1. General Description

This document specifies a proprietary ThermoTek asynchronous, serial communication protocol that allows monitor and control of the ThermoTek devices (Chillers) by the User/Host device (normally the IBM compatible Personal Computer). The protocol is master/slave type with Chiller acting as the slave and Host system as the master.

The first part of the document describes global features using RS232 interface. Specifics of RS485, USB and Ethernet interfaces are covered in separate sections.

1.1 Communications Settings

The transmission rate is 9600 Baud, 8 data bits, no parity, 1 stop bit and XON / XOFF flow control (except the RS485 interface which does not use XON / XOFF).

1.1.1 RS232 Connector

The R232 connector on Chiller is a Female DB9 located on the back of the unit. The RS232 pin assignments are as follows:

	Host (IBM PC)	**Chiller**
Pin	*Description*	*Description*
2	Receive Data	Transmit Data
3	Transmit Data	Receive Data
5	Signal Ground	Signal Ground

1.2 Allowable Characters

Only **printable ASCII characters** are allowed in this protocol. The exceptions are the XON (11h) and XOFF (13h) characters.

1.3 Remote Mode

After the valid serial command is received, Chiller shall enter Remote Mode. Front Keypad will be 'locked' and Chiller will be controlled exclusively through the serial communication. Chiller will automatically exit Remote Mode if valid serial command is not received within **ten seconds**. Refer to section 2.0 for command / response format.

1.4 Software Flow Control

The software flow control characters XON and XOFF are defined as 11h and 13h respectively. If the Chiller has to temporarily stop the flow of data, it will issue a XOFF, and when it is ready to receive new data again, it will transmit a XON character. Exception is the RS485 interface which does not use XON / XOFF.

2. Message Timing

The Host transmits a message to request information or issue command to the Chiller. The Host may not send a new message until a response from the previous message has been received. If however, the Host sends a message and a full response has not been received within **3 seconds**, a new message may be transmitted.

After the response message is received, the Host should wait at least one second before sending the new command message.

The Host must maintain a maximum of 10msec between the characters in the same message. If the Chiller doesn't receive the next character on time, the message will be ignored and the Chiller shall not respond.

2.1 Host Command Message Format

The command message issued by the Host shall be in the following format:

SOC	Device ID	Command Num.	Command Name	Data	Checksum	CR

2.1.1 SOC (Start of Command)

Every Host message shall start with a **2Eh** representing an ASCII **period (.)**. It is one ASCII character (byte) in length.

2.1.2 Device ID

Device ID is used for Chiller identification on multi-drop bus (i.e. RS485). It is two ASCII characters (bytes) long and valid range is **01 – 32**. The default address for RS232, USB or Ethernet connectivity will be 01.

2.1.3 Command Number

Command Number is two ASCII characters (bytes) long and determines what control or monitor function Chiller shall perform. Refer to section 4 for detailed description of all supported commands.

2.1.4 Command Name

Command Name is eight ASCII characters (bytes) long and it describes (in abbreviated form) what control or monitor function Chiller shall perform. Refer to section 4 for detail description of all supported commands.

Note: Chiller software does not check syntax of the Command Name. It just verifies the total length of the message.

2.1.5 Data

Data is an optional field in the message and it is zero to eight ASCII characters (bytes) long. It provides necessary additional information about the command that shall be performed. Refer to section 4 for more details.

2.1.6 Checksum

Checksum field shall be two ASCII hexadecimal bytes representing the sum of all preceding bytes (8 bit summation, no carry) of the command starting with SOC.

2.1.7 CR (Carriage return)

Every Host message shall end with **0Dh** representing an ASCII carriage return. It is one ASCII character (byte) in length.

2.2 Response Format

The general form of the Chiller response message is:

SOR	Device ID	Command Num.	Error Code	Command Name	Data	Checksum	CR

2.2.1 SOR (Start of Response)

Every Chiller response message shall start with a **23h** representing an ASCII **#.** It is one ASCII character (byte) in length.

2.2.2 Device ID

Chiller will echo Device ID (two ASCII characters) that is received in command message.

2.2.3 Command Number

Chiller will echo Command Number (two ASCII characters) that is received in command message.

2.2.4 Error Code

Error Code is one ASCII character (bytes) long and it provides information about the status of the received command message.

