

SECTION G

PUMP ALTERNATION

Revision Date: 1-3-25

Even Run Times

For the typical lift station application the Pump Alternation logic simply switches or alternates which pump starts first.

The more active lift station applications routinely have one or more pumps running much of the time, just to keep up with the station inflow. In these cases the Pump Alternation logic must be able to switch or alternate which pump(s) are left running after an unneeded pump is turned off.

In both cases Pump Alternation ensures that the run times of the pumps are made as even as possible.

Reduced Pump Motor Heating

The electrical motor inside a pump warms up when the pump is running. Also, a pump experiences an inrush of electrical current each time it is started, which adds to the heating of the pump's electrical motor.

If the same pump were always called to run as the lead pump (no alternation), and if there were not much time between pump run cycles, there may not be sufficient time for the pump's electrical motor to cool down before being started again.

A properly alternated set of pumps experiences a reduced amount of pump motor heating.

First On First Off

For the typical duplex pumping station, where only one pump runs at a time, the Controller would simply switch the Lead Pump Position at the end of each complete pump cycle in preparation for the next pump cycle. For such cases an ordinary First On Last Off alternation routine would be sufficient.

However, for many pumping applications the station inflow requires that at least one pump runs for an extended period of time and that one or more additional pumps periodically run to help keep up with the inflow. In such cases, First On First Off alternation (provided by the Controller's internal logic) along with staggered Pump Off Level settings would be essential to ensure proper alternation of the pumps.

For First On First Off alternation to function as intended, the Pump Off Level setting must be staggered to allow for the additional pump(s) to be turned off while leaving at least one pump running.

A First On First Off alternator will alternate the pumps when all of the Pump Off Level settings are set for the same level, it just does so when all of the pumps are turned off in preparation for the next run cycle.

For applications with enough inflow to justify keeping one or more pumps running, there is an electrical power savings to be realized by using the First On First Off alternation feature along with staggered Pump Off Level settings and leaving one or more pumps running for much of the time.

VFD lift station pumping applications typically require the use of the First On First Off alternation with staggered Pump Off Level settings to get the maximum pumping efficiency and electrical cost savings.

Alternation Sequence Modes

The **Standard Alternation** mode is provided for pumping applications where all of the pumps are the same size and all of the pumps are run at the same speed (either all pumps are run at full speed or all are on VFDs). See pages G-2 and G-3.

For applications with mismatched pump sizes or where some have VFDs and some don't, there are four **Special Alternation Sequences** and the Alternation Sequence Modifier A. See pages G-2 through G-5.

Sequence Control Features

To accommodate the need to make temporary changes to the Alternation Sequence, due to pump maintenance issues, the Controller provides the following features:

Pump Disable Discrete Inputs - which can signal the Controller to skip over and not call a disabled pump.

Call Pump Last Discrete Inputs - which can signal the Controller to make a pump the last to be called.

Sequence Input Discrete Inputs - which can signal the Controller to set the lead pump.

Forced Lead Pump Position Parameters - that allow the operator to set the lead pump.

Time Base Alternation

Time Based Alternation - which can be signaled from an internal or an external time clock. See page G-2.

