



SyringePump.com

ANA-BOX-21

**PC & Digital Sensor Interface Addendum
Dual Pump Systems**

Model: ADPT-ANABOX-21

Addendum to Ana-Box-11 User Manual

***WARNING
NOT FOR CLINICAL
USE ON HUMANS***

1. Operation: Addendum to Operational Parameter Setup

1.1 Mode 1 Updates: Pumping Rate Proportional to Voltage

Dual Pump Systems Modes of Operation

Dual pumping modes control 2 pumps, as a system, networked to an Ana-Box™.

The Ana-Box's control parameters only need to be set on the Master pump.

Pumping Program Phase 30: Mode Parameters
 Function = Rate [rRtE], or Increment [trEr]
 Rate setting = Control Mode
 Volume setting = Aux-Mode

Pumping Program Phases 30+: Set control parameter data according to standard Ana-Box-11 Mode 1 setup.

Pump Setup for Dual Pumping Modes

Default pump network addresses for pumps under control:

Master Pump: Address 0 [Rd:00]
 Secondary Pump: Address 1 [Rd:01]

The Master pump will be the Primary device under control of the Ana-Box. When used within a larger pump network, the default addresses for the pumps under control can be changed to prevent addressing conflicts. The Primary pump must be set to an even address. The Secondary pump must be set to the next consecutive (odd) address. The maximum pump address is 7.

Connect the Ana-Box's Pump connector to the Master pump's Computer connector using RS-232 network cable CBL-NET-7. Connect the Master pump to the Secondary pump using another RS-232 network cable, CBL-NET-7. Connect CBL-NET-7 between the Master pump's Network connector and the Secondary pump's Computer connector.

Pumps must be setup with Pumping Programs that are coordinated with the Ana-Box's expected control.

1.1.1 Simultaneous Dual Pumping Modes of Operation

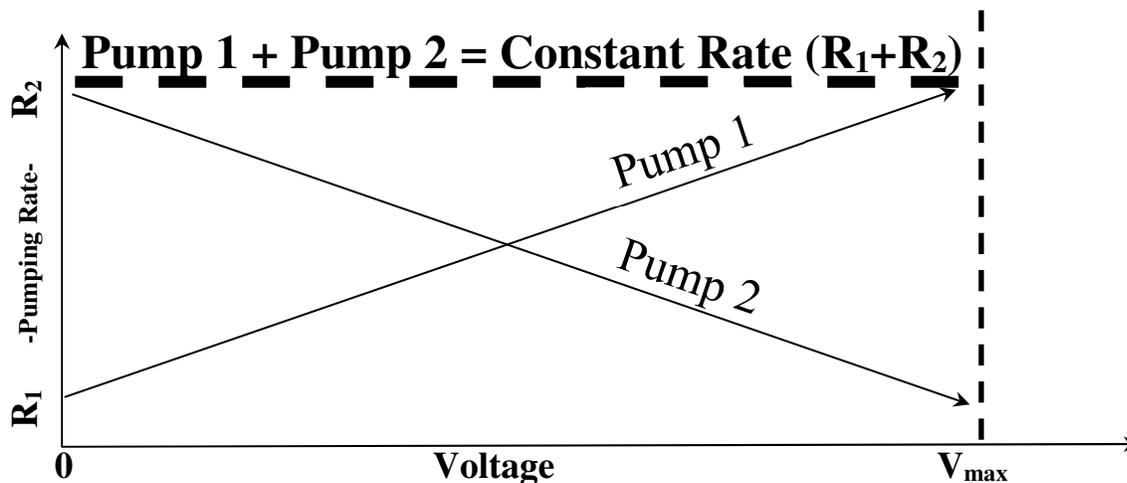
Dual Pump Control Mode: Mode = 1.80; Aux-Mode = 0.0

Both pumps operate simultaneously as a system at the same flow rate and pumping direction. The Secondary pump mimics the operation of the Master pump.

Inverted Gradient Dual Pump Control Mode: Mode = 1.88; Aux-Mode = 0.0

The combined flow of both pumps add to maintain a constant flow rate.

