

# WATER CHILLER

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**PREFACE**

This section describes the operation, installation and maintenance of water chillers controlled by software WC1.01 onwards. The following types of water chiller are covered in the description:

- Type 1193
- Type 2061
- New 2 stages
- New 3 stages

**WATER CHILLER**

**1      INTRODUCTION**

A water chiller consists of the following control and monitoring sections, illustrated in drawing SK353:

- Electronics unit
- Incomer unit
- Pumps
- Compressors 1 and 2

**2      FUNCTIONAL DESCRIPTION**

**2.1    GENERAL DESCRIPTION**

The basic function of the water chiller is to provide cool water for use in a store's air conditioning system. The water temperature is controlled in accordance with defined limits which can be preset by the hand held unit.

The air conditioning is used to maintain the temperature of the room containing the 'Scanning' computer equipment. The attempts to maintain cooling in event of failure of parts of the refrigeration system.

The electronic system is connected to the front end via an RS485 link, and can report the following information to the front end:

- (1)      Status information.
- (2)      Parameter information.
- (3)      Alarm information.

The water chiller electronic system can also receive operating parameters and control information from the front end, or from the hand held unit when plugged into the water chiller controller.

The controller is informed of the type of water chiller it is required to control by the appropriate setting of the bit switches on the CPU card.

## **2.2 ELECTRONIC UNIT**

The electronic unit incorporates the following:

### **2.2.1 Power switch**

The main power switch applies power to the circuit boards in the electronic unit.

### **2.2.2 Display panel**

The display panel consists of two 4-digit displays which normally show return water temperature and flow water temperature, respectively. The displays can also show alarm and operational status.

### **2.2.3 Maintenance diagnostic unit connector**

This connector is provided for the hand held unit.

### **2.2.4 Pressure display switch**

This switch (provided on the newer chillers only) allows selection of compressor 1 or compressor 2 for the display of their respective discharge and suction pressures.

## **2.3 INCOMER**

### **2.3.1 Main isolator**

The main isolator turns power on or off to all sections of the water chiller.

## **2.4 PUMPS**

### **2.4.1 Isolator switch**

The isolator switch applies power to the pump section only.

### **2.4.2 Pump reset/fail**

This consists of a combined push-button switch and lamp. The lamp is illuminated to indicate that a problem has been detected in the water circuit. The lamp remains on even after the fault has been cleared, until switched off by pressing the integral reset switch.

### **2.4.3 Low temperature lamp**

The low temperature alarm lamp is illuminated when the ice well thermostat has indicated that ice could be formed. The lamp is normally extinguished.

#### 2.4.4 Heating and ventilation (H & V) Healthy lamp

This alarm lamp is normally on. It is extinguished when the ice well thermostat has signalled that ice could be formed, or when the water flow switch has indicated that water may not be flowing.

#### 2.4.5 Pump 1 run lamp

This lamp is illuminated to show that pump 1 is running.

#### 2.4.6 Pump 2 run lamp

This lamp is illuminated to show that pump 2 is running.

#### 2.4.7 Hand mode selected lamp

This lamp is illuminated when the AUTO/MAN switch is in the MAN position.

#### 2.4.8 MAN/AUTO switch

This switch is normally set to the AUTO position for automatic control of the water chiller operation. When set to the MAN position the chiller run signal is over-ridden, to be permanently asserted.

### **2.5 COMPRESSOR 1 AND 2**

#### 2.5.1 Isolator switch

Each compressor incorporates an isolator switch, which turns power on or off to the appropriate compressor section.

#### 2.5.2 33% lamp

This lamp indicates that one compressor stage is running.

#### 2.5.3 66% lamp

This lamp indicates that two compressor stages are running.

#### 2.5.4 100% lamp

This lamp indicates that all three compressor stages are running.

#### 2.5.5 Ammeter

The meter shows current supplied to the compressor motor.

#### 2.5.6 Run hours meter

This meter displays the total accumulated hours run by the motor.

### **3 OPERATIONAL DESCRIPTION**

The following paragraphs briefly describe the operation of the principal sections of the water chiller.

### 3.1 NORMAL COMPRESSOR OPERATION

The objective of the water chiller controller is to produce flow water at the required temperature, referred to as the *water temperature setpoint* (F11).

