

Control Techniques Americas



Unidrive M400 Multiplex

Pump Software User Guide

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Issue Number: 8

A large, green, 3D geometric graphic resembling a stylized 'M' or a series of overlapping planes. The year "2017" is printed in a large, black, sans-serif font on the rightmost vertical plane of the graphic.

2017



SAFETY INFORMATION

Persons supervising and performing the electrical installation or maintenance of a Drive and/or an external Option Unit must be suitably qualified and competent in these duties. They should be given the opportunity to study and if necessary to discuss this User Guide before work is started.

The voltages present in the Drive and external Option Units are capable of inflicting a severe electric shock and may be lethal. The Stop function of the Drive does not remove dangerous voltages from the terminals of the Drive and external Option Unit. Mains supplies should be removed before any servicing work is performed.

The installation instructions should be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the Drive and external Option Unit, and the way in which they are operated and maintained complies with the requirements of the Health and Safety at Work Act in the United Kingdom and applicable legislation and regulations and codes of practice in the UK or elsewhere.

The Drive software may incorporate an optional Auto-start facility. In order to prevent the risk of injury to personnel working on or near the motor or its driven equipment and to prevent potential damage to equipment, users and operators, all necessary precautions must be taken if operating the Drive in this mode.

The Stop and Start inputs of the Drive should not be relied upon to ensure safety of personnel. If a safety hazard could exist from unexpected starting of the Drive, an interlock should be installed to prevent the motor being inadvertently started.

GENERAL INFORMATION

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional operating parameters of the equipment or from mismatching the Drive with the motor.

The contents of this User Guide are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the contents of the User Guide, without notice.

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1 INTRODUCTION

1.1 Who Should Read This Manual?

This manual is intended to assist the engineer in commissioning the application software, and should be read in conjunction with the documentation that is supplied with the drive and other associated hardware. The safety systems that are required to prevent risk of injury to persons operating or maintaining the machine are not discussed in this manual. The engineer must be familiar with and able to implement the required safety systems. This manual assumes that the engineer is familiar with relevant Control Techniques products and understands the requirements for the application, and should be used alongside the *Unidrive M400 User Guide* for more information.

If you do not feel confident of the above, then you should contact your local Nidec Industrial Automation/Control Techniques drive centre or distributor to obtain service / advice.

1.2 Document & Parameter References

Referenced document part numbers can be found in Section 7.7 of this user guide.

All parameter references for the Unidrive M400 in this user guide will include the parameter name, location in Menu 0 (if applicable), and drive menu location. The format will appear as follows:

Parameter Name (Pr 0.Parameter/DriveMenu.Parameter).