The Master pump's control parameters, R₁ and R₂, are reversed when controlling the Secondary pump. The resulting combined flow rates of the 2 pumps is a constant flow rate equal to the sum of the 2 flow rate set points (R₁+R₂).



1.1.2 Alternating Pump Control for Continuous Infusion

Creates a continuous, variable rate, infusion system by alternating infusion control between 2 pumps. The pump not under control of the Ana-Box can either be refilling the syringe, waiting for the syringe to be replaced, or control can automatically alternate between 2 pumps.

Description:

Alternates control between 2 pumps, either syringe pumps or peristaltic pumps, to maintain a constant infusion under control of a single Ana-Box. With syringe pumps, the pumps can alternate between pre-filled syringes, or syringes refilled from a reservoir.

When the pump under control starts, the Ana-Box will control the infusion pumping rate. The pumping rate will be proportional to the voltage input, according to the setup parameters.

Depending on the sub-mode, when the pump under control stops, or starts to refill, the Ana-Box will transfer control to the alternate pump, continuing the infusion. When that pump stops, or starts to refill, control will be transferred back to the other pump. In Standard Alternating Mode, the user will need to replace the empty syringe with a new pre-filled syringe.

If an alarm causes a pump to stop, or a pump fails to start for any reason, the Ana-Box will stop and require a new start signal, or toggle of the switch to re-start operation.

Standard Alternating Mode: Pump under control switches to the other pump when the pump under control stops. Pumping control does not switch when executing a pause timer.

Refill Alternating Mode: Pump under control switches to the other pump when the pump under control either stops or begins to withdraw. Pumping control does not switch when executing a pause timer.

With Refill Mode, the initial state of the syringes can be any combination of pre-filled and empty. Empty syringes will be refilled when the Mode is started. See “Mode Modifiers” below to configure the initial filled state of the syringes.

Pumping programs on each pump will need to be coordinated with the control sequences of the Ana-Box. The Ana-Box will only send a start command to start the pump(s) under control, according to the mode setup. Each pump’s program must be written to refill the syringe at the appropriate time.

Each pump is setup individually with the syringe or tubing diameter, initial pumping rate, volume target and pumping direction, or pumping program. If not using refill mode with syringe pumps, pre-filled syringes will need to be loaded onto each syringe pump.

Alternating Dual Pump Modes Setup:

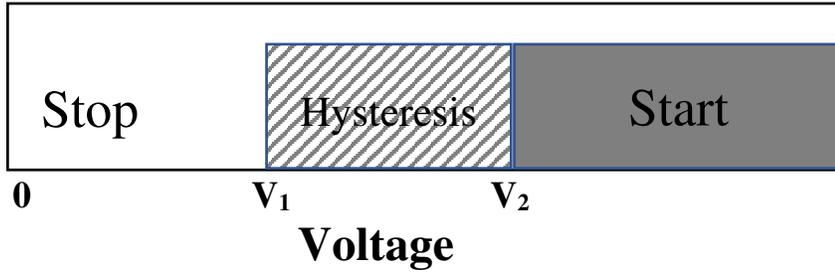
| | | |
|----------------------------|-----------|------|
| Dual Pumps Control Mode: | Mode: | 1.80 |
| Standard Alternating Mode: | Aux-Mode: | 1.00 |
| Refill Alternating Mode: | Aux-Mode: | 3.00 |

Refill Alternating Mode Modifiers:

Aux-Mode modifiers indicate initial syringe pre-filled or empty state. Add modifier values to Aux-Mode 3.00.

