Chain Communications Mode with Pattern Sub-Mode

Chain Mode creates a stand-alone network of pumps that operate as a system. Depending on the selected sub-mode, the chain of pumps can operate as simple sequential dispenses or according to a complex pattern, without a computer attached. The chain can have a mixture of Syringe and Peristaltic pumps.

Hardware Setup:

Pump:	Master	2nd	3rd	4th	5th	<…>
Network Address	Chain [CHAn]	0 [Ad:00]	1 [Ad:0 1]	2 [Ad:02]	3 [Ad:03]	<…>
Cabling	CBL-DUAL-3	CBL-NET-7	CBL-NET-7	CBL-NET-7	CBL-NET-7	

Hardware Requirements:

Minimum Firmware Requirements:

Syringe Pumps: Chain Sub-Modes "Once" and "Repeat": 'X Firmware upgrade (Version: 4.665).
Pattern Sub-Mode: Master Pump: 'X2 Firmware upgrade (Version: 5.665).

Peristaltic Pumps: Chain Mode and Pattern Sub-Mode: 'X2 Firmware upgrade (Version: 5.71).

Each additional pump: 'X firmware upgrade ('X2 only for peristaltic).

Pump Cables:

CBL-DUAL-3: Connects Master pump to second pump.

CBL-NET-7: Connects second pump to third pump.
One additional CBL-NET-7 cable to connect each additional pump.

Computer Cables:

Needed to upload Pattern Sub-Mode data:

CBL-USB232 USB to RS-232 converter cable.

CBL-PC-PUMP-7 Primary RS-232 network cable.

CBL-DUAL-6 Optional cable to allow the computer to be connected while pumps are operating.

Setup Chain Communications Mode

Master Pump: Set RS-232 communications network mode to "Chain", displayed as [CHAn].
Pattern mode network setting will be auto-configured when pattern is uploaded from spreadsheet.

Additional Chain Pumps attached to Master Pump:
Set RS-232 communications network to Address mode (default mode). Set each pump's address incrementally, starting from 0. Address is displayed as [Ad:nn], where "nn" is the pump's address.

Master Pump Chain Mode Sub-Mode Setup:

After setting communications mode to “Chain”, set Sub-Mode parameters:

{ OnCE | rEPt | PAtn } Pattern mode: ‘X2 version only

{ Adr.<n> } Once and Repeat modes only

Sub-Mode Once Displayed as: [OnCE]

Pumps operate in sequence, starting with the Master pump.
Sequence stops after last pump.
Maximum Number of Pumps in Chain: 9

Sub-Mode Repeat Displayed as: [rEPt]

Pumps operate in sequence, starting with the Master pump.
Sequence repeats after the last pump.
Maximum Number of Pumps in Chain: 9

Sub-mode Pattern Displayed as: [PAtn]

*** ‘X2 Version Only ***

Multiple pumps operate simultaneously in each sequence, according to defined pattern
Up to 16 pattern sequences can be defined
Defined pattern operates in a single run or repeats after the last sequence
Maximum Number of Pumps in Chain: 6

Set Chain Size Displayed as: [Adr.<n>]

Once and Repeat Sub-Modes only:

Sets maximum pump network address in chain, where <n> = Maximum chain address.
Maximum chain address = 7, representing a total of 9 pumps.

Pattern Sub-Mode Setup:

Use the Pumping Program Generator spreadsheet file to setup the pumping pattern, and then upload pattern data to the Master pump.

Select “NE-1000 Program” tab: Enter Pumping Program for Master pump.
Select “Pattern” tab: Define pumping pattern.

		Chain Pumping Mode					
		Pump Address: Chain				Sub-Mode: Pattern	
Pump Name:		Pump A	Pump B	Pump C	Pump D	Pump E	Pump F
Pump Address:		Chain	0	1	2	3	4
	1	Start	Off	Off	Off	Start	Off
	2	Off	Start	Off	Start	Off	Off
	3	Off	Off	Start	Off	Off	Off
	4	Start	Off	Off	Start	Off	Off
◉ Singe Run	5	Off	Start	Off	Off	Off	Start
○ Repeat	6	Off	Off	Off	Off	Off	Off
	7	Off	Off	Off	Off	Off	Off

- For each sequence, select “Start” or “Off” for each pump in the chain.
- All pumps in a sequence set to “Off” defines the end of the pattern.
- Select “Single Run” to end the pattern after the last defined sequence in the pattern.
- Select “Repeat” to repeat the pattern after the last defined sequence in the pattern.
- Label names can be assigned to each pump in the chain in row “Pump Name”.

A maximum of 16 sequences can be defined in the pattern.
A maximum of 6 pumps can be used in a pattern chain (Master pump plus max address: 4).

When a pattern sequence begins, a “Start” command is sent to each pump in the sequence set to “Start”. No stop commands are sent to pumps. Pumps set to “Off” are skipped.