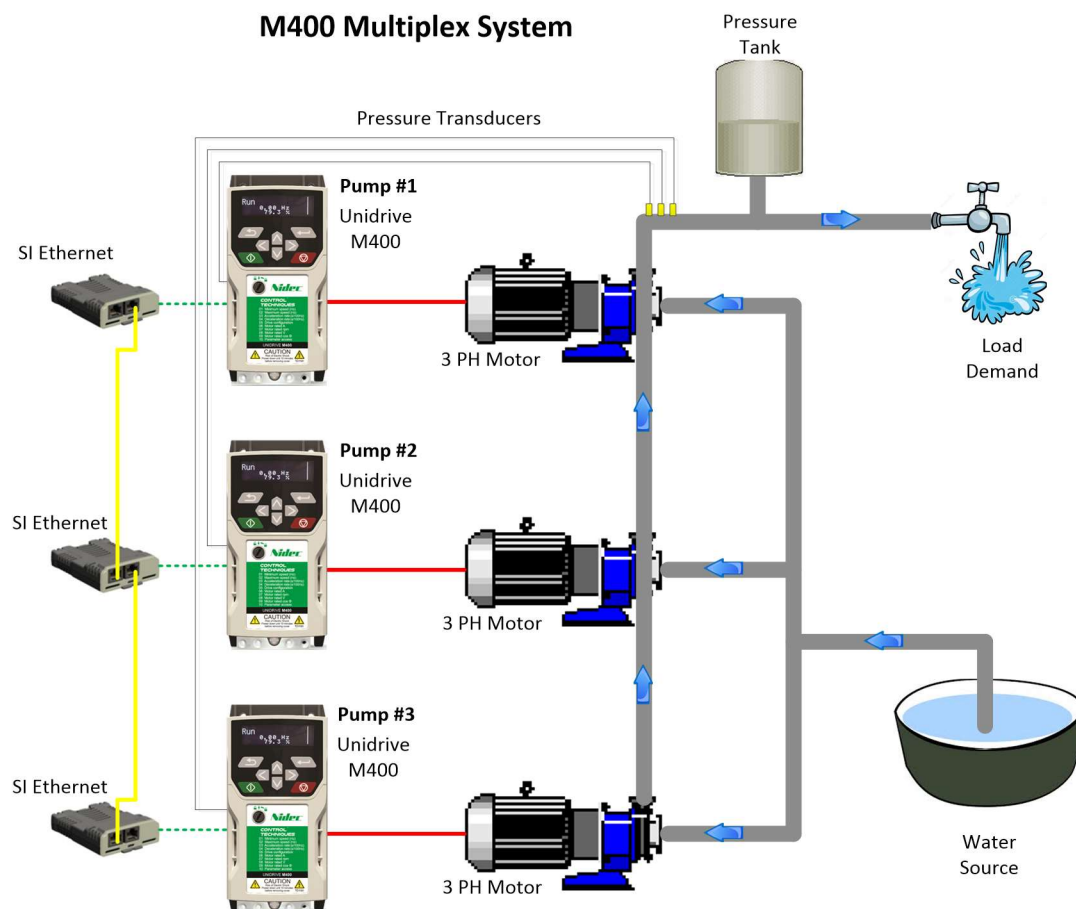
For example,

Motor Rated Frequency (Pr 0.005/5.006)

1.3 Application Overview

The purpose of multiplex pump control is to effectively control multiple pumps in parallel in order to maintain a required pressure with varying load demands. Pumps are often used in parallel banks to:

- Avoid motor overload
- Guaranteed security of supply (system redundancy)
- Reduce running cost due to system load fluctuations
- Provide a wide range of control and flexibility



The system consists of up to 3 variable speed pump drives of similar size. The pumps are controlled to regulate the pressure of the system to an optimum pressure set point. Each pump drive will be run based on the demand where the higher the demand rises, the more drive pumps that will be required to run. The first pump drive to run is known as the lead pump and the pumps that are run after are called lag pumps, with system response controlled by the lead pump.

This software can run 2 or 3 pump systems, in addition to running individual pumps in Simplex mode when necessary. Each drive has the option of a local pressure transducer that can be shared across the network of drives.

1.3.1 Simplex Operation

The Unidrive M400 Multiplex software can be used to control one pump if required, similar to the M400 Simplex pump software. This may occur if a drive falls out of network with other pumps, or if all other pumps on the network become faulted. When controlling a pump with PID control it is important to remember basic fan and pump laws to understand the operation:

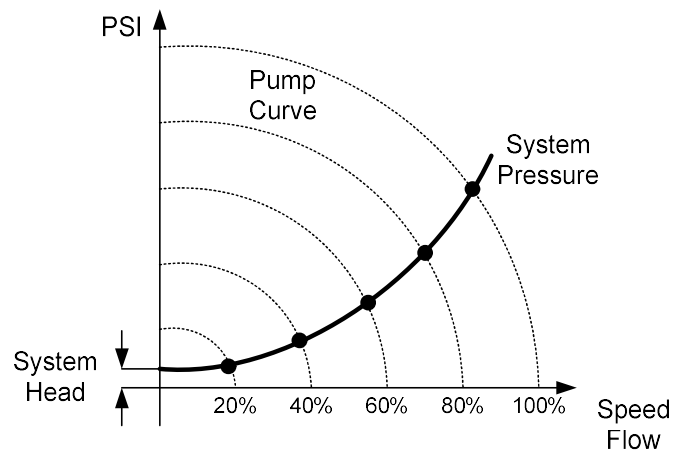
Flow \propto Speed

Pressure \propto Speed²

Power \propto Speed³

From these laws we can see that pressure will increase with speed squared, therefore with PID control, if the actual pressure is less than the required set point the speed will increase and therefore decrease if the actual pressure is greater than the set point. The response of the PID loop is determined by the PID Proportional, Integral, and Derivative gains.