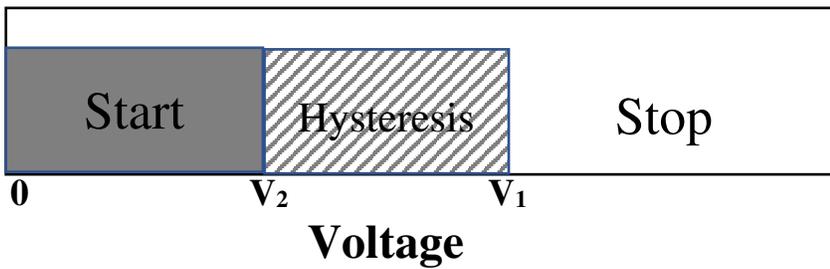
| Value to Add | Initial Syringe State | Starting Control Description |
|--------------|---|--|
| 0.0 | 00b = Both syringes empty | Both pumps refill, then control begins with first pump while second pump waits |
| 0.1 | 01b = First syringe empty; Second syringe pre-filled | Control begins with second pump, while first pump refills |
| 0.2 | 10b = First syringe pre-filled; Second syringe empty | Control begins with first pump, while second pump refills |
| 0.3 | 11b = Both syringes pre-filled | Control begins with first pump, while second pump waits |

1.2 Mode 11: Hysteresis Mode



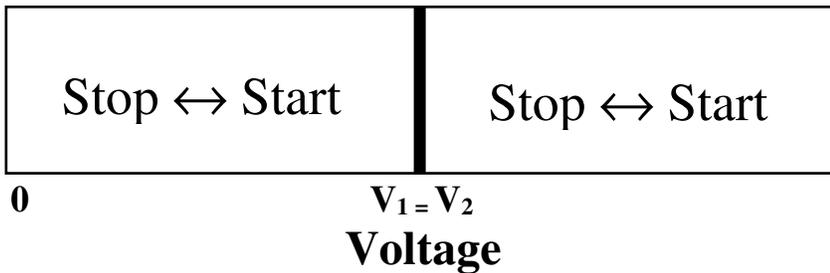
$$\text{Stop} \leq V_1 < \text{Hysteresis Window} < V_2 \leq \text{Start}$$

If $V_1 < V_2$, the pump will stop when equal to or below V_1 , and start when equal to or above V_2 .



$$\text{Start} \leq V_2 < \text{Hysteresis Window} < V_1 \leq \text{Stop}$$

If $V_2 < V_1$, the pump will start when equal to or below V_2 , and stop when equal to or above V_1 .



$$\text{Toggle Start/Stop} < V_1 = V_2 < \text{Toggle Start/Stop}$$

If $V_1 = V_2$, the pump will toggle start/stop when transitioning above or below V_1 .

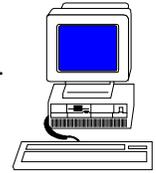
Sets hysteresis threshold voltage windows to trigger the starting or stopping of the pump when the voltage transitions over the trigger voltage. Within a window, the current state will not change.

Mode 11 Setup:

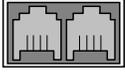
| Parameters | Phase Stored | Description |
|------------|--------------|-------------------------------|
| V_1 | 31 | Stop Pump Voltage Threshold. |
| V_2 | 32 | Start Pump Voltage Threshold. |

2. Serial Communications

The Ana-Box can communicate with any computer or device with an RS-232 communications port or converter.



2.1 Connection and Networking



On the side of the Ana-Box are 2 square RJ-11 (“phone jack” style) sockets. Connect a Primary RS-232 cable (CBL-PC-PUMP-7, not included with the Ana-Box) into the socket labeled “Computer”. Connect the other end to the serial port of the computer, USB converter (CBL-USB232), control device, or sensor.

The Ana-Box can also be used within a pump network. A network cable (CBL-NET-7) attached to a previous device can be attached to the Ana-Box’s “Computer” socket. Additional devices can be networked after the pump under control of the Ana-Box.

Each device on the network needs to be set to the same baud rate and set to a unique network address. The address identifies the device to the computer, and to each Ana-Box. Network addresses are from 00 to 99. The Ana-Box's factory **default address is 9**. The default address of the pump under control of the Ana-Box is 0.

The settings are saved on the device and only need to be set once. Attach each device individually to the computer and then use the '*ADR' command to set the network address and baud rate. A maximum of 8 Ana-Box's can be on the network.