Error Code	Description
0	Command OK – No Errors
1	Checksum Error
2	Bad Command Number (Command Not used)
3	Parameter/Data Out of Bound
4	Message Length Error
5	Sensor/Feature not Configured or Used

2.2.5 Command Name

Chiller will echo Command Name (eight ASCII characters) that is received in command message

2.2.6 Data

Data is an optional field in the message and it is zero to nine ASCII characters (bytes) long. It contains data for read commands. If set command message had data characters, Chiller will echo them. Refer to Section 4 for more details.

2.2.7 Checksum

Checksum field shall be two ASCII hexadecimal bytes representing the sum of all preceding bytes (8 bit summation, no carry) of the command starting with SOR. It is calculated and formatted the same way as checksum in command message.

2.2.8 CR (Carriage return)

Every Chiller response shall end with **0Dh**.representing an ASCII carriage return. It is one ASCII character (byte) in length.

2.3 Examples

2.3.1 Watchdog

Host should send following Command Message to the Chiller:

	SOC	Device ID		Command Number		Command Name								CS		CR
Message (ASCII)	.	0	1	0	1	W	a	t	c	h	D	o	g	0	1	CR
Message (Decimal)	46	48	49	48	49	87	97	116	99	104	68	111	103	48	49	13
Message (Hex)	2E	30	31	30	31	57	61	74	63	68	44	6F	67	30	31	0D

Checksum in Command Message is calculated by adding all Hex values of ASCII characters (0x2E + 0x30 + 0x31 + 0x30 + 0x31 + 0x57 + 0x61 + 0x74 + 0x63 + 0x68 + 0x44 + 0x6F + 0x67 = 0x401). Last byte of the checksum (0x01) is converted in two ASCII characters ('0' and '1'). Checksums for all messages are calculated using the same formula.

Appropriate Chiller Response Message would be:

	SOR	Unit ID		Command Number		Error	Command Name								Response				CS		CR
Message (ASCII)	#	0	1	0	1	0	W	a	t	c	h	D	o	g	0	1	0	0	E	7	CR
Message (Dec.)	35	48	49	48	49	48	87	97	116	99	104	68	111	103	48	49	48	48	69	55	13
Message (Hex)	23	30	31	30	31	30	57	61	74	63	68	44	6F	67	30	31	30	30	45	37	0D

From Chiller Response Message it could be concluded that:

a. There was no error in Command message from the Host (Error = 0)
b. Chiller is in Auto Start Mode (CS = 0)
c. Pump is ON (PS = 1)
d. There is no Alarms present (AS = 0)
e. There is no Warnings present (WS = 0)

2.3.2 Read Supply Temperature

Host should send following Command Message to the Chiller:

	SOC	Device ID		Command Number		Command Name								CS		CR
Message (ASCII)	.	0	1	0	4	r	S	u	p	p	l	y	T	4	6	CR
Message (Decimal)	46	48	49	48	52	114	83	117	112	112	108	121	84	52	54	13
Message (Hex)	2E	30	31	30	34	72	53	75	70	70	6C	79	54	34	36	0D

If Supply Temperature were +29.5 ^{o}C, Chiller Response Message would be:

	SOR	Device ID		Command Number		Error	Command Name								Response					CS		CR
Message (ASCII)	#	0	1	0	4	0	r	S	u	p	p	l	y	T	+	0	2	9	5	6	6	CR
Message (Decimal)	35	48	49	48	52	48	114	83	117	112	112	108	121	84	43	48	50	57	53	54	54	13
Message (Hex)	23	30	31	30	34	30	72	53	75	70	70	6C	79	54	2B	30	32	39	35	36	36	0D

2.3.3 Set Supply Temperature

If Host wants to set Control Temperature to +20.0 ^{o}C, it should send following Message to the Chiller:

	SOC	Device ID		Command Number		Command Name								Data					CS		CR
Message (ASCII)	.	0	1	1	7	s	C	t	r	l	T	_	_	+	0	2	0	0	F	E	CR
Message (Decimal)	46	48	49	49	55	115	67	116	114	108	84	95	95	43	48	50	48	48	70	69	13
Message (Hex)	2E	30	31	31	37	73	43	74	72	6C	54	5F	5F	2B	30	32	30	30	46	45	0D

Appropriate Chiller Response Message would be:

