



2008[®] Series Remote Protocol Manual

2008 Series Remote Protocol Manual

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CONTENTS

About this manual.....	4
Definitions.....	5
CHAPTER 1	
Communications Protocol Overview.....	6
CHAPTER 2	
Data Format.....	8
CHAPTER 3	
Standard Communication Protocol.....	12
CHAPTER 4	
Checksum Communication Protocol.....	13
APPENDIX A	
Commands.....	18
APPENDIX B	
Group Codes.....	19
APPENDIX C	
Field Codes.....	20

About this manual...

The purpose of the *2008 Series Remote Protocol Manual* is to provide a guideline for software developers to generate external applications to be used in conjunction with the 2008T, 2008K, 2008K², or the 2008K@Home™ hemodialysis machine. It is not intended as a guide for performing hemodialysis, a medical treatment that should only be performed under the supervision of a licensed physician.

This document should be used in conjunction with the appropriate operator's manual, depending on the model of hemodialysis machine:

- 2008T Hemodialysis Machine Operator's Manual – P/N 490122
- 2008K Hemodialysis Machine Operator's Manual – P/N 490042
- 2008K² Hemodialysis Machine Operator's Manual – P/N 490136
- 2008K@Home User's Guide – P/N 490180

This manual is organized to guide a software application developer through the syntax expected by the Remote Protocol associated with 2008 Series hemodialysis machines. It begins with the general Communications Protocol Overview, which describes the communications settings necessary for the transmission of data. Next, the programmer is guided through the data format that should be used when communicating with the machine. Finally, the manual leads the reader through the two communication protocols that may be used with a 2008 series hemodialysis machine: standard and checksum. Also included in the appendices are details about the data that may be sent to the machine and the expected information returned by the machine.

The organization of the *2008 Series Remote Protocol* is as follows:

- **Preface**
Identifies the intended audience, and describes how the manual is organized.
- **Chapter 1 – Communications Protocol Overview**
Introduces the operator to the machine interface communication and the framework for communication with a 2008 Series hemodialysis machine.
- **Chapter 2 – Data Format**
Provides instructions on the structure of the data to be transmitted to and from the machine.
- **Chapter 3 – Standard Communication Protocol**
Describes the standard packet structure involved in communicating with the machine.
- **Chapter 4 – Checksum Communication Protocol**
Guides the user through the steps and structure involved in the checksum procedure.
- **Appendix A: Commands**
- **Appendix B: Group Codes**
- **Appendix C: Field Codes**

Definitions

Abbreviation	Meaning
ASCII	ASCII stands for “American Standard Code for Information Interchange”
Machine	Any 2008 Series hemodialysis machine. (i.e. 2008K, 2008K ² , 2008K@Home, 2008T)
RS232	RS232 stands for “Recommended Standard 232” of serial communication
Host	The computer or hardware that houses the communicating application.
<SOH>	ASCII control character 0x01. Start of header.
<STX>	ASCII control character 0x02. Start of transmission.
<ETX>	ASCII control character 0x03. End of transmission.
<ACK>	ASCII control character 0x06. Positive Acknowledgement.
<NAK>	ASCII control character 0x15. Negative Acknowledgement.
TMP	Trans-Membrane Pressure
BTM	Blood Temperature Module
BVM	Blood Volume Module
UF	Ultra Filtrate
SVS	Sodium Variation System
Kecn	Effective Conductivity Clearance
Kt/V	Dialysis Treatment Adequacy
OLC	Online Clearance

Questions?

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Chapter 1

Communications Protocol Overview

Asynchronous RS232 serial communication is used to communicate between the 2008 Series machine and the Host. The data transmission uses Transmit and Receive lines. The baud rate shall be 9600, 8 data bits, 1 stop bit, no parity. No hardware handshaking is supported.

On all 2008 series machines, the serial communications protocol is available on an isolated serial port on the back of the machine. This isolated serial port is physically a D-type 9-pin plug. On this connector, pin 2 is transmit, pin 3 is receive, and pin 5 is signal ground. When connecting to a standard 9-pin serial port on a PC, the cable may be wired with all pins straight through. No other ground connection other than pin 5 on the serial port connector should be made between the Host and the machine to prevent leakage current from the Host from entering the machine. The 9-pin connector shells should not be wired together on the cable.

The 2008T machine contains an optional built-in PC known as the CDX. The CDX is connected from serial port COM1 to the 2008 series processor for serial communications. This connection is independent from the serial connection on the back of the 2008T. Either or both connection may be used and they both work independently.

All communications shall be initiated by the Host, which can send multiple data packets at a time. These packets can specify requests for information to be transmitted back from the machine, as well as the frequency at which the data is sent. The machine, in turn, shall send the corresponding field data back to the Host by the specified time interval. The only exception shall be for alarm packets, which shall be sent as soon as the alarm occurs.

