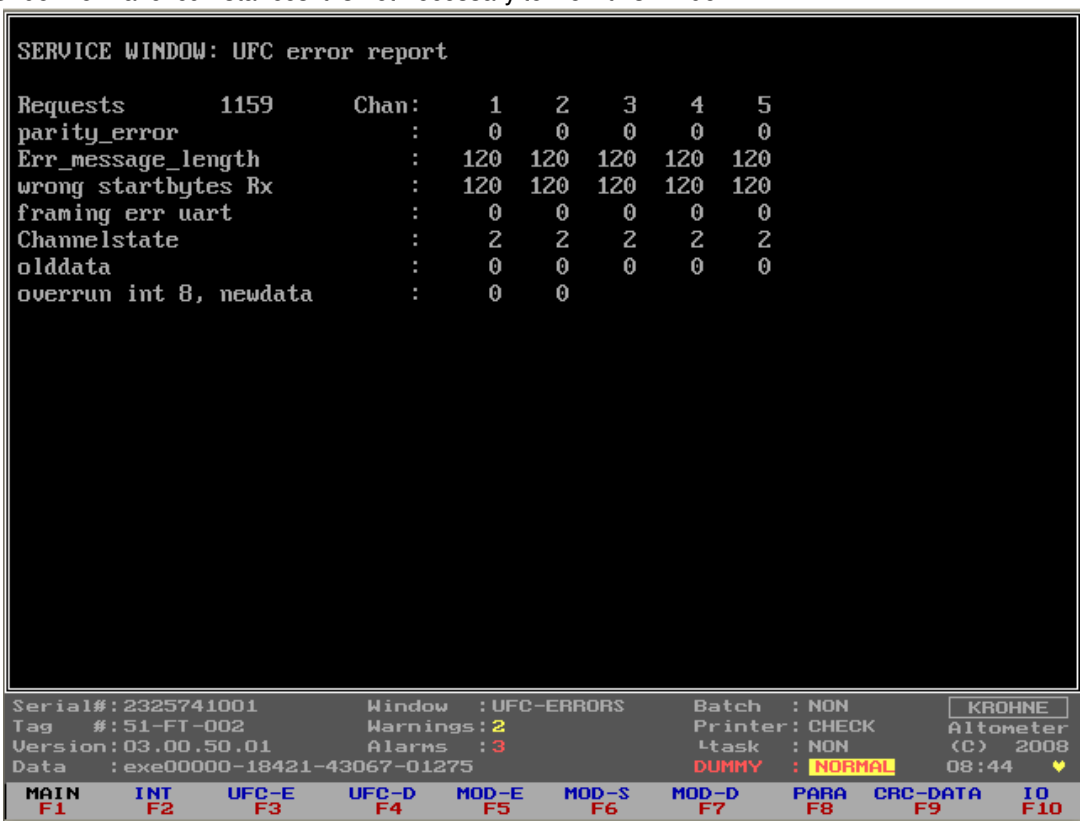
The settings for the communication can be found in parameter file COMS0300.dat
Default settings for the COM ports are:
Irq 3: COM 4, Modbus for RS422/RS485.
Irq 4: COM 3, RS 485 UFC DATA communication.

If the Modbus communication is set up on the RS485 card there must be activity on COM 4. (Or Modbus communication on a RS232 port then use port 2).

If there is no activity then check the configuration in the COMS0300.dat and check the connections and wiring.

4.9.2 Service menu: F3 UFC errors window

Under normal circumstances it is not necessary to view this window.



All data shown here is also available in more common used windows in perhaps other formats or condensed into less variables.
The status is shown as counters per channel.
There is no history in the counters so **previous occurred errors will turn to zero.**

<u>Communication *errors* per communication message (=per channel request):</u>

- Parity errors
- Error in message length
- Wrong start bytes
- Framing error UART

<u>Communication *status* sublimated from communication errors per channel:</u>

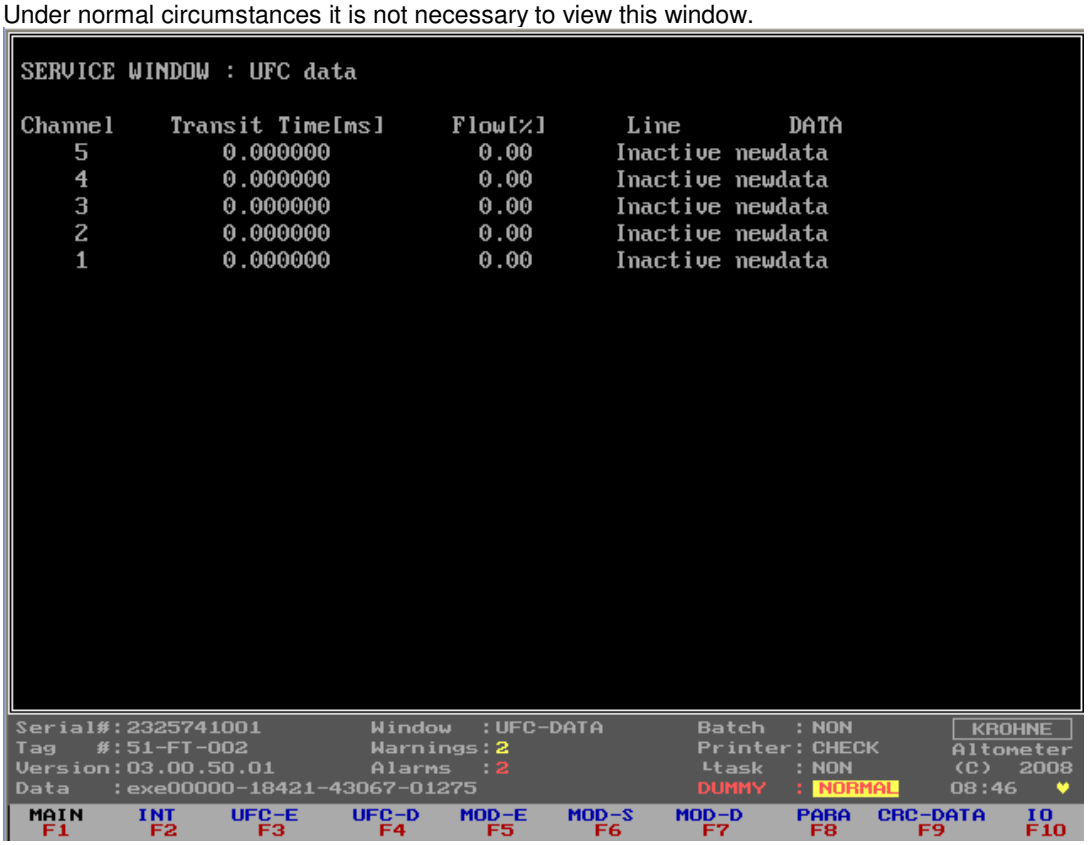
- Channel state = 0: no errors (status normally)
- Channel state = 1: error resulting in a single communication failure (COMFA)
- Channel state = 2: comm. failures in succession resulting in a communication alarm (COMMU)

<u>Communication *status* regarding data skipped or already handled:</u>

- Old data : Counter for data, already handled(Note: normally toggles between 0 and 1).
- Overrun : Counter for data, skipped because of system time shortage (note: cumulative!).

4.9.3 Service menu: F4 UFC data

Under normal circumstances it is not necessary to view this window.



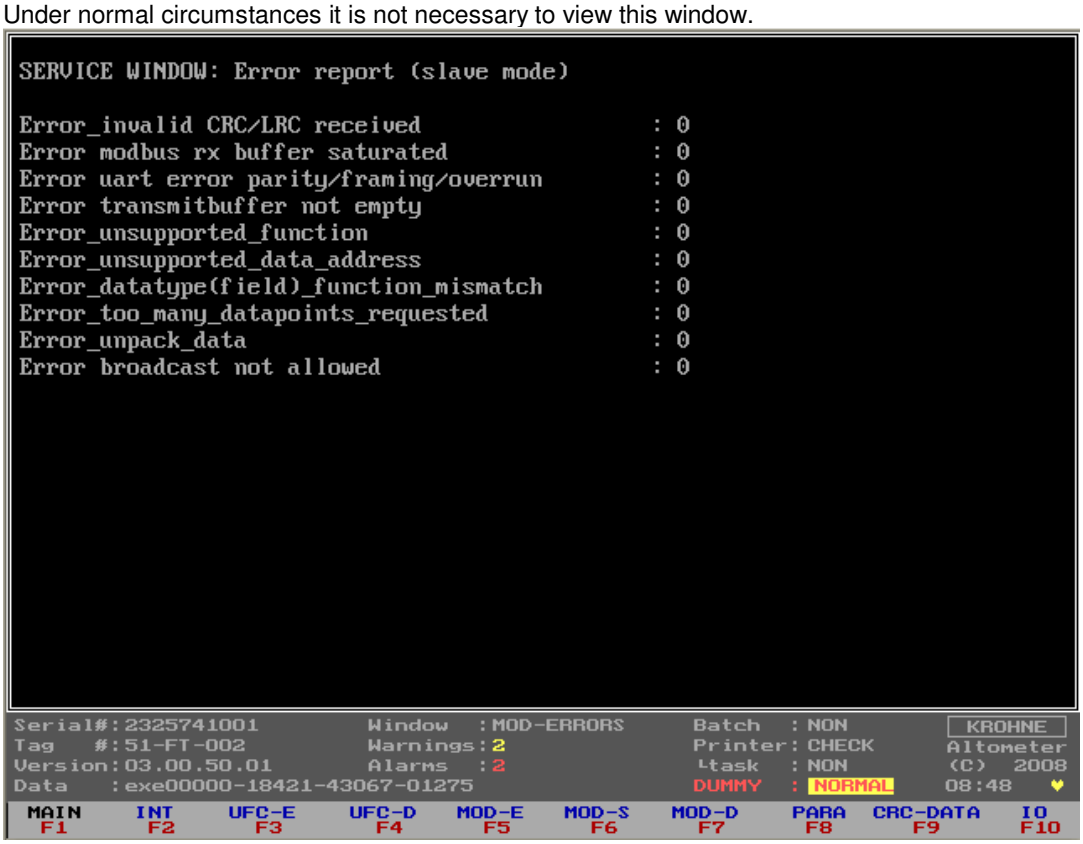
All data shown here is also available in more common used windows in perhaps other formats.
This window shows the raw basic flow data from the UFC-V with no history capacity.

<u>Data of all channels:</u>

- Transit time as [ms]
- Flow rate as percentage [-125...+125%]
- Line status (normally *active*, on communication failure *Inactive*)
- Data status (*New data*, *old data* (previously handled), *old data time out* (on communication alarm))

4.9.4 Service menu: F5 Modbus errors window

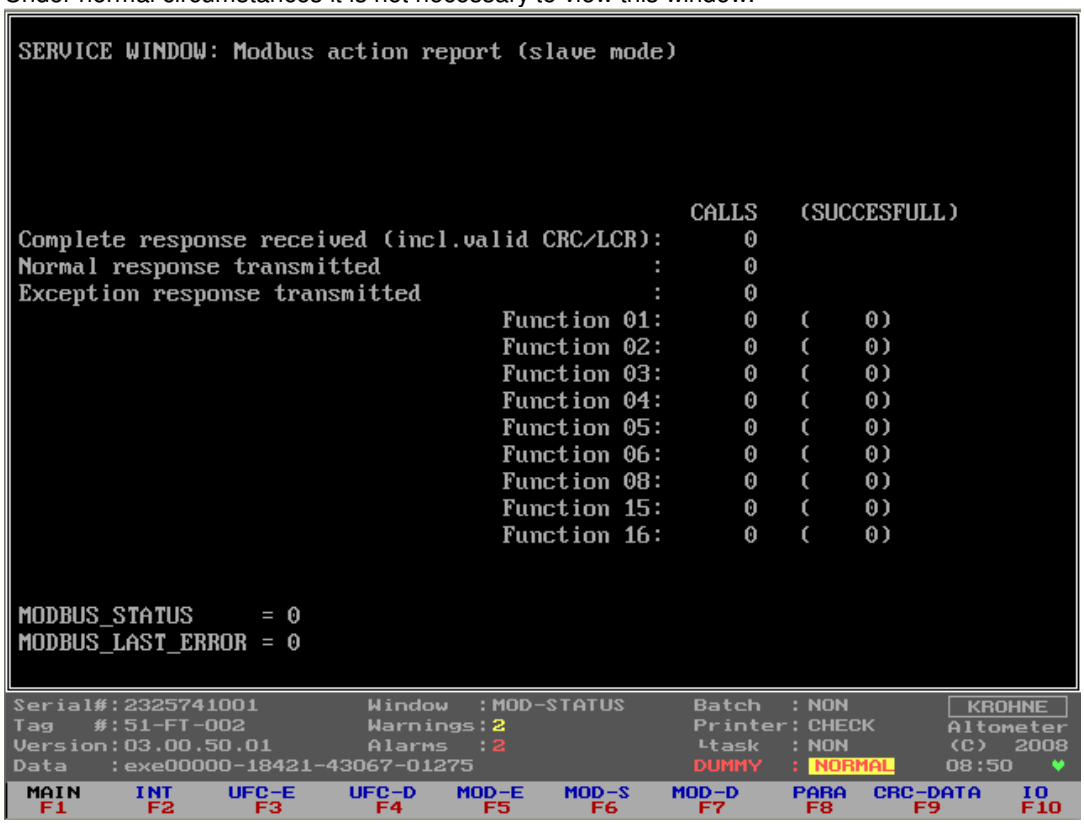
When setting up the UFP-V Modbus driver for communication this window is very useful for showing the occurred Modbus communication errors. The various errors are shown as historical counters per communication error.
Under normal circumstances it is not necessary to view this window.



When every counter is zero but the Modbus communication seems to fail first monitor the Interrupt window for any activity on the Comport.
All data shown here is also available in more common used windows in perhaps other formats or sublimated into less variables.

4.9.5 Service menu: F6 Modbus STATUS

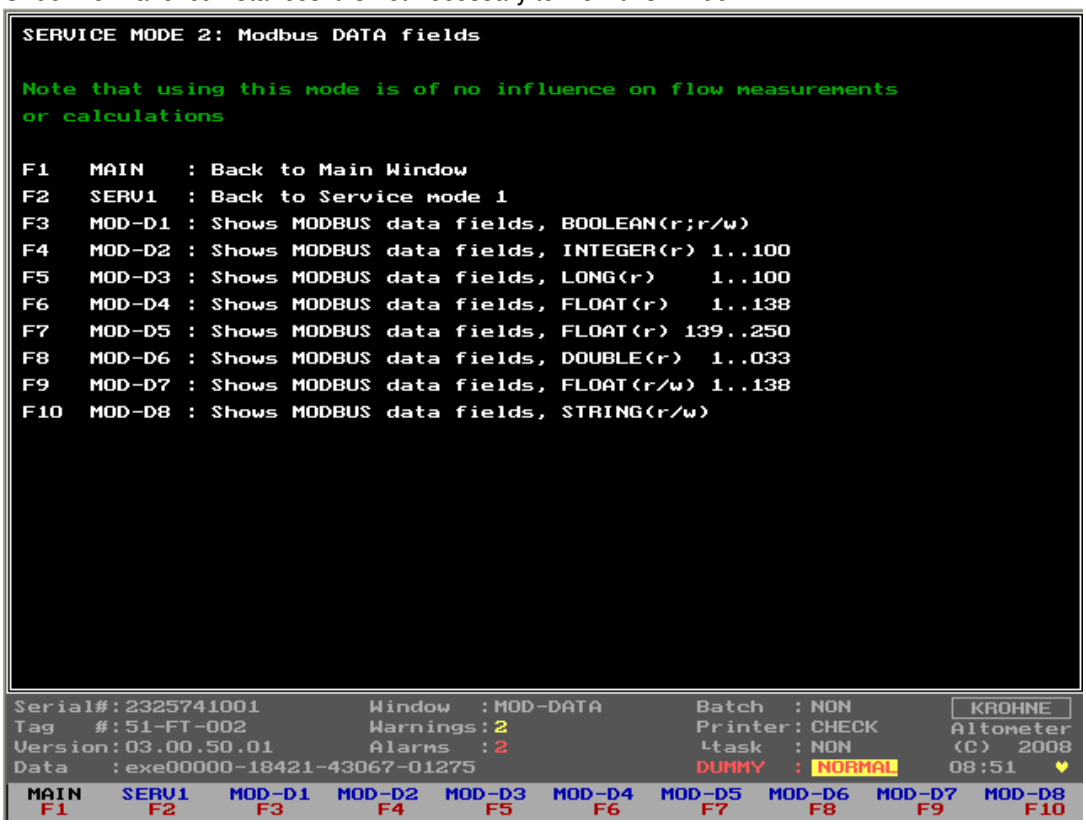
When setting up the UFP-V Modbus driver for communication this window is very useful for showing addressed functions and responses.
Under normal circumstances it is not necessary to view this window.



Function 1 : Read coil
Function 2 : Read input status
Function 3 : Read multiple holding registers
Function 4 : Read input registers
Function 5 : Write single coil
Function 6 : Write single holding register
Function 8 : Diagnostics
Function 15 : Write multiple coil
Function 16 : Write multiple holding register

4.9.6 Service menu: F7 Modbus data window

When setting up the UFP-V Modbus driver for communication this window is very useful for showing the available Modbus data fields in address and value for verifying data on both host side and UFP side per data register.
Under normal circumstances it is not necessary to view this window.



4.9.6.1 Service menu 2: F3 Modbus data1 window Booleans R/W

When setting up the UFP-V Modbus driver for communication this window is very useful for showing the available Modbus data fields in address and value for verifying data on both host side and UFP side per data register.
Under normal circumstances it is not necessary to view this window

```
BOOLEAN(01000):1..128
    1        9        17       25       33       41       49       57
    ¦   .    ¦   .    ¦   .    ¦   .    ¦   .    ¦   .    ¦   .    ¦   .
001:00000000 00010100 10110000 00000000 00000000 00000000 00001000 00000000
065:00000001 10010000 00100000 00000000 00000000 00000000 00000000 00000000

BOOLEAN(02000):1..320
    1        9        17       25       33       41       49       57
    ¦   .    ¦   .    ¦   .    ¦   .    ¦   .    ¦   .    ¦   .    ¦   .
001:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
065:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
129:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
193:00000000 00000000 00000000 00000000 00000000 00000000 00000000 01000000
257:10000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000

Serial#:2325741001      Window   :MOD-DATA1     Batch   : NON        KROHNE
Tag   #:51-FT-002       Warnings:2              Printer: CHECK       Altometer
Version:03.00.50.01     Alarms  :2              Ltask   : NON        (C)  2008
Data    :exe00000-18421-43067-01275             DUMMY   : NORMAL     08:53 ♥
MAIN  SERV1  MOD-D1  MOD-D2  MOD-D3  MOD-D4  MOD-D5  MOD-D6  MOD-D7  MOD-D8
F1    F2     F3     F4     F5     F6     F7     F8     F9     F10
```

4.9.6.2 Service menu 2: F4 Modbus data2 window Integers (R)

When setting up the UFP-V Modbus driver for communication this window is very useful for showing the available Modbus data fields in address and value for verifying data on both host side and UFP side per data register.
Under normal circumstances it is not necessary to view this window

```
INTEGER(03000):1..100
01=000154 02=014921 03=003200 04=000610 05=012693 06=003530 07=000150
08=000098 09=000119 10=000121 11=000119 12=000120 13=000120 14=014921
15=014921 16=014921 17=014921 18=014921 19=000000 20=000002 21=000000
22=000003 23=000000 24=000000 25=000000 26=000008 27=000000 28=000000
29=000000 30=000000 31=000002 32=000002 33=000001 34=000058 35=000008
36=000005 37=000009 38=002008 39=000000 40=000000 41=000000 42=000195
43=000000 44=000000 45=000000 46=000000 47=000000 48=000000 49=000000
50=000000 51=000000 52=000000 53=000000 54=000000 55=000000 56=000000
57=000000 58=000000 59=000000 60=000000 61=000000 62=000000 63=000000
64=000000 65=000000 66=000000 67=000000 68=000000 69=000000 70=000000
71=000000 72=000000 73=000000 74=000000 75=000000 76=000000 77=000000
78=000000 79=000000 80=000000 81=000000 82=000000 83=000000 84=000000
85=000000 86=000000 87=000000 88=000000 89=000000 90=000000 91=000000
92=000000 93=000000 94=000000 95=000000 96=000000 97=000000 98=000000
99=000000 100=000000

Serial#:2325741001      Window   :MOD-DATA2     Batch   : NON        KROHNE
Tag   #:51-FT-002       Warnings:2              Printer: OFF         Altometer
Version:03.00.50.01     Alarms  :2              Ltask   : NON        (C)  2008
Data    :exe00000-18421-43067-01275             DUMMY   : NORMAL     08:58 ♥
MAIN  SERV1  MOD-D1  MOD-D2  MOD-D3  MOD-D4  MOD-D5  MOD-D6  MOD-D7  MOD-D8
F1    F2     F3     F4     F5     F6     F7     F8     F9     F10
```