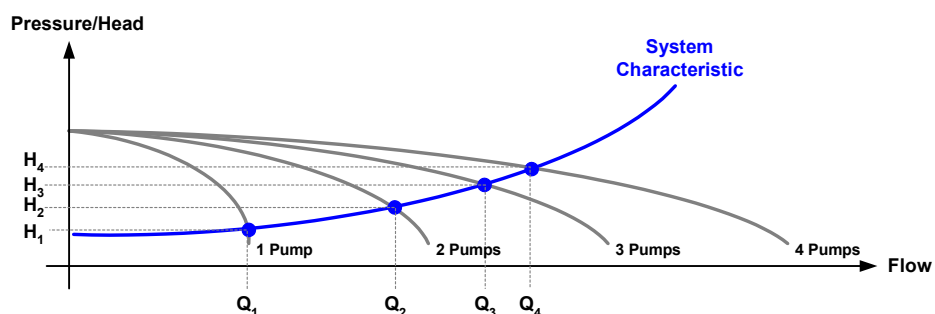
The pump, motor and drive are sized for the demand pressure & flow requirements and pump working speed range (typically 60-100% speed, or approximately 40 – 60 Hz with a 60 Hz motor).



1.3.2 Multiplex (Parallel) Operation of Pumps

Contrary to commonly held beliefs; the flow does not double with the addition of a second similar pump in parallel. In fact, each successive pump adds a smaller amount to the total system pressure and flow, although the total flow is split equally between each pump.

Typical System Curves for parallel pump/fan operation



Compared to the equivalent larger pump system, the multiplex/parallel system has more range in control and is a more efficient system as the larger pump will be less efficient at lower speeds/flows.

The multiplex control has similar features to the simplex control, but with the multiplex operation there is more sequencing logic to control and monitor each pump to start and stop with the variation of the system demand, which is summarized below.

Starting Sequence

1. When system pressure falls below the minimum threshold with no pump running, the current lead pump in the set sequence starts as the lead pump.
2. The lead pump regulates its pressure set point with its own PID.
3. If pressure decreases (demand increases), the pump speed increases.
4. If motor speed reaches a maximum set point value, after a set time, a lag pump will be started. The lag pump selection will be based on the set sequence (positive numerically consecutive) based on which pump is available. (e.g. 1-2-3, 2-3-1, or 3-1-2)
5. When the lag pump is added, all pumps now run at the frequency determined by the PID of the lead pump.
6. This sequence is repeated to add more lag pumps until the demand is satisfied or no further pump is available.

Stopping Sequence

1. When the pressure increases (demand decreases), the last lag drive (in positive numerical sequence) selected to run will be stopped when the system falls below a set frequency threshold for a set time.
2. This sequence is repeated until only the lead drive is running. If at this point the pressure remains high enough to reduce the PID output below a set value, the lead drive will stop and remain in “sleep” mode until the starting sequence is initiated again based upon the demand.
3. If a flow switch is attached and appropriately configured, when a no-flow condition is detected from the switch, all active drives will stop and remain in “sleep” mode until the starting sequence is initiated again based upon demand.

1.3.3 Features

- **Simplex Operation**

- Auto/Hand; Digital control selection from terminal IO (if configured), keypad or fieldbus.
- Pressure set point from keypad or fieldbus.
- Full PID speed control.
- Over Pressure threshold.
- Dry Well/Low suction protection (software detected) and/or wired flow switch.
- Configurable pipe fill function.
- Drive and Pump Fault log.
- Trip Auto Reset function for drive.
- Wake/Sleep, energy save functionality.
- Dynamic V/F, energy save function.
- Loss of Transducer signal modes.
- Signal scaling into Real Engineering Units.
- Optional Fieldbus Interfaces: Modbus RTU, Ethernet, Modbus TCP, EtherNet/IP.

- **Multiplex Operation**

- All the features the Simplex version offers.
- Can run as Triplex or Duplex, automatically detected.
- Assist selection by set sequence configured system node order.
- Lead pump alternation time set by 0.1 hours (default of 24 hours, user settable).
- Peer to Peer Ethernet Communication.
- Dynamic automatic reselection of Lead or Lag pumps if pump is taken out of service, fails to start, or faults.
- Feedback signals shared among drives via Ethernet network for feedback redundancy.
- Network over pressure trip to stop all running pumps together.

- Configurable network loss response.
- Network shared pipe fill function.
- Configurable total pressure sensor loss function.

2 MECHANICAL INSTALLATION

NOTE: Ensure the Unidrive M400 is correctly installed in accordance to the Unidrive M400 User Guide.