Each sequence ends when the Master pump and/or lowest addressed operating pump ends its sequence. For example, if a pattern sequence includes 3 of the pumps from a chain, Master pump plus pumps at address 0 and 4, the pattern sequence will end when the Master pump and pump address 0 end their programmed sequence. The pump at address 4 could continue operating beyond the end of the sequence and into the next sequence. Conditions ending a programmed sequence are described below, under “**Programming Individual Pumps in a Chain”**.

Pattern data is uploaded only to the Master pump. Pattern data is stored on the Master pump in Pumping Program Phases 330-333 as “Increment” Program Functions [InCr].

To upload the program, attach the PC cable CBL-PC-PUMP-7 to the “To Computer” connector on the Master pump. Disconnect cable CBL-DUAL-3 if necessary. After the data is uploaded, disconnect the PC cable and attach cable CBL-DUAL-3 between the Master pump and Second pump. Alternatively, cable CBL-DUAL-6 can be used to program the Master pump. Attach cable CBL-DUAL-6 to the “To Network” connector of the last pump in the chain.

Click on the pump image on the “NE-1000 Program” tab page to upload program to the Master pump.

Programming Individual Pumps in the Chain

The currently operating pump, or for Pattern Mode, the Master pump and the lowest addressed operating pump in a chain sequence can contain pumping programs that further control the pumping sequence.

The Master pump and the lowest addressed operating pump end the sequence when:

The pumping program stops:	STOP program function
A Pause and Wait function [PS:00] is executed	
Pause timer function:	With RUN.0 set in Setup
An overlap pumping function is executed:	OUT.0

Chain or Pattern will not continue to the next pump or sequence when the controlling pump sets the end control function "trigger disable": TR:oF

Running Chain Mode:

To start Chain Mode, press <Start> on the Master pump. The chain of pumps will start according to the selected mode and setup. The Chain can be remotely started from the TTL Trigger input, or from a PC using cable CBL-DUAL-6. CBL-DUAL-6 must be attached between connector CBL-PC-PUMP and the "Network" connector of the last pump in the chain. Communications will only be with the Master pump. Precede all commands to the Master pump with the asterisk symbol "*". To start the Chain, send the command: *RUN

When the Master pump is not running a program, the display will show the current status of the pump chain. Once and Repeat modes will display the address of the current pump running:
[CH:nn] where "nn" is the address of the running pump.

Pattern mode will display the current sequence number of the pattern:
[CH:nn] where "nn" is the sequence number.
Pressing <Stop> on the Master pump will pause the pumping programs of all operating pumps in the Chain.
Pressing <Stop> again will continue the pumping programs of the operating pumps in the Chain.

Remote Setup Command:

ADR CHAN { 0 | 1 | 2 } <n>

0: Once sub-mode	Pump address limit: 7 (9 Total Pumps)
1: Repeat sub-mode	Pump address limit: 7 (9 Total Pumps)
2: Pattern sub-mode	Pump address limit: 4 (6 Total Pumps)

<n>: Maximum pump address in chain. (Relevant only to sub-modes Once or Repeat)

Technical Information

Pattern Sub-Mode Data:

Use the Pumping Program Generator spreadsheet to generate pattern data and upload it to the Master pump. The following is strictly for technical reference only:

Data is encoded as 4 digit Rate and Time data (<abcd>), in Phases 330 to 333.
Each pattern's Phase is set to function "Increment Rate", [InCr].
If the function does not contain Rate data, values will be set to 0.
The pattern ends if the next sequence=0, or the maximum sequence was executed.
If the sub-mode is "Repeat", the pattern will continue with sequence 1.
If the sub-mode is "Once", the pattern execution will stop.

For each Phase the 4 digit Rate Data <abcd> is relevant to sequences (n, n+1). The 4 digit Time data <abcd> is relevant to sequences (n+2, n+3).

Where sequence "n" = 1 + ((Current Phase #) – 330) * 4

<abcd> contains data for 2 consecutive pattern sequences: <ab> and <cd>.
Each pattern sequence, <xy>, contains binary coded decimal (BCD) start/off pattern data for 1 sequence for a chain of up to 6 pumps. BCD values range: <00> to <77>:
Binary Pattern: x=<0, A4, A3, A2>, y=<0, A1, A0, AM>, Where <Az> is the pump address <z> and <AM> is the Chain Master pump.
For each bit: 1 = pump start, 0 = pump stopped.

For Rate data, set the default decimal point after the first digit: <n.nnn>
If the first digit of a rate is "0", replace it with the digit "8" to prevent shifting out of leading 0's.

Pattern Repetition Mode: Once or Repeat
Phase 330, Rate data: Decimal point position determines Pattern Mode: Once or Repeat.
Pattern Once Mode: Position decimal point between digits 1 and 2: <n.nnn>
Pattern Repeat Mode: Position decimal point between digits 2 and 3: <nn.nn>