There are two types of communication protocols that can be used when interacting with the 2008 Series hemodialysis machine:

- Standard Protocol

This is the fundamental layer of data protocol. It involves a simple set of request and response data packets without handshaking. (See Chapter 3)

- Checksum Protocol

This is the data protocol that encapsulates the data inside. The protocol adds header and checksum components for data security, as well as handshaking to enhance communication. The Checksum Protocol can also be referred to as “New Protocol” or “iCare Protocol”. (See Chapter 4)

The communication can be configured to run either protocol by entering the machine’s Service Mode. To enter Service Mode, turn on the machine and press the [Enter] key when prompted “Press CONFIRM For Service Mode”. After the machine boots up in Service Mode, navigate to the *Options* menu and select *Comm Options*. On this screen, the “New Protocol” button controls the communication type. To configure the communication for the CDX on the 2008T hemodialysis machine, this screen also contains a “CDX New Protocol” button. Selecting *Yes* enables the Checksum Protocol; selecting *No* enables the Standard Protocol. After selecting the intended protocol, press the [Enter] key to confirm the selection.

Chapter 2

Data Format

A packet shall contain a single Data Section that may fall under one of three categories:

- **Control**
- **Field**
- **Acknowledgement.**

Control-type Data

A **Control**-type data packet can only be sent from the Host to the 2008 Series hemodialysis machine.

The data may include one or more of the following components: *Commands*, *Group Codes*, and *Interval Updates*. Each component should be separated by a comma.

A *Command* is a 2- or 3-character string that prompts the machine to perform a function. No data should be transmitted back from the machine in response to a *Command*.

A *Group Code* is a 2-character string that prompts the machine to send **Field** packets back to the Host that correspond with the designated group. (See Appendix B)

An *Interval Update* is a 2- or 3-character string that prompts the machine to change the frequency at which data is sent back from the machine. The default interval is 0 seconds. The minimum interval in Standard Protocol is 10 seconds; the minimum interval in Checksum Protocol is 11 seconds. The maximum interval for both protocols is 600 seconds. Any value outside the range of accepted values is defaulted to 0. When an *Interval Update* is successfully transmitted, the machine's internal interval timer resets.

When each component is received, the machine updates an internal list of controls, adding the component to the list if it was not already called. Duplicate controls shall be treated as if only one instance of the control is made. Invalid controls shall be ignored by the machine. The only way to clear the list is to send a Reset *Command* "CX". This *Command* also resets the interval to 0 unless followed by an *Interval Update*.

Components of a **Control**-type data packet shall be read from left to right. Items listed before a *Reset Command* shall be cleared and replaced with the items after “CX”. Also, in the case of multiple *Interval Updates*, only the rightmost integer shall be considered.

Here are some examples of valid **Control**-type Data Sections*:

Example 1: CX

0x43 0x58

Situation: Single Control

Result: Prompt the machine to reset communications (including the interval)

Example 2: DI,VX,013

0x44 0x49 0x2C 0x56 0x58 0x2C 0x30 0x31 0x33

Situation: Multiple Controls

Result: Prompt the machine to send DI and VX group data packets (TP, DF, CD, BF; VP, VH, VL) to the Host every 13 seconds.

Example 3: BP,CX,DI

0x42 0x50 0x2C 0x43 0x58 0x2C 0x44 0x49

Situation: Embedded CX

Result: Prompt the machine to reset communications (including the interval) and send DI group data packets (TP, DF, CD, BF). Data will not be sent from the machine until an interval update.

Example 4: BP,011,DI,015

0x42 0x50 0x2C 0x30 0x31 0x31 0x2C 0x44 0x49 0x2C 0x30 0x31 0x35

Situation: Multiple *Interval Updates*

Result: Prompt the machine to send BP and DI group data packets (SY, DY, PL, MA; TP, DF, CD, BF) to the Host every 15 seconds.

Example 5: BP,BP

0x42 0x50 0x2C 0x42 0x50

Situation: Duplicate *Group Codes*

Result: Prompt the machine to send BP group data packets (SY,DY,PL,MA). This will occur at the specified interval.

* Each example shows the ASCII string of the **Controls**. The subsequent line represents the hexadecimal ASCII of the data.

Field-type Data

A **Field**-type data packet can only be sent from the 2008 Series hemodialysis machine to the Host. It shall contain information requested by previous **Control**-type data packets. These packets shall be sent continuously at the specified interval until a Reset *Command* is received.

This data is composed of any number of **Field** items. Each item is separated by a comma. If there is no data to be transmitted under Standard Protocol, the Data Section shall remain empty but the packet will be sent at the specified interval. Otherwise, if there is no data to be transmitted in Checksum Protocol, the machine will not send any packet back.

Each item has two components: a 2-character *Field Code* and a corresponding *Field Value*. Certain *Field Codes* are only available when running Checksum Protocol. The format of the *Field Value* is dependent on the *Field Code*. (See Appendix C)

Here are some examples of valid **Field**-type Data Sections*:

Example 1: UR0600,UTT

0x55 0x52 0x30 0x36 0x30 0x30 0x2C 0x55 0x54 0x54

Situation: Host sent UF *Group Code*

Result: UF rate (xxxx) = 600 mL/min.