	SOR	Device ID		Command Number		Error	Command Name								Response					CS		CR
Message (ASCII)	#	0	1	1	7	0	s	C	t	r	l	T	_	_	+	0	2	0	0	2	3	CR
Message (Decimal)	35	48	49	49	55	48	115	67	116	114	108	84	95	95	43	48	50	48	48	50	51	13
Message (Hex)	23	30	31	31	37	30	73	43	74	72	6C	54	5F	5F	2B	30	32	30	30	32	33	0D

2.3.4 Alarm Level 1 & 2

Alarm pooling Command Message is:

	SOC	Device ID		Command Number		Command Name								CS		CR
Message (ASCII)	.	0	1	1	8	r	A	l	r	m	L	v	1	E	9	CR
Message (Decimal)	46	48	49	49	56	114	65	108	114	109	76	118	49	69	57	13
Message (Hex)	2E	30	31	31	38	72	41	6C	72	6D	4C	76	31	45	39	0D

If Chiller is in Alarm state due to Supply Temperature Sensor Error, Low Process Flow and Current Sensor Error (see Alarm & Warning List) it would reply with following Response Message:

	SOR	Device ID		Command Number		Error	Command Name								Response						CS		CR
Message (ASCII)	#	0	1	1	8	0	r	A	l	r	m	L	v	1	0	1	A	0	0	0	4	0	CR
Message (Decimal)	35	48	49	49	56	48	114	65	108	114	109	76	118	49	48	49	65	48	48	48	52	48	13
Message (Hex)	23	30	31	31	38	30	72	41	6C	72	6D	4C	76	31	30	31	41	30	30	30	34	30	0D

Alarm Level 2 Command could give more information about Chiller Errors.

	SOC	Device ID		Command Number		Command Name								Data		CS		CR
Message (ASCII)	.	0	1	1	9	r	A	l	r	m	L	v	2	2	1	D		CR
Message (Decimal)	46	48	49	49	57	114	65	108	114	109	76	118	50	50	49	68		13
Message (Hex)	2E	30	31	31	39	72	41	6C	72	6D	4C	76	32	32	31	44		0D

If the Supply Temperature Sensor is shorted and Current Sensor 1 is open, Chiller would respond with:

	SOR	Device ID		Command Number		Error	Command Name								Data		Response							CS		CR
Msg.(ASCII)	#	0	1	1	9	0	r	A	l	r	m	L	v	2	2	0	9	0	0	0	1	0	0	C	C	CR
Msg. (Dec.)	35	48	49	49	57	48	114	65	108	114	109	76	118	50	50	48	57	48	48	48	49	48	48	67	67	13
Msg. (Hex)	23	30	31	31	39	30	72	41	6C	72	6D	4C	76	32	32	30	39	30	30	30	31	30	30	43	43	0D

3. RS485 Interface

3.1 Number of Devices

Up to 31 Chillers could be connected on common RS485 bus. All Chillers on common RS485 bus must have unique address – ID in range 2-32.

3.2 RS485 Configuration

Chiller could be placed in RS485 Interface Mode only if it is factory configured for RS485 Interface. While Chiller is STANDBY mode, press the 'MENU' key until the 'COMM LINK' is displayed and then press 'UP' key to select 'RS485' mode. If either display message failed to appear, Chiller is not configured for RS485 Interface.

3.3 RS485 ID Assignment

Chiller RS485 ID (address) could be assigned only using the front keypad while the unit is in STANDBY mode. Press the 'MENU' key until the 'RS485 ID' is displayed and then press 'UP' key to set wanted RS485 Address.

3.4 RS485 Connector

RS485 connector is DB-9 female on the back of the Chiller. Pin 2 is DATA A (+) and Pin 7 is DATA B (-).

REVISION AMENDMENT PAGE

REVISION AMENDMENT PAGE

Revision	Issue Date	Reason for Change	Approval
X2_1	8/17/05	Ext RTD and Return Temp indices corrected in Set Control Sensor command	
X2_2	8/18/05	Typo corrections on page 5 (Temp Values)	
X2_3	11/2/06	Type corrections (page 4 'H' replaced with 'h')	