The controller attempts to control the temperature of the flow water as follows:

It is possible to associate with each stage of compressor capacity a certain temperature drop across the water tank, the *specific stage temperature difference* (F09). The controller measures the *return water temperature* (F01) and runs the appropriate number of stages required to produce a *flow water temperature* (F00) as close as possible to the *water temperature setpoint* (F11).

The controller also measures the actual temperature drop across the tank and continuously modifies the value of the specific compressor capacity to reflect the actual performance of the machine.

At start up the controller uses a nominal value for the specific compressor temperature difference, appropriate to the type of water chiller being controlled.

On assertion of the *chiller run* signal, the number of stages required for cooling is determined by comparing the *return water temperature* (F01) with the *current water temperature control set points* (F03) to (F08).

Compressor rules may restrict the number of stages in each compressor allowed to run.

When the number of stages running is changed, a *chiller reaction timer* (F13) is started. The calculations described above are repeated when the *chiller reaction period* (F13) has finished.

When this occurs, provided that at least one compressor stage is running, the *water temperature control set points* (F03) to (F08) are re-calculated using the *water temperature set point* (F11) and the (F09). The latter is calculated from the formula:

$$\text{SSTD} = \frac{\text{Return water temperature} - \text{Flow temperature}}{\text{Number of stages running}}$$

### 3.2 NORMAL FANS OPERATION

The electronic controller switches the fans on and off by comparing the *discharge pressure* with the fan control thresholds. These thresholds are set up by the user by means of the hand held unit, or from the front end terminal, and consist of the following parameters: *fan 1 set point* (F61), *fan 4/6 set point* (F62), and *fan off differential* (F63).

### 3.3 NORMAL PUMPS OPERATION

The system is constrained to only allow one pump to run at any one time.

#### 3.3.1 Chiller run asserted

The system attempts to start each pump twice, in order to establish water flow. Once flow has been established, if a pump fails the other pump will be started. If that pump also fails, the appropriate alarm signal is generated for failure of both pumps, and the system waits for the pump reset button to be pressed by the operator.

Any pump fail alarm, ice alarm or water flow alarm can be cleared by pressing the pump reset button.

### 3.3.2 Chiller run not asserted

The system will keep the pump running for a period of five minutes. At the end of this time the pump is stopped.

### 3.3.3 Pump reset pressed

Pressing the pump reset push button switch clears the pump fail alarms, ice detect alarms, and water flow alarms. The pump fail lamp is extinguished.

## 3.4 **DISPLAY PANEL INDICATORS**

### 3.4.1 Temperature/pressure displays

Each display consists of a four-digit alpha-numeric display. Specific indications and their meanings are as follows:

<u>Message</u>	<u>Meaning</u>
hELP	Processor alarm present.
8888 / ----	Sensor associated with the variable to be displayed has failed.
hI	High water temperature alarm present.
LO	Low water temperature alarm present.

On chillers fitted with a pressure display switch, it is possible to select the display to show discharge and suction pressures by turning the switch to the left for compressor 1 and to the right for compressor 2.

The display also permits the following indications to be displayed:

hP	High pressure alarm present
LP	Low pressure alarm present

### 3.4.2 LED Indicators

LED indicator functions are as shown in the following table:

**TABLE 1 LED INDICATOR FUNCTIONS**

<b>LED Indication</b>	<b>Explanation of function</b>
RC1 or RC2 Comp fault	Compressor fault.
RC1 or RC2 Fan fault	Fan trip or fan supply fault.
Pump 1 or Pump 2 fault	Pump has failed. LED remains illuminated until pump reset button is pressed.
Water flow fault	Either pump has failed, or water is flowing with no pump running alarm present, or ice formation has been detected. LED remains illuminated until pump reset button is pressed.
BMS demand	This LED is illuminated whenever the heating and ventilation system is calling for cooled water.
Increase	This LED is illuminated when the required number of stages for cooling is greater than the total number of stages actually running.
Decrease	This LED is illuminated when the required number of stages for cooling is less than the total number of stages actually running.
Electronic supply healthy	LED indicates that power is being supplied to the electronics.