UF on (T/F) = True

Example 2: RIF,DSF,DIT,BST

0x52 0x49 0x46 0x2C 0x44 0x53 0x46 0x2C 0x44 0x49 0x54 0x2C 0x42 0x53 0x54

Situation: Host sent MS *Group Code*

Result: Rinse Mode (T/F) = False

Disinfect Mode (T/F) = False

Dialysis Mode (T/F) = True

Blood Sensed (T/F) = True

* Each example shows the ASCII string of the **Fields**. The subsequent line represents the hexadecimal ASCII of the data. Items within the result parentheses display the *Field Value* data formats of their respective *Field Codes*.

Acknowledgment-type Data

An **Acknowledgement**-type data packet can be sent by either the Host or the 2008 Series hemodialysis machine. It should be sent after receiving a Control or Field packet only in Checksum Protocol.

This data is generated after verifying the checksum of a received **Control**-type or **Field**-type data packet. The result of the verification dictates the appropriate acknowledgement response.

The Data section can contain exactly one of two characters*:

<ACK>

0x06

Description: Sends a *Positive Acknowledgement* response.

<NAK>

0x15

Description: Sends a *Negative Acknowledgement* response.

* Each **Acknowledgement** is a one-character response. The subsequent line represents the hexadecimal ASCII of the data.

The <ACK> *Positive Acknowledgement* is sent in response to a valid checksum. Likewise, the <NAK> *Negative Acknowledgment* is sent in response to an invalid checksum. Further explanation is provided in Chapter 4 – Checksum Communication Protocol.

Chapter 3

Standard Communication Protocol

The Standard Communication Protocol is the basic layer of data transmission between the Host and the 2008 Series hemodialysis machine. Upon machine start-up, the interval at which **Field** packets are sent defaults to 0 seconds (i.e. no packet sent). The machine shall wait to receive an initial **Control** packet from the Host. When receiving a **Control** packet, the machine shall update an internal list of **Controls** and send the appropriate **Field** packets to the Host at a specified interval. If the machine receives a lone Reset *Command* or an *Interval Update* that is out of range, it shall stop sending **Field** packets.

The data packet of the Standard Communication Protocol follows the following format:



Section	Length (Bytes)	Description
Data	Size (variable)	ASCII Packet information (See Chapter 2 – Data Format)
<CR>	1	Carriage Return character (ASCII hexadecimal 0x0D)

Here are some examples of valid Standard Protocol data packets*:

Example 1: CX,015<CR>

0x43 0x58 0x2C 0x30 0x31 0x35 0x0D

Situation: **Control** Packet sent from the Host to the machine

Result: Clear the internal list and set the interval to 15 seconds.

Example 2: UR0700,UTT<CR>

0x55 0x52 0x30 0x37 0x30 0x30 0x2C 0x55 0x54 0x54 0x0D

Situation: **Field** Packet sent from the machine to the Host

Result: UF Rate = 700 mL/min., UF on = True

* Each example shows the ASCII representation of the Standard data packet. The subsequent line represents the same information in hexadecimal ASCII.

*Chapter 4***Checksum Communication Protocol**

The Checksum Communication Protocol provides another layer of security to the already existing Standard Communication Protocol. Each **Control** and **Field** packet is validated by the receiving member through the verification of the checksum. This protocol differs from the Standard Communication Protocol in its handshaking procedure and in its data packet format.

Handshaking Process

For every **Control** or **Field** packet sent, there are two members: a *Sender* and a *Receiver*. When transmitting a **Control** packet, the Host is the *Sender* and the machine is the *Receiver*. Likewise, when transmitting a **Field** packet, the machine is the *Sender* and the Host is the *Receiver*.

When the *Sender* transmits a data packet, it shall initialize an internal counter and wait 5 seconds for an **Acknowledgment** response. If the *Receiver* does not send this response within 5 seconds, the *Sender* should time out after 5 seconds, increment the count, and send the packet again. This situation may occur when the *Receiver* fails to detect incoming data.

Otherwise, if the *Receiver* successfully obtains the sent data packet, it will verify that the checksum in the packet corresponds with the received data. If the checksum is valid, the *Receiver* shall return a *Positive Acknowledgement* response with the same sequence number as the data packet it validated. If the checksum is invalid, the *Receiver* shall return a *Negative Acknowledgment* response with the same sequence number as the data packet it attempted to validate.

When the *Sender* identifies a *Positive Acknowledgment* response, it will reset the internal counter and proceed to send the next data packet. If the *Sender* encounters a *Negative Acknowledgment* response, it shall increment the count and resend the original data packet. This cycle can be repeated until 3 send attempts have been made (i.e. the count reaches 3). At this point, the *Sender* shall reset the internal counter and proceed to send the next data packet.

