

CARDIOSAVE*
HIS CIS COMMUNICATION PROTOCOL



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1 INTRODUCTION

This communication protocol is applicable to **CARDIOSAVE** Intra-Aortic Balloon Pump.

1.1 PURPOSE

This document specifies the external network communications architecture incorporated into the IABP software. Unless otherwise noted, all information is compatible with **CARDIOSAVE** Intra Aortic Balloon Pumps. Several communication packet descriptions are proprietary and have been intentionally omitted. This document assumes that the reader is familiar with layered data communication protocols and their implementations.

1.2 REFERENCE MATERIALS

1. CARDIOSAVE Operating Instructions (P/N: 0070-00-0638-01)
2. IETF RFC 2616
3. IEEE 802.3

1.3 COMMUNICATIONS ARCHITECTURE OVERVIEW

Note:

CARDIOSAVE must be configured for HIS CIS communication. See CARDIOSAVE Operating Instructions.

The HIS/CIS protocol is a client/server protocol which shall be used to transmit IABP Data over TCP/IP using a 100 Base-T IEEE 802.3 Ethernet connection.

The HIS/CIS protocol shall be implemented using HTTP 1.1 as defined by IETF RFC 2616.

The HIS/CIS protocol shall transmit IABP data in a binary structure. This binary structure shall be the message body of an HTTP 1.1 POST request made to the HIS/CIS server.

The HIS/CIS server shall listen for HTTP 1.1 connections at TCP/IP port 33320. When the HIS/CIS protocol on the IABP has been configured and activated, a new HTTP 1.1 POST request shall be made to the HIS/CIS server every 500 milliseconds at the relative URL /CardiosaveClinicalData/labpData. This HTTP 1.1 POST request shall contain binary data aggregated from the previous 500 milliseconds of IABP operation. Successful responses from the HIS/CIS server shall be indicated with the with the HTTP response status code 200. In addition, the HIS/CIS server shall respond with the text **OK** at the beginning of the response body if the binary data was able to be decoded, and **FAIL** at the beginning of the response body if there was an error in decoding the data.

The binary data contained in the HTTP 1.1 POST request message body shall contain the fields in the HIS/CIS Binary Payload Structure section.

1.4 HIS CIS PROTOCOL VERSIONS

The following table represents the version of the HIS CIS protocol which corresponds to each CARDIOSAVE Intra Aortic Balloon Pump software version.

CARDIOSAVE IABP Software Version	HIS CIS Protocol Version
A.04	Revision A
B.02	Revision B
B.04 and Above	Revision C

HIS/CIS BINARY PAYLOAD STRUCTURE

All fields single packet sent every 500 ms. ALL multibyte types are BIG ENDIAN (network byte order)

Byte offset	Name	Type	Type Size (bytes)	Overall Size (bytes)	Sample Rate (ms)	Comment
0	protocolVersion	unsigned int	4	4	N/A	Numeric identifier for protocol revisions Protocol Version id for Rev A is 0xA Protocol Version id for Rev B is 0xB Protocol Version id for Rev C is 0xC
4	pumpID	unsigned int	4	4	N/A	Contains lower 3 bytes of MAC address
8	timeStampSeconds	unsigned int	4	4	500	Time in seconds since the epoch January 1, 1970 12:00AM
12	timeStampSecondsFraction	unsigned int	4	4	500	32 bit fixed point fractional time in seconds
16	ecgWaveformArray	short	2	200	5	13.2 fixed point data, divide by 4.0F
216	apWaveformArray	short	2	200	5	9.6 fixed point data, divide by 64.0F
416	balloonWaveformArray	short	2	200	5	11.4 fixed point data, divide by 16.0F
616	ecgTriggerMarkerInterval	bool	1	25	20	True if ECG markers are displayed
641	apInflationInterval	bool	1	25	20	True if AP inflation interval is displayed
666	pressureThresholdBeatToBeat	short	2	50	20	Beat to Beat Pressure trigger threshold values
716	skinPacerDetected	bool	1	25	20	True if a Pacer spike detected from Skin ECG Leads
741	externalPacerDetected	bool	1	25	20	True if a Pacer spike detected from External ECG Leads
766	triggerSourceSelection	int (enum)	4	4	500	The currently selected trigger source 0 = ECG Trigger Mode 1 = BP Trigger Mode 2 = Pacer VAV Trigger Mode 3 = Pacer A Trigger Mode 4 = Internal Trigger Mode
770	pacerAV	bool	1	1	500	True if pacer AV is selected false if V is selected
771	ecgCableType	int (enum)	4	4	500	The currently selected ECG trigger source 0 = All ECG cables disconnected 1 = AAMI 3 Lead ECG cable connected 2 = AAMI 5 Lead ECG cable connected 3 = ECG IAB connected 4 = IEC 3 wire cable detected 5 = IEC 5 wire cable detected