Processor healthy	LED indicates that the software is running.
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### 3.5 COMMISSIONING

#### 3.5.1 CPU Bit switch settings

Before starting the water chiller for the first time, ensure that the bit switches on the CPU board are set up in accordance with Table 2 and Table 3:

**TABLE 2: BIT SWITCH 1 AND 2 SETTINGS**

Chiller type	Bit switch 1	Bit switch 2	Type code HHU(F98)
1193	ON	ON	700
2061	OFF	ON	701
New 2 stage	ON	OFF	702
New 3 stage	OFF	OFF	703

**TABLE 3: BIT SWITCH 3 AND 4 SETTINGS**

Number of fans on condenser	Bit switch 1	Bit switch 2	Comments
0	See below	See below	The number of fans set up may be
3	ON	ON	checked on the hand held unit (F75)
4	OFF	ON	
5	ON	OFF	
6	OFF	OFF	

The only water chillers which do not have fans are the type 1193 chillers. When this type has been selected on bit switches 1 and 2, bit switches 3 and 4 are ignored and the controller will not control the fans.

If any other type is selected, bit switches 3 and 4 are read and must be set correctly.

Bit switches 5 to 8 have no effect on controller operation.

### 3.6 START UP PROCEDURE

Before starting the water chiller for the first time, carry out the operations described in Para 3.5 above. Then proceed as follows:

Turn electronics section power switch to ON, or from 0 to 1.

If the default values are to be loaded, plug in the hand held unit and select function 98 on the unit. Press the red button on the hand held unit. Check that the correct bit switch code is displayed. Then un-plug the hand held unit.

If a re-start is required, turn the electronics section power switch to OFF or 0, and then turn it back on again. Load the default values if required, by carrying out the steps described above.

If parameter values are to be loaded which are different from default values, plug in the hand held unit and set up the required values in the following order:

- (1) Water temperature set point (F11).
- (2) Chiller reaction period (F13).

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- (3) Fan 1 on set point (F61).
- (4) Fan 4/6 on set point (F62).
- (5) Fan off differential (F63).
- (6) Unit number (F99).
- (7) Compressor run hours (F29, F39).

Then un-plug the hand held unit to store the required parameter values in the front end.

### **3.7 STOP PROCEDURE**

To stop the water chiller electronics, turn the on the electronics section to OFF, or 0.

## **4 MAINTENANCE**

### **4.1 ALARM MESSAGES**

The following is a list of event alarm messages together with a brief explanation of their meaning. WHERE AN ALARM MESSAGE IS PRINTED IN CAPITAL LETTERS, this indicates a CRITICAL alarm. Non-critical alarms are printed in lower case letters.

#### **4.1.1 Comms fault (critical alarm)**

The front end has been unable to communicate with the water chiller. Check water chiller unit number. Check RS485 Comms link.

#### **4.1.2 Flow water over temperature (critical alarm)**

Set when all of the following conditions apply:

- (1) BMS signal asserted for 1 hour or more.
- (2) Maximum compressor capacity in use.
- (3) Flow water temperature above flow water over-temperature alarm limit for 30 mins.  
(See drawing SK357)

Clear when: Any of 1, 2 or 3 above not true.

#### **4.1.3 High return water temperature (critical alarm)**

Set when both of the following conditions apply:

- (1) BMS signal asserted for 1 hour or more, and
- (2) Return water temperature above return water high temperature alarm threshold for more than 1 minute. (See drawing SK355)

Clear when:

- (1) BMS signal has not been asserted for 1 hour or more, or
- (2) Return water temperature has been below return water high temperature alarm threshold for at least 1 minute.

#### **4.1.4 Ice formation fault (critical alarm)**

Ice thermostat indicates that the conditions for ice formation are present.

4.1.5 Water flowing with no pump running (critical alarm)

Water flow detected more than 1 minute after the pump was instructed to stop. Check water flow switch. Check pumps circuits.

4.1.6 Water flow problem (critical alarm)

Both water pumps have failed to establish water flow. Check water flow switch. Check ice thermostat. Check pumps circuits.

4.1.7 Compressor 1 fan supply fault

The fan supply healthy signal is not present.

4.1.8 Compressor 2 fan supply fault

The fan supply healthy signal is not present.

4.1.9 Flow water temperature sensor fault

Set when either of the following conditions applies:

- (1) Sensor reading out of range -50 to 150 C for more than 2 minutes, or:
- (2) Sensor reading has not changed by more than 0.2 deg C for more than 30 minutes while the BMS signal is asserted.