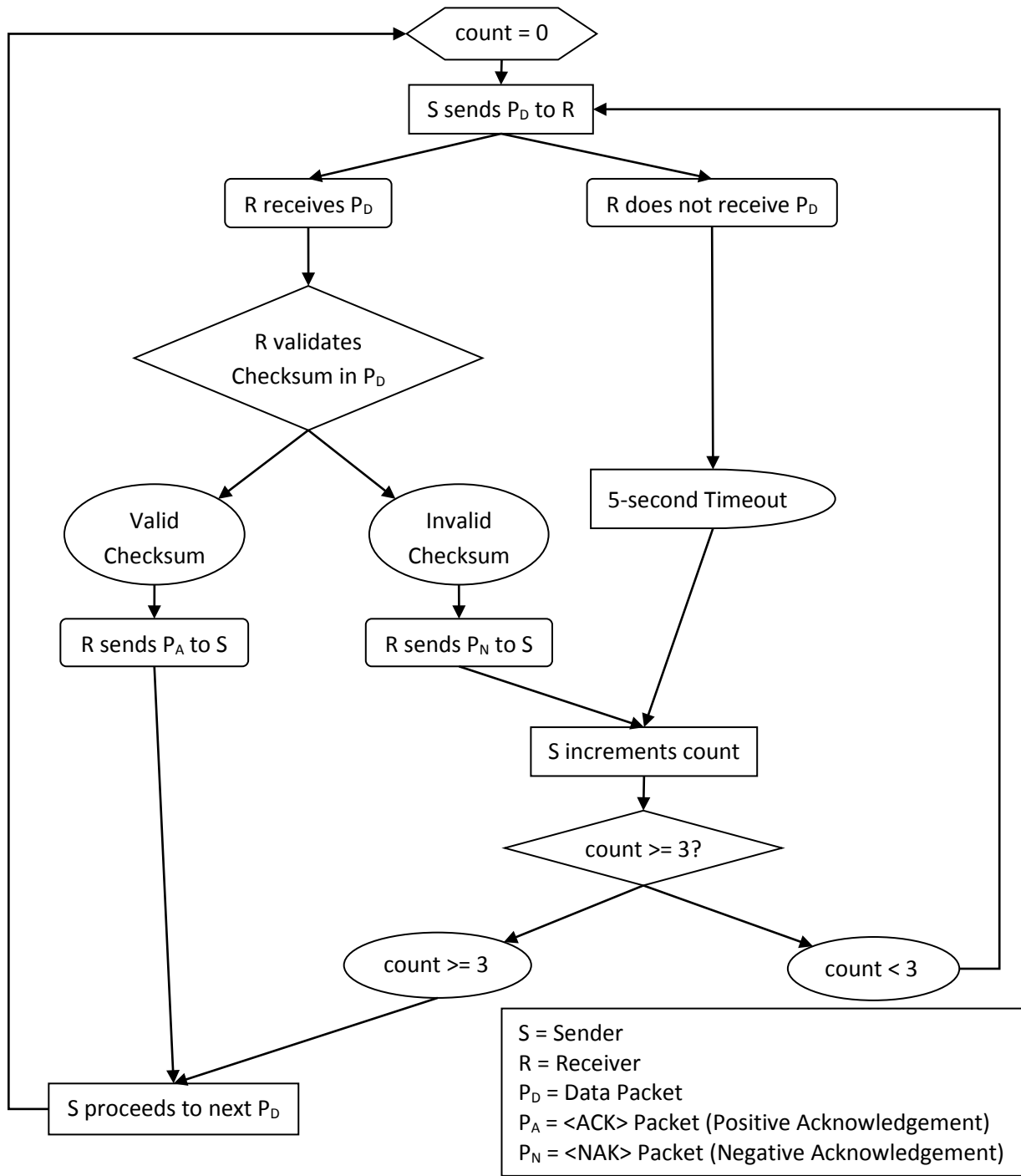
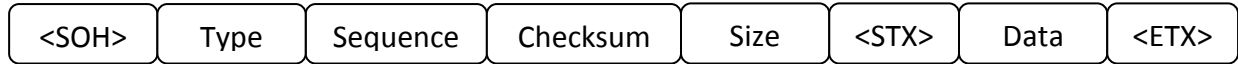


Figure 1 – Checksum Communication Protocol Handshaking Process

Packet Format

The data packet of the Checksum Communication Protocol follows the following format:



Name	Length (Bytes)	Description
<SOH>	1	Start of packet/header <SOH> (ASCII hexadecimal 0x01) Represents the beginning of a Checksum Communication Packet. If missing, the packet shall be ignored.
Packet Type	1	Designates the packet type. (ASCII hexadecimal 0x46) Currently, only Full-type “F” is supported.
Sequence Number	1	Number of sequence from hexadecimal 0 to F. (ASCII hexadecimal 0x30 to 0x39, 0x41 to 0x46) Incremented each time a new Field or Control packet is sent. An Acknowledgement packet shall use the same sequence number as the original packet to which it is responding. The Host and the Machine maintain their own independent sequence counter. When a sequence number reaches F, the next number shall wrap back to 0.
Checksum	4	Data checksum in hexadecimal. Calculated as the sum of the ASCII hexadecimal values that make up the Data Section.
Size	3	Number of bytes in the Data Section. Expressed in decimal format.
<STX>	1	Start of Packet Data/Acknowledgement <STX> (ASCII hexadecimal 0x02) Represents the beginning of the Data Section.
Data	Size (≤ 999)	ASCII Packet Data See Chapter 2 – Data Format If <i>Positive Acknowledgment</i> , this section will only contain <ACK> (ASCII hexadecimal 0x06). If <i>Negative Acknowledgement</i> , this section will only contain <NAK> (ASCII hexadecimal 0x15).
<ETX>	1	End of Packet Data <ETX> (ASCII hexadecimal 0x03) Represents the end of the Data section, as well as the end of the Checksum packet.

Here are some examples of valid Checksum Protocol data packets*:

Example 1: CX

Item	Value	ASCII Hexadecimal
Checksum	$0x43 + 0x58 = 0x009B$	0x30 0x30 0x39 0x42
Size	002	0x30 0x30 0x32
Packet	<STX>F0009B002<STX>CX<ETX>	0x01 0x46 0x30 0x30 0x30 0x39 0x42 0x30 0x30 0x32 0x02 0x43 0x58 0x03

Example 2: BV,011

Item	Value	ASCII Hexadecimal
Checksum	$0x42 + 0x56 + 0x2C + 0x30 + 0x31 + 0x31 = 0x0156$	0x30 0x31 0x35 0x36
Size	006	0x30 0x30 0x36
Packet	<STX>F00156006<STX>BV,011<ETX>	0x01 0x46 0x30 0x30 0x31 0x35 0x36 0x30 0x30 0x36 0x02 0x42 0x56 0x2C 0x30 0x31 0x31 0x03

Example 3: UR0600,UTT

Item	Value	ASCII Hexadecimal
Checksum	$0x55 + 0x52 + 0x30 + 0x36 + 0x30 + 0x30 + 0x2C + 0x55 + 0x54 + 0x54 = 0x0296$	0x30 0x32 0x39 0x36
Size	010	0x30 0x31 0x30
Packet	<STX>F00296010<STX>UR0600,UTT<ETX>	0x01 0x46 0x30 0x30 0x32 0x39 0x36 0x30 0x31 0x30 0x02 0x55 0x52 0x30 0x36 0x30 0x30 0x2C 0x55 0x54 0x54 0x03

Example 3: <ACK>

Item	Value	ASCII Hexadecimal
Checksum	0x06 = 0x0006	0x30 0x30 0x30 0x36
Size	001	0x30 0x30 0x31
Packet	<STX>F00006001<STX><ACK><ETX>	0x01 0x46 0x30 0x30 0x30 0x30 0x36 0x30 0x30 0x31 0x02 0x06 0x03

Example 4: <NAK>

Item	Value	ASCII Hexadecimal
Checksum	0x15 = 0x0015	0x30 0x30 0x31 0x35
Size	001	0x30 0x30 0x31
Packet	<STX>F00015001<STX><NAK><ETX>	0x01 0x46 0x30 0x30 0x30 0x31 0x35 0x30 0x30 0x31 0x02 0x15 0x03

Note: With some versions of the 2008T hemodialysis machine, the *Negative Acknowledgement* packet has a different format, as seen below. In this packet, no “End of Transmission” character <ETX> is sent.

Item	Value	ASCII Hexadecimal
Checksum	0x15 = 0x0015	0x30 0x30 0x31 0x35
Size	001	0x30 0x30 0x31
Packet	<STX>F00015001<STX><ACK><NAK>	0x01 0x46 0x30 0x30 0x30 0x31 0x35 0x30 0x30 0x31 0x02 0x06 0x15

* Each example shows the intended data to be transmitted and its corresponding Checksum packet. The sequence number for all these examples is 0.

Appendix A

Commands

Command Code	Meaning	Comments
CX	Reset communications	Send as the first command, or whenever needed
DXF*	Turn Green traffic/status light off	
DXT*	Turn Green traffic/status light on	
EXF*	Turn Yellow traffic/status light off	
EXT*	Turn Yellow traffic/status light on	
CG	Change the color of the communication icon for a 60-second duration (only available in Checksum Protocol on the 2008K@Home)	This command changes the color of the communication icon (phone) in the dialogue box to: <ul style="list-style-type: none"> - Grey – power on or dialysis paused - Green – signal received during treatment - Red – no signal received in 1 minute during treatment
###	Communication interval time. Begin sending data packets every ### seconds	ASCII number from minimum to 600. Minimum is 10 in Standard Protocol; minimum is 11 in Checksum Protocol. If out of range, the interval time defaults to 000. In Standard Protocol, an interval time of 0 seconds means that no packets are transmitted from the machine, regardless of the controls. In Checksum Protocol, an interval of 0 seconds means that packets are transmitted continuously from the machine if there are Field packets to be sent.