4.9.6.3 Service menu 2: F5 Modbus data3 window LongInt (R)

When setting up the UFP-V Modbus driver for communication this window is very useful for showing the available Modbus data fields in address and value for verifying data on both host side and UFP side per data register.
Under normal circumstances it is not necessary to view this window

```
LONGINT(05000):1..100
01=0001709155 02=0000000154 03=0000014921 04=0001666693 05=0000000150
06=0001149504 07=0000000098 08=0000000002 09=0001709155 10=0000000000
11=0001666693 12=0000000000 13=0001149504 14=0000000000 15=2147483647
16=0003005001 17=0000000000 18=0000000008 19=0000000000 20=0000000000
21=0000000000 22=0000000000 23=0000000000 24=0000087307 25=0000027370
26=0000027370 27=0000000000 28=0000026830 29=0000026830 30=0000000000
31=0000018101 32=0000018101 33=0000000000 34=0000000000 35=0000000000
36=0000000000 37=0000000000 38=0000000000 39=0000000000 40=0000000000
41=0000000000 42=0000000000 43=0000000000 44=0000000000 45=0000000000
46=0000000000 47=0000000000 48=0000000000 49=0000000000 50=0000000000
51=0000000000 52=0000000000 53=0000000000 54=0000000000 55=0000000000
56=0000000000 57=0000000000 58=0000000000 59=0000000000 60=0000000000
61=0000000000 62=0000000000 63=0000000000 64=0000000000 65=0000000000
66=0000000000 67=0000000000 68=0000000000 69=0000000000 70=0000000000
71=0000000000 72=0000000000 73=0000000000 74=0000000000 75=0000000000
76=0000000000 77=0000000000 78=0000000000 79=0000000000 80=0000000000
81=0000000000 82=0000000000 83=0000000000 84=0000000000 85=0000000000
86=0000000000 87=0000000000 88=0000000000 89=0000000000 90=0000000000
91=0000000000 92=0000000000 93=0000000000 94=0000018421 95=0000043067
96=0000001275 97=0000000000 98=0000000000 99=0000232574 100=0000001001

Serial#:2325741001      Window  :MOD-DATA3      Batch   :NON        KROHNE
Tag   #:51-FT-002       Warnings:2              Printer:CHECK       Altometer
Version:03.00.50.01     Alarms  :2              ↳task   :NON        (C) 2008
Data    :exe00000-18421-43067-01275             DUMMY   :NORMAL     08:59
MAIN  SERV1  MOD-D1  MOD-D2  MOD-D3  MOD-D4  MOD-D5  MOD-D6  MOD-D7  MOD-D8
 F1    F2     F3     F4     F5     F6     F7     F8     F9     F10
```

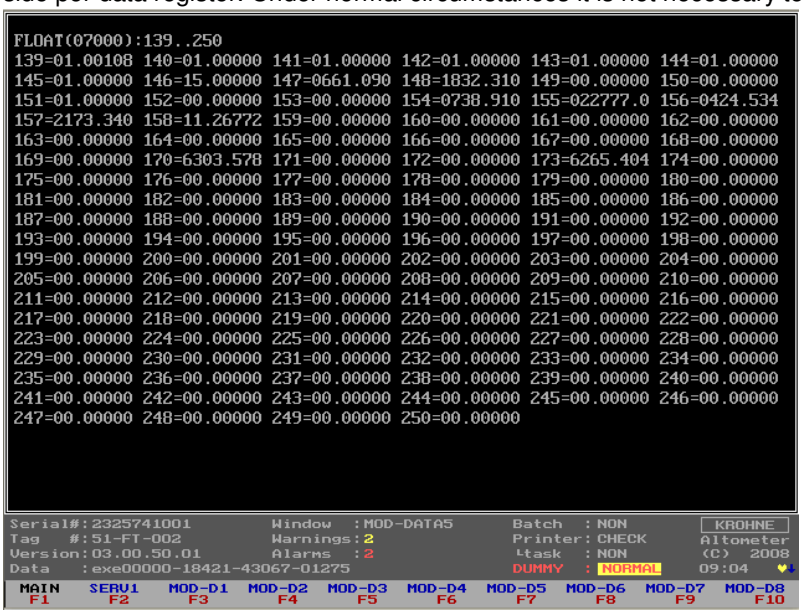
4.9.6.4 Service menu 2: F6 Modbus data4 window Float (R 1..138)

When setting up the UFP-V Modbus driver for communication this window is very useful for showing the available Modbus data fields in address and value for verifying data on both host side and UFP side per data register.
Under normal circumstances it is not necessary to view this window

```
FLOAT(07000):1..138
001=14.69225 002=1492.100 003=32.00000 004=06.10000 005=0634.663 006=35.30000
007=14.34557 008=09.32462 009=04.55172 010=04.61679 011=04.53840 012=04.59351
013=04.57610 014=1492.100 015=1492.100 016=1492.100 017=1492.100 018=1492.100
019=14.94198 020=00.00000 021=00.00000 022=00.00000 023=00.00000 024=00.00000
025=00.00000 026=00.00000 027=01.00000 028=01.00000 029=00.00000 030=01.00000
031=01.00076 032=0650.000 033=00.00000 034=00.00000 035=00.00000 036=00.00000
037=00.00000 038=22.46545 039=04.55172 040=04.61679 041=04.53840 042=04.59351
043=04.57610 044=00.00000 045=35.10000 046=03.60000 047=00.00000 048=00.00000
049=00.00000 050=00.00000 051=00.00000 052=00.00000 053=00.00000 054=00.00000
055=00.00000 056=00.00000 057=00.00000 058=00.00000 059=00.00000 060=00.00000
061=00.00000 062=00.00000 063=00.00000 064=00.00000 065=00.00000 066=00.00000
067=0725.300 068=2500.000 069=00.97512 070=01.00131 071=01.00000 072=01.00000
073=01.00000 074=01.00000 075=01.00000 076=01.00000 077=35.30000 078=34.90000
079=00.00000 080=35.10000 081=06.10000 082=00.00000 083=03.60000 084=0725.300
085=0689.660 086=00.00000 087=00.97413 088=01.00105 089=01.00000 090=01.00000
091=01.00000 092=01.00000 093=01.00000 094=01.00000 095=15.00000 096=0672.557
097=1838.368 098=00.00000 099=00.00000 100=01.00000 101=00.00000 102=00.00000
103=00.00000 104=1775.000 105=00.00000 106=1070.748 107=00.00000 108=00.00000
109=00.00000 110=00.00000 111=00.00000 112=00.00000 113=00.00000 114=00.00000
115=00.00000 116=00.00000 117=00.00000 118=00.00000 119=4785.142 120=00.00000
121=00.00000 122=4785.177 123=00.00000 124=00.00000 125=00.00000 126=00.00000
127=00.00000 128=30.87428 129=30.54346 130=00.00000 131=30.69029 132=05.69353
133=00.00000 134=03.31189 135=0667.253 136=0674.546 137=00.00000 138=00.97916

Serial#:2325741001      Window  :MOD-DATA4      Batch   :NON        KROHNE
Tag   #:51-FT-002       Warnings:2              Printer:OFF         Altometer
Version:03.00.50.01     Alarms  :2              ↳task   :NON        (C) 2008
Data    :exe00000-18421-43067-01275             DUMMY   :NORMAL     09:01
MAIN  SERV1  MOD-D1  MOD-D2  MOD-D3  MOD-D4  MOD-D5  MOD-D6  MOD-D7  MOD-D8
 F1    F2     F3     F4     F5     F6     F7     F8     F9     F10
```

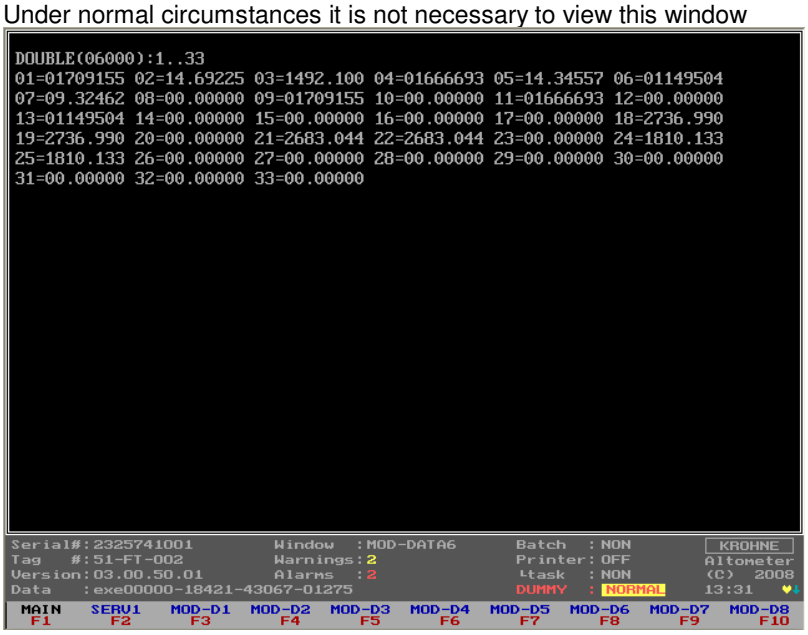
4.9.6.5 Service menu 2: F7 Modbus data5 window Float (R 1..138)

When setting up the UFP-V Modbus driver for communication this window is very useful for showing the available Modbus data fields in address and value for verifying data on both host side and UFP side per data register. Under normal circumstances it is not necessary to view this window



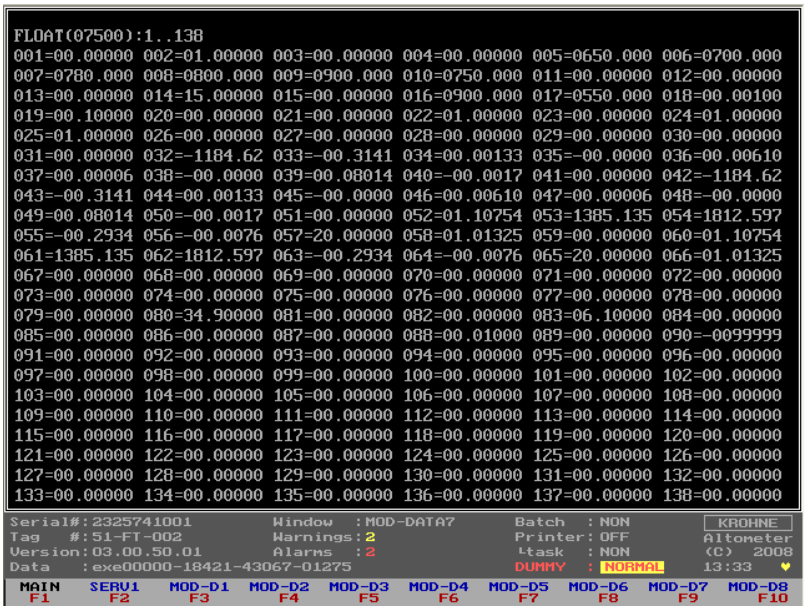
4.9.6.6 Service menu 2: F8 Modbus data6 window Double (R)

When setting up the UFP-V Modbus driver for communication this window is very useful for showing the available Modbus data fields in address and value for verifying data on both host side and UFP side per data register.
Under normal circumstances it is not necessary to view this window



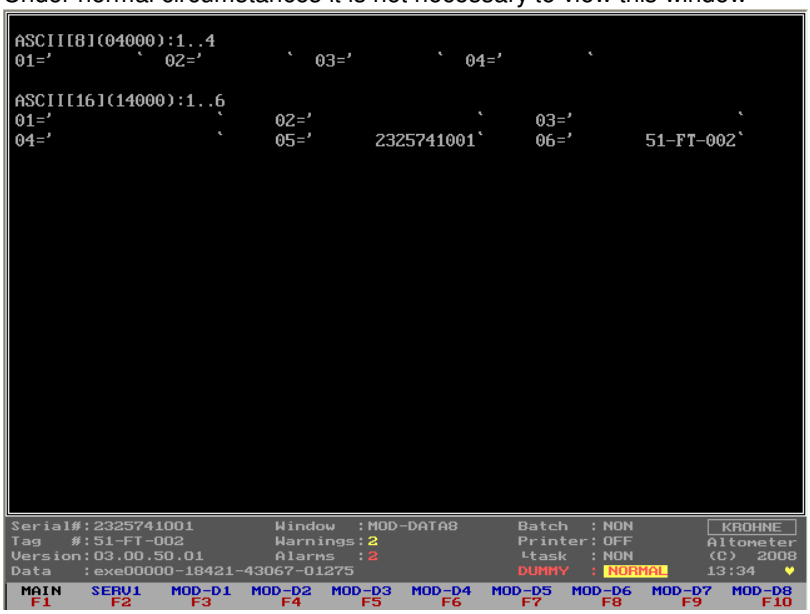
4.9.6.7 Service menu 2: F9 Modbus data6 window Float (R 139..250)

When setting up the UFP-V Modbus driver for communication this window is very useful for showing the available Modbus data fields in address and value for verifying data on both host side and UFP side per data register.
Under normal circumstances it is not necessary to view this window



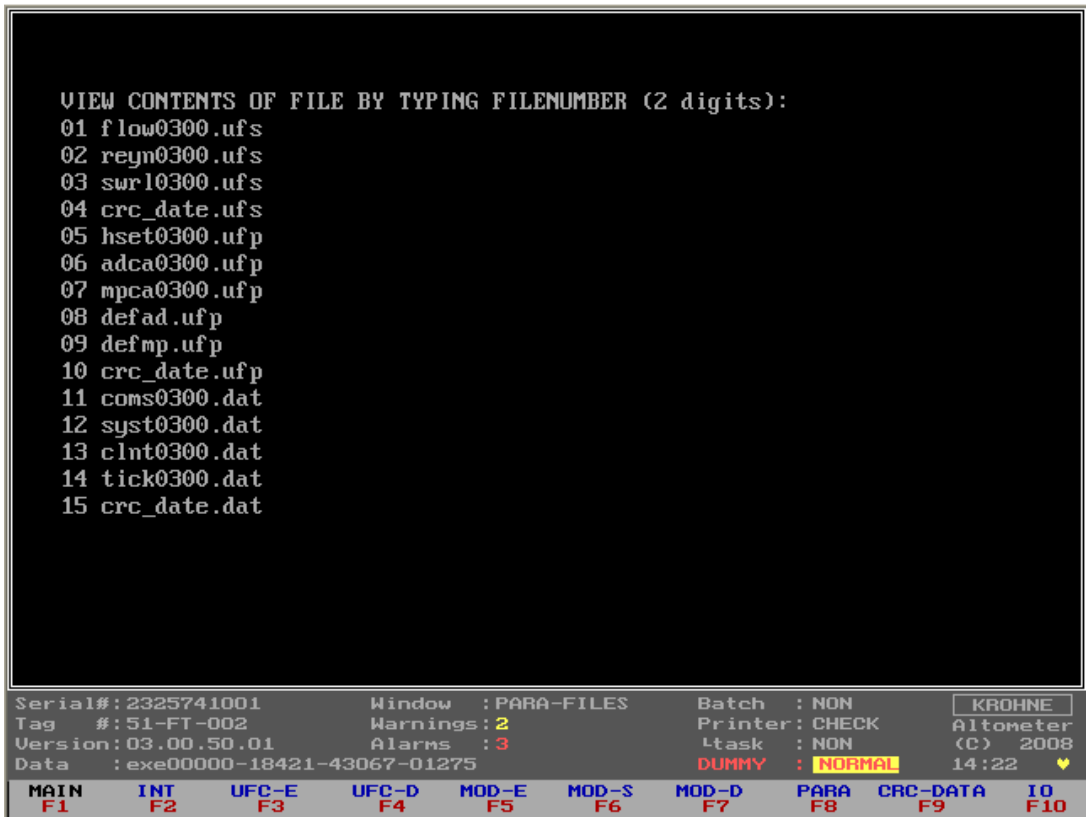
4.9.6.8 Service menu 2: F10 Modbus data6 window ASCII 8 char (R), 16 char (R/W)

When setting up the UFP-V Modbus driver for communication this window is very useful for showing the available Modbus data fields in address and value for verifying data on both host side and UFP side per data register.
Under normal circumstances it is not necessary to view this window



4.9.7 Service menu: F8 Parameter window

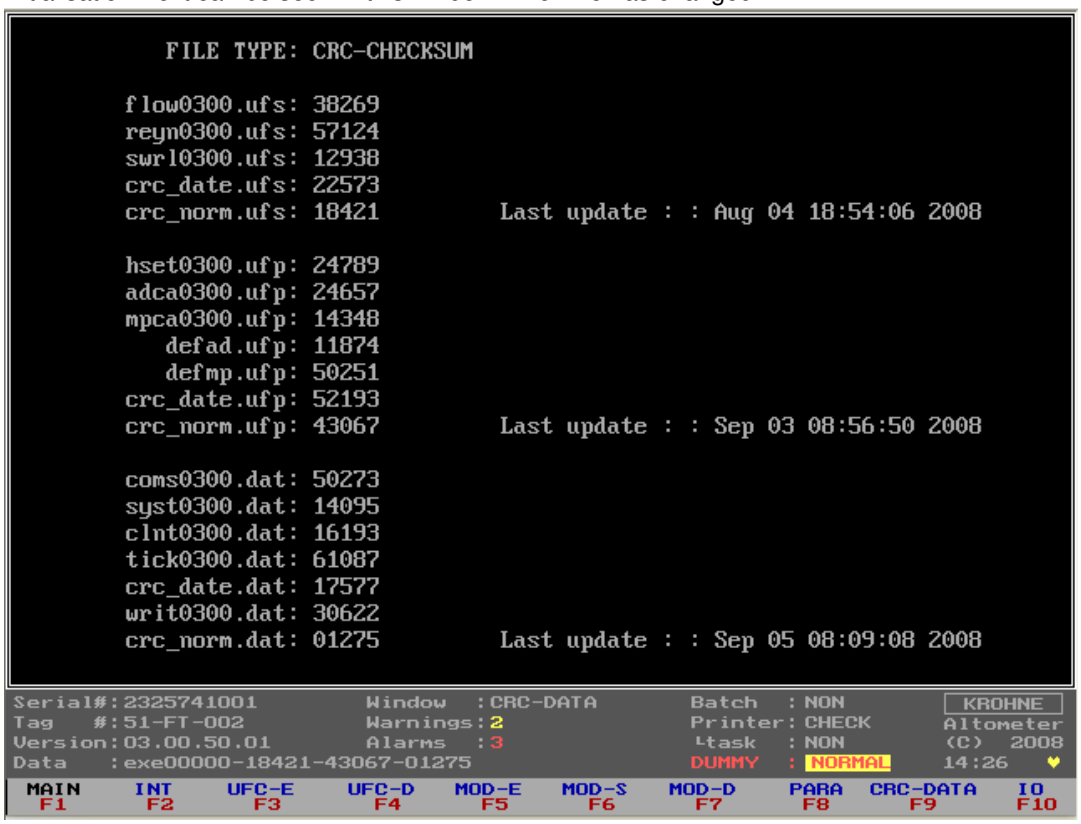
It is possible to view the Initialisation files on line while measuring.
For safety not the actual files are viewed but the backup file, so parameter files themselves are safe.



Type the two numerical digits that are in front of the filename and the content of the file can be viewed.
Page down is activated by SPACE key.
It is save to use the function keys at any time during viewing the file to switch to other windows.

4.9.8 Service menu: F9 CRC checksum window

As an extra service the CRC-checksums per file can be viewed, so in case of a change in a initialisation file it can be seen in this window which file has changed.



Note that the CRC_NORM file CRC checksums are also at the bottom of the Status window
This file holds the CRC checksums of the other files in the data set.
So when anything changes in a file in the data set this also changes the CRC_NORM CRC-checksum.

Extra since software version 03.00.50.00 is that these CRC checksums are also printed to a text file CRC_VAL.RAP each program start-up. This is for easy checking any file changes later on.

4.9.9 Service menu: F10 IO window

All secondary inputs and all outputs other then Modbus can be seen in this window

Under normal circumstances it is not necessary to view this window.

```
   INPUT  AD CARD    INPUT MODBUS        INPUT  FREQUENCY     OUTPUT ADCARD
          [mA] ch     Read new[s]       [Hz] ch new[s] func   DO ch funct
Tbody -20.028 01      ----  ----        ---- --    --  ----    0 01 Warn. bfm
Tproc -20.028 01      ----  ----        ---- --    --  ----    0 02 Alarm bfm
Tprov   ----- --      ----  ----        ---- --    --  ----    0 03 Warn. sysrun
Tdens -20.053 03      ----  ----        ---- --    --  ----    0 04 Alarm sysrun
Pproc -20.055 02      ----  ----        ---- --    --  ----    0 05 Warn. sysset
Pprov   ----- --      ----  ----        ---- --    --  ----    0 06 Oor AD Body
Pdens -20.048 04      ----  ----        ---- --    --  ----    0 07 Oor D15
Ddens -20.418 06      ----  ----        ---- --    --  ----    0 08 Hold corr
Dstan   ----- --      ----  ----        ---- --    --  ----    0 09 Reserved
Visco   ----- --      ----  ----        ---- --    --  ----    0 10 Oor AD temp
BS&W    ----- --      ----  ----        ---- --    --  ----    0 11 Oor AD pres
                                                                0 12 Oor AD dens
                                                                0 13 Bfm oor
                                                                0 14 Bfm path
                                                                0 15 Bfm dev c
                                                                0 16 Bfm com
INPUT        DI       OUTPUT MP103       OUTPUT ADCARD
Reset Totals          4.0000 [mA]Qv     0.0000  [V]Qv        DO ch funct MP103
Reset Alarms            0.00 [Hz]Qv     0.0000  [V]Qv         1 00 Dir -flow
                                                                1 01 Alarm bfm
                                                                0 02 Warn. bfm
                                                                1 03 Dir +flow
Serial#:2325741001        Window   :IO-PARAM       Batch   : NON        KROHNE
Tag    #:51-FT-002        Warnings:2               Printer: OFF        Altometer
Version:03.00.50.01       Alarms   :2               Task    : NON       (C)  2008
Data    :exe00000-18421-56309-31865                DUMMY   : NORMAL    14:42  ♥
 MAIN    INT    UFC-E   UFC-D   MOD-E   MOD-S   MOD-D   PARA   CRC-DATA   IO
 F1      F2     F3      F4      F5      F6      F7      F8     F9         F10
```

Input secondary signals

The signals for temperatures pressures densities and viscosity can be input by AD Card, Modbus or Frequency Input.
The configuration of these signals is in the CLNT0300.dat file.