Byte offset	Name	Type	Type Size (bytes)	Overall Size (bytes)	Sample Rate (ms)	Comment
775	ecgLeadSelection	int (enum)	4	4	500	The currently selected ECG Lead source 0 = ECG Lead I selection 1 = ECG lead II selection 2 = ECG lead III selection 3 = ECG lead AVR selection 4 = ECG lead AVL selection 5 = ECG lead AVF selection 6 = ECG lead V selection 7 = External ECG source
779	ecgLeadFaultStatus	int (enum)	4	4	500	ECG lead fault status 0 = Right arm electrode faulted 1 = Left arm electrode faulted 2 = Left leg electrode faulted 3 = Right and left arm electrode faulted 4 = Right arm and left leg electrode faulted 5 = Left arm and left leg electrode faulted 6 = Unable to pin point the faulted electrodes 7 = Chest lead faulted 8 = Right leg electrode faulted 9 = Chest lead and right leg electrode faulted 10 = ECG cable disconnected 11 = All electrodes are connected or external ECG is the selected ECG source
783	ecgLeadWireMode	int (enum)	4	4	500	3, 4 or 5 wire mode 0 = RA, LA and LL electrodes are connected. 1 = RA, LA, LL and RL electrodes are connected. 2 = RA, LA, LL, RL and chest electrodes are connected.
787	extECGCableConnected	bool	1	1	500	True if ECG cable is connected
788	apSourceSelection	int (enum)	4	4	500	The currently selected enumerated AP source 0 = Fiber optic sensor as AP source 1 = Transducer as the AP source 2 = External as AP source
792	apTransConnected	bool	1	1	500	True if direct AP transducer is connected
793	apFosConnected	bool	1	1	500	True if FOS AP is connected
794	apExtConnected	bool	1	1	500	True if external AP cable is connected
795	pressureThresholdMode	bool	1	1	500	True if Auto Pressure Threshold mode is selected, false otherwise
796	pressureThresholdModeValue	short	2	2	500	The current Pressure Trigger Threshold value setting
798	operationMode	int (enum)	4	4	500	Current Operation Mode 0 = Auto operations mode 1 = Semi-auto operations mode

Byte offset	Name	Type	Type Size (bytes)	Overall Size (bytes)	Sample Rate (ms)	Comment
802	pneumaticMode	int (enum)	4	4	500	Current Pneumatic/Assist mode 0 = Vent - Initial mode and pneumatics failure mode 1 = Standby - The pump is ready to enter the assist mode 2 = Assist - The pump is assisting or is in pseudo standby 3 = Fill (Assist) - The system is in fill mode and if successful will then transition to assist 4 = Fill (Standby) - The system is in fill mode and if successful will then transition to standby 5 = FOS Cal - The system is performing the partial inflation for FOS Calibration
806	minutesInStandby	unsigned short	2	2	500	The number of minutes in standby
808	apFosCalibrated	bool	1	1	500	True if AP FOS is calibrated
809	apTransducerZeroStatus	int (enum)	4	4	500	Zero status states for the AP transducer 0 = Successful zeroing of transducer 1 = Transducer not yet zeroed 2 = Zeroing of transducer failed 3 = Transducer Zero has been requested
813	consoleModeEnabled	bool	1	1	500	True if IABP is in the cart, false otherwise
814	assistedSystolicPressure	short	2	2	500	Assisted Systolic Pressure mmHg
816	assistedDiastolicPressure	short	2	2	500	Assisted Diastolic Pressure mmHg
818	unassistedSystolicPressure	short	2	2	500	Unassisted Systolic Pressure mmHg
820	unassistedDiastolicPressure	short	2	2	500	Unassisted Diastolic Pressure mmHg
822	meanPressure	short	2	2	500	Mean Pressure mmHg
824	augmentedPressure	short	2	2	500	Augmented pressure mmHg
826	atmosphericPressure	short	2	2	500	Atmospheric Pressure 11.4 fixed point data, divide by 16.0F
828	heartRate	short	2	2	500	Heart rate in BPM
830	iabAugLevel	short	2	2	500	Balloon Augmentation level setting 0-9
832	iabFrequencySelection	int (enum)	4	4	500	Enumeration of IAB Assist Frequency settings. 0 = invalid setting 1 = 1:1 assist ratio 2 = 1:2 assist ratio 3 = 1:3 assist ratio
836	inflationSliderValue	short	2	2	500	Inflation Slider Setting, -40 to 40, divide by 10
838	deflationSliderValue	short	2	2	500	Deflation Slider Setting, -40 to 40, divide by 10
840	rWaveDeflateActive	bool	1	1	500	True if user has selected R-Wave deflate timing via deflation slider in ECG Mode
841	autoRWaveDeflateActive	bool	1	1	500	Auto R-Wave deflate is active if true
842	battery1RSOC	short	2	2	500	Battery Charge Level, 0-100%
844	battery2RSOC	short	2	2	500	Battery Charge Level, 0-100%
846	batteryTimeRemaining	unsigned short	2	2	500	Battery Time remaining in minutes
848	onACMains	bool	1	1	500	True if the IABP is plugged into an AC outlet