* The traffic/status light control can only be enabled by setting an option in the machine's Service Mode. To enter Service Mode, turn on the machine and press the [Enter] key when prompted "Press CONFIRM For Service Mode". After the machine boots up in Service Mode, navigate to the *Options* menu and select *Hardware Options*. On this screen, the *Beacon* button controls the input for the traffic/status light. Use the [Up] and [Down] arrow keys to select *FDS08* and press the [Enter] key to confirm the selection. When using the traffic/status light commands, it is recommended to turn one light off when turning the other on to avoid confusion.

Appendix B

Group Codes

Group Code	Data packet sent by the Machine shall include	Comments
{ }	VP, AP, TM, TP, DF, CD, BF, AC, AT, AF, AB, AA, AR, AV, AU, AL, AN, AD, RI, DS, DI, BS, UR, UT, SY, DY, PL, MA	Equivalent to sending the following groups: PR, DI, AL, MS, UF, and BP. When the machine receives { }, it will return the appropriate Field Packets immediately and only once. The internal list will not be updated by this <i>Control</i> . Note: Standard Protocol Only
PR	VP, AP, TM	Pressure Values
DI	TP, DF, CD, BF	Dialysate Values
AL	AC, AT, AF, AB, AA, AR, AV, AU, AL, AN, AD	Alarms Note: AD field for future use.
MS	RI, DS, DI, BS	Machine States
UF	UR, UT	Ultra Filtrate Values
BP	SY, DY, PL, MA	Blood Pressure Module Data
XT	UV, BV, PA, UG, RT, MI, UF, UP, SP, NS, NB, BI, ST	Extra Values
SS	PR, PE, PX, WA, WE	Safety System (only available on the 2008K@Home)
VX	VP, VH, VL	Venous Group Note: Standard Protocol Only
BT	TA, TV, TB, TE, RE, HA	Blood Temperature Module (BTM) and Heparin Data
CL	PN, VS, HC, KO, KE, PK, EK, DK, KT	Clearance Data
KS	TX, QB, QD, TT, DK, KT, HA, HR	Treatment Data
FL	FA, P1, P2, P3, P4, P5, P6	Functional Options
BV	RB, TR, HT, HB	Blood Volume Module (BVM) Data
VR	VR	Functional Board Version Number
CM	CB, CP, CC, CH, CO, MO, OA, BA, CM, CW	Crit-Line Module Data (only available on the 2008T machine, v2.48 or later)

Appendix C

Field Codes

Group Code	Field Code	Field	Format [units]	Send		Checksum Protocol Only	Comment
				Each Interval	New Data*		
PR	VP	Venous pressure	±xxx [mmHg]	✓			Also sent in VX group. Send '-000' if no data.
	AP	Arterial pressure	±xxx [mmHg]	✓			Send '-000' if no data.
	TM	TMP	±xxx [mmHg]	✓			Send '-000' if no data.
DI	TP	Monitor Temperature	xx.xx [°C]	✓			37.5 °C will be displayed as 3750.
	DF	Dialysate flow rate	xxxx [mL/min.]	✓			Send '0000' if the flow is stopped.
	CD	Conductivity	xx.xx [mS/cm]	✓			14.3 mS/cm will be displayed as 1430.
	BF	Blood flow rate	xxxx [mL/min.]	✓			Send '0000' if the blood pump is stopped. Note: On the 2008K machine, this value may be inaccurate if a Blood Pump Serial Communication cable (P/N 670658-Q) is not installed. Please see Bulletin 11-FHK-001 Rev B for more details.
AL	AC	Conductivity alarm	T/F	✓	✓		
	AT	Temperature alarm	T/F	✓	✓		
	AF	Dialysate flow alarm	T/F	✓	✓		
	AB	Blood pump alarm	T/F	✓	✓		
	AA	Level detector alarm	T/F	✓	✓		
	AR	Arterial Pressure alarm	T/F	✓	✓		
	AV	Venous Pressure alarm	T/F	✓	✓		
	AU	TMP alarm	T/F	✓	✓		
	AL	Blood leak alarm	T/F	✓	✓		
	AN	Check Venous Access Alarm	T/F	✓	✓		Send 'T' if venous needle disconnected. For 2008K machine only
	AD	Blood pressure alarm	T/F		✓	✓	Any systolic, diastolic, pulse, MAP alarm, high or low. Sent upon occurrence only. Note: AD field for future use.
MS	RI	Rinse mode	T/F	✓			Returns 'T' if in Water Rinse.
	DS	Disinfect mode	T/F	✓			Returns 'T' if in Acid Clean, Chemical Rinse, Chemical Dwell, or Heat Disinfection.
	DI	Dialysis mode	T/F	✓			Returns 'T' if in Dialysis Mode.
	BS	Blood Sensed	T/F	✓			Returns 'T' if blood sensed in Dialysis Mode.