When setting up analog and digital I/O signals this window shows the signals for the AD card and MP103 card of the UFP-V. Per card functions can be enabled / disabled card through off-line software settings.

AD card configuration : see chapters DATA ACQUISITION and OUTPUT
MP103 card configuration : see chapters DATA ACQUISITION and OUTPUT

5 CALCULATION OF STANDARD VOLUME AND MASS

The principle of the UFP-V is measuring the volumetric proces flow rate. Integrating this value in time results in the volumetric proces total.
Often measured quantities are compared. Because of temperature and pressure dependency of the volumetric proces it can be preferable to convert to more standard conditions:

- Volumetric standard (1.01325 bar and for example 15°C).
- Mass

5.1 Volumetric standard

The correction of the volumetric proces to volumetric standard is done according to API/ASTM-IP standards.
The volume correction factor VCF can be divided into:

- Correction for the temperature dependency, using API 11.1 standard 2540 equation and constants, resulting in a correction factor C_{tl}
- Correction for the pressure dependency, using API 11.2.1M equation and constants, resulting in a correction factor C_{pl}.

$$VCF = C_{tl} \cdot C_{pl}$$

$$Vol_{stand} = Vol_{proces} \cdot VCF$$

VCF : Volume correction factor
C_{tl} : Temperature correction factor
C_{pl} : Pressure correction factor
Vol_{stand} : Volumetric standard [m3]
Vol_{proces} : Volumetric proces [m3]
Also available after calculation is the density at proces conditions. This means that mass is also calculated.

5.1.1 Calculation of correction temperature dependency C_{tl}

The correction for the temperature dependency to the 15°C reference base:

$$C_{tl} = EXP[-\alpha_T \cdot (T_{process} - 15) \cdot (1 + 0.8 \cdot \alpha_T \cdot (T_{process} - 15))]$$

C_{tl} : Temperature correction factor
α_T : Thermal expansion coefficient [1/°C]
T_{proces} : Temperature proces [°C]
In this, the equation is independent of the group or substance. It can be used with any valid method of obtaining the thermal expansion coefficient for a given fluid, as long as a statistically significant number of points is obtained. A minimum of ten such points is recommend. In addition, the values of the constants K_0, K_1 and K_2 are given for each major group.
These constants relate the thermal expansion coefficient to base density by :

$$\alpha_T = \frac{K_0}{\rho_{15}^{\ 2}} + \frac{K_1}{\rho_{15}} + K_2$$

α_T : Thermal expansion coefficient [1/°C]
ρ_{15} : Density at reference 15 °C [kg/m^3]
K_0, K_1, K_2: Constants, depending on the type of the product

The API table for the 15°C reference base as installed in the UFP-V is:

Type of product	Low limit ρ_{15} [kg/m3]	High limit ρ_{15} [kg/m3]	K_0	K_1	K_2
Crude	610.5	1075.0	613.9723	0	0
Gasoline	653.0	770.0	346.4228	0.4388	0
Trans.area	770.5	787.5	2680.3206	0	-0.00336312
Jet group	788.0	838.5	594.5418	0	0
Fuel oil	839.0	1075.0	186.9696	0.4862	0
Free fill in	500.0	2000.0	0	0	0

Practical rule: The correction per °C is approximately 0.05% - 0.15% depending on conditions and type of product.

Standard temperature different from 15°C:
The method is based on a reference standard of 15°C. For example if the proces temperature is 65°C.

$$C_{tl} = C_{tl65\rightarrow15}$$

If the required standard temperature is different from 15°C the correction for the difference is introduced. For example if the standard temperature is 20°C,

$$C_{tl} = \frac{C_{tl65\rightarrow15}}{C_{tl20\rightarrow15}}$$

Note: If the standard temperature is different from 15°C the density limits per product type also change. The UFP-V calculates the limitations for the installed standard temperature. A density can not be filled in beyond limitations. The Free Fill product type is for uncommon products, K0, K1 K2 are adjustable.

5.1.2 Calculation of correction pressure dependency C_{pl}

The basic mathematical model, used to develop this standard, relates the compressibility factor exponentially to temperature and the square of the molecular volume. That is:

$$F = EXP[-1.62080 + 0.00021592 \cdot T_{process} + \frac{0.87096}{\rho_{15}{}^{2} \cdot 10^{-6}} + \frac{0.0042092 \cdot T_{process}}{\rho_{15}{}^{2} \cdot 10^{-6}}]$$

F : Compressibility factor, [1/kPa]
T_{proces} : Temperature proces [°C]
ρ_{15} : Density at 15 °C [kg/m^3]

The compressibility factor F is used in the normal manner of volume correction to make the correction for the pressure effect:

$$C_{pl} = \frac{1}{1 - F \cdot P_{process} \cdot 10^{-4}}$$

C_{pl} : Pressure correction factor
F : Compressibility factor
P_{proces} : Pressure proces [bar]
Practical rule: The correction per bar is approximately 0.005% - 0.015% depending on conditions and product.

5.1.3 Operating with the standard density

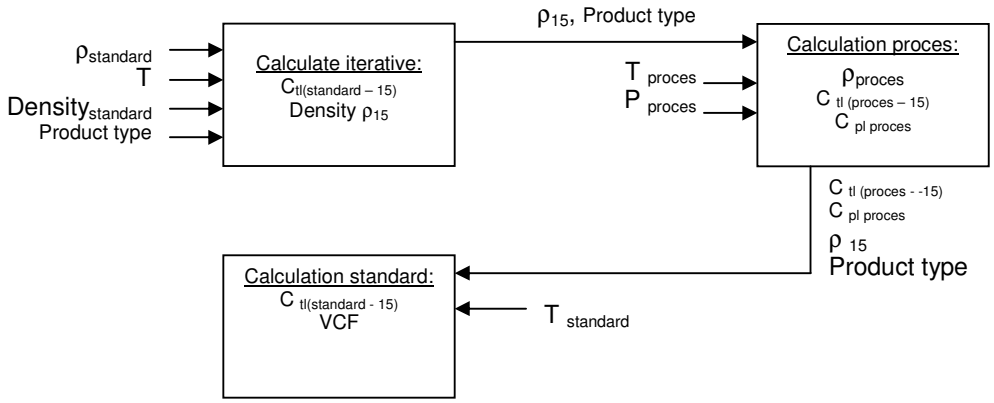
Products with a known constant homogeneous standard density do not need to be monitored by a densitometer.
Input of the standard density can be

- Manually in the running UFP-Program
- Through Modbus
- Analog input

It is named standard density and not density 15 because of the possibility to have a standard temperature different from 15°C.

The density at 15°C is calculated through iteration by the input of the standard density in a maximum of 40 steps or a remainder REM less then 10^{-5}:

Diagram for calculation VCF from standard density input:



Input for calculating density at 15°C:

- $T_{standard}$:[°C] Temperature standard
- $\rho_{standard}$:[kg/m^3] Density standard
- Product type
- Start value for density at 15°C is the mean value of the high and low limits of the required product type.

In a maximum of 40 loops:

- Calculate the thermal expansion coefficient α_T with the new found density 15
- Calculate the C_{tl} factor ($C_{tl\ standard\ -->15}$)
- Calculate the new reference density at 15°C by:

$$\rho_{15} = \frac{\rho_{s\tan dard}}{C_{tl(s\tan dard-15)}}$$

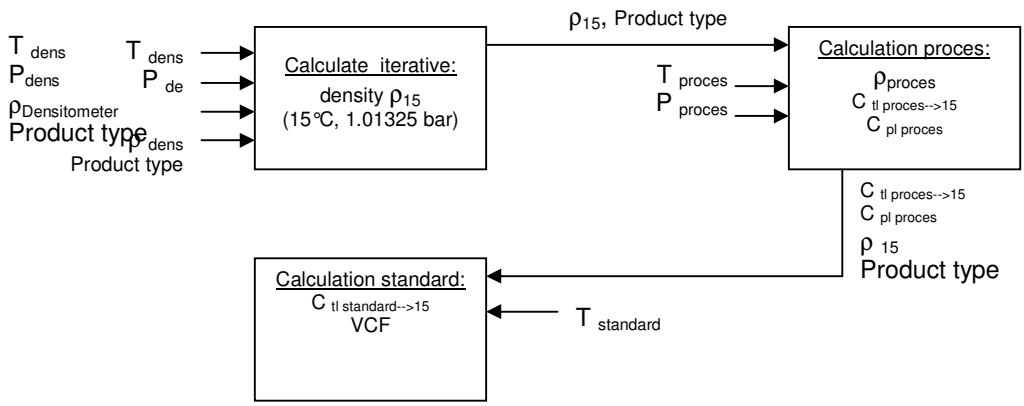
- Calculate the difference between the new found density15 and the last found density15. If the difference is smaller then 0.001% then the new found density15 is correct, otherwise use the new found density15 as new input.
- If the density 15 after 40 loops is not found then an alarm is shown on screen and through Modbus communication.

So now the density at 15°C is found.

5.1.4 Operating with the measured density

For less homogenous products like Crudes it is more practical to measure the density.
The density at 15°C is calculated through iteration by the input of the measured density in a maximum of 40 steps or a remainder REM less then 10^{-5}.

Diagram for calculation VCF from measured density input:



Input for calculating density at 15°C:

- T_{dens} :[°C] Temperature densito meter
- P_{dens} :[bar] Pressure densito meter
- ρ_{dens} :[kg/m3]Density densito meter (measured density)
- Product type
- Start value for density at 15°C is the mean value of the high and low limits of the required product type.

In a maximum of 40 loops:

- Calculate the thermal expansion coefficient α_T with the new found density15
- Calculate the C_{tl} factor ($C_{tl\ Tdens\ -->15)}$)
- Calculate the C_{pl} factor.($C_{pl\ Pdens}$)
- Calculate the new density at 15°C by:

$$\rho_{15} = \frac{\rho_{dens}}{C_{tldens} \cdot C_{pldens}}$$

- Calculate the difference between the newfound density15 and the last found density15. If the difference is smaller then 0.001% then the newfound density15 is correct, otherwise use the newfound density15 as new input.
- If the density15 after 40 loops is not found then an alarm is shown on screen and through Modbus communication.

So the density at 15°C is found.
Practically the conditions (T, P) for the densitometer can differ from the conditions of the measured flow rate in the UFS-V.
Therefore, the VCF that is eventually used, is calculated using the found density at 15°C as its base and the conditions of the measured flow rate as its goal.

5.2 Mass calculation

For mass calculation without using API standard volume calculations for the proces density it is of great importance that its measurement conditions are approximately similar to the measurement conditions of the flow rate in the UFS.

$$\phi_m = \phi_v \cdot \rho$$

Φm : Mass flow rate [kg/hr], the unit used in UFP is [ton/hr], 1 [ton] is 1000 [kg]
Φv : Volume flow rate at proces conditions
ρ : Density at proces conditions [kg/m^3]

Any deviation in measured density as function of the measurement conditions is directly proportional in the calculation of the mass flow rate.

For example: Crude oil with flow measurement at 25 °C and density measurement at 24°C.
Density 25°C: 845.00 kg/m3
Density 24°C: 845.71 kg/m3

This gives a deviation in mass flow rate of:

$$\frac{845.71 - 845}{845} \cdot 100 = 0.08\%$$

So variations of the measurement conditions for densitometer position to flow rate position will effect linearity and repeatability of the mass measurement.

When this problem occurs it is better to use the API standard volume calculation for its mass calculation. Its a little more complicated but then there is a correction for the measurement conditions.

5.3 Solartron meter density is calculated as follows:

Density calibration at 20 °C, 1 barA.
Density temperature and pressure corrected:

$$D = K0 + K1 \cdot T + K2 \cdot T^2$$

$$D_t = D(1 + K18(t - 20)) + K19(t - 20)$$

$$D_p = D_t(1 + K20(p - 1)) + K21(P - 1)$$

Where K20 and K21 are:

$$K20 = K20A + K20B(p - 1)$$
$$K21 = K21A + K21B(p - 1)$$

D : Density, uncorrected [kg/m^3]
Dt : Density, temperature corrected [kg/m^3]
Dp : Density, pressure corrected [kg/m^3]
T : Periodic time [µs]
t : Temperature [°C]
p : Pressure [barA]
K0, K1, K2 : Calibration factors, Density calibration at 20 °C, 1 barA.
K18, K19 : Calibration factors, Density calibration at 20 °C, 1 barA.
K20A,K20B : Calibration factors, Density calibration at 20 °C, 1 barA.
K21A,K21B : Calibration factors, Density calibration at 20 °C, 1 barA.

The calibration factors can be altered on-line while the system is operating, by keyboard (CONTROLS F9, DENSITO F5) or by Modbus control.
But for custody transfer reasons the write access to the density cells can be blocked in the configuration file CLNT0300.DAT

5.4 Sarasota meter density is calculated as follows:

$$T_0^{'} = T_0 + N_t(t - t_{cal}) + N_p(p - p_{cal})$$

$$\rho_m = D_0 \cdot \frac{T - T_0^{'}}{T_0^{'}} \cdot (2 + K \cdot \frac{T - T_0^{'}}{T_0^{'}})$$

ρ_m	: Calculated measured mass density of fluid [kg/m^3]
T	: Measured periodic time [µs]
T_0'	: Corrected value of T_0 [µs]
T_0	: Calibration factor, reference periodic time [µs] of spool at 15°C and zero density
t	: Absolute temperature [K]
t_{cal}	: Calibration factor, calibration temperature used in density calculations [15°C]
p	: Absolute pressure [bar]
p_{cal}	: Calibration factor, calibration pressure used in density calculations [1.01325 bar]
N_t	: Calibration factor, temperature coefficient of spool [µs/K]
N_p	: Calibration factor, pressure coefficient of density transducer [µs/bar]
D_0	: Calibration factor, calibration constant of spool [kg/m^3]
K	: Calibration factor, spool calibration constant [ ]

The calibration factors can be altered on-line while the system is operating, by keyboard (CONTROLS F9, DENSITO F5) or by Modbus control.
But for custody transfer reasons the write access to the density cells can be blocked in the configuration file CLNT0300.DAT

6 BATCH MODE

In batch mode the UFP-Program generates batch tickets by manual demand, Modbus controlled demand or time controlled demand.
These batch tickets are printed by a serial printer, according to DIN66258 standard

The latest MID certification holds the following printer setups:

- EPSON 880 serial printer with DIN66258 protocol
- Printer OKI 280 elite (Standard Serial Printer) + MFX_4 SDI module
  The MFX_4 SDI Serial Data Interface is for transmission of legal data (DIN66258 protocol) to a standard printer.

6.1 Hardware set-up

The hardware set-up concerning Baud rate, stop bits etc. of the serial printer port is defined in an initialisation file used for all communication settings: COMS0300.DAT
Under section 2:

```
2<PRINTER COMMUNICATION SETUP>
2.1 PRINTER_COMPORT        =#1     //1,2,3,4
2.2 PRINTER_WORD_LENGTH    =#8     //7 or 8
2.3 PRINTER_PARITY         =#2     //0=disabled,1=odd,2=even
2.4 PRINTER_STOP_BITS      =#1     //1 or 2
2.5 PRINTER_BAUDRATE       =#9600  //38400, 19200, 9600, 4800, 2400, 1800
                                   //1200, 600, 300, 200, 150, 134.5, 110, 75
2.6 PRINTER_DTR_POLARITY   =#1     //0=pos,1=neg
2.7 PRINTER_RTS_POLARITY   =#1     //0=pos,1=neg
2.8 PRINTER_TIMEOUT        =#5000  //Timeout[ms] on acknowledges etc.
2.9 PRINTER_TIMEOUT_MANAGE =#10    //Timeout[ s] for print management switch
```

These settings <u>must also be done</u> at the printer side.

6.2 Layout of the ticket

The layout of the ticket is fixed in a file named TICK0300.DAT (see next page)
This file can be configured as required.
The file is protected by a CRC-checksum as all initialisation files are.
The CRC-checksums from the 3 data sets used (UFS, UFP and DAT) are printed on the ticket for additional security. Any change in the ticket layout is identified by a change in CRC-checksum.
The layout of the ticket consists of free to fill in text and data.

The data is framed as follows:

~	1 or 3	1 to 999	L or R	@
Frame Start character	1=batch start value 2=batch stop value 3=special character input	Parameter Mapping address	Optional alignment Left or right Default is R	Frame End Character

If the data needs to be printed in a specific format (by default the values are printed in format %10.3)

~	1 or 2	1 to 999	L or R	%	1 to 15	.	0 to (Width-1)	@
Frame Start character	1=start value 2=stop value	Parameter Mapping address	Optional alignment Left or right Default is R	Indicator For specific format	Width, number of characters to print	Period as decimal point	Number of characters in decimal	Frame End Character

Example of ticket layout in file TICK0300.dat:

```
~3027@~3087@~3049@            KROHNE
~3027@~3087@~3048@
IDENTIFICATION
  Ticket number   : ~1001L@
  Start time      : ~1101L@
  Stop  time      : ~2101L@
  Serial number   : ~1201L@
  Software version: ~1202L@
  Tag number ID   : ~1203L@
  Batch ID        : ~1204L@
  Batch name      : ~1205L@

TOTALISERS
                 Proces[m3]     Standard[m3]       Mass[tonM]
Start Cum.:~1401R%10.2@     ~1404R%10.2@     ~1407R%10.2@
Stop  Cum.:~2401R%10.2@     ~2404R%10.2@     ~2407R%10.2@
Batch     :~2301R%10.2@     ~2304R%10.2@     ~2307R%10.2@


BATCH FLOW WEIGHTED AVERAGES
            Temperature[°C]    Pressure[bar]  Density [kg/m3]
Proces       :  ~2502R%8.2@      ~2505R%8.2@      ~2520R%9.3@
Densito meter:  ~2504R%8.2@      ~2507R%8.2@      ~2508R%9.3@
Standard     :  ~2519R%8.2@                       ~2509R%9.3@


CONFIGURATION ON STANDARD VOLUME CALCULATION
Calculation Method       : ~2701L@
Temperature standard [°C]: ~2702L%5.2@
Density standard by      : ~2703L@
Api group fluid type     : ~2704L@
API correction factor K0 : ~2705L%11.4@
API correction factor K1 : ~2706L%11.4@
API correction factor K2 : ~2707L%11.8@


ALARMS                              Measured[s]     Override[s]
Temperature Body                : ~2606R%10.1@    ~2616R%10.1@
Temperature Proces              : ~2607R%10.1@    ~2617R%10.1@
Temperature Densitometer        : ~2609R%10.1@    ~2619R%10.1@
Pressure    Proces              : ~2610R%10.1@    ~2620R%10.1@
Pressure    Densitometer        : ~2612R%10.1@    ~2622R%10.1@
Density     Proces              : ~2613R%10.1@    ~2623R%10.1@
Density     Standard            : ~2614R%10.1@    ~2624R%10.1@


General Flow 1-4 channels down  : ~2601R%10.1@
General Flow all channels down  : ~2602R%10.1@
Calculation API group mismatch  : ~2603R%10.1@
```

For the specific parameter mapping addresses see next paragraph

6.3 Parameter mapping addresses

Ticket number		Operation
1	Non resetable sequence number for the batch	B
2	… 99 reserved	
Times		Operation
101	Time and date of start and stop	B
102	... 199 reserved	
Operate names (optional at batch set-up)		Operation
201	Serial number (internal)	B
202	Software version (internal)	B
203	Tag number ID (internal)	B
204	Batch ID (fill in optional)	B
205	Batch name/source (fill in optional)	B
206	Batch reference number (only accessible by Modbus input)	B
207	... 209 reserved	B
210	Guard Digital contact, text according to CLNT0300.DAT item 20.04 and 20.05 See also chapter 10.4.3	E
211	... 220 reserved	
221	Print Modbus ASCII 8 character write string, Modbus address (NotModicon compatible) 4001	E
222	Print Modbus ASCII 8 character write string, Modbus address (NotModicon compatible) 4002	E
223	Print Modbus ASCII 8 character write string, Modbus address (NotModicon compatible) 4003	E
224	Print Modbus ASCII 8 character write string, Modbus address (NotModicon compatible) 4004	E
225	... 260 reserved	
261	Print Modbus ASCII 16 character write string, Modbus address (NotModicon compatible) 14001	E
262	Print Modbus ASCII 16 character write string, Modbus address (NotModicon compatible) 14002	E
263	Print Modbus ASCII 16 character write string, Modbus address (NotModicon compatible) 14003	E
264	Print Modbus ASCII 16 character write string, Modbus address (NotModicon compatible) 14004	E
265	... 299 reserved	
Resetable Totalisers (at start and stop time)		Operation
301	Resetable Actual Totaliser	B
302	Resetable Actual forward Totaliser	B
303	Resetable Actual reverse Totaliser	B
304	Resetable Standard Totaliser	B
305	Resetable Standard forward Totaliser	B
306	Resetable Standard reverse Totaliser	B
307	Resetable Mass Totaliser	B
308	Resetable Mass forward Totaliser	B
309	Resetable Mass reverse Totaliser	B
310	Resetable External Flow meter Standard Totaliser	E
311	Resetable External Flow meter Standard Forward Totaliser	E
312	Resetable External Flow meter Standard Reverse Totaliser	E
313	.. 399 reserved	
Non Resetable Totalisers (at start and stop time)		Operation
401	Non resetable Actual Totaliser	B
402	Non resetable Actual Forward Totaliser	B
403	Non resetable Actual Reverse Totaliser	B
404	Non resetable Standard Totaliser	B
405	Non resetable Standard Forward Total	B