4. COMMANDS

COMMAND MESSAGE

		SOC	DEVICE ID		COMMAND NUMBER		COMMAND NAME								COMMAND DATA									CHECK SUM		EOC
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		22	23	24
1	Serial WatchDog	.	0	1	0	1	W	a	t	c	h	D	o	g										0	1	CR
2	Read Control Sensor	.	0	1	0	2	r	C	t	r	l	S	e	n										1	E	CR
3	Read Set Temperature	.	0	1	0	3	r	S	e	t	T	e	m	p										2	6	CR
4	Read Supply Temperature	.	0	1	0	4	r	S	u	p	p	l	y	T										4	6	CR
5	Read External RTD	.	0	1	0	5	r	E	x	t	R	T	D	_										E	0	CR
6	Read External Thermistor	.	0	1	0	6	r	E	x	t	T	h	r	m										3	3	CR
7	Read Return Temperature	.	0	1	0	7	r	R	e	t	u	r	n	T										3	C	CR
8	Read Ambient Temperature	.	0	1	0	8	r	A	m	b	T	e	m	p										0	F	CR
9	Read Process Flow	.	0	1	0	9	r	P	r	o	s	F	l	o										2	F	CR
10	Read TEC Bank 1 Current	.	0	1	1	0	r	T	E	C	B	1	C	r										2	1	CR
11	Read TEC Bank 2 Current	.	0	1	1	1	r	T	E	C	B	2	C	r										2	3	CR
12	Set Extern Sensor Status	.	0	1	1	2	s	E	x	t	S	e	n	s	ES									X	X	CR
13	Read TE Drive Level	.	0	1	1	3	r	T	E	C	D	r	L	v										B	9	CR
14	Reserved (not used)																									
15	Set Chiller Status	.	0	1	1	5	s	S	t	a	t	u	s	_	SS									X	X	CR
16	Set Control Sensor	.	0	1	1	6	s	C	t	r	l	S	e	n	SN									X	X	CR
17	Set Control Temperature	.	0	1	1	7	s	C	t	r	l	T	_	_	+/-	t	t	t	t					X	X	CR
18	Read Alarm State Level 1	.	0	1	1	8	r	A	l	r	m	L	v	1										E	9	CR
19	Read Alarm State Level 2	.	0	1	1	9	r	A	l	r	m	L	v	2	1									1	C	CR
		.	0	1	1	9	r	A	l	r	m	L	v	2	2									1	D	CR
20	Read Warning State Level 1	.	0	1	2	0	r	W	a	r	n	L	v	1										E	E	CR
21	Set Hi Supply Temp Warn	.	0	1	2	1	s	H	i	S	p	T	W	n	+/-	t	t	t	t					X	X	CR
22	Set Low Supply Temp Warn	.	0	1	2	2	s	L	o	S	p	T	W	n	+/-	t	t	t	t					X	X	CR
23	Set Hi Ambient Temp Warn	.	0	1	2	3	s	H	i	A	m	T	W	n	+/-	t	t	t	t					X	X	CR
24	Set Low Ambient Temp Warn	.	0	1	2	4	s	L	o	A	m	T	W	n	+/-	t	t	t	t					X	X	CR
25	Set Low Process Flow Warn	.	0	1	2	5	s	L	o	P	F	l	W	n	+	f	f	f	f					X	X	CR
26	Set Hi Supply Temp Alarm	.	0	1	2	6	s	H	i	S	p	T	A	l	+/-	t	t	t	t					X	X	CR
27	Set Low Supply Temp Alarm	.	0	1	2	7	s	L	o	S	p	T	A	l	+/-	t	t	t	t					X	X	CR
28	Set Hi Ambient Temp Alarm	.	0	1	2	8	s	H	i	A	m	T	A	l	+/-	t	t	t	t					X	X	CR
29	Set Low Ambient Temp Alarm	.	0	1	2	9	s	L	o	A	m	T	A	l	+/-	t	t	t	t					X	X	CR
30	Set Low Process Flow Alarm	.	0	1	3	0	s	L	o	P	F	l	A	l	+	f	f	f	f					X	X	CR
31	Reserved (not used)																									
32	Reserved (not used)																									
33	Reserved (not used)																									
34	Read Hi Supply Temp Warn	.	0	1	3	4	r	H	i	S	p	T	W	n										F	5	CR
35	Read Low Supply Temp Warn	.	0	1	3	5	r	L	o	S	p	T	W	n										0	0	CR
36	Read Hi Ambient Temp Warn	.	0	1	3	6	r	H	i	A	m	T	W	n										E	2	CR
37	Read Low Ambient Temp Warn	.	0	1	3	7	r	L	o	A	m	T	W	n										E	D	CR
38	Read Low Process Flow Warn	.	0	1	3	8	r	L	o	P	F	l	W	n										E	E	CR
39	Read Hi Supply Temp Alarm	.	0	1	3	9	r	H	i	S	p	T	A	l										E	2	CR
40	Read Low Supply Temp Alarm	.	0	1	4	0	r	L	o	S	p	T	A	l										E	4	CR
41	Read Hi Ambient Temp Alarm	.	0	1	4	1	r	H	i	A	m	T	A	l										C	6	CR
42	Read Low Ambient Temp Alarm	.	0	1	4	2	r	L	o	A	m	T	A	l										D	1	CR
43	Read Low Process Flow Alarm	.	0	1	4	3	r	L	o	P	F	l	A	l										D	2	CR
44	Reserved (not used)																									
45	Reserved (not used)																									
46	Read PWM and Relay Status	.	0	1	4	6	r	P	u	l	W	d	M	o										1	3	CR
47	Reserved																									
48	Read PID Status	.	0	1	4	8	r	P	I	D	S	t	a	t										E	6	CR
49	Read Unit Up Time	.	0	1	4	9	r	U	p	T	i	m	e	_										2	1	CR
50	Read Fan 1 Speed	.	0	1	5	0	r	F	a	n	S	p	d	1										D	3	CR
51	Read Fan 2 Speed	.	0	1	5	1	r	F	a	n	S	p	d	2										D	5	CR
52	Read Fan 3 Speed	.	0	1	5	2	r	F	a	n	S	p	d	3										D	7	CR
53	Read Fan 4 Speed	.	0	1	5	3	r	F	a	n	S	p	d	4										D	9	CR
54	Reserved																									
55	Reserved																									
56	Reserved																									
57	Reserved																									
58	Reserved																									
59	Set Default User EEPROM	.	0	1	5	9	s	D	U	s	r	E	E	P	U									1	D	CR
60	Reserved																									