Group Code	Field Code	Field	Format [units]	Send		Checksum Protocol Only	Comment
				Each Interval	New Data*		
UF	UR	UF flow rate	xxxx [mL/h]	✓			Send '0000' if UF off.
	UT	UF flow on	T/F	✓			Send 'T' if UF on.
BP	SY	Systolic pressure	xxx [mmHg]	✓	✓		
	DY	Diastolic pressure	xxx [mmHg]	✓	✓		
	PL	Pulse	xxx [bpm]	✓	✓		
	MA	Mean Arterial Pressure (MAP)	xxx [mmHg]		✓		
XT	UV	UF removed	xxxx [mL]	✓			
	BV	Blood volume processed	xxx.xx [L] (BTM) xxx.x [L] (else)	✓			BV is sent with an extra digit if BTM group is selected, else sent with only 4 digits.
	PA**	Patient ID	String	✓			2008K/K2, 2008K@Home, 2008T: 10 characters. 2008H: 6 characters No data string sent if there is no patient ID.
	UG	UF goal	xxxx [mL]	✓			
	RT	Remaining Time of Dialysis (RTD)	xxxx [minutes]	✓			
	MI***	Machine ID	String	✓			Send up to 9 characters (e.g. 'machine01'). If less than 9 characters, send trailing spaces (e.g. 'mchine1'). Send '000000000' if no data.
	UF	UF Time	xxxx [minutes]	✓		✓	
	UP	UF profile #	xxx	✓		✓	
	SP	SVS profile	xxx	✓		✓	Send only if SVS program is active: 000: SVS program off 001: Step SVS program 002: Linear SVS program 003: Exponent SVS program
	NS	SVS On/Off	T/F	✓		✓	
	NB	Na base	xxxx [mEq/L]	✓		✓	
	BI	Na start	xxxx [mEq/L]	✓		✓	
	ST	Bicarbonate	xxxx [mEq/L]	✓		✓	
SS	PR	Pulse Rate from Pulse Oximeter	xxx [bpm]	✓			Send '000' if no data.
	PE	Pulse Error	T/F	✓	✓		For all warnings, send 'T' if Pulse Oximeter Error occurred.
	PX	Pulse Alarm	T/F	✓	✓		Defaults to 'F'.
	WA	Wetness Alarm	T/F	✓	✓		Send 'T' if wetness detected.
	WE	Wetness Error	T/F	✓	✓		Send 'T' if no communication or low battery from Wetness Detector.

Appendix C – Field Codes

Group Code	Field Code	Field	Format [units]	Send		Checksum Protocol Only	Comment
				Each Interval	New Data*		
VX	VP	Venous pressure	±xxx [mmHg]	✓			Also sent in PR group
	VH	Venous High Limit	xxxx	✓			High Limit = 20 mmHg * VH – 100 mmHg
	VL	Venous Low Limit	xxxx	✓			Low Limit = 20 mmHg * VL – 100 mmHg
BT	TA	Arterial Temperature (Tart)	xx.x [°C]	✓			Send '000' if no data.
	TV	Venous Temperature (Tven)	xx.x [°C]	✓			Send '000' if no data.
	TB	Body Temperature (Tbody)	xx.x [°C]	✓			Send '000' if no data.
	TE	BTM change in energy	±xxx.x [kJ/h]	✓			
	RE	% recirculation	±xxx.x [%]	✓	✓		Send '1000' if no data Sent with interval data.
	HA	Total heparin infused	xx.x [mL]	✓			Also sent in KS group.
CL	PN	First Plasma Na	xxx.x [mEq/L]	✓	✓		Sent with interval data. Send '0000' if no data. Same as P1 Field otherwise.
	VS	Blood Volume Processed	xx.x [L]	✓	✓		Sent with interval data with Kecn test data. Send '000' if no data.
	HC	Hematocrit	xxx [%]	✓	✓		Sent with interval data with Kecn test data. Send '000' if no data. Send '035' otherwise. Note: deprecated.
	KO	Overall mass transfer coefficient multiplied by dialyzer surface area (KOA)	xxxx	✓	✓		Sent with interval data with Kecn test data. Send '0000' if no clearance data. Send '0400' otherwise. Note: deprecated.
	KE	Mean Kecn	xxx	✓	✓		Sent with interval data. Send '000' if no data.
	PK	Projected Single Pool (sp) Kt/V	x.xx	✓	✓		Sent with interval data with Kecn test data. Send '000' if no data.
	EK	Delivered Equilibrated (E) Kt/V	x.xx	✓	✓		Sent with interval data with Kecn test data. Send '000' if no data.
	DK	Delivered Single Pool (sp) Kt/V	xxx.xx	✓	✓	✓	Sent with interval data with Kecn test data only. Also sent in KS group. Send '00000' if no data.
	KT	Delivered Kt	xxxx.x [L]	✓	✓	✓	Sent with interval data with Kecn test data only. Also sent in KS group. Send '00000' if no data.