406	Non resetable Standard Reverse Total	B
407	Non resetable Mass Totaliser	B
408	Non resetable Mass Forward Totaliser	B
409	Non resetable Mass Reverse Totaliser	B
410	..499 reserved	
Batch Flow weighted averages		Operation
501	Batch 1 average temperature body	B
502	Batch 1 average temperature proces	B
503	Batch 1 average temperature proving external flow meter	E
504	Batch 1 average temperature densito meter	B
505	Batch 1 average pressure proces	B
506	Batch 1 average pressure proving external flow meter	E
507	Batch 1 average pressure densito meter	B
508	Batch 1 average density densito meter	B
509	Batch 1 average density standard	B
510	Batch 1 average External Viscosity kynematic	B
511	Batch 1 average Ctl (15°C to proces)	B
512	Batch 1 average Cpl (0 Bar to proces)	B
513	Batch 1 average Ctl (15°C to standard)	B
514	Batch 1 average Cpl (0 Bar to standard, always 1)	B
515	Batch 1 average Ctl (15°C to densito meter)	B
516	Batch 1 average Cpl (0 Bar to densito meter)	B
517	Batch 1 average Ctl (15°C to proving external flow meter)	B
518	Batch 1 average Cpl. (0 Bar to proving external flow meter)	B
519	Batch 1 average temperature standard	B
520	Batch 1 average density proces	B
521	Batch 1 average flow actual	B
522	Batch 1 average density proving external flow meter	E
523	Batch 1 average flow proving external flow meter	E
524	Batch 1 average Installed Kfactor proving external flow meter	E
525	Batch 1 found New Kfactor proving external flow meter	E
526	Batch 1 difference installed vs new found Kfactor external	E
527	Batch 1 Air Buoyancy correction: Air Buoyancy number CLNT0300.DAT item 19.02	E
528	Batch 1 Air Buoyancy correction: Calculated Liter Weight	E
529	Batch 1 Air Buoyancy correction: Calculated Weight in Air	E
530	…550 reserved	
551	Batch1 : Lowest measured Temperature (for high viscosity applications)	B
552	Batch1 : Deviation % (worst case estimate due to batch alarms)	B
553	…599 Reserved	
Batch alarms in seconds		Operation
601	Batch 1 alarm: General Flow 1-4 channels down	B
602	Batch 1 alarm: General Flow all channels down	B
603	Batch 1 alarm: calculation API group mismatch	B
604	Batch 1 alarm: system runtime alarm occurred	B
605	Batch 1 alarm: real time profile out of range when used	B
606	Batch 1 alarm: measured Body temperature out of range	B
607	Batch 1 alarm: measured Proces temperature out of range	B
608	Batch 1 alarm: measured External Prove temperature out of range	E
609	Batch 1 alarm: measured Densito temperature out of range	B
610	Batch 1 alarm: measured Proces pressure out of range	B
611	Batch 1 alarm: measured External Prove pressure out of range	E

612	Batch 1 alarm: measured Densito pressure out of range	B
613	Batch 1 alarm: measured Densito Density out of range	B
614	Batch 1 alarm: measured Standard Density out of range	B
615	Batch 1 alarm: measured External viscosity out of range	E
616	Batch 1 alarm: override Body temperature applied	B
617	Batch 1 alarm: override Proces temperature applied	B
618	Batch 1 alarm: override External Prove temperature applied	E
619	Batch 1 alarm: override Densito temperature applied	B
620	Batch 1 alarm: override Proces pressure applied	B
621	Batch 1 alarm: override External Prove pressure applied	E
622	Batch 1 alarm: override Densito pressure applied	B
623	Batch 1 alarm: override Densito Density applied	B
624	Batch 1 alarm: override Standard Density applied	E
625	Batch 1 alarm: override External viscosity applied	B
626	…627 reserved	
Configuration API etc		Operation
701	Calculation method: Only proces flow, Standard volume/mass by API standards, mass measurement by proces density	B
702	Temperature standard in value	B
703	Density standard by: fill in manually, calculated from densito meter density, on AD / Modbus input	B
704	Fluid type: crude, gasoline, trans.area, jetgroup, fuel oil, free fill	B
705	API correction factor K0	B
706	API correction factor K1	B
707	API correction factor K2	B
708	..749 reserved	
750	Print Modbus float32, Modbus address (NotModicon compatible) 7095 (1751) or 7100 (2751)	E
751	Print Modbus float32, Modbus address (NotModicon compatible) 7096 (1752) or 7101 (2752)	E
752	Print Modbus float32, Modbus address (NotModicon compatible) 7097 (1753) or 7102 (2753)	E
753	Print Modbus float32, Modbus address (NotModicon compatible) 7098 (1754) or 7103 (2754)	E
754	Print Modbus float32, Modbus address (NotModicon compatible) 7099 (1755) or 7104 (2755)	E
755	Print Modbus float32, Modbus address (NotModicon compatible) (7095 – 7100) (with 1756) (7100 – 7095) (with 2756)	E
756	Print Modbus float32, Modbus address (NotModicon compatible) (7096 – 7101) (with 1757) (7101 – 7096) (with 2757)	E
757	Print Modbus float32, Modbus address (NotModicon compatible) (7097 – 7102) (with 1758) (7102 – 7097) (with 2758)	E
758	Print Modbus float32, Modbus address (NotModicon compatible) (7098 – 7103) (with 1759) (7103 – 7098) (with 2759)	E
759	Print Modbus float32, Modbus address (NotModicon compatible) (7099 – 7104) (with 1760) (7104 – 7099) (with 2760)	E
760	..799 reserved	
Security		Operation
801	CRC checksum on data set UFS	B
802	CRC checksum on data set UFP	B
803	CRC checksum on data set DAT	B
804	CRC checksum on Executable	B
805	..999 reserved	

Operation B: Basic operations
Operation E: Extended operations

6.3.1 Special characters for printer control:

Special characters for printer control start with a 3.
The so called escape codes for printer control can be inserted into the Ticket Layout
Examples:

~3007@	Printer sounds a bel
~3012@	Formfeed
~3027@~3067@~3000@~30xx@	Set page length in inch in ~30xx@: xx=1…22
~3027@~3067@~3000@~3xxx@	Set page length in lines in ~3xxx@: xx=1…127
~3027@~3087@~3049@	Select double sized characters
~3027@~3087@~3048@	Cancel double sized characters
~3027@~3071@	Select double strike printing
~3027@~3072@	Cancel double strike printing
~3027@~3052@	Select italic characters
~3027@~3053@	Cancel italic characters
~3027@~3054@	Cancel italic characters
~3027@~3057@	Enable paper out sensor
~3027@~3056@	Disable paper out sensor

6.4 Initial batch set-up

The initial batch set-up is by initialisation file CLNT0300.dat file under section 12:

```
12 <BATCHING CONTROL>
Only in use when a Epson Serial Printer according DIN66258 standard
is connected.
Note that in the HSET0300.UFP file (for hardware setup) the following data
must be set:
-1.4 Location_stat must be enabled (saving of status)
-1.8 Location_tic  must be a disk with enough storage capacity

12.1 BATCHING_ON    c=#2   //0=Internal batching disabled
                           //Manual batching modes:
                           //1=Enable Batching (start stop at zero flow)
                           //2=Enable Batching (start stop at all flows)
                           //Continuous piipe line modes
                           //3=Enable Batching: (Automatic)
                           //4=Enable Batching: (No Reset,possibly forced reset)
                           //If enabled then automatic initialize printer
12.2 Max_tickets    c=#100 //Maximum number of last tickets saved 10..100000
                           //depending on disk space (see Location_tic above)
12.3 Hour_start     c=#10  //Start hour    0..23 for continous pipe line ticket
12.4 Hour_interval  c=#1   //Interval hour 1..24 for continous pipe line ticket
                           //0=No tickets automatically, only on demand
12.5 Modbus_control c=#1   //0=No Control batching through modbus
                           //1=Control batching through modbus
                           //2=as 0 with no printer alarm on printer failure
                           //3=as 1 with no printer alarm on printer failure
```

- There are 4 modes for Batch configuration:

BATCHING ON	Start stop batch permission	Confirmation asked on batch settings	API settings during batch possible
0	Batch mode disabled	-------	------
1	Only at zero flow conditions	Yes	No
2	At all flowing conditions	Yes	No

3	At all flowing conditions	No	Yes (continuous pipe line measurement)
4	At all flowing conditions	No	Yes (continuous pipe line measurement)

BATCHING_ON 1 and 2 have the following restrictions during a batch:
-No reset possible of resetable totalisers
-No reset of error times but the possibility to reset occurred error messages

- The previous number of tickets saved is set with MAX_TICKETS. Default is 100 tickets.
  Be careful with increasing the number of tickets. Not enough disk space means losing tickets

- For Continuous Pipe Line Measurement the ticket automatically is printed starting from HOUR_START

- For Continuous Pipe Line Measurement the ticket automatically is printed every HOUR_INTERVAL, but if interval 0 is installed than tickets are only printed on demand

- By MOD_BUS_CONTROL it is possible to enable the controls through Modbus for batching:
  -Start batch
  -Stop batch
  -Reset printing
  -Confirm printing
  Or in case of using continuous Pipe Line measurement
  -Ticket on demand with reset of values
  -Ticket on demand without reset of values
  - Reset printing

6.5 Batch status

Batch status (status window text)	As a value on Modbus	Explanation
NON	0	No batch active, ready to set-up
SETUP	1	In set-up mode. After set-up is done, it is possible to start a batch
RUNNING	2	Batch is started
END-BATCH	3	Batch is stopped and ticket is made, then attempt to END_PRINT
END-PRINT	5	Status during successful printing
END-FAIL	6	If printing fails or printer is busy too long
CONFIRM	7	After successful print job waiting for manual confirmation
RESET	10	Waiting for reset command after END_FAIL

6.6 Printer status

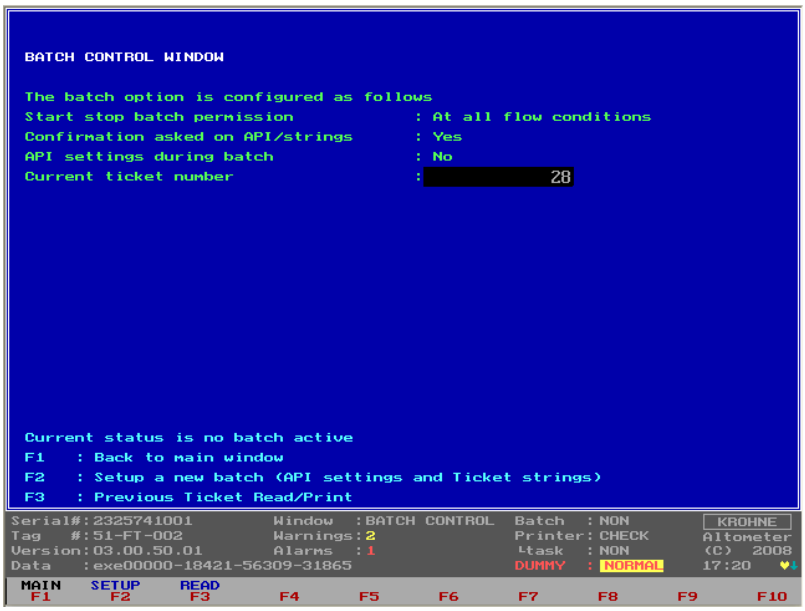
Printer status (status window text)	As a value on Modbus	Explanation
Ready	0	Ready for printing
Fail	1	If printer failed during print job
Busy Check	2 2	During print job If no print job, check if printer is connected and ready
Off	3	If printer is not found after Check

6.7 Printer task status

Printer status (status window text)	As a value on Modbus	Explanation
NON	0	No print job
BUSY	1..2	Attempt first character
Xxxs …0s Timeout print management Value in seconds counting down, if 0 then status to RESET	3	Getting acknowledge if printer is taking print job. For multiple UFP's connected by a printer switch to 1 serial printer. Timeout print management can be set in COMS0300.dat under section 2.9
BUSY	4..98	Printing headers
Progress counter as percentage 0…100	99	Successful printing ticket
CONFIRM	100	Ready to confirm print job, see batch status CONFIRM
RESET	101	Ready for reset command on batch status RESET

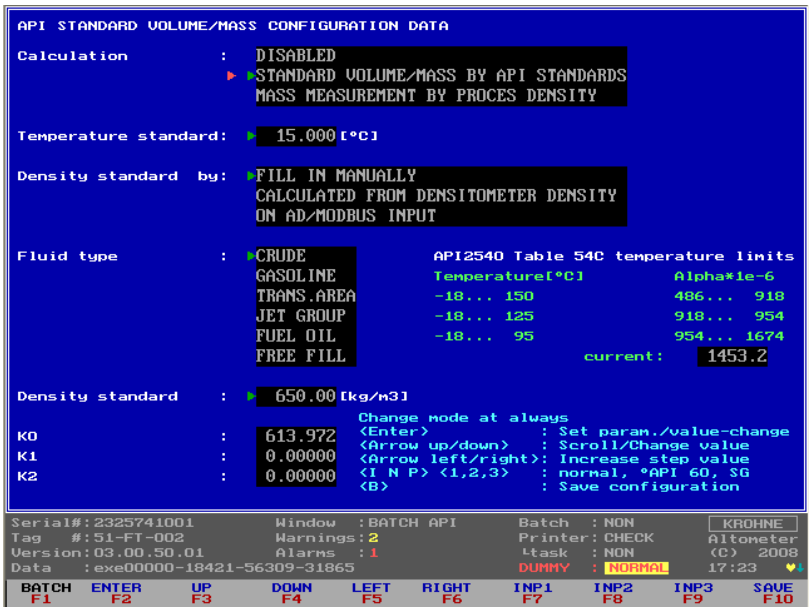
6.8 Batch set-up

BATCHING_ON 1 or 2 is a normal batch that requires batch set-up:



A new batch can only be set if the last batch is stopped and the ticket is printed correctly and confirmed
Start the set-up by pressing function key F2 for confirmation on the API settings

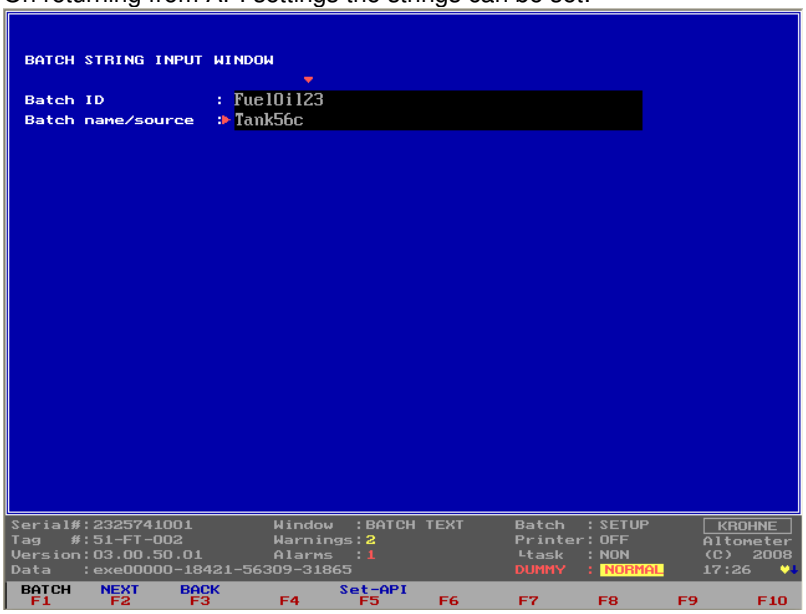
6.8.1 API set-up



The operator is forced to look at the API setting. He can change the settings and SAVE by F10 or return back to BATCH by F1.
If the batch is controlled by Modbus this step must be handled by the Host system.

6.8.2 Batch text set-up

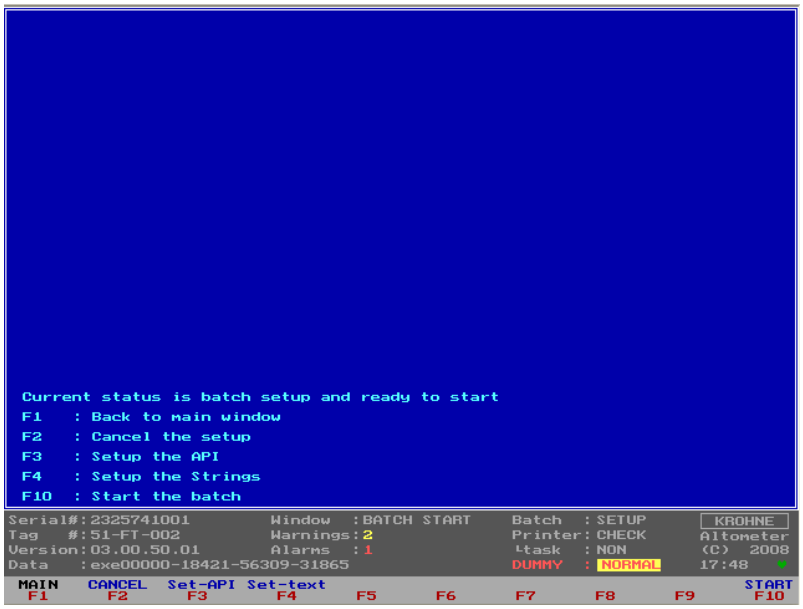
On returning from API settings the strings can be set:



Returning to F1 “batch” means confirmation on texts.
Confirmation on Batch ID and Batch name/source is only possible with manual set-up

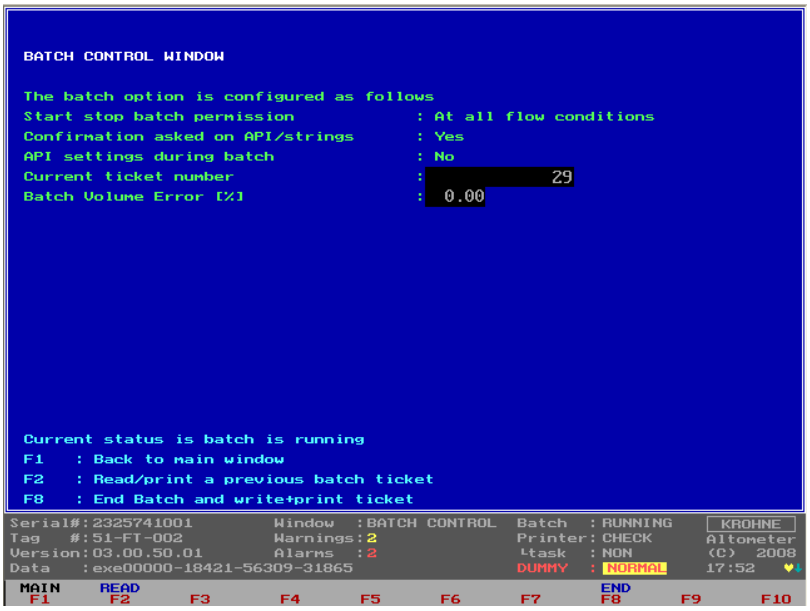
Note that there are now also Modbus ASCII based strings available.
By data input through Modbus, 4 names (8 characters) and 4 names (16 characters) can printed on the ticket. Also 10 external numeric values by Modbus input can be printed on the batch ticket, see printer registers 751…760

6.8.3 Ready to start batch after set-up is complete



- Now batch is ready to start by Function key F10 or by Modbus command if enabled. Note that depending on security level it is only possible to start a batch if flow is at zero flow conditions
- Possible to cancel the set-up (F2)
- Or return to the API settings (F3) or the Text settings (F4)

6.9 Batch start



Starting a batch holds the following automatic actions:

- Reset of: errors, resetable totalisers and batch flow-weighted averages (temp, press, densities etc.)
- Increase ticket number by one (is saved in the “batch status” file.
- Saving of all batch parameters (for later use when batch is stopped and certain batch start values are requested on ticket) in a “batch start” file that is secured by a CRC-checksum

New since software version 03.00.50.01 is the option to view, during the batch, the worst case batch Volume Error % estimate due to batch alarms such as path failures, input signals alarms etc etc

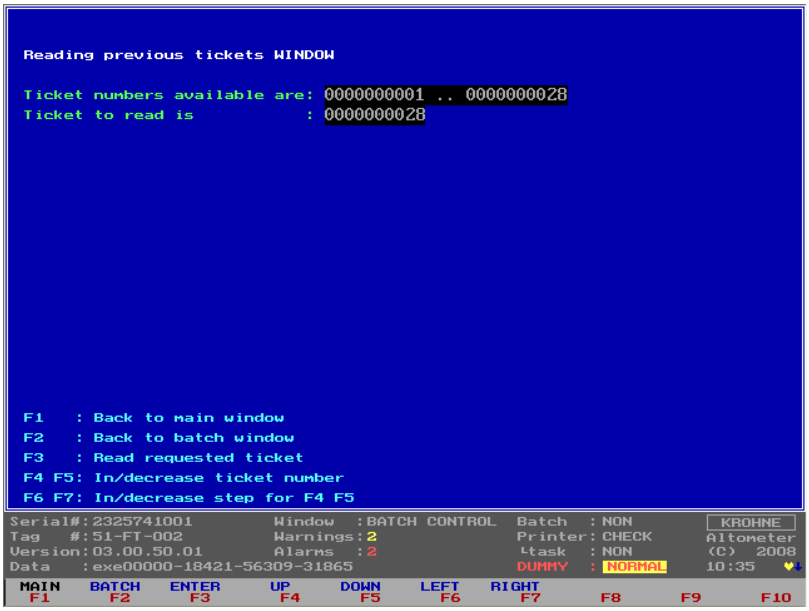
6.10 During batch

During a batch the restrictions are handled as the installed BATCHING_ON level prescribes.
Files with all alarm times, totalisers, and batch averages are saved every 12 seconds to a SRAM disk (or industrial compact flash with static and dynamic wear levelling) in dual files.