RESPONSE MESSAGE

		SOR	DEVICE ID		COMMAND NUMBER		ERROR	COMMAND NAME								RESPONSE DATA												CHECK SUM		EOR
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			25	26	27
1	Serial WatchDog	#	0	1	0	1	0	W	a	t	c	h	D	o	g	CS	PS	AS	WS									X	X	CR
2	Read Control Sensor	#	0	1	0	2	0	r	C	t	r	l	S	e	n	SN												X	X	CR
3	Read Set Temperature	#	0	1	0	3	0	r	S	e	t	T	e	m	p	+/-	t	t	t	t								X	X	CR
4	Read Supply Temperature	#	0	1	0	4	0	r	S	u	p	p	l	y	T	+/-	t	t	t	t								X	X	CR
5	Read External RTD	#	0	1	0	5	0	r	E	x	t	R	T	D	_	+/-	t	t	t	t								X	X	CR
6	Read External Thermistor	#	0	1	0	6	0	r	E	x	t	T	h	r	m	+/-	t	t	t	t								X	X	CR
7	Read Return Temperature	#	0	1	0	7	0	r	R	e	t	u	r	n	T	+/-	t	t	t	t								X	X	CR
8	Read Ambient Temperature	#	0	1	0	8	0	r	A	m	b	T	e	m	p	+/-	t	t	t	t								X	X	CR
9	Read Process Flow	#	0	1	0	9	0	r	P	r	o	s	F	l	o	+	f	f	f	f								X	X	CR
10	Read TEC Bank 1 Current	#	0	1	1	0	0	r	T	E	C	B	1	C	r	+/-	i	i	i	i								X	X	CR
11	Read TEC Bank 2 Current	#	0	1	1	1	0	r	T	E	C	B	2	C	r	+/-	i	i	i	i								X	X	CR
12	Set Extern Sensor Status	#	0	1	1	2	0	s	E	x	t	S	e	n	s	ES												X	X	CR
13	Read TE Drive Level	#	0	1	1	3	0	r	T	E	C	D	r	L	v	z	z	z	,	r								X	X	CR
14	Reserved (not used)																													
15	Set Chiller Status	#	0	1	1	5	0	s	S	t	a	t	u	s	_	SS												X	X	CR
16	Set Control Sensor	#	0	1	1	6	0	s	C	t	r	l	S	e	n	SN												X	X	CR
17	Set Control Temperature	#	0	1	1	7	0	s	C	t	r	l	T	_	_	+/-	t	t	t	t								X	X	CR
18	Read Alarm State Level 1	#	0	1	1	8	0	r	A	l	r	m	L	v	1	A0	A1	A2	A3	A4	A5							X	X	CR
19	Read Alarm State Level 2	#	0	1	1	9	0	r	A	l	r	m	L	v	2	1	B0	B1	B2	B3	B4	B5	B6	B7				X	X	CR
		#	0	1	1	9	0	r	A	l	r	m	L	v	2	2	C0	C1	C2	C3	C4	C5	C6	C7				X	X	CR
20	Read Warning State Level 1	#	0	1	2	0	0	r	W	a	r	n	L	v	1	W0	W1	W2	W3									X	X	CR
21	Set Hi Supply Temp Warn	#	0	1	2	1	0	s	H	i	S	p	T	W	n	+/-	t	t	t	t								X	X	CR
22	Set Low Supply Temp Warn	#	0	1	2	2	0	s	L	o	S	p	T	W	n	+/-	t	t	t	t								X	X	CR
23	Set Hi Ambient Temp Warn	#	0	1	2	3	0	s	H	i	A	m	T	W	n	+/-	t	t	t	t								X	X	CR
24	Set Low Ambient Temp Warn	#	0	1	2	4	0	s	L	o	A	m	T	W	n	+/-	t	t	t	t								X	X	CR
25	Set Low Process Flow Warn	#	0	1	2	5	0	s	L	o	P	F	l	W	n	+	f	f	f	f								X	X	CR
26	Set Hi Supply Temp Alarm	#	0	1	2	6	0	s	H	i	S	p	T	A	l	+/-	t	t	t	t								X	X	CR