Group Code	Field Code	Field	Format [units]	Send		Checksum Protocol Only	Comment										
				Each Interval	New Data*												
KS	TX	Tx clock status	T/F	✓			Send 'T' if running or paused. Send 'F' if stopped.										
	QB	Average Blood Flow (Qb)	xxxx [mL/min]	✓													
	QD	Average Dialysate Flow (Qd)	xxxx [mL/min]	✓													
	TT	Treatment time	xxxx [min.]	✓													
	DK	Delivered Single Pool (sp) Kt/V	xxx.xx		✓	✓	Also sent in CL group.										
	KT	Delivered Kt	xxxx.x [L]		✓	✓	Also sent in CL group.										
	HA	Total heparin infused	xx.x [mL]	✓			Also sent in BT group.										
	HR	Heparin rate	xx.x [mL/h]	✓													
FL	FA	Access Flow	±xxxx		✓		Send '-0000' if no data.										
	P1-P6	Plasma Na 1 – Plasma Na 6	xxx.x		✓		Sent with OLC Measurement.										
BV	RB	Relative Blood Volume (RBV)	±xxx.x [%]	✓			Send '-0000' if no data.										
	TR	Trend	xxx	✓			<table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td style="text-align: center;">↑</td> <td style="text-align: center;">↗</td> <td style="text-align: center;">↔</td> <td style="text-align: center;">↘</td> <td style="text-align: center;">↓</td> </tr> <tr> <td style="text-align: center;">001</td> <td style="text-align: center;">002</td> <td style="text-align: center;">003</td> <td style="text-align: center;">004</td> <td style="text-align: center;">005</td> </tr> </table> Otherwise, if Crit-Line, send "000"	↑	↗	↔	↘	↓	001	002	003	004	005
	↑	↗	↔	↘	↓												
	001	002	003	004	005												
HT	Hematocrit	±xxx.x [%]	✓			If Crit-Line, send '-0000'											
HB	Hemoglobin (HgB)	±xxx.x	✓			If Crit-Line, send '-0000'											
VR	VR	Software version number	xx.xx		✓		Functional Board version. Version 2.41 will be returned as 0241										
CM	CB	RBV (Crit-Line)	±xxx.x [%]	✓			If no Crit-Line, sends '-0000'										
	CP	Profile (Crit-Line)	00A, 00B, 00C	✓			If no Crit-Line, sends '000'										
	CC	Hematocrit	±3456 [%]	✓			If no Crit-Line, sends '-0000'										
	CH	HgB	±xxx.x	✓			If no Crit-Line, sends '-0000'										
	CO	O2 Sat.	±xxx.x [%]	✓			If no Crit-Line, sends '-0000'										
	MO	Min. O2 Sat.	±xxx.x [%]	✓			If no Crit-Line, sends '-0000'										
	OA	O2 Alert Level	±xxxx [%]	✓			If no Crit-Line, sends '-0000'										
	BA	BV Alert Level	±xxxx [%]	✓			If no Crit-Line, sends '-0000'										
	CM	Crit-Line Marker	000, SYM, INT	✓			000 – No Marker (or no Crit-Line) SYM – Symptom Marker INT – Intervention Marker										
	CW	Crit-Line Warning	000, NCA, SYS, OBS, NBS, BVA, O2A, PRF	✓			000 – No Warning (or no Crit-Line) NCA – No Comm Alert SYS – System Error OBS – Obstruction NBS – Need Blood Sensed BVA – BV Alert O2A – O2 Alert PRF – Print Failure										

Appendix C – Field Codes

* Alarms shown in the “New Data” column are sent upon occurrence in the following format:



In the event of a Conductivity Alarm (AC), the data “!AC” will be sent at the time of the alarm and “ACT” will be sent for the subsequent packets.

Fields shown in the “New Data” column display ‘0’-filled data until new and valid data values are available, unless otherwise stated in the table. For example, if the ‘BP’ group data is requested by the *Host* but the Blood Pressure Module data is not available, the machine should return the field data ‘SY000,DY000,PL000,MA000’.

** The Patient ID may be set by navigating to the *Test & Options* screen. Select the “Patient ID” button and enter the characters with the keyboard. Press [Enter] to confirm the entered Patient ID.

*** The Machine ID may be set by entering Service Mode. Navigate to the *Options* page and select *Comm Options*. Select the “Machine Name” button and use the keyboard to enter the Machine ID. Press [Enter] to confirm the entered Machine ID.

Note:

Formats indicated by this table are meant as place holders. “x”s shall be replaced by the characters of the Field Values. Positive signs (+) and negative signs (-) shall be included in the sent data in the implied position shown. Decimal places (.) are implied and will not appear in the data packet.

Not all field codes may be returned on all the machines. Group data sent from the Crit-Line module (CM) is only available on the 2008T machine, v2.48 or later. Host software should be written to expect new future Field Codes.