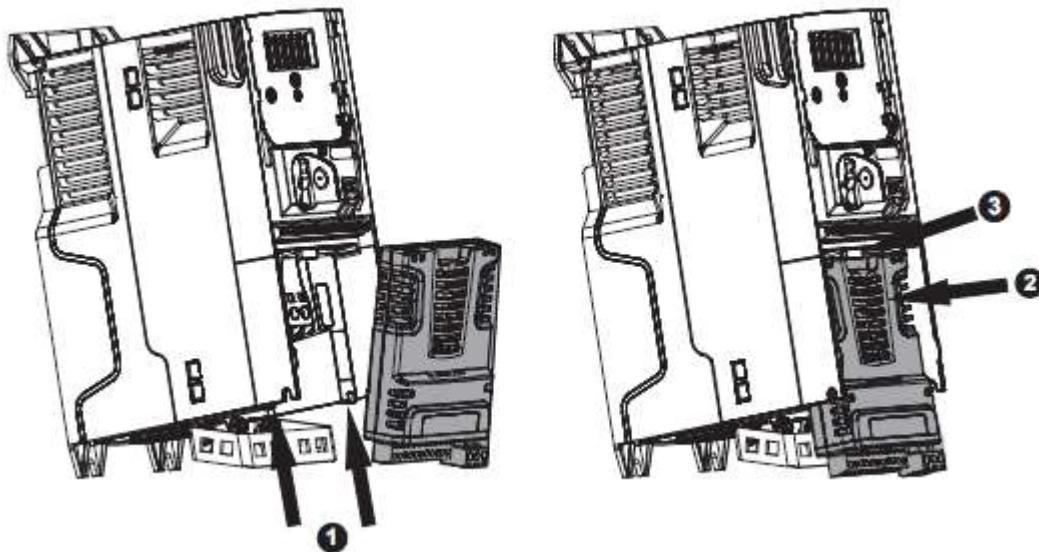
2.1 General Mechanical Installation

Please see the *Unidrive M400 User Guide* for detailed references on how to correctly install the Unidrive M400, based upon frame size and installation configuration.

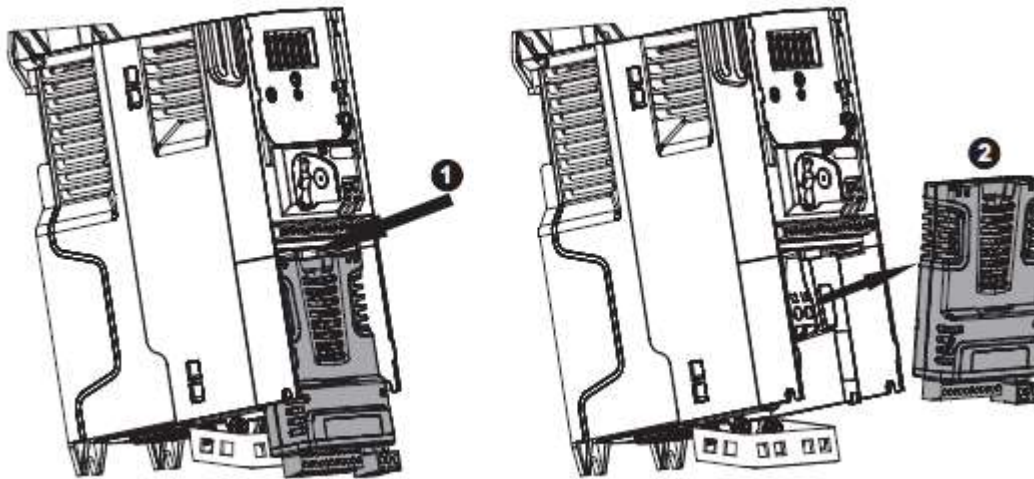
2.2 Fitting of Option Module

For the Unidrive M400 Multiplex solution, an SI Ethernet Option module must be fitted to Slot 1 of the Unidrive M400 drive for drive to drive communication. The following procedure should be followed when installing the SI Ethernet module:

- Isolate the drive from the main supply and allow 5 minutes for the DC Bus capacitors to discharge.
- Remove the front bib cover on the drive to access the Slot 1 module connection location, and using a small need nosed pliers, remove the small plastic cover covering the Slot 1 connection pins.
- With the SI Ethernet option module tilted slightly backwards, alight and locate the two holes in the rear of the option module onto the two tabs (1) on the drive.
- Press the option module onto the drive as shown in (2) until the connector mates with the drive, ensuring that the tab (3) retains the option module in place.



- To remove (only with power disconnected), press down on the tab (1) to release the option module from the drive housing as shown.
- Tilt the option module slightly towards you and pull away from the drive housing (2).



For more information on installing the SI Ethernet communication option module, please reference Section 3.4 of the *Unidrive M400 User Guide*.