27	Set Low Supply Temp Alarm	#	0	1	2	7	0	s	L	o	S	p	T	A	l	+/-	t	t	t	t								X	X	CR
28	Set Hi Ambient Temp Alarm	#	0	1	2	8	0	s	H	i	A	m	T	A	l	+/-	t	t	t	t								X	X	CR
29	Set Low Ambient Temp Alarm	#	0	1	2	9	0	s	L	o	A	m	T	A	l	+/-	t	t	t	t								X	X	CR
30	Set Low Process Flow Alarm	#	0	1	3	0	0	s	L	o	P	F	l	A	l	+	f	f	f	f								X	X	CR
31	Reserved (not used)																													
32	Reserved (not used)																													
33	Reserved (not used)																													
34	Read Hi Supply Temp Warn	#	0	1	3	4	0	r	H	i	S	p	T	W	n	+/-	t	t	t	t								X	X	CR
35	Read Low Supply Temp Warn	#	0	1	3	5	0	r	L	o	S	p	T	W	n	+/-	t	t	t	t								X	X	CR
36	Read Hi Ambient Temp Warn	#	0	1	3	6	0	r	H	i	A	m	T	W	n	+/-	t	t	t	t								X	X	CR
37	Read Low Ambient Temp Warn	#	0	1	3	7	0	r	L	o	A	m	T	W	n	+/-	t	t	t	t								X	X	CR
38	Read Low Process Flow Warn	#	0	1	3	8	0	r	L	o	P	F	l	W	n	+	f	f	f	f								X	X	CR
39	Read Hi Supply Temp Alarm	#	0	1	3	9	0	r	H	i	S	p	T	A	l	+/-	t	t	t	t								X	X	CR
40	Read Low Supply Temp Alarm	#	0	1	4	0	0	r	L	o	S	p	T	A	l	+/-	t	t	t	t								X	X	CR
41	Read Hi Ambient Temp Alarm	#	0	1	4	1	0	r	H	i	A	m	T	A	l	+/-	t	t	t	t								X	X	CR
42	Read Low Ambient Temp Alarm	#	0	1	4	2	0	r	L	o	A	m	T	A	l	+/-	t	t	t	t								X	X	CR
43	Read Low Process Flow Alarm	#	0	1	4	3	0	r	L	o	P	F	l	A	l	+	f	f	f	f								X	X	CR
44	Reserved (not used)																													
45	Reserved (not used)																													
46	Read PWM and Relay Status	#	0	1	4	6	0	r	P	u	l	W	d	M	o	y	y	y	,	r								X	X	CR
47	Reserved																													
48	Read PID Status	#	0	1	4	8	0	r	P	I	D	S	t	a	t	+/-	t	t	t	t	,	k						X	X	CR
49	Read Unit Up Time	#	0	1	4	9	0	r	U	p	T	I	m	e	_	m	m	m	m	m	m							X	X	CR
50	Read Fan 1 Speed	#	0	1	5	0	0	r	F	a	n	S	p	d	1	h	h	h	h									X	X	CR
51	Read Fan 2 Speed	#	0	1	5	1	0	r	F	a	n	S	p	d	2	h	h	h	h									X	X	CR
52	Read Fan 3 Speed	#	0	1	5	2	0	r	F	a	n	S	p	d	3	h	h	h	h									X	X	CR
53	Read Fan 4 Speed	#	0	1	5	3	0	r	F	a	n	S	p	d	4	h	h	h	h									X	X	CR
54	Reserved																													
55	Reserved																													
56	Reserved																													
57	Reserved																													
58	Reserved																													
59	Set Default User EEPROM	#	0	1	5	9	0	s	D	U	s	r	E	E	P	U												4	2	CR
60	Reserved																													