Clear when: both (1) and (2) are not true.

4.1.10 Insufficient data

Data corruption has occurred within the unit. Check CPU board. Re-start the unit. Check parameters.

4.1.11 Low flow water temperature cut out

Set when: Flow water temperature has fallen below the flow water cut-out set-point.

Clear when: Flow water temperature has risen above the water temperature set-point.

4.1.12 Low flow water temperature alarm

Set when: Flow water temperature has been below the stage-off flow water temperature set-point for 30 seconds or more.

Clear when: Flow water temperature rises above the water temperature set-point.

4.1.13 Pressure sensing failure

Set when either of the following conditions applies:

- (1) Pressure transducer board has failed.
- (2) Pressure sensor returns a value outside normal limits.

Clear when: (1) and/or (2) not true.

#### 4.1.14 Processor fault

The software has found an internal fault condition and should have re-started itself.

#### 4.1.15 RC1 compressor fault

Compressor fault signal has been detected in compressor 1. Check pressure and thermistor trips.

#### 4.1.16 RC2 compressor fault

Compressor fault signal has been detected in compressor 2. Check pressure and thermistor trips.

#### 4.1.17 RC1 fan trip

A fan fault signal has been detected while at least one fan was running.

#### 4.1.18 RC2 fan trip

Fan fault signal has been detected while at least one fan was running.

#### 4.1.19 RC1 high discharge pressure

Set when: Discharge pressure above 295 psi for more than 1 minute.

Clear when: Discharge pressure below 295 psi for more than 1 minute.

#### 4.1.20 RC2 high discharge pressure

Set when: Discharge pressure above 295 psi for more than 1 minute.

Clear when: Discharge pressure below 295 psi for more than 1 minute.

#### 4.1.21 RC1 high discharge temperature

Set when: Discharge temperature above 100 deg C for more than 5 minutes.

Clear when: Discharge temperature below 100 deg C for more than 5 minutes.

#### 4.1.22 RC2 high discharge temperature

Set when: Discharge temperature above 100 deg C for more than 5 minutes.

Clear when: Discharge temperature below 100 deg C for more than 5 minutes.

#### 4.1.23 RC1 high suction pressure

Set when: Suction pressure above 120 psi for more than 1 minute.

Clear when: Suction pressure below 120 psi for more than 1 minute.

#### 4.1.24 RC2 high suction pressure

Set when: Suction pressure above 120 psi for more than 1 minute.

Clear when: Suction pressure below 120 psi for more than 1 minute.

#### 4.1.25 RC1 low discharge pressure

Set when: Discharge pressure below 58 psi for more than 1 minute.

Clear when: Discharge pressure above 58 psi for more than 1 minute.

4.1.26 RC2 low discharge pressure

Set when: Discharge pressure below 58 psi for more than 1 minute.

Clear when: Discharge pressure above 58 psi for more than 1 minute.

4.1.27 RC1 low suction pressure alarm

Set when: Suction pressure below 58 psi for more than 1 minute and compressor running.

Clear when: Suction pressure above 58 psi for more than 1 minute.

4.1.28 RC2 low suction pressure alarm

Set when: Suction pressure below 58 psi for more than 1 minute and compressor running.

Clear when: Suction pressure above 58 psi for more than 1 minute.

4.1.29 Return water temperature sensor fault

Set when: Sensor reading out of range -50 to 150 degrees C.

Clear when: Sensor reading inside range -50 to 150 degrees C.

4.1.30 Temperature sensing fault

An invalid temperature reading has been detected by the software.

4.1.31 Water pump 1 failure

The water pump has failed to establish water flow. Check pump circuit.

4.1.32 Water pump 2 failure

The water pump has failed to establish water flow. Check pump circuit.

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Water chiller hand held functions for WC1.01 onward

Hand held functions are numbered as shown below.