Sequentially saving it each time in a different file (file1 or file2). So when the power is turned of during a file-save causing the file to be corrupted, the previously saved dual file is used at start-up to load previously saved alarm times, totalisers, and batch averages.

6.10.1 Reading / Printing previous batch ticket

During a batch it is possible to read and print a previous batch ticket
From Main window to Batch Control window by F7 and then Function Key F2 for reading previous batch ticket



Explanation Function keys:

F1	: Back to Main Window
F2	: Return to Batch Control window
F3	: Upload “Ticket to read “
F4…F7	: Change “Ticket to read” number within the limits of “Tickets available”

6.10.1.1 Read ticket

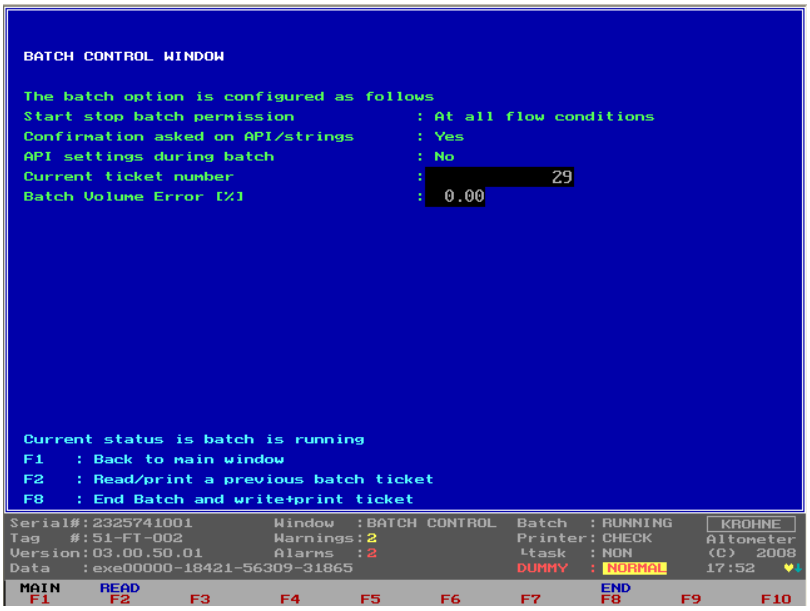
```
DECISIVE PRESENTATION: NOT VALID, SYSTEM ERRORS DURING BATCH

--------------------------------------------------------------------------------
System runtime alarms occurred  :          83.6
Realtime Profile out of range   :           0.0

Batch Error %                   :         26.22
Low Temperature during batch[°C]:         21.38

                                                        Krohne Oil&Gas B.V.

ERROR IN BATCH BY:
-during read/write start-stop data
-during making ticket file
-during batch: system stopped during batch
-during batch: measurement alarms possibly cause > 0.06 % deviation
CRC-CHECKSUMS: EXE00000 UFS18421 UFP56309 DAT31865 TICxxxxx

--------------------------------------------------------------------------------
Serial#:2325741001        Window  :BATCH CONTROL  Batch   : NON        KROHNE
Tag   #:51-FT-002         Warnings:2              Printer: CHECK       Altometer
Version:03.00.50.01       Alarms  :2              Ltask   : NON        (C)  2008
Data    :exe00000-18421-56309-31865               DUMMY   : NORMAL     10:45 ♥
 MAIN   BATCH    UP    DOWN                                   PRINT   NEW
  F1     F2     F3     F4     F5     F6     F7     F8          F9     F10
```

Notice that the ticket that is read is not valid:
The header explains that there were system errors.
The System errors are mentioned at the bottom of the ticket therefore in this example the reading of the ticket is scrolled down to the bottom.

Function keys:
F1 : back to Main window
F2 : back to Batch control
F3 : Scroll up in ticket
F4 : Scroll down in ticket
F9 : Print the ticket
F10 : Read another ticket

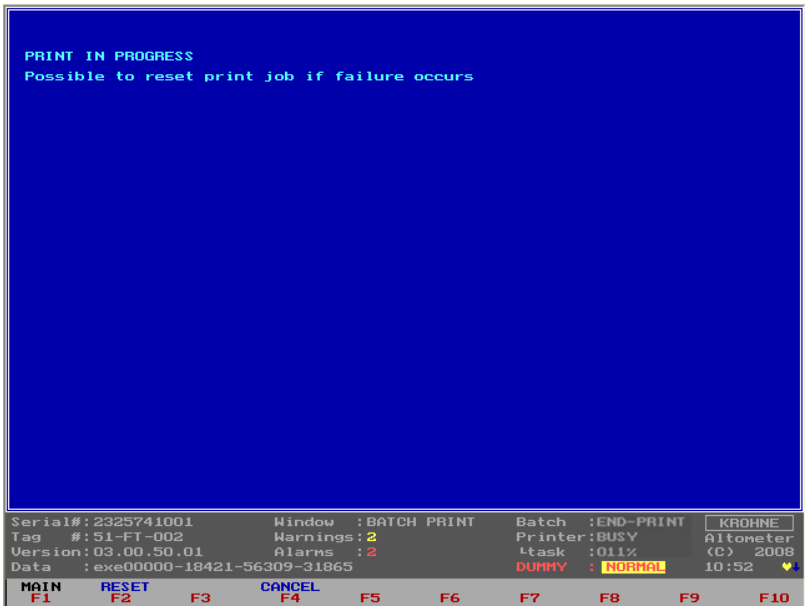
6.11 Batch stop

After starting a batch, this batch can be stopped manually in the Batch Control window by F8, or by Modbus command if enabled
Note that depending on security level it is only possible to stop a batch if flow is at zero conditions



Stopping a batch holds the following automatic actions:

- Saving of all parameters possible (in values) on ticket in a “batch stop” file that is secured by a CRC-checksum.
- Make and save ticket according to the “layout ticket” file that is secured by a CRC-checksum
- If saving of the ticket failed a message will appear on screen and on the ticket.
- The ticket will be send to the printer after saving the ticket



In the picture above the batch is ended and is just started to print.
Batch status : END PRINT
Printer status : BUSY

Printer task at : 011%
It is always possible to reset the printer buffer in the UFP, this will cause the print task to start at the beginning of the ticket again.
Note that it can be necessary to reboot the printer itself on a real print failure.

Stopping a batch holds the following “manual actions” / “ModBus commands”:
- After ticket is printed, confirm the printed ticket is printed successful and is the same as shown on screen.
- If the printing has failed the software generates an alarm and no confirmation can be given only a reset of the printer. Check and reset the printer. After reset, the complete ticket is printed again. If the ticket is printed correct a confirmation can be given.

Note that a next batch can only be started when the previous batch is confirmed.

If any CRC is corrupted this will be indicated on the ticket Printout
- In the header of the ticket, that the ticket is invalid due to system errors
- At the end of the ticket, the explanation of the system errors and so that there was a crc checksum failure

If status batch files are all corrupt at initialisation of the UFP-Program, a new status file is made. The ticket number can then be set to desired value (for logistical reasons) and the DAT data set will have CRC checksum update.

6.11.1 Possible errors that cause an Invalid Batch ticket

In the header of the ticket one of the 3 following messages will be printed
- Decisive presentation: Valid
- Decisive presentation: Not valid, crc-checksum error (ticket)
- Decisive presentation: Not valid, system errors during batch

At the end of the ticket, there will be an explanation of the system errors if they have occurred:
Error in batch by:
- During read/write of start/stop value files
- During making ticket file (write errors)
- During batch: batch status files
- During batch: batch totaliser files
- During batch: batch average files
- During batch: system stopped during batch
- During batch: measurement alarms possibly cause > 0.04 percent deviation
- During batch: batch status file saving

6.11.2 Measurement alarms batch validation

There are 2 methods for the batch validation:

1. Validation using the maximum flow. This is the method as used in previous versions of this program. Using the maximum flow for validation has shown in practice that it can lead to overrated Batch Error% values.
2. Validation using the current flow as long as the current flow is calculated. Since version 03.00.50.01.

The method is set in the CLNT0300.DAT file item: “21.17 Method of weighing”

6.11.2.1 Method 1 static maximum flow

To validate a batch when a measurement alarm has occurred over a period of time (Alarm in [s]) the following calculation is used to validate the batch within a 0.04% error.

$$Volume\_error[m3] = \frac{MaxFlow[m3/h]}{3600} \cdot Alarm[s] \cdot \frac{Error[\%]}{100}$$

$$Deviation[\%] = \frac{Volume\_error[m3]}{Batch\_Volume\_proces[m3]} \cdot 100[\%]$$

Secondary inputs measurement Error% on occurred alarm:

Secondary inputs	Error%	Explanation
Temperature body	1	10℃ is 0.036% deviation: 2% caused by >500℃
Temperature process	25	1℃ is 0.1% deviation: 25% caused by 250℃ deviation
Temperature proving external flow meter	25	1℃ is 0.1% deviation: 25% caused by 250℃ deviation
Temperature densito meter	25	1℃ is 0.1% deviation: 25% caused by 250℃ deviation
Pressure proces	2.5	1 bar is 0.01% deviation: 2.5% caused by 250 bar deviation
Pressure proving external flow meter	2.5	1 bar is 0.01% deviation: 2.5% caused by 250 bar deviation
Pressure densito meter	2.5	1 bar is 0.01% deviation: 2.5% caused by 250 bar deviation
Density densito meter	100	Standard volume correction uncertain therefore 100% errror
Density standard	100	Standard volume correction uncertain therefore 100% errror

UFP measurement Error% on occurred alarm:

Secondary inputs	Error%	Explanation
1-4 channels down	0.5	Correction curve over viscosity never > 0.5%. (together with Real time profile out of range error will lead to 4% error)
All channels down	100	System is not measuring flow therefore 100% error
API group mismatch	100	Standard volume correction uncertain therefore 100% errror
System alarms	10	Over estimated value on alarms as file not found, overrun etc
Real time profile out of range	3.50	Correction curve over viscosity never > 3.5%. To secure validity value=10%

Each alarm is measured in seconds, and the Volume_Error it causes, is calculated.
All Volume_error values are summated and the total deviation is calculated.

Example: How long may a certain error be active during a batch before the batch is Not Valid:

- Only alarm 1-4 channels down: alarm time is x
- Maximum flow rate is 1200m3/h
- Batch time is 24 hours at 80% of the maximum flow rate

<u>The batch volume in 24 hours at 80% flow rate:</u>

$$Batch\_Volume\_\mathrm{Pr}oces[m3] = 24[h] \cdot \frac{80[\%]}{100} \cdot 1200[m3/h] = 23040[m3]$$

For the alarm “1-4 channels down” to be within 0.06% :

$$Volume\_error\_\max = \frac{0.06[\%]}{100} \cdot 23040[m3] = 13.824[m3]$$

$$Alarm[s] = 13.824[m3] \cdot \frac{3600}{1200[m3/h]} \cdot \frac{100}{0.5[\%]} = 8294[s] = 2.3[\text{hour}]$$

6.11.2.2 Method 2 current flow

The calculations are during the batch instead of at the end of the batch. When an error occurs, this error is calculated using the current gross flow as long as not all 5 channels are down (then max flow is used). This leads to less overrated batch volume error% values.
Because the error % is calculated during the batch using the current gross flow it is not possible to recalculate this method at the end of the batch. Only method 1 can be recalculated.
This method prevents overrated batch volume error% during startup where low flow rates and path failures due to gas outbreak can co-exist.

6.12 Continuous Pipeline Measurement tickets

When the BATCHING_ON mode is in Continuous Pipeline Measurement no confirmations are asked after printing the ticket.
If a new ticket has failed in printing it is asked to reset. But if no reset is made then the next ticket will just make the reset and start printing the next ticket.
The previous ticket can then be printed as described in paragraph: Reading / Printing previous batch ticket

There are two options for continuous Pipeline measurement:

- 3 Auto reset of totalisers, errors, averages etc between tickets
- 4 No auto reset of totalisers, errors, averages etc between tickets, but possible on demand.

(clnt0300.dat file section 12.1 option 3 or 4)

For Continuous Pipe Line Measurement the ticket automatically is printed, counting the hours starts from HOUR_START (clnt0300.dat file section 12.3)

For Continuous Pipe Line Measurement the ticket automatically is printed every HOUR_INTERVAL, but if interval 0 is installed than tickets are only printed on demand (clnt0300.dat file section 12.4)

6.13 Example of ticket to output:

```
DECISIVE PRESENTATION: NOT VALID, SYSTEM ERRORS DURING BATCH


                                                    KROHNE Altometer
IDENTIFICATION
  Ticket number   : 3
  Start time      : May 21 18:34:46 2001
  Stop  time      : May 21 18:51:46 2001
  Serial number   : 98843901
  Software version: 03.00.00
  Tag number ID   : F2501
  Batch ID        : Crude oil23
  Batch name      : Tank56C

TOTALISERS
          Proces[m3]     Standard[m3]       Mass[tonM]
Start Cum.:    731.60           747.43           485.83
Stop  Cum.:    757.43           773.82           502.99
Batch     :     25.83            26.39            17.15


BATCH FLOW WEIGHTED AVERAGES
              Temperature[°C]    Pressure[bar]  Density [kg/m3]
Proces       :      0.00             0.00           664.072
Densito meter:      0.00             0.00           500.000
Standard     :     15.00                            650.000


CONFIGURATION ON STANDARD VOLUME CALCULATION
Calculation Method       : API2540
Temperature standard [°C]: 15.00
Density standard by      : Manually
Api group fluid type     : Crude
API correction factor K0 : 613.9723
API correction factor K1 : 0.0000
API correction factor K2 : 0.00000000


ALARMS                              Measured[s]     Override[s]
Temperature Body                :        0.0             0.0
Temperature Proces              :       51.7             0.0
Temperature Densitometer        :        0.0             0.0
Pressure    Proces              :       51.7             0.0
Pressure    Densitometer        :        0.0             0.0
Density     Proces              :        0.0             0.0
Density     Standard            :        0.0             0.0

General Flow 1-4 channels down  :        0.0
General Flow all channels down  :        0.0
Calculation API group mismatch  :        0.0
System runtime alarms occurred  :        0.0
Realtime Profile out of range   :        0.0


ERROR IN BATCH BY:
-during batch: measurement alarms possibly cause > 0.06 percent deviation
CRC-CHECKSUMS:EXE00000 UFS35374 UFP04625 DAT53611 TICxxxxx
```

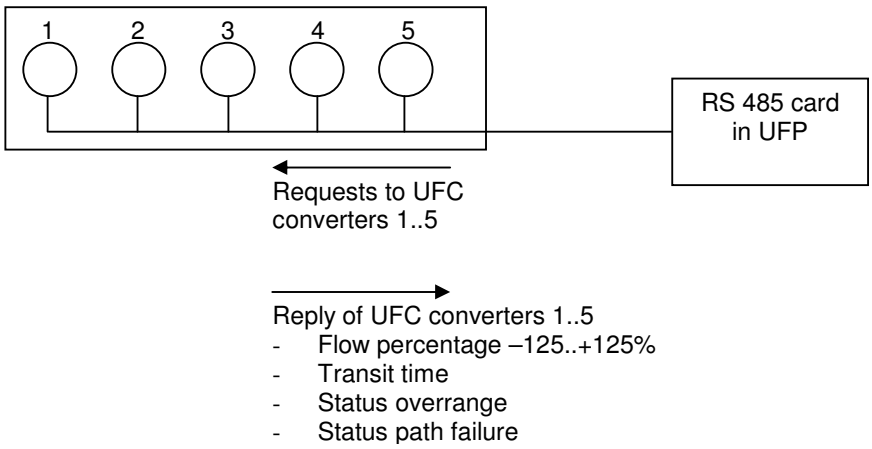
The alarms on Temperature Proces and Pressure Proces caused a deviation on the Standard Volumes that will be larger then 0.06% therefore the batch is declared not valid.
The produced ticket has an incorporated crc checksum that is checked every time the ticket is retrieved from memory to read/print. If this check fails, this is clearly stated on the ticket as ticket Not valid due to crc checksum fail

7 DATA ACQUISITION

Input data can be divided into:
- Data input RS485 card
- Digital inputs MP103 card
- Frequency inputs MP103 card
- Analog inputs AD card

7.1 Data input RS485 card

The data measured by the five converters UFC-V is transferred to the UFP-V by using a half-duplex Krohne communication protocol based on balanced data transmission (RS485).
The Krohne communication protocol requests the five converters for new measured data. The incoming data is first checked on parity-errors, framing-errors, and overruns. The data essentially contains the measured flow from 5 ultrasonic measuring paths, transit time, and error codes. The converter sends data on every request the UFP makes (about every 35ms).



7.2 Digital inputs MP103 card

The MP103 card has 4 digital inputs.
The digital inputs are normally open (is 0)
The logic level is TTL compatible, maximum 12 VDC.

Channel no.	Function	Action
0	Reset measured volume, proces-time and error messages	Make input ‘1’ to reset
1	Reset error messages	Make input ‘1’ to reset
2	Calibration start-signal (KROHNE Altometer use only)	Make input ‘1’ to arm, make ‘0’ to enable
3	Calibration stop-signal (KROHNE Altometer use only)	Make input ‘1’ to arm, make ‘0’ to enable

- The digital input function can be disabled/enabled in the Initialisation files: HSET0300.UFP section 3
- The individual channels can be disabled/enabled in the Initialisation files: CLNT0300.dat section 8
- The signals can be checked on value in the service window IO.
- Monitoring is also possible by its calibration program (see Manual: ALTOSONIC V UFP Calibration and Verification I/O)

HSET0300.UFP section 3

```
3.3 MP_Dig_in    =#0    //Digital   Inputs  0=disable, 1=NC, 2=NO
```

CLNT0300.dat section 8

```
8 <DIGITAL INPUT CHOICES>
8.1  DI_ZERO_VOL   =#1     //0=disable, 1=MP103 CARD 2=ADCARD812/816
8.2  DI_ZERO_ERR   =#1     //0=disable, 1=MP103 CARD 2=ADCARD812/816
8.3  DI_START_STOP =#0     //0=disable, 1=MP103 CARD 2=ADCARD812/816
                           //if disabled then possible to choose Solartron1 or 2
                           //see frequency input parameters for further details,
```

7.3 Frequency inputs MP103 card

There are 2 frequency-input channels.
The MP103 card itself can only handle TTL signals. With optional signal converters/barriers a non-TTL input signal can be converted into a TTL signal.
The used crystal oscillator properties are:

Stability 100 ppm over an operating temperature range of 0 –70 °C.

Frequency measurement (option on channel 1 and 2):
The frequency-input range is 1-5000 Hz.
The frequency measurement is 24 bit. Multiple pulses are counted over a period of time.
Each frequency measurement takes approximately 8 seconds.
The function is to measure the density input from a Solartron/Sarasota densitometer.

Pulse counter (option on channel 1 only):
The input range is 0-5000 pulse/sec.
The pulse counter is 32 bit. Every 35 ms the counter is read. The counter can reset on demand.
It is used for the pulse input from an external flow meter.

Note that the two options are also embedded in the hardware, so depending on the used chipset for channel 1 the option is available.