ALARMS & WARNINGS

Char	Value	Alarm
A0	0	No Alarm
	1	Ambient Temp. Sensor Alarm
	2	High Control Temperature Alarm
	4	PT7 High Temperature Alarm
	8	Low Control Temperature Alarm
A1	0	No Alarm
	1	Supply Temp Sensor Alarm (Latched)
	2	External RTD Sensor Alarm
	4	Return Temperature Sensor Alarm
	8	External Thermistor Sensor Alarm
A2	0	No Alarm
	1	Low Coolant Level Alarm (Latched)
	2	Low Process Flow Alarm
	4	Low Plant Flow Alarm
	8	Current Sensor 1 Alarm
A3	0	No Alarm
	1	PT7 Low Temperature Alarm
	2	High Ambient Temperature Alarm
	4	Low Ambient Temperature Alarm
	8	External Connector Not Installed
A4	0	No Alarm
	1	Default High Temperature Alarm
	2	Default Low Temperature Alarm
	4	No Process Flow Alarm
	8	Fan Failure Alarm
A5	0	No Alarm
	1	Current Sensor 2 Alarm
	2	Internal 2.5V Reference Alarm
	4	Internal 5V Reference Alarm
	8	System Error Alarm (Global)

Char	Value	Alarm
B0	0	No Alarm
	1	Reserved (Not Used)
	2	Reserved (Not Used)
	4	Reserved (Not Used)
	8	Reserved (Not Used)
B1	0	No Alarm
	1	ADC System Error Alarm
	2	I2C System Error Alarm
	4	EEPROM System Error Alarm
	8	Watchdog System Error Alarm
B2	0	No Alarm
	1	Reserved (Not Used)
	2	Reserved (Not Used)
	4	Reserved (Not Used)
	8	Reserved (Not Used)
B3	0	No Alarm
	1	ADC Reset Error Alarm
	2	ADC Calibration Error Alarm
	4	ADC Conversion Error Alarm
	8	Reserved (Not Used)
B4	0	No Alarm
	1	IO Expender Acknowledge Error Alarm
	2	PSA IO Expender Acknowoledge Alarm
	4	RTC Acknowledge Error Alarm
	8	Reserved (Not Used)
B5	0	No Alarm
	1	I2C SCL Low Error Alarm
	2	I2C SDA Low Error Alarm
	4	EEPROM 1 (U201) Acknowledge Alarm
	8	EEPROM 2 (U200) Acknowledge Alarm
B6	0	No Alarm
	1	Reserved (Not Used)
	2	Reserved (Not Used)
	4	Reserved (Not Used)
	8	Reserved (Not Used)
B7	0	No Alarm
	1	EEPROM 1 (U201) Read Error Alarm
	2	EEPROM 1 (U201) Write Error Alarm
	4	EEPROM 2 (U200) Read Error Alarm
	8	EEPROM 2 (U200) Write Error Alarm