3 ELECTRICAL INSTALLATION

3.1 General Electrical Installation

See *Unidrive M400 User Guide* for additional details on the proper installation of the various sizes of the Unidrive M400 drive, along with motor and power distribution wiring.

3.2 Control Wiring Notes

All digital inputs on the Unidrive M400 are positive logic only, meaning that connecting +24VDC to an input terminal will turn the input ON. Terminal T9 and T17 provide 200 mA at +24VDC.

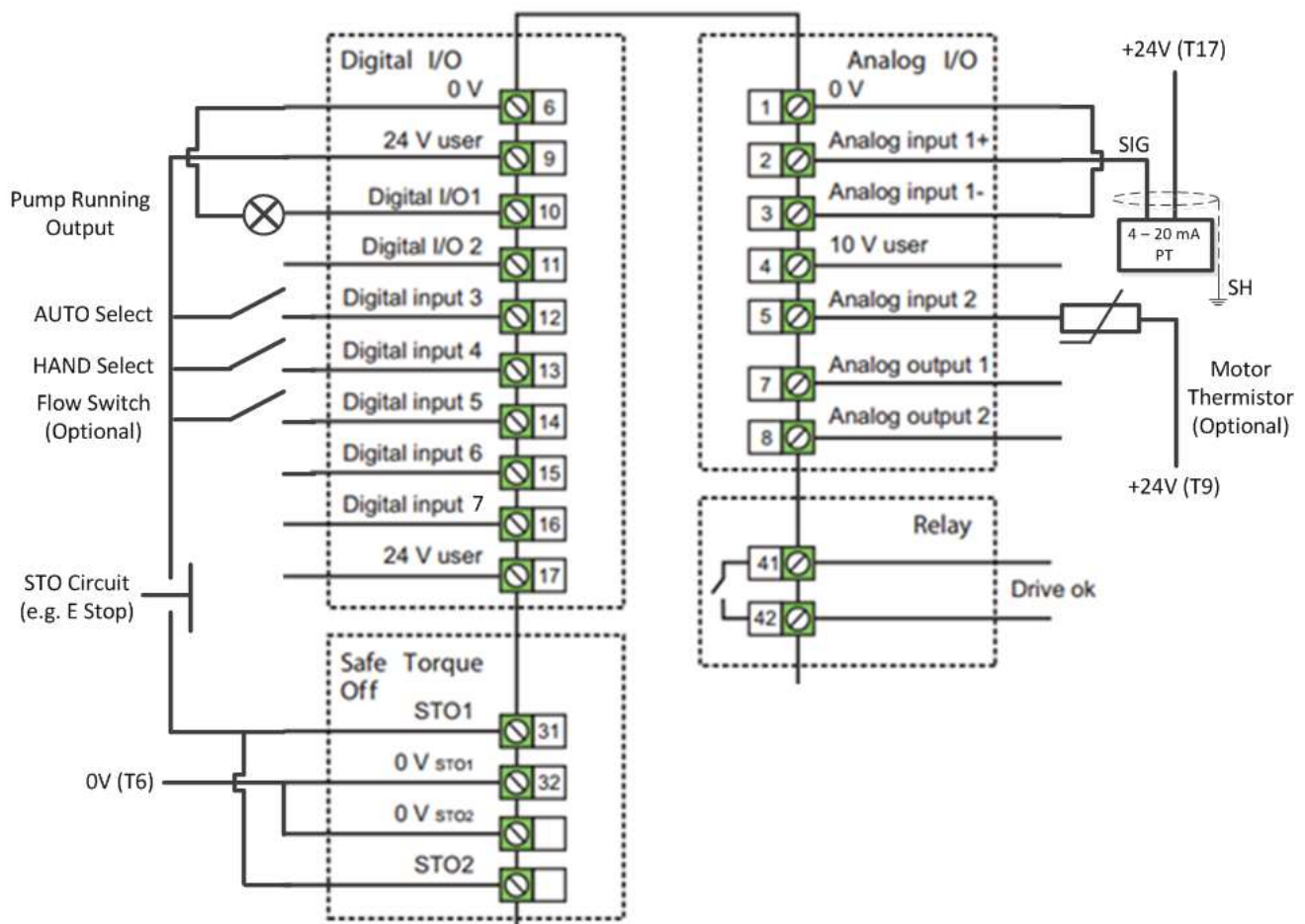
All analogue inputs on the M400 are unipolar only, and for the M400 Multiplex system, 4-20 mA pressure feedback sensors are required.