PUMP ALTERNATION

User / Operator Info.			SCADA	Description of Parameters and SCADA Notes
Parameter	Default Value	Current Value	Register Address	
Pump Alternation Setup				
P.16	1		40116	<p>Alternation Sequence Mode</p> <p>1 = Standard Alternation: Group 1: Pumps 1 - 4 See page G-3.</p> <p>2 = Pump 1 Always Lead: Group 1: Pump 1 See page G-3. Group 2: Pumps 2 - 4</p> <p>3 = Pump 3 Always Last: Group 1: Pumps 1 - 2 See page G-4. Group 2: Pump 3</p> <p>4 = Pump 4 Always Last: Group 1: Pumps 1 - 3 See page G-4. Group 2: Pump 4</p> <p>5 = Split Alternation: Group 1: Pumps 1 - 2 See page G-5. Group 2: Pumps 3 - 4</p> <p>Also see: Alternation Sequence Modifier A (Parameter P.17) below.</p>
P.17	0		40117	<p>Alternation Sequence Modifier A</p> <p>0 = Group 1 Pump(s) Are Allowed To Run With Pumps From Group 2</p> <p>1 = Group 1 Pump(s) Not Allowed To Run With Pumps From Group 2 (Pump(s) in Group 1 are turned off before starting Pumps in Group 2)</p> <p>Note: This applies when Parameter P.16 = 2 or 5</p>
P.18	0		40022	<p>Forced Lead Pump Position - Group 1</p> <p>0 = Normal Alternation X = Pump X as Lead</p> <p>Note: This applies to Group 1 when Parameter P.16 = 1, 3, 4 or 5</p>
P.19	0		40026	<p>Forced Lead Pump Position - Group 2</p> <p>0 = Normal Alternation X = Pump X as Lead</p> <p>Note: This applies to Group 2 when Parameter P.16 = 2 or 5</p>
P.20	0		40120	<p>Time Based Alternation - Group 1 Range: 0 - 65535 minutes</p> <p>0 = Disabled 60 = 1 hour 480 = 8 hours 1440 = 24 hours</p> <p>Note: Group 1 may be triggered to alternate by using the Internal Time Clock setup using Parameter P.20, or it can also be triggered by an External Time Clock, which may be either a hardware device connected to a Discrete Input setup to perform Function 5, or it may be triggered to alternate by momentarily setting Modbus Coil 136 (Register 40009 Bit 7).</p>
P.21	0		40121	<p>Time Based Alternation - Group 2 Range: 0 - 65535 minutes</p> <p>0 = Disabled 60 = 1 hour 480 = 8 hours 1440 = 24 hours</p> <p>Note: Group 2 may be triggered to alternate by using the Internal Time Clock setup using Parameter P.21, or it can also be triggered by an External Time Clock, which may be either a hardware device connected to a Discrete Input setup to perform Function 6, or it may be triggered to alternate by momentarily setting Modbus Coil 137 (Register 40009 Bit 8).</p>
Pump Alternation Status				
Ad.1	-	-	40023	Current Lead Pump - Group 1 Shows the number of the current Lead Pump.
Ad.2	-	-	40027	Current Lead Pump - Group 2 Shows the number of the current Lead Pump.

PUMP ALTERNATION - SEQUENCE MODES

STANDARD ALTERNATION

Parameter P.16 = 1

Unless there is some special circumstance that requires a more complicated pump call sequence, this is the sequence that should be used.

The pumps will be Alternated “First On First Off”.

Discrete Inputs assigned the Function of “Pump Disable” (Functions 1 - 4) inputs may be used to disable pumps so that they will not be called to run and will be skipped in the pump call sequence.

Discrete Inputs assigned the Function of “Call Pump Last” (Functions 13 - 16) may be used to assign pumps to standby status, where they will only be called to run if no other pumps are available and will be skipped in the normal pump call sequence.

Discrete Inputs assigned the Function of “Sequence Input” (Functions 9 - 12) may be used to set the lead pump.

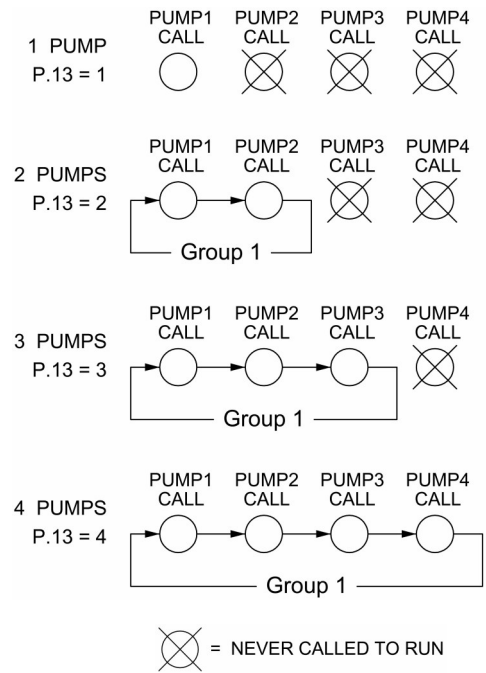
The “Forced Lead Pump Position - Group 1” (Parameter P.18) may be used to set the lead pump.

“Time Based Alternation - Group 1” (Parameter P.20) may be setup to force an alternation using an Internal Time Clock.

A Discrete Input assigned the Function of “External Alternation - Group 1” (Function 5) may be connected to an External Time Clock and used to force alternation.

A SCADA system may initiate an alternation by momentarily setting Modbus Coil 136 (Register 40009, Bit 7).

Movement of Lead Pump Upon Alternation



PUMP 1 ALWAYS LEAD

Parameter P.16 = 2

This sequence is used when it is required that pump 1 always be the lead pump.