- The Frequency input function can be disabled/enabled in the Initialisation file: HSET0300.ufp section 3
- The Secondary input parameter can be set in Initialisation file CLNT0300.dat section 9 and 11.
- The signals can be checked on value in the service window IO
- Monitoring is also possible by its calibration program (see Manual: ALTOSONIC V UFP Calibration and Verification I/O)

HSET0300.ufp section 3

```
3.5 MP_freq_inp1 =#1    //Frequency input1  0=disable, 1=Frequency
3.6 MP_freq_inp2 =#0    //Frequency input2  0=disable, 1=Frequency
```

CLNT0300.dat section 9 example density densitometer

```
DENSITY DENSITOMETER
9.50 MODE          =#1    //Use input:0=disable, 1=AD-input, 2=Modbus, 3=Freq-in
9.51 MODBUS_SERVICE=#2    //Service input:0=disable, 1=AD-input, 2=Freq-in
9.52 Alarm_out     =#1    //disable=0, enable=1  alarm to output
9.53 alarmLow      =#500  //Low alarm  below this value [kg/m3]
9.54 alarmHigh     =#1200 //High alarm above this value [kg/m3]
9.55 Override      =#750  //Default static override value [kg/m3] on alarm
9.56 Override_code =#0    //0=disable override value, 1=use default override
                          //2=use default batch average as override
```

CLNT0300.dat section 11 example Frequency input 1

```
11.1 FREQ1_APPLIANCE=#6     //0 =SOLARTRON1, 1=SARASOTA1,
                            //2 =SOLARTON 1/2 CHOICE by digital input,
                            //3 =SARASOTA 1/2 CHOICE  by digital input
                            //4 =Density Densitometer with span
                            //5 =Density Standaard with span
                           //6 =Counter for external flowmeter
                           //99=disabled
11.2 FREQ1_val_low  =#0     //Lowerlimit Value, for FREQ1_APPLIANCE 4-5
11.3 FREQ1_val_high =#1000  //Upperlimit Value, for FREQ1_APPLIANCE 4-5
11.4 FREQ1_low      =#0     //Lowerlimit Freq[Hz],(min=0 Hz   ) FREQ1_APPL 4-5
11.5 FREQ1_high     =#1000  //Upperlimit Freq[Hz],(max=5000 Hz) FREQ1_APPL 4-5
```

7.4 Analog inputs AD card

The AD card has 16 analog inputs.

The input range is bipolar and only the positive range is used, therefore the resolution is 11 bit for 0 - 20mA (range has 2048 positions).
The linearity is ± 1 positions.
Accuracy 0.015% of reading ± 1bit
The resolution for 4-20 mA is 1638 positions .

This is sufficient for the standard volume correction:

- The deviation approximately is 0.1% per 1°C for the temperature correction on the standard volume.
- For a span of 0 - 100°C and 4-20 mA this gives: 100°C / 1638 positions = 0.061 °C/ positions

The deviation in standard volume per bit then is 0.1%/°C * 0.061 °C/ positions = 0.0061% / positions

- The AD input function can be disabled/enabled in the Initialisation file: HSET0300.ufp section
- The specific secondary input can be set in Initialisation file CLNT0300.dat section 9 and 10.
- The signals can be checked on value in the service window: IO
- Monitoring is also possible by its calibration program (see Manual: ALTOSONIC V UFP Calibration and Verification I/O)
- All inputs can have high/low alarm limitations. In case of an alarm a pre-defined override value can be used (see CLNT0300.dat section 9)
- Adjustable input range 0-20 mA

HSET0300.ufp section 4

```
4.1 AD_Card_Type =#0    //0=disable, 1=AD12 card, 2=AD16 card
4.2 AD_curr_in   =#0    //Current inputs  disable=0, enable=1
```

CLNT0300.dat section 9: example Temperature proces parameter

```
TEMPERATURE PROCES
9.8  MODE          =#1    //Use input:0=disable, 1=AD-input, 2=Modbus
9.9  MODBUS_SERVICE=#0    //Service input:0=disable, 1=AD-input
9.10 Alarm_out     =#1    //disable=0, enable=1  alarm to output
9.11 alarmLow      =#0    //Low alarm  below this value [øC]
9.12 alarmHigh     =#100  //High alarm above this value [øC]
9.13 Override      =#20   //Default static override value [øC] on alarm
9.14 Override_code =#0    //0=disable override value, 1=use default override
                          //2=use default batch average as override
```

CLNT0300.dat section 10: example Temperature proces on AD input

```
AD TEMPERATURE PROCES
10.7  val_low  =#0        //Lowerlimit proces temperature as [Celsius]
10.8  val_high =#100      //Upperlimit proces temperature as [Celsius]
10.9  curr_low =#4        //Lowerlimit current as [mA] (min.  0mA)
10.10 curr_high=#20       //Upperlimit current as [mA] (max. 20mA)
10.11 tau      =#1        //Timeconstant (average) [sec]
10.12 channel  =#2        //Channelnr on ad812/816 card ch2/5, 99=disable
```

8 OUTPUT

The output consists of:

- Frequency output MP103 card
- Analog output MP103 card
- Relay outputs MP103 card
- Analog outputs AD card
- Digital outputs AD card
- Modbus communication

8.1 Frequency output MP103 card

Frequency output:
- Maximum output range is software adjustable 1 – 2000 Hz
- 12V/24V / open-collector selectable by card jumpers
- There is one output value but there are two physical outputs, these can be phase-shifted 90°/180° selectable by card jumper to simulate a turbine output for pulse fidelity and integrity check.

The resolution of the frequency output is max 0.016% of the output value. The resolution mentioned is for a static output value. In practice, the output resolution will be averaged because of the variations in signal. Over a period of time with different output values the resolution will not be an issue.

The most likely frequency output is the proces volumetric flow (default).
- The frequency output function can be disabled/enabled in the Initialisation file: HSET0300.ufp section 3
- The frequency output can be configured in the Initialisation file: CLNT0300.dat section 5
- The signals can be checked on value in the service window: IO.
- Monitoring is also possible by its calibration program (see Manual: ALTOSONIC V UFP Calibration and Verification I/O)

HSET0300.ufp section 3

```
3.1 MP_freq_out =#0    //Frequency output 0=disable, 1=enable
```

CLNT0300.dat section 5

```
-----------------------------------------------------------------------------
5 <FREQUENCY OUTPUT, mp103 card>
5.1  Freq_max      =#1000  //Max.scale [Hz], range= 1 - 2000 [Hz]
5.2  Freq_mode     =#1     //0=DIS 1=flow[m3/h] 2=flow15 3=mass[ton/hr]
                           //4=dens[kg/m3] 5=c_s[m/s] 6=VCF   7=viscosity[10e-6
m2/s]
                           //8=dens15[kg/m3] 9=Temp[øC] 10=Pres[bar]
5.3  Freq_min_unit =#0     //Min outputvalue in [unity]
5.4  Freq_max_unit =#1800  //Max outputvalue in [unity]
5.5  Freq_tau      =#0     //Averaging time tau[s]
5.6  Freq_dir_flow =#1     //Directionflow for output frequency: 0=+, 1=+-
```

8.2 Analog output MP103 card

The analog output is a pulse width modulated current output, resolution 14 bit.

- The AD output function can be disabled/enabled in the Initialisation file: HSET0300.ufp section 3
- The AD output can be configured in the Initialisation file CLNT0300.dat section 6
- The signals can be checked on value in the service window: IO.
- Monitoring is also possible by its calibration program (see Manual: ALTOSONIC V UFP Calibration and Verification I/O)

HSET0300.ufp section 3

```
3.2 MP_curr_out   =#0    //Current   output  0=disable, 1=enable
```

CLNT0300.dat section 6:

```
-----------------------------------------------------------------------------
6 <ONE D/A OUTPUT 0-22mA (adjustable), mp103 card>
6.1  Out1_mode     =#1     //0=DIS 1=flow[m3/h] 2=flow15 3=mass[ton/hr]
                           //4=dens[kg/m3] 5=c_s[m/s] 6=VCF 7=viscosity[10e-6
m2/s]
                           //8=dens15[kg/m3] 9=Temp[øC] 10=Pres[bar]
6.2  Out1_min_curr =#4     //Minscale I [mA], range= 0 - max_currout [mA]
6.3  Out1_max_curr =#20    //Maxscale I [mA], range= min_currout - 22 [mA]
6.4  Out1_min_unit =#0     //Min outputvalue in [unity] choice
6.5  Out1_max_unit =#1000  //Max outputvalue in [unity] choice
6.6  Out1_tau      =#0     //Averaging time tau[s]
```

8.3 Relay output MP103 card

There are four relay outputs, normally (no power) open.
Open is 0, closed is 1.

Relay No.	Open/Close	Function
0	0	Negative flow, a flow smaller than minus low-flow cut-off
	1	Flow larger than minus low-flow cut-off
1	0	Alarm (system is not reliable): - More than 2 channels failure - One or more channels failure and flow is out of range for correction - System alarm
	1	No alarms(system is reliable)
2	0	Warning (system is still reliable): - 1 or 2 channels failure - System warning
	1	No warnings
3	0	Positive flow, flow larger than positive low-flow cut-off
	1	No flow (flow rate within limit low-flow cut-off)

- The digital output function can be disabled/enabled in the Initialisation files: HSET0300.UFP section 3
- The signals can be checked on value in the service window: IO.
- Monitoring is also possible by its calibration program (see Manual: ALTOSONIC V UFP Calibration and Verification I/O)
- More information on warnings and alarms can be found in chapter RUNTIME Windows (alarm window)

HSET0300.ufp section 3

```
3.4 MP_Dig_out   =#0    //Digital   Outputs 0=disable, 1=NC, 2=NO
```

8.4 Analog outputs AD card

The AD card has two 0-10V analog outputs.
Resolution is 12 bits, linearity ±½ bit, settling time 30 microseconds. With additional converters the 0-10V range can be converted into 4-20 mA signals

- The AD output function can be disabled/enabled in the Initialisation file: HSET0300.ufp section 4
- The AD output can be configured in the Initialisation file CLNT0300.dat section 7
- The signals can be checked on value in the service window: IO.
- Monitoring is also possible by its calibration program (see Manual: ALTOSONIC V UFP Calibration and Verification I/O)

HSET0300.ufp section 4

```
4.3 AD_curr_out  =#0    //Current outputs disable=0, enable=1
```

CLNT0300.dat

```
-----------------------------------------------------------------------------
7 <TWO D/A OUTPUTS 0-10 volt, ad812/ad816 card>
7.1  Out2_mode     =#4     //0=DIS 1=flow[m3/h] 2=flow15 3=mass[ton/hr]
4=dens[kg/m3]
                           //5=c_s[m/s] 6=VCF 7=viscosity[10e-6 m2/s]
                           //8=dens15[kg/m3] 9=Temp[øC] 10=Pres[bar]
7.2  Out2_min_volt =#0     //Minscale U [V], range= 0 - max_volt [V]
7.3  Out2_max_volt =#10    //Maxscale U [V], range= min_volt - 10 [V]
7.4  Out2_min_unit =#610   //Min outputvalue in [unity] choice
7.5  Out2_max_unit =#1075  //Max outputvalue in [unity] choice
7.6  Out2_tau      =#10    //Averaging time tau [s]
7.7  Out3_mode     =#7     //0=DIS 1=flow[m3/h] 2=flow15 3=mass[ton/hr]
4=dens[kg/m3]
                           //5=c_s[m/s] 6=VCF 7=viscosity[10e-6 m2/s]
8=dens15[kg/m3]
                           //9=Temp[øC] 10=Pres[bar]
7.8  Out3_min_volt =#0     //Minscale U [V], range= 0 - max_volt [V]
7.9  Out3_max_volt =#10    //Maxscale U [V], range= min_volt - 10 [V]
7.10 Out3_min_unit =#0     //Min. outputvalue in [unity] choice
7.11 Out3_max_unit =#150   //Max. outputvalue in [unity] choice
7.12 Out3_tau      =#60    //Averaging time tau [s]
```

8.5 Digital outputs AD card

The Ad card has 16 digital outputs, these outputs are connected to the output board PCLD-885:
The relays on this board are normally open (no power), single-pole-single-throw(SPST).
Open is 0, closed 1.
When the message is valid the relay is opened

Relay No.	Message
0	Basic flow measurement WARNING
1	Basic flow measurement ALARM
2	System runtime WARNING
3	System runtime ALARM
4	System set-up WARNING
5	Body temp. on AD input not within set limits for low and high ALARM
6	Density 15°C OUT OF RANGE
7	Corrections on hold due to flow deviations WARNING
8	Percentage data filtered OUT OF RANGE
9	Temperature on AD input not within set limits for low and high ALARM
10	Pressure on AD input not within set limits for low and high ALARM
11	Density on input not within set limits for low and high ALARM
12	Basic flow measurement, status channel(s): out of range
13	Basic flow measurement, status channel(s): path failure (mostly due to gas or particles)
14	Basic flow measurement, status channel(s): deviation in measured sound velocities
15	Basic flow measurement, status channel(s): communication failure

- The digital output can be disabled/enabled in the Initialisation file: HSET0300.ufp section 4
- The signals can be checked on value in the service window: IO.
- Monitoring is also possible by its calibration program (see Manual: ALTOSONIC V UFP I/O Calibration and Verification)
- Further information on warnings and alarms can be found in chapter of the Alarm window

HSET0300.ufp section 4

```
4.5 AD_Dig_out   =#0    //Digital inputs  disable=0, 1=NC, 2=NO
```

8.6 Modbus communication

The Modbus protocol defines a message structure that controllers, using a master-slave principle, will recognise and use, regardless of the type of networks over which they communicate.
In the communication confiiguraton file COMS0300.DAT the configuration can be changed to make the program compatible with the host system.
The program can act as master and as slave.
Both transmission modes ASCII and RTU are supported.
The data types supported are Boolean, Integer (16 bit), Long Integer (32 bit), Float (32 bit) and double (64 bit).
With these data types all relevant data from the ALTOSONIC V can be retrieved.

The available data is grouped in 9 levels (groups):

1. Gross flow measurement
2. Standard flow measurement
3. Net flow measurement
4. Batching, includes normally the levels 1..3
5. Analysis, diagnostics, quality
6. Control data
7. Used settings (corrections on/of etc)
8. Master meter configuration (direct connection with duty meter)
9. Data measured but not directly used by Altosonic-V, but as an extra service. .

- The data available in these fields can be shown real-time on the ALTOSONIC V flow processor screen. See chapter RUNTIME USER WINDOWS.
- For more details on the Modbus protocol and on the available data by Modbus communication see the **ALTOSONIC V ModBus Manual**.

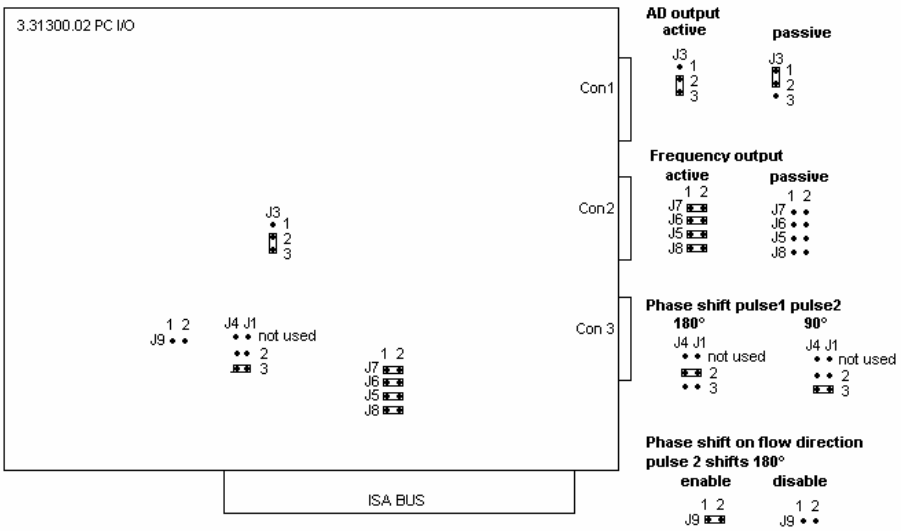
9 Hardware configuration

9.1 MP103 card

There are two possible generations of MP103 cards:

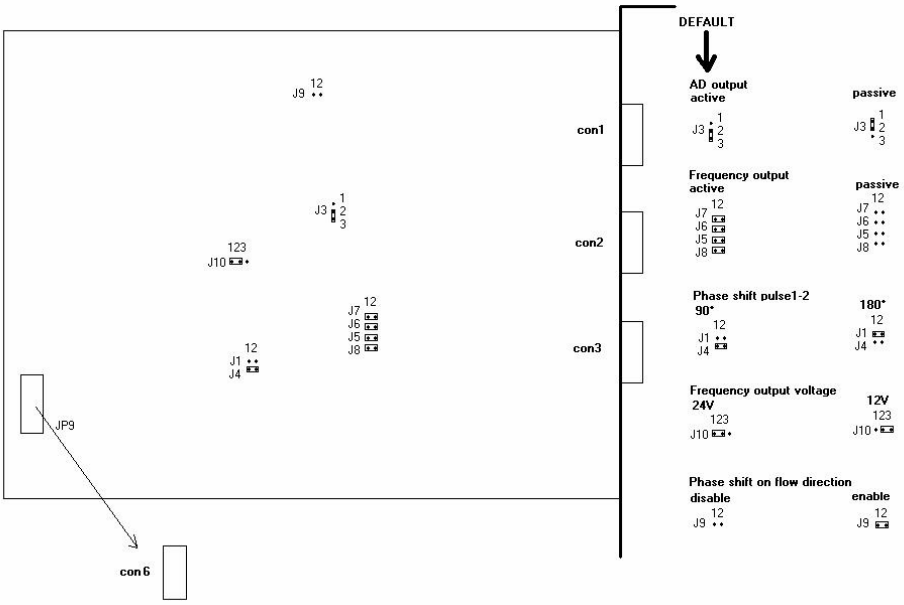
9.1.1 MP103 revision: 3.31300.02

The first generation of MP103 cards, note that this card does not work correct together with the current P233 processor card, only with the previous 486 DX4 100.



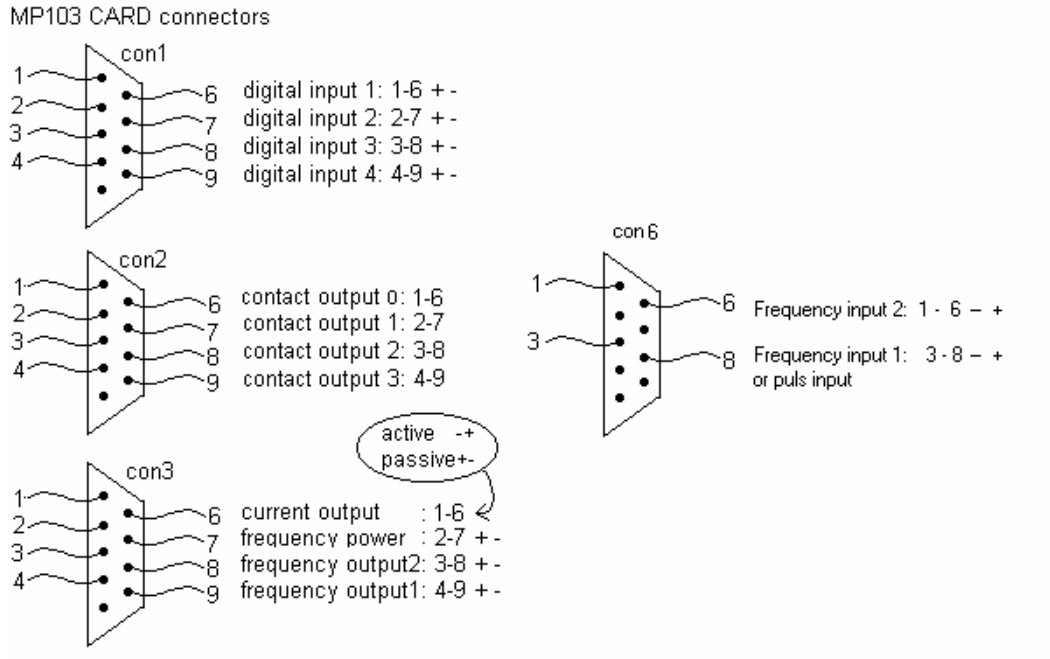
9.1.2 MP103 revision: 3.399993.01

The current generation MP103 card



JP9 : To frequency input connector con6 (connected to frequency input bracket)

9.1.3 The signals on the D connectors of the MP103 cards

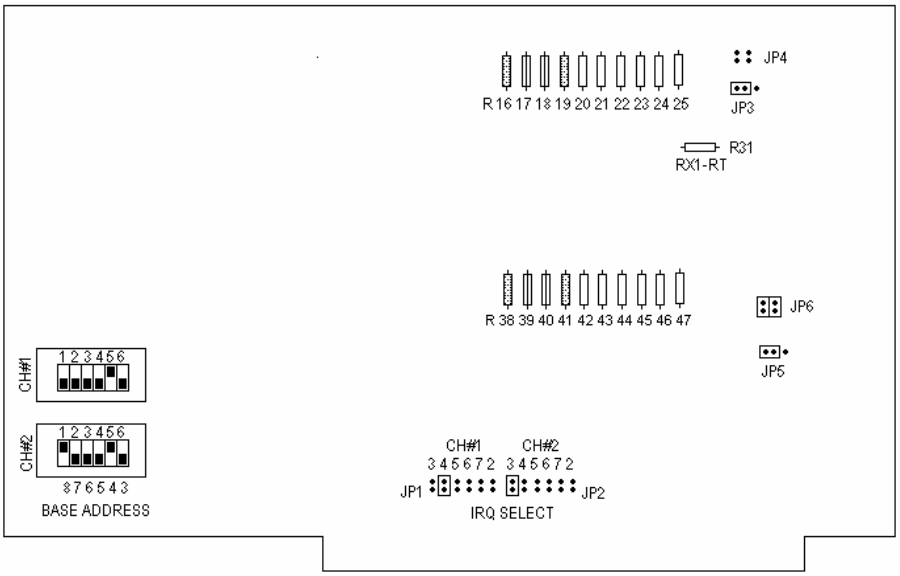


9.2 RS485/422 card

There are two possible generations of RS485 cards

9.2.1 RS485/422 card: AX4285A

The first generation of RS 485 cards used



DIP SWITCH CH1***	: COM 3 Baseaddress ch#1: 3E8
DIP SWITCH CH2***	: COM 4 Baseaddress ch#2: 2E8
JP1***	: COM3 Interrupt IRQ4
JP2***	: COM4 Interrupt IRQ3
JP3***	: COM3 RS 485 mode
JP4***	: COM3 Serial resistors enabled, No jumpers installed
JP5	: COM4 RS 485 mode as a default
JP6	: COM4 Serial resistors not enabled, jumpers installed