Detailed specification for the digital and analogue IO on the Unidrive M400 are listed in the Section 4 of the *Unidrive M400 User Guide*.

3.3 Unidrive M400 Multiplex Control Connections

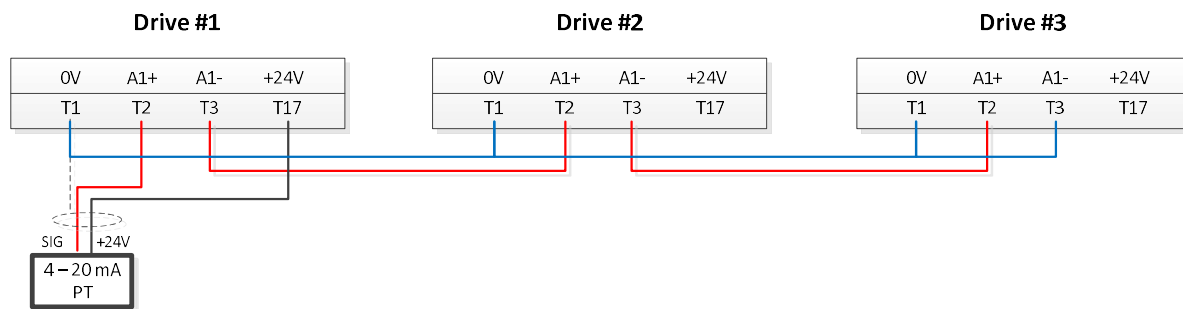
For each drive on the system, the only required IO control connections are for HAND/AUTO selection, as well as STO (Safe Torque Off). If HAND/AUTO select will not be commanded from digital IO, it must be reconfigured in the drive parameter set as outlined in Section 4.2.9 of this user guide. For a multi-pump system, at least 1 drive must have a pressure transducer connected for system pressure feedback, and it is preferable that all drives have independent feedback devices. By default, the output relay on the drive will signal that the drive is healthy (on a high signal), and will break the signal if there are any trips. If auto reset is configured through *Number of Auto Resets* (Pr 0.033/10.034) and *Auto Reset Delay* (Pr 0.034/10.035), on fault or trip the output relay will not signal that the drive is no longer healthy until all auto resets have been made. As indicated, a “Pump Running” output is available, as well as an input terminal for a flow switch if it is present in the system. If a motor/pump thermistor is available, it can be connected to the “Analog Input 2” connection, which then will be reconfigured as a digital input. With all of the connections considered here, the following control connections should be made:

Unidrive M400 Multiplex Control Connections



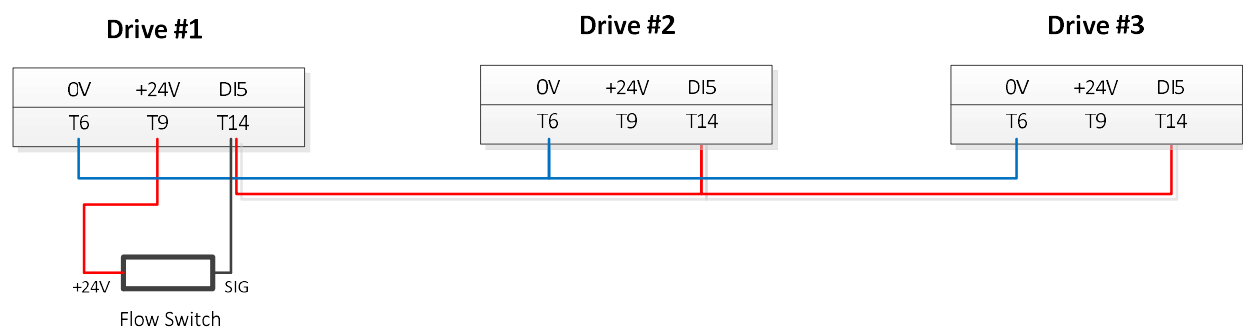
Note that this connection diagram shows a configuration for the STO connection that requires only one input. The jumpers that are shown in the above drawing could be removed to allow for dual channel STO.

The connection diagram above illustrates the connections for a single drive, assumedly in a multiplex system. The M400 Multiplex system requires at least 1 pressure feedback device, which can be shared across the network if there is not individual feedback devices fit to each drive. Alternatively (for redundancy) a single 4-20 mA feedback sensor can be electrically looped from drive to drive. In this case with a single sensor, there is more protection in the event that the input itself on the drive was to fail. The configuration of a triplex system in this mode is shown below. For a duplex system of this design, simply connect T3 of the first drive to T2 of the last drive, with all other connections the same.