The pumps in Group 2 will be Alternated “First On First Off”.

“Alternation Sequence Modifier A” (Parameter P.17) is provided to set whether or not pump 1 stays on when pumps from Group 2 are called to run.

Discrete Inputs assigned the Function of “Pump Disable” (Functions 1 - 4) inputs may be used to disable pumps so that they will not be called to run and will be skipped in the pump call sequence.

Discrete Inputs assigned the Function of “Call Pump Last” (Functions 14 - 16) may be used to assign pumps to standby status, where they will only be called to run if no other pumps are available and will be skipped in the normal pump call sequence.

Discrete Inputs assigned the Function of “Sequence Input” (Functions 10 - 12) may be used to set the lead pump of Group 2.

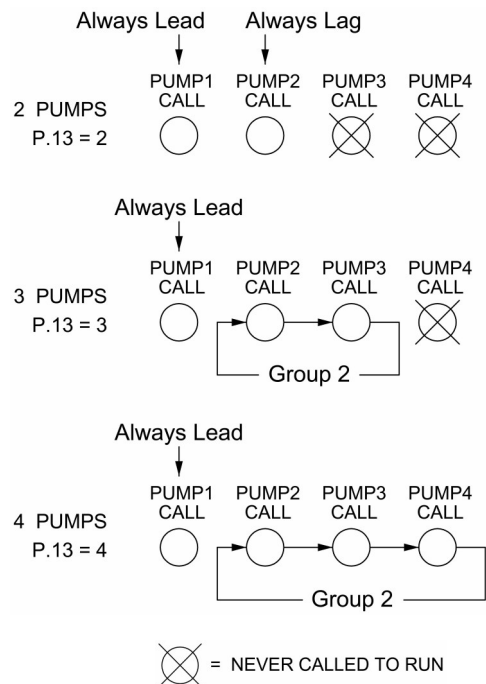
The “Forced Lead Pump Position - Group 2” (Parameter P.19) may be used to set the lead pump.

“Time Based Alternation - Group 2” (Parameter P.21) may be setup to force an alternation using an Internal Time Clock.

A Discrete Input assigned the Function of “External Alternation - Group 2” (Function 6) may be connected to an External Time Clock and used to force alternation.

A SCADA system may initiate an alternation by momentarily setting Modbus Coil 137 (Register 40009, Bit 8).

Movement of Lead Pump Upon Alternation



PUMP ALTERNATION - SEQUENCE MODES

PUMP 3 ALWAYS LAST

Parameter P.16 = 3

This sequence is used where there are three pumps and it is required that pumps 1 and 2 alternate and that pump 3 is always last to be called to run.

The pumps in Groups 1 will be Alternated "First On First Off".

Discrete Inputs assigned the Function of "Pump Disable" (Functions 1 - 2) inputs may be used to disable pumps so that they will not be called to run and will be skipped in the pump call sequence.

Discrete Inputs assigned the Function of "Sequence Input" (Functions 9 - 10) may be used to set the lead pump of Group 1.

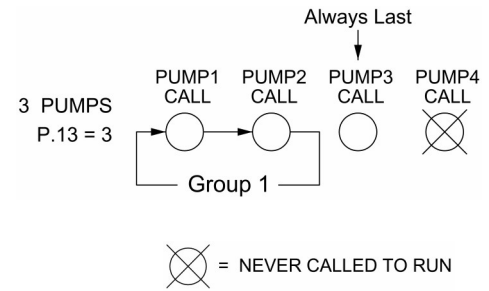
The "Forced Lead Pump Position - Group 1" (Parameter P.18) may be used to set the lead pump.

"Time Based Alternation - Group 1" (Parameter P.20) may be setup to force an alternation using an Internal Time Clock.

A Discrete Input assigned the Function of "External Alternation - Group 1" (Function 5) may be connected to an External Time Clock and used to force alternation.

A SCADA system may initiate an alternation by momentarily setting Modbus Coil 136 (Register 40009, Bit 7).

Movement of Lead Pump Upon Alternation



PUMP 4 ALWAYS LAST

Parameter P.16 = 4

This sequence is used where there are four pumps and it is required that pumps 1, 2 & 3 alternate in Group 1 and pump 4 is always last to be called to run.

The pumps in Groups 1 will be Alternated "First On First Off".