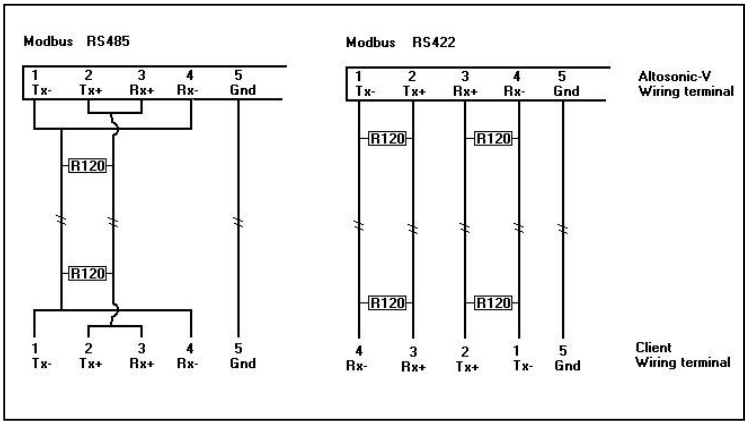
***(=KROHNE Altometer setting)

NOTE:

RS485 mode and RS422 mode for COM4 (Modbus) differs in set-up by:

- Jumper JP5 RS485 or RS422
- The external wiring for RS422 and RS485

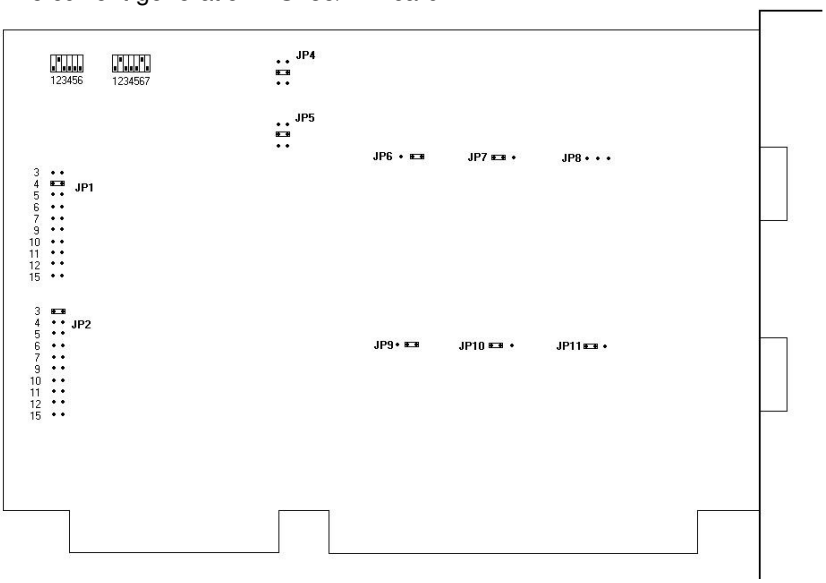
External wiring AX5285A for Modbus:



The resistors of 120 Ohm must be placed At the ALTOSONIC V wiring terminal

9.2.2 RS485/422 card: PCL-745 S

The current generation RS485/422 card



Dip switch ch1***	: COM 3 Address 3E8 (KROHNE Altometer setting)
Dip switch ch2***	: COM4 Address 2E8
JP1***	: Interrupt COM3 IRQ4
JP2***	: Interrupt COM4 IRQ3
JP4***	: Transmit driver enable COM3 always RTS
JP5	: Transmit driver enable COM4 default RTS
JP6***	: Receive COM3 (422 is always on)
JP7***	: Terminator jumper COM3 120
JP8***	: Terminator jumper COM3 always not installed
JP9***	: Receive COM4 (422 is always on)
JP10***	: Terminator jumper COM4 120
JP11	: Terminator jumper COM4 (120 for RS422 mode, not installed for RS485 mode)

***(=KROHNE Altometer setting)

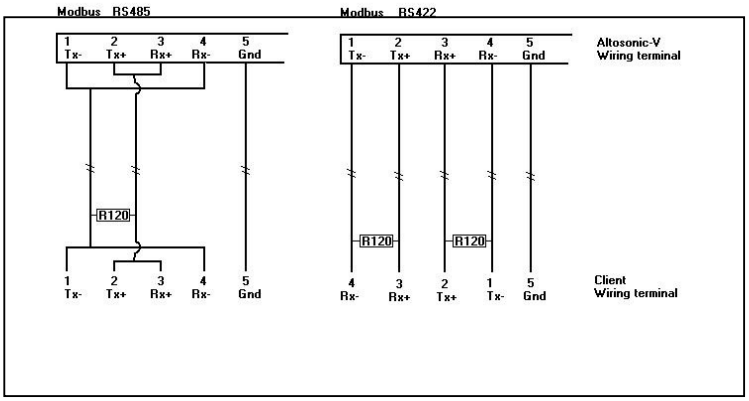
NOTE:

JP6 and JP9 are always 422 because the receiver is for both RS485 mode and RS422 mode expected to be enabled for the UFP-Program.

RS485 mode and RS422 mode for COM4 (Modbus) therefore only differs in set up by:

- Jumper JP11 not installed (RS485) or installed on 120 (RS422)
- The external wiring for RS422 and RS485

External wiring PCL745 for Modbus:

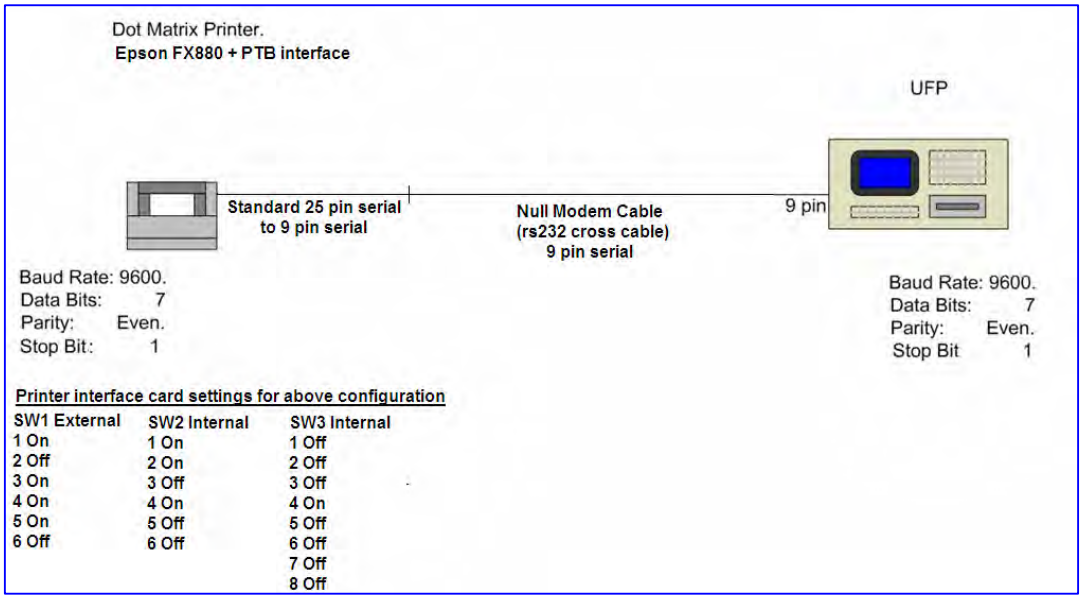


9.3 Printer connections

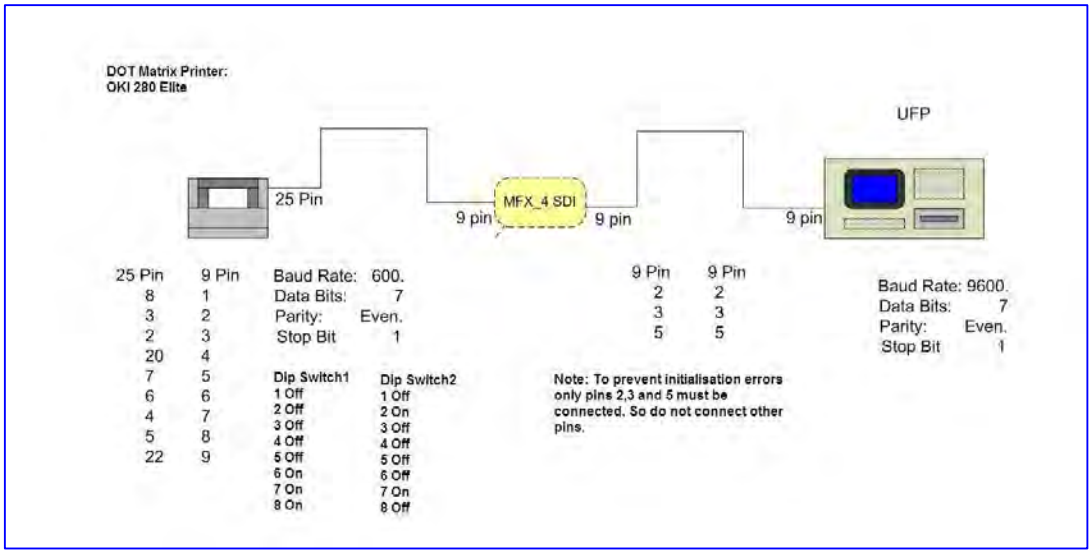
Printer settings in the UFP can be found in the COMS0300.DAT file in section 2

```
02 [PRINTER COMMUNICATION SETUP]

02.01 PRINTER_COMPORT          c=#1        //1, 2, 3, 4
02.02 PRINTER_WORD_LENGTH      c=#7        //7, 8
02.03 PRINTER_PARITY           c=#2        //0=disabled, 1=odd, 2=even
02.04 PRINTER_STOP_BITS        c=#1        //1, 2
02.05 PRINTER_BAUDRATE         c=#9600     //38400, 19200, 9600, 4800, 2400, 1800
                                           //1200, 600, 300, 200, 150, 134.5, 110, 75
02.06 PRINTER_DTR_POLARITY     c=#1        //0=pos, 1=neg
02.07 PRINTER_RTS_POLARITY     c=#1        //0=pos, 1=neg
02.08 PRINTER_TIMEOUT          c=#5000     //Timeout [ms] on acknowledges etc.
02.09 PRINTER_TIMEOUT_MANAGE   c=#30       //Timeout [ s] for print management switch
```

9.3.1 Epson FX880 with PTB z5.574/98.97 interface



9.3.2 OKI280 Elite + MFX_4 SDI module + UFP



10 Extended Operations

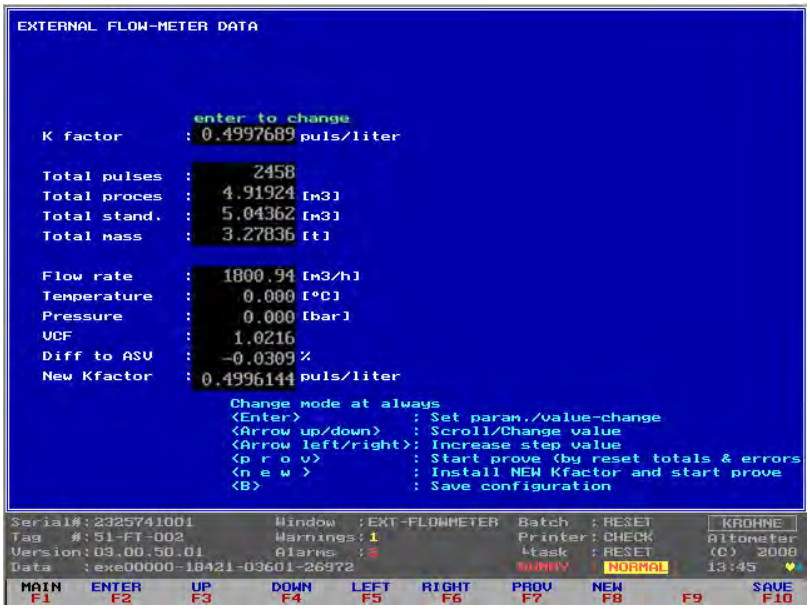
The following extended operation options are possible:

- External Flowmeter setup (master duty)
- Base Sediment and Water content
- Other Standard Volume standards than API2540
- Extra batching functions
- Simulated Frequency on failure
- Meter factor adjustment through Modbus
- Reynolds Warning function

10.1 External Flow meter (master duty)

The UFP-V has the possibility to act as a Master Duty system. The duty meter is the external flow meter input. An online comparison is possible over the volume preferred. A good comparison is only made by comparing the standard volumes of both systems.

Under F9 Controls, F3 Extern the below window can be found.
In this window the following actions can be done (also possible by Modbus input)



- The used K factor can be inputted
- Comparison tests can be started and stopped
- A new found K factor after a proving can be committed

Note: Do not forget to save the configuration after a change, only the saved configuration values are used.

The necessary inputs for the comparison are:

- The flow signal from the external flow meter must be a pulse input for the UFP-V. An optional pulse counter on the MP103 card reads in the number of pulses. The K factor (pulse/liter) converts the counted pulses to a measured proces external volumetric total
- Recommend is to use the temperature and pressure at external flow meter conditions for calculation of the standard volume. If the meter is close enough to the ALTOSONIC V system the

proces temperature and pressure can be copied to the external temperature and pressure but note that 1°C difference causes about 0.1% error, and 1 bar difference causes about 0.01% error.

Practice shows that both repeatability and linearity improve when comparing calculated standard values.
It is possible to compare the proces volumetric total of the external flow meter with the proces volumetric total of the UFP-V but then the ALTOSONIC V must also be set as only calculating proces volume.

Description of the controls in this window:
Function keys do the controls of this window, therefore it is only possible to go back to the Main window.

F1	: Go back to Main window
F2 (or ENTER)	: Disable/enable value change of the K factor manually
F3 (or arrow up)	: If value change is enabled (F2) increase value
F4 (or arrow down)	: If value change is enabled (F2) decrease value
F5 (or <arrow left>)	: If value change is enabled F2) increase step value of change (F3,F4)
F6 (or <arrow right>)	: If value change is enabled (F2) decrease step value of change (F3,F4)
F7 (or <PROV>)	: Start proving, reset of totals and errors on both UFP-V and External
F8 (or <NEW>)	: Install found NEW K factor and start prove as described in F7
F10 (or < B>)	: Save configuration if K factor is manually installed

Note: Starting a prove involves resetting of resetable totalisers and occurred alarms.

10.2 Base Sediment and water (BSW)

The Base Sediment and Water (BSW) is inputted by AD input or Modbus as a percentage of the volume flow.
The actual value of the BS&W percentage is provided through modbus: F7591
or alternatively on an AD input channel if the modbus connection times out for more than 30 seconds.
It is off course also possible to input the value only by the AD-input.

The nett totalisers are calculated by subtracting the BSW percentage from the gross flow (proces, standard, mass) and totalising this into separate totalisers.

10.3 Other Standard Volume standards than API2540

Other then API2540 volume correction standards are implemented.

- ASTM-IP (D1250, 1953)
  API 11.2.1M can be used to calculate the compressibility correction.
- LPG (GPA) TP25
  API 11.2.2M is used to calculate the compressibility correction.
- ULHC (Unstable Liquid Hydro Carbons), specially developed for the Russian

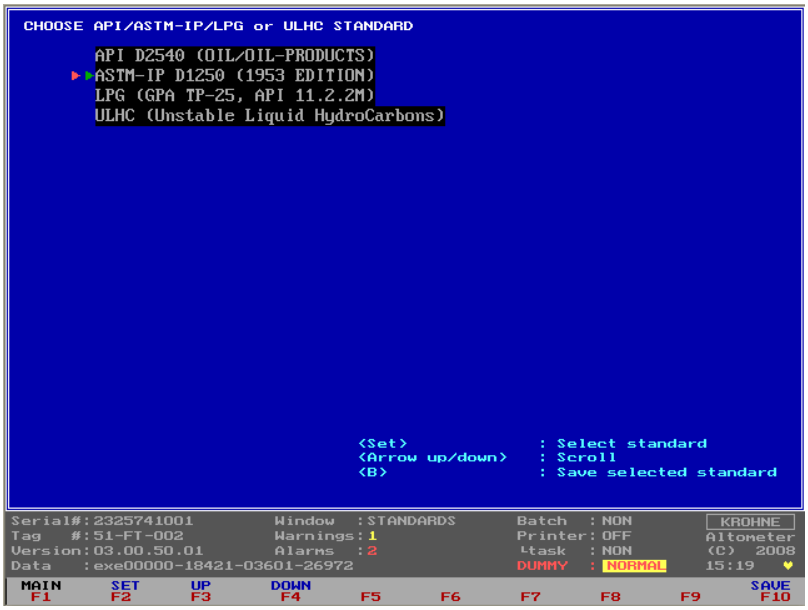
Depending on the standard choosen, under F9, F2 the configuration can be made

CLNT0300.DAT configuration file excerpt:

```
15 <STANDARD CONTROL>
Can be used to change to the old ASTM-IP (table 53/54, D1250) or LPG standard
volume correction as opposed to the (default) API (D2540, 54C) standard.
NOTE: For both D2540 and D1250 the API 11.2.1M equation is used to calculate
                the compressability correction.
15.1 Standard_control      c=#0  // 0=API (D2540, Table 54C)
                                 // 1=ASTM-IP (D1250, 1953)
                                 // 2=LPG (GPA)
                                 // 3=ULHC (Unstable Liquid Hydro Carbons)
                                 // with online changeable standards BLOCKED:
                                 // 10=as 0 but blocked
                                 // 11=as 1 but blocked
                                 // 12=as 2 but blocked
                                 // 13=as 3 but blocked
```

Note that there is an option to select the desired standard on-line. Due to custody transfer regulations that differ per country, it is also possible to block that possibility.

10.3.1 F9, F8 Choose standard volume calculation standard

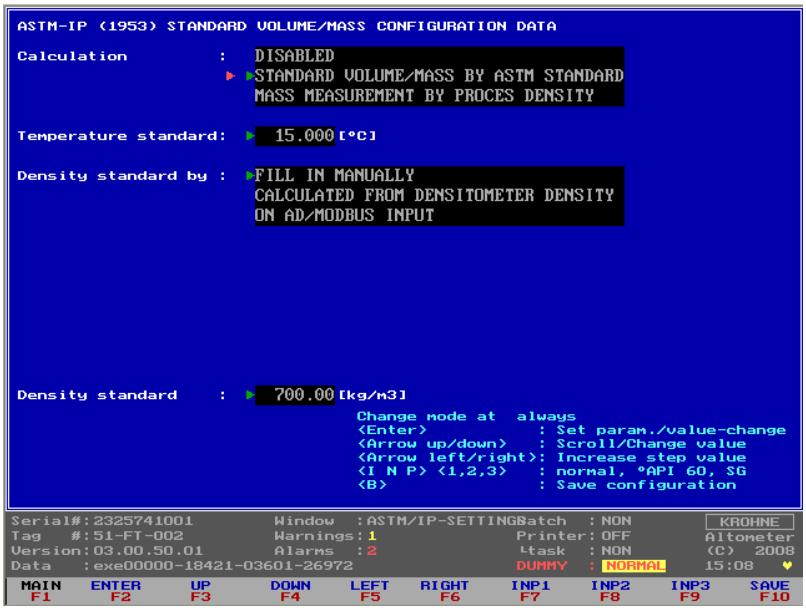


These options and values can also be inputted by Modbus

Note that this window control (and Modbus control) can be blocked from normal use, as described in the previous paragraph.

10.3.2 F2 ASTM-IP window

If the standard volume correction is set to ASTM-IP (1953 edition)



Calculation options : same as options under API2540
Temperature standard : same as options under API2540
Density standard by : same as options under API2540
Density standard value : Input value, same as under API2540

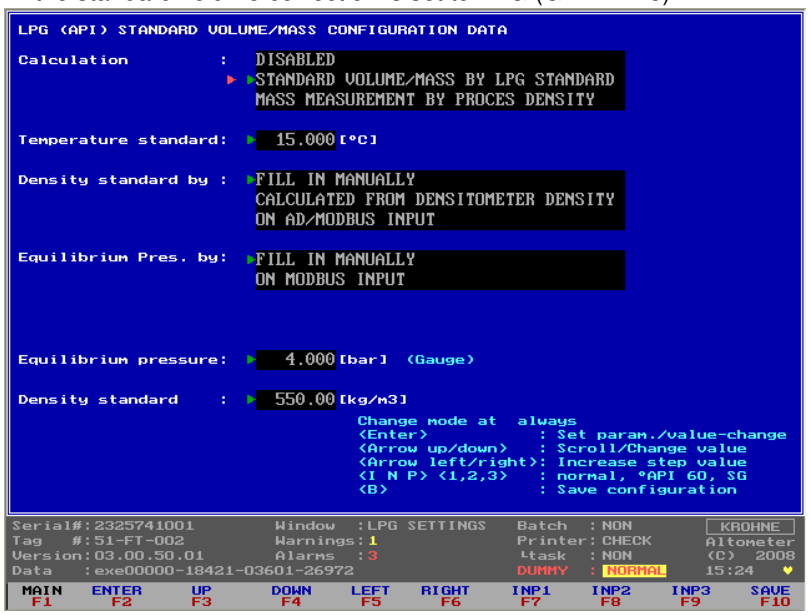
There is no distribution of fluid types in the ASTM-IP (D1250, 1953).