Byte offset	Name	Type	Type Size (bytes)	Overall Size (bytes)	Sample Rate (ms)	Comment
849	powerSlot1Status	int (enum)	4	4	500	0 = Slot is empty 1 = Bulk Jr. in slot is being used to power unit 2 = Bulk Jr. is present and available but not used to power unit 3 = Battery in slot is being used to power unit 4 = Battery in slot is not being used or charging 5 = Battery in slot is currently being charged 6 = Bulk Jr. is present in slot but not currently available to power unit 7 = Battery is present in slot but not currently available to power unit
853	powerSlot2Status	int (enum)	4	4	500	0 = Slot is empty 1 = Bulk Jr. in slot is being used to power unit 2 = Bulk Jr. is present and available but not used to power unit 3 = Battery in slot is being used to power unit 4 = Battery in slot is not being used or charging 5 = Battery in slot is currently being charged 6 = Bulk Jr. is present in slot but not currently available to power unit 7 = Battery is present in slot but not currently available to power unit
857	internalHeliumTankCalibration	bool	1	1	500	True if the internal helium tank is calibrated
858	externalHeliumTankCalibration	bool	1	1	500	True if the external helium tank is calibrated
859	internalHeliumTankPressure	short	2	2	500	Internal helium tank pressure in PSI
861	externalHeliumTankPressure	unsigned short	2	2	500	External helium tank pressure in PSI
863	skinPacerThreshold	int (enum)	4	4	500	Pacer detection setting for skin leads 0 = Low pacer threshold 1 = Normal pacer threshold 2 = Medium pacer threshold 3 = High pacer threshold
867	externalPacerThreshold	int (enum)	4	4	500	Pacer detection setting for external leads 0 = Low pacer threshold 1 = Normal pacer threshold 2 = Medium pacer threshold 3 = High pacer threshold
871	rTracEnabled	bool	1	1	500	True if R-Trac is enabled, false otherwise
872	gasLossAlarmsEnabled	bool	1	1	500	True if gas loss alarms are enabled false otherwise
873	catheterAlarmsEnabled	bool	1	1	500	True if catheter alarms are enabled, false otherwise
874	internalRate	short	2	2	500	Rate setting for internal trigger (40-120bpm)
876	augAlarmValue	short	2	2	500	Augmentation alarm value (60-200 and -1 to indicate OFF)
878	bpUpperLowerWindowRange	int	4	4	500	High order 16 bits is the AP Upper Window Value, Low order 16 bits is the AP Lower Window value (0 - 300)

Byte offset	Name	Type	Type Size (bytes)	Overall Size (bytes)	Sample Rate (ms)	Comment
882	ecgScaleSize	int (enum)	4	4	500	Currently selected ECG Scale 0 = X0.25 ECG size 1 = X0.5 ECG size 2 = X1.0 ECG size 3 = X2.0 ECG size 4 = X3.0 ECG size 5 = Max ECG sizes
886	alarmArray	bool	1	Rev A: 81 Rev B: 83 Rev C: 84	500	Alarm list 0 = Dummy alarm 1 = Power-Up Test Fails. This alarm has a code associated with it. 2 = System Failure 3 = Internal Communication Failure 4 = System Over temperature 5 = Gas Gain in IAB Circuit 6 = Autofill Failure - No Helium Console 7 = Autofill Failure - No Helium Transport 8 = Autofill Failure - Blood Suspected 9 = Autofill Failure 10 = IAB Disconnected 11 = High Drive Pressure 12 = IAB Catheter Restriction 13 = Gas Loss in IAB Circuit 14 = Low Vacuum 15 = Trigger Interference 16 = Check pacer Timing 17 = No Trigger Auto Mode 18 = No Trigger on Switch Auto Mode 19 = No Trigger Semi-Auto 20 = No Trigger on Switch Semi-Auto 21 = Poor Signals Persist 22 = No Pressure Trigger 23 = No Pressure Trigger on Switch 24 = ECG Detected 25 = Augmentation Below Limit Set 26 = Fiber-Optic IAB Signal Failure 27 = Poor Signal Quality 28 = No Pressure Source Available 29 = Low battery 30 = Catheter Alarms Paused - Enable AUG. ALARM 31 = Over Temperature Condition Detected 32 = Transport Power Supply Over Temperature