Discrete Inputs assigned the Function of "Pump Disable" (Functions 1 - 3) inputs may be used to disable pumps so that they will not be called to run and will be skipped in the pump call sequence.

Discrete Inputs assigned the Function of "Sequence Input" (Functions 9 - 11) may be used to set the lead pump.

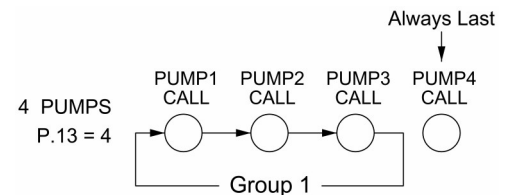
The "Forced Lead Pump Position - Group 1" (Parameter P.18) may be used to set the lead pump in Group 1.

"Time Based Alternation - Group 1" (Parameters P.20) may be setup to force an alternation using an Internal Time Clock.

A Discrete Input assigned the Function of "External Alternation - Group 1" (Function 5) may be connected to an External Time Clock and used to force alternation.

A SCADA system may initiate an alternation by momentarily setting Modbus Coil 136 (Register 40009, Bit 7).

Movement of Lead Pump Upon Alternation



PUMP ALTERNATION - SEQUENCE MODE

SPLIT ALTERNATION

Parameter P.16 = 5

This sequence is used when there are four pumps and it is required that the pumps be separated into two groups with pumps 1 & 2 in Group 1 and pumps 3 & 4 in Group 2.

The pumps in Group 1 are called to run first before the pumps in Group 2.

The pumps 1 and 2 will be Alternated "First On First Off".

The pumps 3 and 4 will also be Alternated "First On First Off".

"Alternation Sequence Modifier A" (Parameter P.17) is provided to set whether or not pumps in Group 1 stay on when pumps from Group 2 are called to run.

Discrete Inputs assigned the Function of "Pump Disable" (Functions 1 - 4) inputs may be used to disable pumps so that they will not be called to run and will be skipped in the pump call sequence.

Discrete Inputs assigned the Function of "Sequence Input" (Functions 9 - 12) may be used to set the lead pump.

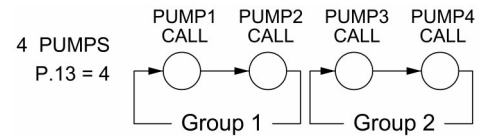
The "Forced Lead Pump Position - Group 1(2)" (Parameters P.18 and P.19) may be used to set the lead pump in each Group.

"Time Based Alternation - Group 1(2)" (Parameters P.20 and P.21) may be setup to force an alternation using Internal Time Clocks.

A Discrete Input assigned the Function of "External Alternation - Group 1(2)" (Functions 5 and 6) may be connected to External Time Clocks and used to force alternation.

A SCADA system may initiate an alternation by momentarily setting Modbus Coils 136 or 137 (Register 40009, Bit 7 or Bit 8).