The compressibility is calculated according to API 11.2.1M, when needed pressure inputs are enabled.

These options and values can also be inputted by Modbus

10.3.3 F2 LPG window

If the standard volume correction is set to LPG (GPA TP25)



Calculation options	: same as options under API2540
Temperature standard	: same as options under API2540
Density standard by	: same as options under API2540
Equilibrium Pres. By	: Fill Manually or Modbus input
Equilibrium Pres. (value)	: Available if chosen to fill value Manually (gauge pressure)
Density standard value	: Input value, same as under API2540

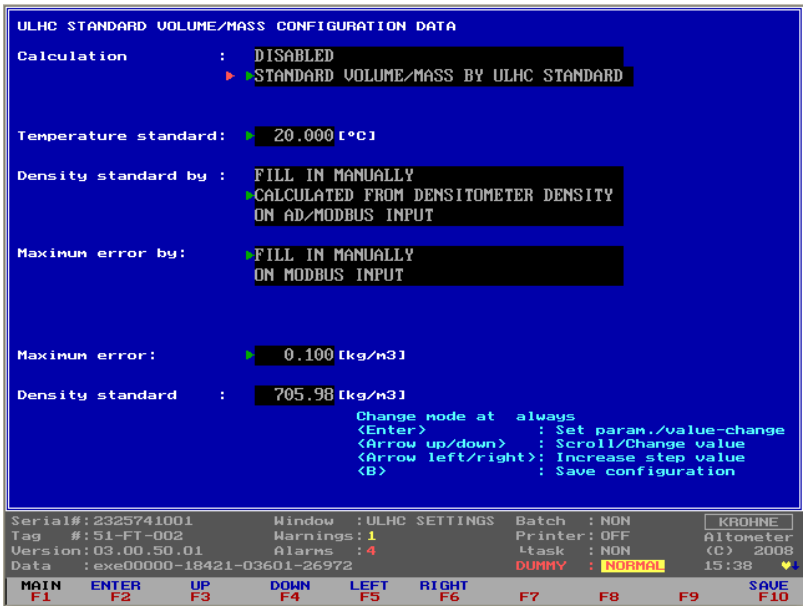
The compressibility is calculated according to API 11.2.2M

These options and values can also be inputted by Modbus

.

10.3.4 F2 ULHC window

If the standard volume correction is set to ULHC



Calculation options	: No direct mass calculation available
Temperature standard	: same as options under API2540
Density standard by	: same as options under API2540
Maximum error by	: Options are: “Fill Manually” or “Modbus input”
Maximum error (value)	: Maximum allowed error in iterative proces.
Density standard value	: Input value, same as under API2540

These options and values can also be inputted by Modbus

10.4 Extra batching options

10.4.1 Air buoyancy correction

If this option is enabled, at the end of the batch the Air buoyancy correction is calculated and possible printed on the ticket (registers 527…529).

CLNT0300.DAT Excerpt

```
19 [WEIGHT OF STANDARD (batch) VOLUME IN AIR (AirBuoyancy correction)]

The weight (in air) is calculated as follows:
  W.I.A. = Volume(15) * ( Density(15) + AirBuoyancy ) * Factor + Offset
  [kg]   = [m3]       * ( [kg/m3]     + [kg/m3]     )
Where the * Factor + Offset part is to be able to influence the unit of
the W.I.A. Ie. a factor of 0.001 will give the W.I.A. in metric tons [t].

19.01 WeightInAir        =#0        //[0..1] 0=OFF, 1=ON
19.02 AirBuoyancy        =#-1.10    //[-100..100] Air Buoyancy number [kg/m3]
19.03 Factor             =#0.001    //19.3 and 19.4 are for calculating the desired
19.04 Offset             =#0.000    //unit by utilising: Y = X * Factor + Offset
```

10.4.2 Batching without printer

The option to use batching without use of the printer. The tickets are saved in the UFP. If a printer is connected, the tickets will be printed. If there is no printer available, no alarm or window swapping will take place.

```
12.05 Modbus_control     c=#2       //0=No Control batching through Modbus
                                    //1=Control batching through Modbus
                                    //2=as 0 with no printer alarm
                                    //3=as 1 with no printer alarm
```

10.4.3 Measurement alarms batch validation error values input

Depending on the application the batch validation error values can be changed.
For example if the temperature input can not differ more from the measured value than for example 100°C, than the validation error on that input can be changed to 10% of 25% (250°C difference).
Also the weighing method as described in chapter 6 can be changed.

CLNT0300.DAT excerpt

```
21 [BATCH VALIDITY PERCENTAGES]

The following percentages [0..100] are used (if batching is enabled) to
calculate if the batch has an acceptable error volume.
(Worst case batch volume error calculation in relation to the total
batch volume for all occured errors.)
See the Altosonic-V Operator manual for a more detailed explanation of
the calculation being utilized for this.

Discuss/verify the batch error percentage (21.16) with you local DTI!

21.01 Weight (%) for Temperture Body          c=#1.00
21.02 Weight (%) for Temperture Process       c=#25.00
21.03 Weight (%) for Temperture External      c=#25.00
21.04 Weight (%) for Temperture Density       c=#25.00
21.05 Weight (%) for Pressure   Process       c=#2.50
21.06 Weight (%) for Pressure   External      c=#2.50
21.07 Weight (%) for Pressure   Density       c=#2.50
21.08 Weight (%) for Density                  c=#100.00
21.09 Weight (%) for Density    Standard      c=#100.00
21.10 Weight (%) for Viscosity                c=#7.00
21.11 Weight (%) for 1-4 channels down        c=#0.50
21.12 Weight (%) for All channels down        c=#100.00
21.13 Weight (%) for API group mismatch       c=#100.00
21.14 Weight (%) for System Alarms            c=#10.00
21.15 Weight (%) for RealTimeProfiel OOR      c=#3.50
21.16 Weight (%) for allowed batch error      c=#0.06
21.17 Method of weighing                      c=#2     //1=Weighing on Max Flow only
                                                       //2=Weighing on Actual Flow when
                                                       //    possible
```

10.4.4 Guard digital contacts

The GuardDigitalContacts feature (ab)uses the start and stop contacts (Digital Input 3 and 4 from the MP-103 card, so this only works when NOT in calibration mode) to guard one or two digital inputs (pe. Valve states) from batch-start untill batch-stop. (So only works when batching is on) and reports any detected change as an error on the BOL.
If 20.2 and 20.3 are 0, Boolean 2076 is checked at batch end and if it is '0' an ERROR is reported, if it is '1' an OK status is reported.

Clnt0300.dat

```
20.01 GuardDigitalContacts        =#0        //[0..1] 0=OFF, 1=ON
20.02 CheckContact_3 (Strt)       =#0        //[0..1] 0=OFF, 1=ON, Guard DI 3
20.03 CheckContact_4 (Stop)       =#0        //[0..1] 0=OFF, 1=ON, Guard DI 4
                                             //Text can be 20 characters, and also
                                             //each '@' will be replaced by a space
20.04 System status OK text       =#OK       //Status OK text,
20.05 system status ERROR text    =#NOT@OK   //Status ERROR text
```

See also chapter 6.3 register 210 for printing message to batch ticket.

10.5 Simulated Frequency on failure

If the meter is installed downstream of a separator that can lead to total meter failure due to air/liquid mix the following function is made to avoid Platform shutdown on meter failure due to gas/liquid mixture.

Technic & Specification BC00-32-173:
1.0 *Effects of water in oil on USM measurements*
1.1 *Concern has been raised surrounding the effects of varying levels of water in crude oil that may be presented to the liquid ultrasonic flow meters that are proposed for fiscal custody transfer on BP Miller Platform. Levels of water below 5% are considered to be within the USM manufacturer's level of uncertainty. The commingled flow of oil and water is homogeneously mixed by the LP pumps and normal water content does not exceed 1%. At a certain level of water in oil above 5% (yet to be confirmed) the USM will attenuate or scatter the ultrasonic signals. The overall effect of this will result in all five paths of the ultra sonic flow meter being lost and no actual flow measurement being recorded through the metering station. The frequency and duration of these events are historically 1 hour every two weeks and the levels of water in the crude may vary between 5% and 40%.*
1.2 *These produced water plant upsets introduce a period of instability when significant quantities of produced water can be exported to the pipeline although steps are taken immediately by operations to limit the amount of water being exported. The ultrasonic flow meter will continue to provide accurate information even after four of the acoustic paths have attenuated. Only after the fifth acoustic path attenuates will the meter cease to measure.*
1.3 *When the ultrasonic meter stops measuring it is proposed to provide information from the USM, the flow computer and the density analyser that will allow a mismeasurement calculation to be carried out. The Krohne flow computer will generate virtual flow pulses that reflect the last actual flow rate measured. This information will be time stamped and recorded in a separate trend analysis file together with the density trends. Once the USM re-establishes an actual flow rate these virtual flow pulses will stop and the file time stamped. It will then be possible to estimate the amount of oil exported during these upset periods using a mismeasurement calculation.*
1.4 *In order to limit the discontinuity during the transient periods of loss of measurement the following proposals are suggested:*

a. *On loss of all five probe signals the Krohne flow computer will produce virtual flow pulses to the SGC flow computer and will not indicate loss of signal for a period of I minute.*
b. *If, during the I minute period, the flow signals are re-established then real flow pulses will be re-instated and the SGC flow computer will NOT record a m ismeasu reme nt.*
c. *If, after I minute, the flow signals are NOT re-instated then the SGC flow computer will start to record a mismeasurement.*
d. *The end of the mismeasurement period will be flagged by the Krohne flow computer after real pulses have been re-instated for at least 10 seconds.*

CLNT0300.DAT excerpt:

```
16 [SIMULATED FREQUENCY (PULSE TRAIN) OUTPUT FOR FLOW]

Upon Velocity Of Sound (VOS) failure on all channels, the UFP will transmit
simulated pulses (flow) on the first frequency output of the MP103 card.
Note that the MP103 should be configured to output the Gross Flow or the
Standard Flow (Section 5) for this feature to work properly.

For a full technical specification of this feature see the AMEC document:
  BC00-32-173-issue-0002

16.01 SimulatedFrequency      N=#1        //[0..1] 0=OFF, 1=ON
16.02 SimFreqTimer1             =#60      //time before alarm [1..300 s]
16.03 SimFreqTimer2             =#30      //data validation timer [15..150 s]
16.04 SimFreqLowVOS             =#1.0     //VOS low  limit [1.0..5000.0 m/s]
16.05 SimFreqHighVOS            =#5000.0  //VOS high limit [1.0..5000.0 m/s]
16.06 TotalisersUpdate          =#0       //[0..1] 0=OFF,1=ON update totals on fail
16.07 SimFlowOnPath             =#0       //[0..1] 0=OFF,1=ON SimFlow on path fail
```

10.6 Meter factor adjustment through Modbus

In a master duty configuration the master checks the meter factor of the Duty meter.
This option provides access to the meter factor by Modbus communication.

CLNT0300.DAT excerpt

```
17 [METER FACTORS]

Possibility to set the meter factor (MF) for positive and reverse flow
directions. The meterfactors can be set on modbus addresses F7524 and F7525
respectively

17.01 MeterFactorsOn        N=#1                //[0..1] 0=OFF, 1=ON
```

Note that the reverse direction Meter Factor can only be accessed if the Reynolds Correction is also enabled in reverse direction (REYN0300.UFS, see parameter 2.1 and section 4)

10.7 Reynolds Warning function

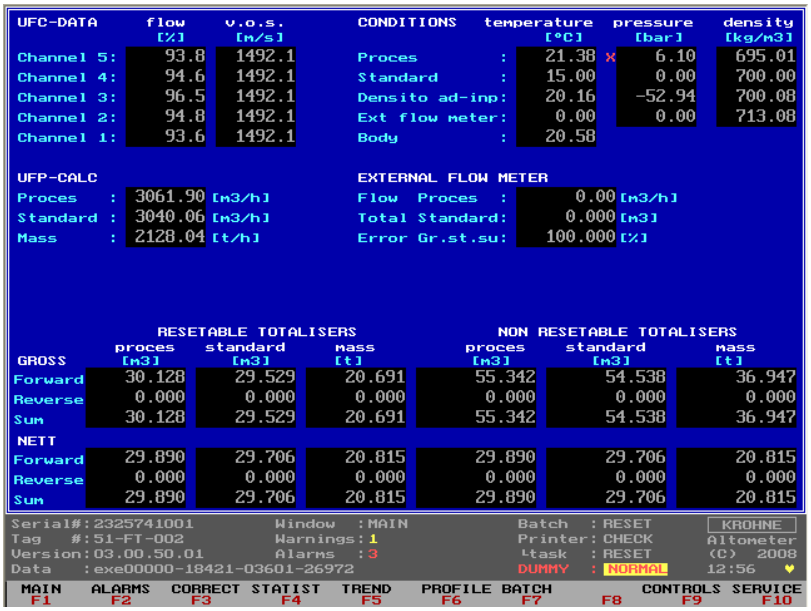
The transition area between laminar and turbulent flow can be set up with an alarm system as this is an area that needs attention for its influence on accuracy on ultrasonic flowmeters.

```
18 [WARNING REYNOLDS NUMBER (Re/1000)]

18.01 Reynolds_warning      c=#1                //[0..1] 0=OFF, 1=ON
18.02 Warning_on_number     c=#1.25             //ON  if > than Reynolds number [Re/1000]
18.03 Warning_off_number    c=#3.5              //OFF if > than Reynolds number [Re/1000]
```

10.8 Window changes due to extended operations

This leads to some changes in the normal windows of the UFP

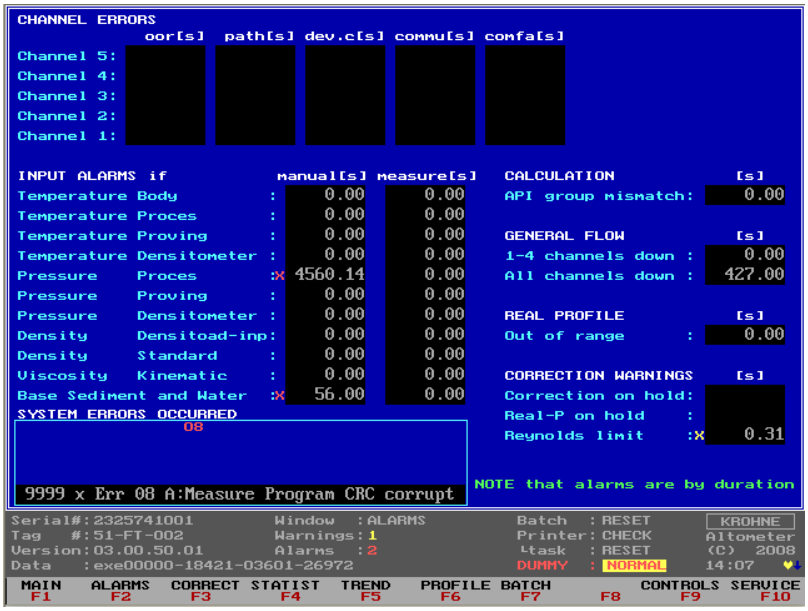
10.8.1 F1 Main Window changes due to extended operations



Above is the full operations Main Window.
Extra in this window is :

- "Ext Flow Meter" conditions (T, P, D) under CONDITIONS
  A separate temperature and pressure input are provided in the software under the name Temp Proving and Pressure Proving. The density under the given temperature and pressure are calculated is the density under standard conditions is available (through calculation or input)
- External Flow Meter: Flow, Totaliser, Error (deviation)%
  There is a on-line continuous comparison between the master and the duty. The comparison is controlled under F9 Controls, F3 Extern.
- Nett volume totalisers due to Base Sediment and Water % subtraction.

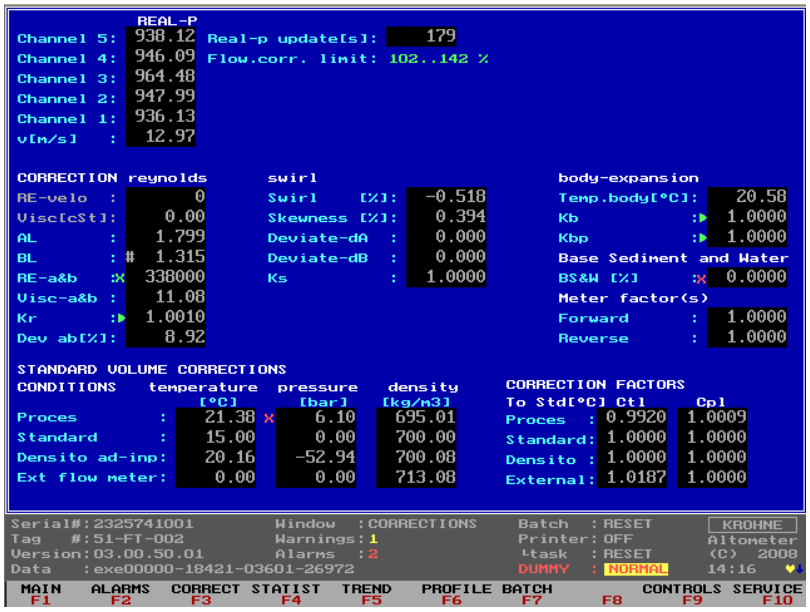
10.8.2 F2 Alarm Window changes due to extended operations



Above is the full operations Alarm Window.
Extra in this window is :

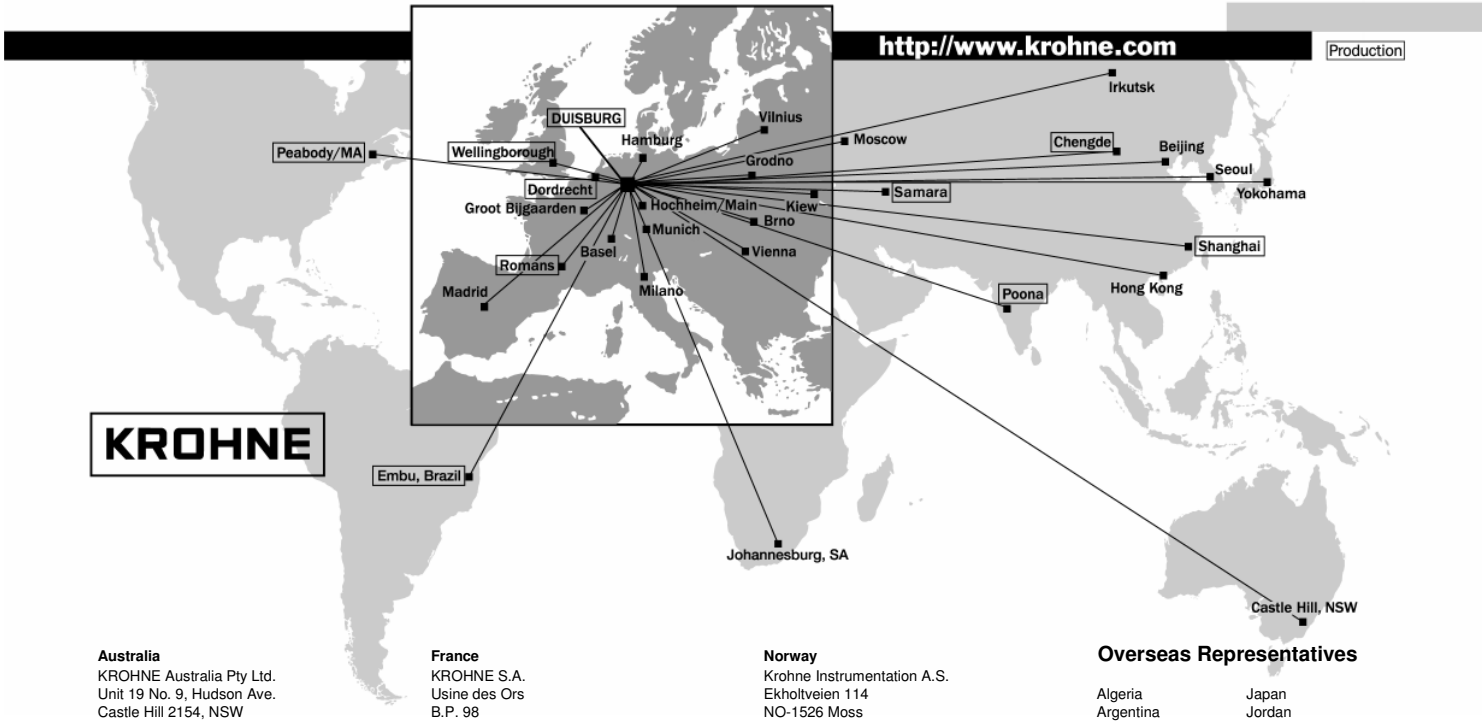
- Input Alarm Temperature Proving (also in basic operations visible)
- Input Alarm Pressure Proving (also in basic operations visible)
- Input Alarm Base Sediment and water
- The Reynolds Warning function (Reynolds limit) active, yellow cross **X**

10.8.3 F3 Correct Window changes due to extended operations



Above is the full operations Correction Window.
Extra in this window is :

- Base Sediment and water content [%]
- Meter factor values forward and reverse (adjustment through Modbus only)
- “Ext Flow Meter” conditions (T, P, D) under CONDITIONS
- “Ext Flow Meter” correction factors Ctl and Cpl under CORRECTION FACTORS



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