2.2 Digital Sensor Mode

A sensor with a digital serial output can be attached to the Ana-Box’s “Computer” jack. In Digital Mode, the sensor data output will override the analog input. The sensor must output ASCII data as floating point or integer data, which will be interpreted by the Ana-Box as voltage. Floating point data will be interpreted directly as voltage. Integer data will be first divided by 1000, then interpreted as voltage.

The Ana-Box will automatically enter digital mode after receiving a serial data packet whose first 3 bytes are ASCII digits. The Ana-Box can be set to digital mode by adding the value 50 to the operational mode setting. For example, mode 1 will become mode 51. Serial communications commands sent to the Ana-Box will set command mode and disable digital mode

The maximum data packet is 4 digits plus one decimal point. Each data packet is terminated by a non-digit, or a minimum 0.4 Second delay between packets. The maximum interpreted digital voltage is 65V. Digits beyond 4 will be ignored.

A smoothing algorithm will prevent large jumps in digital data causing erratic changes to pumping control. Due to hardware limitations, occasional digital packets can be lost if sent while communicating with the pump.

2.3 Command Mode: Serial Protocol

Precede each command with a network address. Devices will ignore all commands that do not have their defined network address. If the network address is not specified with the command, the address will default to 0.

After a command is sent to a device, the device will not accept any further communications until the current command has been processed. Completion of the command processing is indicated when the first byte of the response packet is transmitted.

While the Ana-Box is actively controlling a device (LED solid), only commands addressed to that Ana-Box, or device under control, will be accepted. Commands addressed to other devices, networked to the device under control, physically past an active Ana-Box, will be ignored.

To set the address on a device, individually attach that device to the PC. Use the command *ADR to set the address.

On the Ana-Box, to set the address of the device under control of the Ana-Box, use the command ADRP.

Addresses will be saved to memory. They only need to be set once.

Communication to and from the Ana-Box uses the following data frame:

Ana-Box Default Network Address: 9

Supported Serial Data Frame

Selectable Baud Rates: 2400, 9600, 19200, 38400
 Default Baud rate: 19200
 Frame: 10-bit data frame (8N1):
 Start bit: 1
 Data bits: 8
 Stop bits: 1
 Parity: None

Every command received by a device on the network is acknowledged by the device with a response packet that includes a status character indicating the current operational state of the device.

2.3.1 General Command Syntax Legend

The following syntax expansion legend is common to all syntax expansions:
 Except where indicated, all command and response characters are ASCII data.

| | |
|--|---|
| <float> => <f> [<float>] | Floating point number. Maximum of 4 digits plus 1 decimal point. Maximum of 3 digits to the right of the decimal point. |
| <on-off> => 1 0 | On, enabled Off, disabled |
| <count data> => <n> [<n>] | Valid values: 1 to 99 |
| <number data> => <n> [<n>] | Valid values: 0 to 99 |
| <text> => "any printable character" [<text>] | |
| <f> => { <n> . } | Floating point digits |
| <n> => { 0 1 2 3 4 5 6 7 8 9 } | Digits |
| <byte> => "one byte of any data" | |
| () | One byte of data expressed as (0xhh), where 'hh' is the data in hexadecimal. |
| => | Is defined by. Syntax expands to next level of expansion. |
| <> | Non-terminal syntax expansion |
| [] | Optional syntax |
| { } | Required syntax |
| | Or. Choose one of the syntax options. |
| λ | None. Syntax expands to nothing (lambda production). |
| " " | Description of syntax expansion |

2.3.2 Serial Protocol: Basic Mode

Command syntax (to device):

<basic command protocol> => <command data> <CR>

Response syntax (from device):

<basic response protocol> => <STX> <response data> <ETX>

In the "Basic" communications mode, a master-slave protocol is used, whereby the device will only transmit in response to a received command.

When the device receives the <basic command protocol>, <command data> will automatically be stripped of all space and control characters, and all text will be converted to upper case. This simplifies communications with the device when commands are being manually typed in from a generic terminal emulator.