Note that if a single transducer is used on the system, it is only optional for it to be wired as shown above, since the feedback value will be shared over the drive to drive Ethernet network. Wiring a single transducer as shown above can create a hardware redundancy to protect against failure in the drive IO.

Additionally, a flow switch can be installed such that it is shared by all drives in the case that there are not individual flow switches available for each pump, which can be helpful given that the flow switch state is not shared on the drive to drive communications network. This requires wiring the thermistor in parallel to each pump, where the output signal is connected to DI5 (T14) on each drive, and the 0V return is shared by wiring 0V (T6) on each drive in parallel as shown below.



4 GETTING STARTED

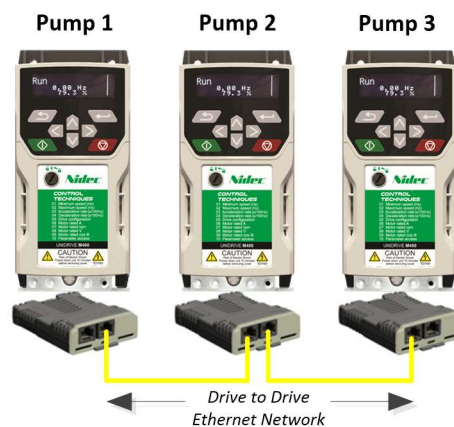
4.1 General

It is recommended to fully commission the Unidrive M400 in Open Loop mode before attempting to enable the drive and run the M400 Multiplex application software. The M400 Multiple application software is a combination of a user program and unique individual parameter files that will be loaded to each drive based upon their drive node identification (i.e. 1, 2, 3 on a triplex system). These parameter files will appropriately setup the drive to drive communication channels, as well as initialize various parameters necessary to run the application software. Be sure to consult the *Unidrive M400 User Guide* for full details on drive use and general commissioning. For guidance, all or some of the related parameters that are listed in Section 5.1 of this user guide may need to be configured.

4.2 M400 Multiplex

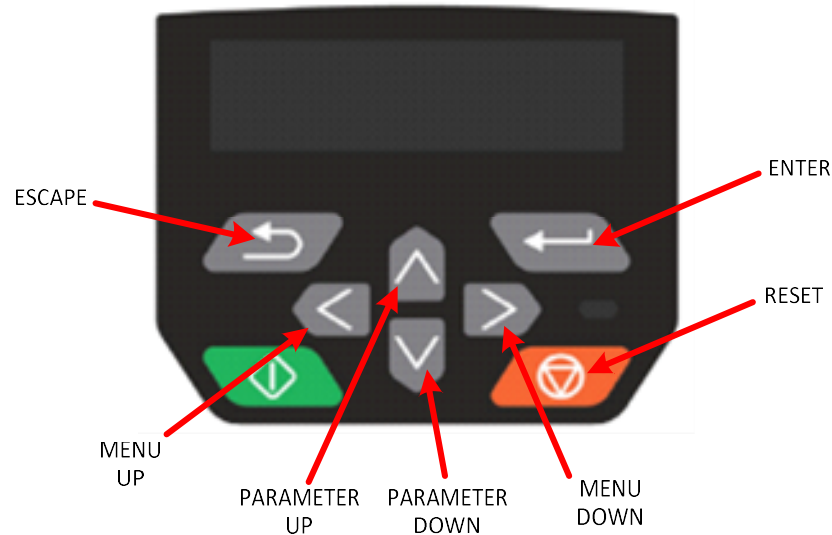
The following details a simple procedure for getting started with the M400 Multiplex application software (on board program and parameter files). Relevant features of the pump control algorithms are further described in flow diagrams as illustrated in Section 6 of this user guide. Before beginning, be sure to the following items in place:

1. Up to 3 appropriately installed (electrically and mechanically) Unidrive M400 drives, set to Open Loop control mode.
2. SI-Ethernet module installed in Slot 1 of each installed drive (see Section 2.1).
3. SD Card loaded with on board user program and M400 Multiplex parameter sets.
4. 1 AI-Backup Adapter to be fitted to the top the drive being programmed and configured.
5. At least 1 CI-Keypad to be used to load the files to the drive and configure the installation.
6. Shielded Ethernet cables connecting all drives in series on the system through the SI Ethernet Modules as shown below:



4.2.1 Keypad Operation

Many of the following steps to get the system started will utilize the CI-KEYPAD to select and change appropriate parameter values. The operation of the keypad is displayed in more detail in Section 5.2 of the *Unidrive M400 User Guide*, but a quick reference for button operation is provided below:



Remember, when parameters are reference in this user guide, it is in the form of Menu.Parameter, where the up and down arrows will scroll through parameters, and the left and right arrows will scroll through menus.