<b>DIGIT 1</b>	<b>DIGIT 2</b>	<b>DIGIT 3</b>	<b>DIGIT 4</b>
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<b>Water chiller HHU functions (WC 1.01 onwards)</b>				
HHU	Description	Type	Limits/Units	Defaults
00	Flow water temperature	D	deg C	
01	Return water temperature	D	deg C	
02	Number of stages: Dig 1: Required stages for cooling Dig 4: Total stages running	D		
03	Stage 1 on threshold	D	deg C	
04	Stage 2 on threshold	D	deg C	
05	Stage 3 on threshold	D	deg C	
06	Stage 4 on threshold	D	deg C	
07	Stage 5 on threshold - 3 stage system only	D	deg C	
08	Stage 6 on threshold - 3 stage system only	D	deg C	
09	Specific stage temp difference	D		
10	Dig 1: BMS demand 1 = demanding 0 = not demanding	D		
	Dig 2: Ice state 1 = ice 0 = no ice			
	Dig 3: Water flow switch 1 = water flow 0 = no water flow			
	Dig 4: Water pump running 2 = pump 2 running 1 = pump 1 running 0 = not running			
11	Water temperature setpoint	S	5 to 12 deg C	6.0
12	Stage on differential	S	0.1 to 1.0 deg C	0.2
13	Chiller reaction time	S	5 to 120 secs	20
14	Low flow water temp cut out setpoint	S	2 to 4 deg C	3
15	Flow water	S	4 to 5 deg C	4.5
16	Flow water overtemp alarm differential	S	2 to 10 deg C	5
17	Return water overtemp alarm setpoint	S	15 to 25 deg C	20
18	-			
19	-			
20	Time until next comp 1 start permitted	D	secs	
21	Dig 1: Max stages allowed on comp1 Dig 2: C1 number of stages running	D D	stages stages	
22	Compressor 1 valve states Dig 1: Equalise start Dig 2: LSV Dig 3: Gas dump Dig 4: LP over ride	D	1= open, 0= shut	

23	Compressor 1 valve states Dig 1: Stage 2 Dig 2: Stage 3	D	1= open, 0= shut	
D = DISPLAY S = SETTABLE A = ALARM				
<b>Water chiller HHU functions (WC 1.01 onwards)</b>				
HHU	Description	Type	Limits/Units	Defaults
23	Compressor 1 valve states Dig 1: Stage 2 Dig 2: Stage 3	D	1= open, 0= shut	
24	Compressor 1 fault	D	0= OK, 1= fault	
25	Compressor 1 discharge pressure	D	psi	
26	Compressor 1 suction pressure	D	psi	
27	Compressor 1 discharge temperature	D	deg C	
28	Compressor 1 suction temperature	D	deg C	
29	Compressor 1 run hours	S	0000 to 9999 hrs	0
30	Time until next comp 2 start permitted	D	secs	
31	Dig 1: Max stages allowed on comp 2 Dig 2: C2 number of stages running	D D	stages stages	
32	Compressor 2 valve states Dig 1: Equalise start Dig 2: LSV Dig 3: Gas dump Dig 4: LP over ride	D	1= open, 0= shut	
33	Compressor 2 valve states Dig 1: Stage 2 Dig 2: Stage 3	D	1= open, 0= shut	
34	Compressor 2 fault	D	0= OK, 1= fault	
35	Compressor 2 discharge pressure	D	psi	
36	Compressor 2 suction pressure	D	psi	
37	Compressor 2 discharge temperature	D	deg C	
38	Compressor 2 suction temperature	D	deg C	
39	Compressor 2 run hours	S	0000 to 9999 hrs	0
40	Stage off discharge pressure setpoint	S	260 to 275 psi	265
41	Stage off discharge pressure differential	S	5 to 15 psi	10
42	Shutdown discharge pressure differential	S	5 to 10 psi	7
43	Restart discharge pressure differential	S	10 to 30 psi	20
44	Gas dump setpoint	S	58 to 65 psi	60
45	Gas dump differential	S	1 to 4 psi	2
46	-			
47	-			
48	-			
49	-			
50	-			
51	-			
52	-			
53	-			
54	-			
55	-			
56	-			
57	-			
58	Compressor 1 condenser air off temp	D	deg C	
59	Compressor 2 condenser air off temp	D	deg C	
60	Dig 1: Comp 1 number of fans running Dig 4: Comp 2 number of fans running	D D	fans fans	