2.3.3 Serial Protocol: Basic Mode Common Syntax

| | |
|--|--|
| <transmitted data> => { <command data> <response data> } | |
| <command data> => [<address> *] [<command>] | To device |
| <response data> => <address> <status> [<data>] | From device |
| <status> => { <prompt> <alarm> } | Operational state of device |
| <prompt> => | |
| S | Ana-Box control Stopped |
| R | Ana-Box control Active |
| <alarm> => A ? <alarm type> | Alarm |
| <alarm type> => | |
| R | Power was reset (power was interrupted) |
| E | Error |
| O | Out of range |
| H | High voltage alarm |
| <address> => <n> [<n>] | Device network address, 0 to 99 |
| * | System command (overrides network address) |
| <data> => <text> | Response to command |
| <CR> => (0x0D) | Carriage return |
| <STX> => (0x02) | Start of packet transmission indicator |
| <ETX> => (0x03) | End of packet transmission indicator |
| <length> => <byte> | Number of bytes remaining in packet, including this byte |

2.4 Command Errors and Alarms

If a command received by the device is not recognized or the data is invalid, an error message will be in the <data> field of the response packet following the <prompt> field. The following are the error responses:

| | |
|--|---|
| <command error> => [? <error> IGN] | |
| IGN | Command ignored, but valid. Ignored pump command sent to Ana-Box. |
| <error> => | |
| λ | General command error. '?' only. |
| NA | Command is not currently applicable. |
| OOR | Command data is out of range. |
| COM | Invalid communications packet received. |
| IGN | Command ignored due to a conflict. |

When an alarm occurs, the alarm must be acknowledged before any data is changed or the device is started. Alarms are acknowledged by the user clearing the alarm message on the keypad, or the alarm status being sent in response to any valid serial command.

2.5 Serial Command Set

A packet without a command is interpreted as a status query. The addressed device responds with a status only response packet.

Except where noted, a setting command without its parameter queries the command setting. The response packet data will include the requested data. In general, the query response data will be in the same format as the parameter for setting the command. For example, the query voltage command 'VLT' will respond with '<n.nnn>' as the response '<data>'.

Otherwise, the command is a set command. If the data was set, a status only response packet will be sent. If the data was not set, the response packet will include an error (<command error>) message indicating why the data was not set.

All commands are upper case. Spaces are optional. Lower case letters are converted to uppercase when received. Settings will be saved to memory and will be recalled on power up.

2.6 Serial Commands

<command> =>

2.6.1 CONTROL COMMANDS

START ANA-BOX CONTROL

RUN Enter active mode. Actively control the pump under control according to the mode setup.

STOP ANA-BOX CONTROL

STP Exit active mode. Stops control of the pump under control.

2.6.2 Status and Setup Commands

CONTROL MODE

MOD Query control mode according to settings on pump under control
Query response: <n.nn>

CONTROL MODE PARAMETERS

PAR <n> Queries control mode parameter <n> according to settings on pump under control Where parameter <n> is the parameter set at Pumping Program Phase 30+n. Valid values for <n> are 1 to 7.
Query response <float>

VOLTAGE INPUT QUERY

VLT Query Voltage input reading
Query response: <float>

USER CONTROL SWITCH

IN0 Query setting of user control switch, where 1 indicates Run and 0 indicates Stop
Query response: { 0 | 1 }

EXTERNAL CONTROL INPUT

IN1 Query setting of external control input, where 1 indicates Run and 0 indicates Stop
Query response: { 0 | 1 }

2.6.3 LOCAL PARAMETER SETUP COMMANDS

The Ana-Box's operational parameters can be stored directly in the Ana-Box's internal memory. When local parameter mode is enabled, the Ana-Box will not read the setup parameters from the device under control and instead operate according to the setup stored in internal memory. The local parameter mode enabled setting will also be stored in memory. Once enabled the Ana-Box will continue to read from internal memory until local parameter mode is disabled.

Command to enable local parameter mode:

PHN E1

Commands to configure the Ana-Box's operational mode are identical to commands used to configure devices under control. This allows existing pumping programs to be uploaded to the Ana-Box. Commands in pumping programs not relevant to the Ana-Box will be ignored. The Ana-Box will respond with an informational only ignore response "IGN", not an error message.