Byte offset	Name	Type	Type Size (bytes)	Overall Size (bytes)	Sample Rate (ms)	Comment
886	alarmArray	bool	1	Rev A: 81	500	33 = Multiple AC Power Sources Detected
(Cont.)				Rev B: 83		34 = Disconnect Trainer - Patient Cable(s) Connected
				Rev C: 84		35 = Unable To Update Timing
						36 = Battery Over Temperature in Bay 1
						37 = Battery Over Temperature in Bay 2
						38 = Prolonged Time in Standby silent
						39 = Prolonged Time in Standby 5 minutes
						40 = Prolonged Time in Standby 2 minutes
						41 = Fiber-Optic Sensor Module Failure
						42 = Irregular Pressure Trigger
						43 = Unable to Calibrate Fiber-Optic Sensor
						44 = Low Helium Console
						45 = Low Helium Transport
						46 = Gas Loss in IAB Circuit Overridden
						47 = No Trigger Auto mode Standby
						48 = No Trigger Semi-Auto Mode Standby
						49 = No Pressure trigger standby
						50 = Fiber-Optic IAB Sensor Calibration Postponed
						51 = Verify Proper Timing
						52 = Autofill Complete
						53 = Autofilling
						54 = Calibrating Fiber-Optic Sensor
						55 = Autofilling and Calibrating Fiber-Optic Sensor
						56 = Calibration Only Available in Assist mode
						57 = Unable to Zero - transducer Not Vented
						58 = Catheter Alarms are temporarily Disabled
						59 = Gas Loss Alarm has been set to Off
						60 = Function Unavailable in External Pressure Source
						61 = Function Unavailable in Auto Operation Mode
						62 = Function Unavailable
						63 = Battery in Use
						64 = System test OK
						65 = Trainer in Use
						66 = Auto R-Wave Deflate
						67 = R-Wave Deflate
						68 = Help Available for Initial Set Up
						69 = Unable to Charge Batteries
						70 = Unable to Charge Battery in Bay 1
						71 = Unable to Charge Battery in Bay 2
						72 = Unusable Battery Detected in Bay 1
						73 = Unusable Battery Detected in Bay 2

Byte offset	Name	Type	Type Size (bytes)	Overall Size (bytes)	Sample Rate (ms)	Comment
886 (Cont.)	alarmArray	bool	1	Rev A: 81 Rev B: 83 Rev C: 84	500	74 = No Battery Backup Detected 75 = Press and Hold Power Button for 2 Seconds 76 = Internal Transducer Calibration out of Range 77 = Fan Failure Detected 78 = Rev A: Helium Transducer Not Calibrated (Console) Rev B and Above: IABP May Require Maintenance: (Ver 1) 79 = Rev A: Helium Transducer Not Calibrated (Transport) Rev B and Above: IABP May Require Maintenance: (Ver 2) 80 = Rev A: Fiber Optic Sensor Module requires Maintenance Rev B and Above: Helium Transducer Not Calibrated (Console) 81 = Rev B and Above: Helium Transducer Not Calibrated (Transport) 82 = Rev B and Above: Fiber Optic Sensor Module requires Maintenance 83 = Rev C: The Safety Disk Replacement Is Due
Rev A: 967 Rev B: 969 Rev C: 970	etf	int	4	4	500	Electrical Test Failure Codes 0 = Prior Compressor Failure 1 = Solenoid watchdog circuit test failure during PIM test 2 = Pressure/Vacuum reservoirs failed to vent to atm 3 = Vacuum reservoir failed to reach minimum vacuum 4 = Drive transducer atm calibration offset out of range 5 = Shuttle transducer atm calibration offset out of range 6 = Unable to configure touch screen controller device electrical test failure 7 = Unable to calibrate touch screen controller device electrical test failure 8 = At least one software version is not compatible 9 = Audio Processor Electrical Test Failure Code 10 = DSP and Host calibration data does not match 11 = Electrical test failure code used for the ISO DSP start bit failure 12 = Electrical test failure code used for the NON ISO DSP start bit failure 13 = Indicates time out for startup tests to complete

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