Char	Value	Alarm
C0	0	No Alarm
	1	External RTD Sensor Open Alarm
	2	External RTD Sensor Short Alarm
	4	Return Temp Sensor Open Alarm
	8	Return Temp Sensor Open Alarm
C1	0	No Alarm
	1	Global Supply Temp Sensor Alarm
	2	Supply Temp Sensor Locked Alarm
	4	Supply Temp Sensor Open Alarm
	8	Supply Temp Sensor Short Alarm
C2	0	No Alarm
	1	Internal 2.5V Reference High Alarm
	2	Internal 2.5V Reference Low Alarm
	4	Internal 5V Reference High Alarm
	8	Internal 5V Reference Low Alarm
C3	0	No Alarm
	1	External Therm. Sensor Open Alarm
	2	External Therm. Sensor Short Alarm
	4	Ambient Temp Sensor Open Alarm
	8	Ambient Temp Sensor Short Alarm
C4	0	No Alarm
	1	Reserved (Not Used)
	2	Reserved (Not Used)
	4	Reserved (Not Used)
	8	Reserved (Not Used)
C5	0	No Alarm
	1	Current Sensor 1 Open Alarm
	2	Current Sensor 1 Short Alarm
	4	Current Sensor 2 Open Alarm
	8	Current Sensor 2 Short Alarm
C6	0	No Alarm
	1	Rear Left Fan Noise Alarm
	2	Rear Right Fan Noise Alarm
	4	Front Left Fan Noise Alarm
	8	Front Right Fan Noise Alarm
C7	0	No Alarm
	1	Rear Left Fan Open Alarm
	2	Rear Right Fan Open Alarm
	4	Front Left Fan Open Alarm
	8	Front Right Fan Open Alarm

Char	Value	Warning
W0	0	No Alarm
	1	Low Process Flow Warning
	2	Process Fluid Level Warning
	4	Switch to Supply Temp as Control Temp Warning
	8	Reserved (Not Used)
W1	0	No Alarm
	1	High Control Temp Warning
	2	Low Control Temp Warning
	4	High Ambient Temp Warning
	8	Low Ambient Temp Warning
W2	0	No Alarm
	1	Reserved (Not Used)
	2	Reserved (Not Used)
	4	Reserved (Not Used)
	8	Reserved (Not Used)
W3	0	No Alarm
	1	Reserved (Not Used)
	2	Reserved (Not Used)
	4	Reserved (Not Used)
	8	Reserved (Not Used)

Title:	TTK Serial Communication Protocol Release II	Rev:	X2.003	Date: 11/2/06

LEGEND

No	Symbol	Description	Unit	Range	Example
1	CS	Control Status Mode		0 - 4	0 - Auto-start, 1 - Standby, 2 - Run, 3 - Safety, 4 - Test
2	PS	Pump Status Flag		0 - 1	0 - Pump OFF, 1 - Pump ON
3	AS	Alarm Status Flag		0 - 1	0 - No Alarm, 1 - Alarm Present
4	WS	Warning Status Flag		0 - 1	0 - No Warning, 1 - Warning Present
5	SN	Control Sensor		0 - 3	0 - Supply temp, 1 - Return temp , 2 - Ext RTD, 3 - External termistor
6	tttt	Temp Data Format	degC	000.0 - 999.9	tttt = 0152 - 15.2 degC
7	ffff	Flow Data Format	lpm	000.0 - 999.9	ffff = 0032 - 3.2lpm
8	iiii	Current Data Format	ADC	0.000 - 9.999	iiii = 2152 - 2.152 ADC
9	ES	External Sensor Status		0 - 1	0 - External Sensors Disabled, 1 - External Sensors Enabled
10	zzz	Format for %	%	0-100	zzz = 063 - 63%
11	r	Relay Status		C, H	C- Cool Mode, H - Heat Mode
12	SS	Chiller Status		0 - 1	0 - Standby, 1 - Run
13	A0 - A5	Alarm Level 1 Status		0-F	see Alarm and Warning Section for more details
14	B0 - B7	Alarm Level 2 Status 1		0-F	see Alarm and Warning Section for more details
15	C0 - C7	Alarm Level 2 Status 2		0-F	see Alarm and Warning Section for more details
16	W0-W3	Warning Level 1 Status		0-F	see Alarm and Warning Section for more details
17	yyy	PWM Output		1-255	yyy = 190 - PWM output (duty cycle) is 190
18	k	PID Mode Flag		0 - 9	
19	mmmmmm	Unit Up Time	min	000000 - 999999	mmmmmm = 001234 - 1234 minutes
20	hhhh	Fan Speed	Hz	0000 - 9999	hhhh = 0131 - 131Hz (see Fan position chart)