Movement of Lead Pump Upon Alternation

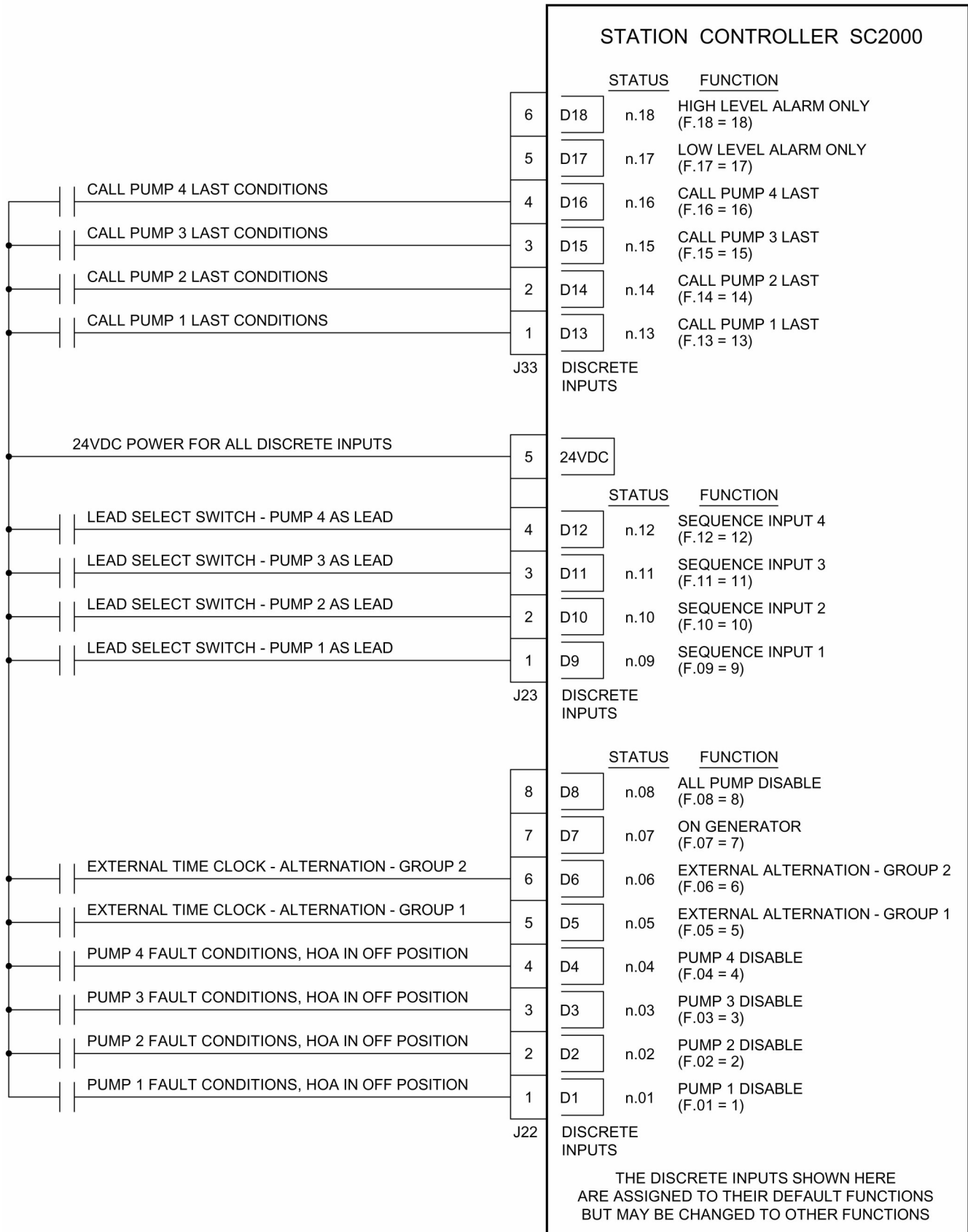


PUMP ALTERNATION - SCADA REGISTER

SCADA Register Address	Description of Register Contents (Where a Modbus Coil is represented by a Bit in a Register)																
	144	143	142	141	140	139	138	137	136	135	134	133	132	131	130	129	Coil
40009								Force Pump Alternation Group 2	Force Pump Alternation Group 1								
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Bit

PUMP ALTERNATION - DISCRETE INPUTS

Connection Diagram



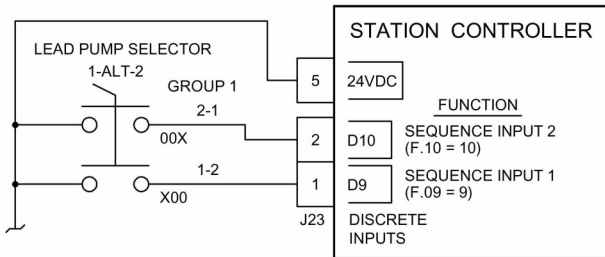
For More Information On Using the Discrete Inputs See Section A.