NOTE: NOT UNDER DOCUMENTATION CONTROL

D = DISPLAY S = SETTABLE A = ALARM				
<b>Water chiller HHU functions (WC 1.01 onwards)</b>				
HHU	Description	Type	Limits/Units	Defaults
61	Fan 1 on setpoint	S	Lo limit =120 psi Hi limit =(F62)- 10 psi	180
62	Fan max on setpoint Fan 4 for 2 stage chiller Fan 6 for 3 stage chiller	S	Lo limit= (F61)+ 10 psi Hi limit = 250 psi	230
63	Fan stop differential	S	10 to 50 psi	15
64	Fan 2 on setpoint	D	psi	
65	Fan 3 on setpoint	D	psi	
66	Fan 4 on setpoint - only if 4 or more fans on condenser	D	psi	
67	Fan 5 on setpoint - only if 5 or more fans on condenser	D	psi	
68	Fan 6 on setpoint - only if 6 fans on condenser	D	psi	
69	Fan 1 off setpoint	D	psi	
70	Fan 2 off setpoint	D	psi	
71	Fan 3 off setpoint - only if 3 or more fans on condenser	D	psi	
72	Fan 4 off setpoint - only if 4 or more fans on condenser	D	psi	
73	Fan 5 off setpoint - only if 5 or more fans on condenser	D	psi	
74	Fan 6 off setpoint - only if 6 fans on condenser	D	psi	
75	Number of fans designated by bit switch	D		
76	Temperature sensor failure Dig 1: Flow water Dig 2: Return water Dig 3: C1 condenser air off Dig 4: C2 condenser air off	A	0= OK, 1= alarm	
77	Gas temperature sensor failure Dig 1: Compressor 1 suction Dig 2: Compressor 1 discharge Dig 3: Compressor 2 suction Dig 4: Compressor 2 discharge	A	0= OK, 1= alarm	
78	Pressure sensor failure Dig 1: Compressor 1 suction Dig 2: Compressor 1 discharge Dig 3: Compressor 2 suction Dig 4: Compressor 2 discharge	A	0= OK, 1= alarm	
79	Dig 1: Total pressure sensing failure Dig 2: Pressure board sensing failure Dig 3: not used Dig 4: Total temperature sensing failure	A	0= OK, 1= alarm	
80	Flow water temperature failure Dig 1: Over temperature Dig 2: Low temperature Dig 3: Low temperature shutdown	A	0= OK, 1= alarm	

NOTE: NOT UNDER DOCUMENTATION CONTROL

	Dig 4: not used			
D = DISPLAY S = SETTABLE A = ALARM				
<b>Water chiller HHU functions (WC 1.01 onwards)</b>				
81	Return water temperature	A	0= OK, 1= alarm	
82	Water pump faults Dig 1: Pump 1 failed Dig 2: Pump 2 failed Dig 3: Both pumps failed Dig 4: water flow with no pumps running	A	0= OK, 1= alarm	
83	High discharge temperature alarm	A	0= OK, 1= alarm	
84	Fan alarms Dig 1: Compressor 1 fan fault Dig 2: Compressor 1 fan supply fault Dig 3: Compressor 2 fan fault Dig 4: Compressor 2 fan supply fault	A	0= OK, 1= alarm	
85	High discharge pressure shutdown alarm Dig 1: Compressor 1 Dig 2: Compressor 2	A	0= OK, 1= alarm	
86	Compressor 1 pressure alarm Dig 1: High suction pressure Dig 2: Low suction pressure Dig 3: High discharge pressure Dig 4: Low discharge pressure	A	0= OK, 1= alarm	
87	Compressor 2 pressure alarm Dig 1: High suction pressure Dig 2: Low suction pressure Dig 3: High discharge pressure Dig 4: Low discharge pressure	A	0= OK, 1= alarm	
88	Ice formation alarm	A	0= OK, 1= alarm	
89	Plant alarm	A	0= OK, 1= alarm	
90	Faulty RAM	A	0= OK, 1= alarm	
91	PROM checksum fault	A	0= OK, 1= alarm	
92	PC out of range	A	0= OK, 1= alarm	
93	SP out of range	A	0= OK, 1= alarm	
94	Background execution fault	A	0= OK, 1= alarm	
95	Backed up data checksum fault	A	0= OK, 1= alarm	
96	-			
97	Software issue number	D		
98	Force default data parameter load (check bit switch setup)	S		
99	Unit number	S		
D = DISPLAY S = SETTABLE A = ALARM				

NOTE: NOT UNDER DOCUMENTATION CONTROL