Phase Number or Local Parameter Mode

PHN [<n [n] > | E [0 | 1]]

<nn> Set current Phase # to store settings

E [0 | 1] Enable or disable local parameter mode

When set (1), setup parameters are read from the Ana-Box's internal memory and not from the pump under control

Setting a Phase number outside the range for Ana-Box setup parameters will be responding to with "IGN".

Rate Setting

RAT [<float > [<units >]]

Rate parameter data for currently selected Phase.

Volume Setting

VOL [<float >]

Volume parameter data for currently selected Phase: Auxiliary Mode setting if Phase 30.

Direction Setting

DIR [INF | WDR]

Pumping direction for currently selected Phase.

2.6.4 GENERAL SETUP COMMANDS

ENABLE AUTO-LOGGING OUTPUT

LOG [0 | 1 | V [<n> [<n>]]] Query/Set Automatic logging output of status information to computer
 0 = Enable; 1 = Disable
 When enabled, all events will be transmitted.
 V [<n> [<n>]] Enables voltage logging output during Run mode/
 Voltage will be transmitted every <nn> seconds.
 {nn} will default to 1 second if not specified.
 Event logging will be disabled while Voltage logging is enabled
 Default value: 0 (Logging disabled)
 Query response: { 0 | 1 | V<nn> }

Example: Enable voltage logging output every 5 seconds:
 LOGV5

COMMAND MODE

CMD [0 | 1] Enable of disables command only mode. Due to hardware limitations, communications with the computer can be lost while the Ana-Box is communicating with the pump under control. Command mode disables status communications with the pump under control, improving communications with the computer.

Can only be set when the Ana-Box is stopped. Automatically disabled when the Ana-Box enters Run mode.

SET NETWORK ADDRESS AND BAUD RATE

ADR [P [<n >] | D | <address> [B { 38400 | 19200 | 9600 | 2400 }]]]

Set/query devices network address and baud rate

<address> => <n> [<n>]

<address> Valid range: 0 to 99

Query response: <nn>

Default address = 9 Default baud rate = 19,200

B { 38400 | 19200 | 9600 | 2400 } If specified, will change the baud rate as indicated. NOTE: The command response and all further communications will be at the specified baud rate.

D Force digital reception mode.

P [<n>] Set/Query address of primary device under control of the Ana-Box.

<n> Address of device. Valid range: 0 to 7.

Query response: <n>

Default address = 0

Once set, the device will only respond to commands with the set address and at the specified baud rate.

Example: ADR Query current network address setting
 ADR 3 Set network address to 3. The Ana-Box will now only respond to commands with address 3
 ADR 5 B 9600 Set the Ana-Box's network address to 5 and the baud rate to 9600. The command's response will be at 9600 baud
 ADR P 3 The Ana-Box's primary device under control will be the device at network address 3.

FIRMWARE VERSION

VER [B] Query firmware version.
 Query response:: NE700V<n>.<nn>
 VER B Query firmware build date

3. Accessories

3.1 RS-232 Serial Network Cables

RS-232 Serial Network Primary Cable

7-foot cable Part #: CBL-PC-PUMP-7
25-foot cable Part #: CBL-PC-PUMP-25

Cable to connect the first device of an RS-232 serial network to a standard PC's serial port with a DB-9 connector.

RS-232 Serial Network Secondary Cable

7-foot cable Part #: CBL-NET-7
25-foot cable Part #: CBL-NET-25

Cable to connect additional devices, after the first, to an RS-232 serial network.

USB to RS-232 Converter Cable

USB to RS-232 cable
Part #: CBL-USB232

Attaches to the RS-232 Serial Network Primary Cable to allow communication through a PC's USB port. Includes a CD with software drivers.

4. Specifications

| | |
|-------------------------------------|--|
| RS-232 serial network protocol | Supported Baud rates: 38,400; 19,200; 9600; 2400 Default: 19,200 Data Frame: 8N1 |
| RS-232 serial network address range | 00 to 99 (100 devices maximum). Default address: 9 |