PUMP ALTERNATION - LEAD SELECT SWITCH EXAMPLES

Connection Diagrams

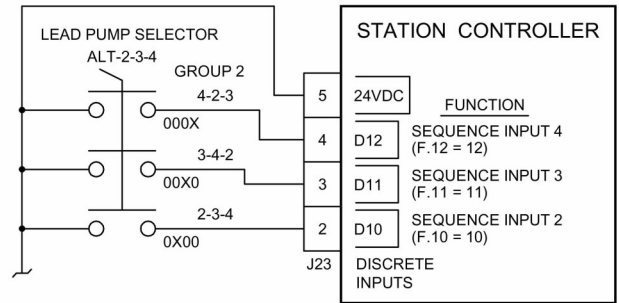
2 PUMPS - STANDARD ALTERNATION

NUMBER OF PUMPS PRESENT: P.13 = 2
ALTERNATION SEQUENCE MODE: P.16 = 1



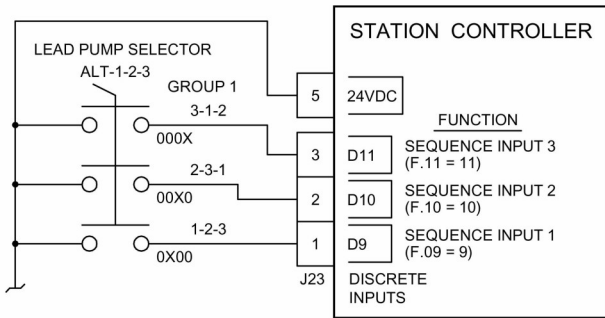
4 PUMPS - PUMP 1 ALWAYS LEAD

NUMBER OF PUMPS PRESENT: P.13 = 4
ALTERNATION SEQUENCE MODE: P.16 = 2



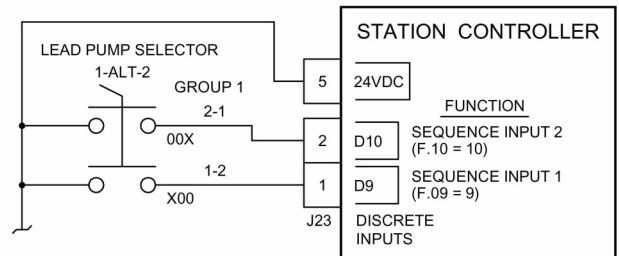
3 PUMPS - STANDARD ALTERNATION

NUMBER OF PUMPS PRESENT: P.13 = 3
ALTERNATION SEQUENCE MODE: P.16 = 1



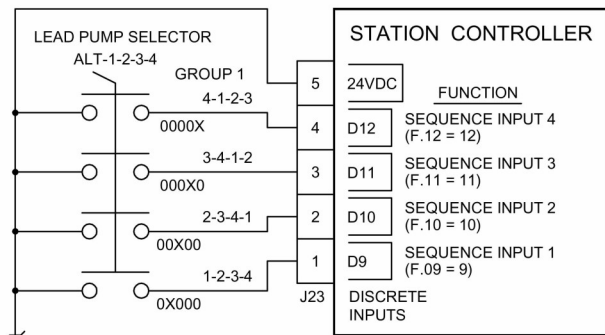
3 PUMPS - PUMP 3 ALWAYS LAST

NUMBER OF PUMPS PRESENT: P.13 = 3
ALTERNATION SEQUENCE MODE: P.16 = 3



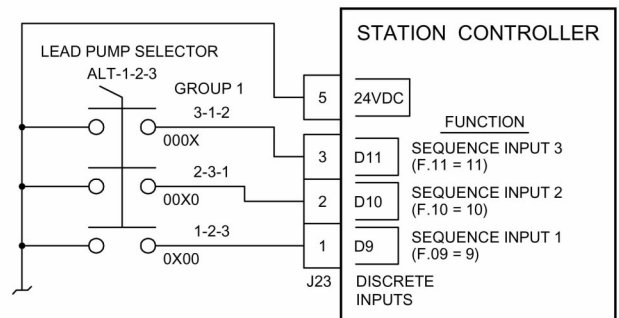
4 PUMPS - STANDARD ALTERNATION

NUMBER OF PUMPS PRESENT: P.13 = 4
ALTERNATION SEQUENCE MODE: P.16 = 1



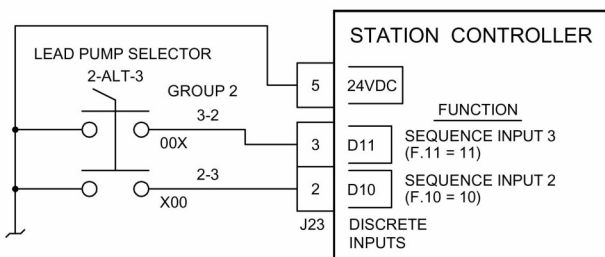
4 PUMPS - PUMP 4 ALWAYS LAST

NUMBER OF PUMPS PRESENT: P.13 = 4
ALTERNATION SEQUENCE MODE: P.16 = 4



3 PUMPS - PUMP 1 ALWAYS LEAD

NUMBER OF PUMPS PRESENT: P.13 = 3
ALTERNATION SEQUENCE MODE: P.16 = 2



4 PUMPS - SPLIT ALTERNATION

NUMBER OF PUMPS PRESENT: P.13 = 4
ALTERNATION SEQUENCE MODE: P.16 = 5