4.2.2 Load Software and Parameters

The application parameter files are different in order to define each node on the network with different communication settings, so that each respective drive is broadcasting information that is relative to its own status. After powering the drives (from an “Open Loop” defaulted state; see Section 5.5 of the *Unidrive M400 User Guide* on how to change operating mode), this is done through the following procedure, which will first install the application software (which is the same on each drive) and then the specific drive parameter file.

1. Remove all STO signals from the drive so that the drive keypad displays “Inhibit”.
2. Install the SD card (loaded with files) into the AI-Backup Adapter. Install the CI-Keypad and AI-Backup Adapter into the top of the first Unidrive M400 in the system (Pump 1). See Section 9 of the *Unidrive M400 User Guide* for more information about installation of the AI Backup Adapter.
3. Navigate to Menu 00, Parameter 000 (00.000) using the up or down arrows on the keypad so that the keypad displays “No Action”.
4. Press the upper right enter key so that “No Action” is flashing. Press the left arrow key 3 times to navigate to the “1000” position, and press the up arrow 6 times so that the keypad displays “6000”.

5. Press the right arrow 2 times to navigate to the “10” position, and press the up arrow 1 time so that the keypad displays “6010”.
6. Press enter, and then the red “Reset” button.
7. After the red “Reset” button is pressed with this value entered in, the drive will display this value for 20 – 30 seconds as the software loads, and then automatically power cycle the drive. The drive will display “Unidrive M400 Open-Loop” when the power cycle is complete.
8. A “User Trip 53” message will display on the drive keypad. This is simply indicating that the application software has altered the custom menu (Menu 30) on the drive. Press the red “Reset” button to reset this trip.
9. To prevent this trip from occurring again on a power cycle, perform a save by pressing the upper right enter key, and then the up arrow 1 time so that “Save parameters” is flashing on the keypad. Press the red “Reset” button to complete the save of the parameters to the drive. This drive is now loaded with the correct software, and the version can be verified by reading the *Software Version* (Pr 0.055/30.003).
10. Next, to load the correct pump parameter file for Pump 1 on the system, repeat steps 3 – 5, but enter a value of “6001”. This will load the parameter file in location “1” to the drive, which will setup and identify this drive as “Pump 1”.
11. Perform another save to the drive as outlined in Step 9.
12. Repeat Steps 1 – 11 for all drives on the system. When entering in the parameter file to be loaded for Pumps 2 and 3, be sure to enter values of “6002” and “6003”, respectively, instead of “6001”. This will ensure that the network and pump identifications are setup correctly.
13. Once all drives are loaded and saved with the correct parameter files and application software, power down the entire system and replace the STO signals to the drives. The system is now ready to be configured with the appropriate configuration data.
14. To confirm that everything has been loaded correctly, power cycle the system and check that the *Node ID* (Drive 1: Pr 0.060/18.011 = 1, Drive 2: Pr 0.067/18.017 = 2, or Drive 3: Pr 0.074/18.023 = 3) and *Software Version* (Pr 0.055/30.003) are the correct values.

4.2.3 Configure Pump Motor

For each drive on the system, the attached motor should be appropriately wired and configured for the pump to operate correctly. According to the nameplate of the motor, enter in the following parameters. Further description and information of these parameters can be found in Section 5 of this manual.

Menu 0 Location	Parameter	Units	Description	Range
0.005	5.006	0.01 Hz	Motor Rated Frequency	0.00 – 550.00
0.006	5.007	0.01 Amps	Motor Rated Current	Model Limited
0.007	5.008	0.1 RPM	Motor Rated Speed	0.0 – 36000.0
0.008	5.009	Volts	Motor Rated Voltage	Model Limited
0.009	5.010	NA	Motor Rated Power Factor	0.00 – 1.00

After the motor is configured on the drive, it is helpful to perform a static auto tune with the motor in order to measure resistance and inductance values within the motor, as well as a series of other parameters related to drive. To perform this auto tune, use the following steps:

1. Confirm that the security access for the drive is setup correctly for this procedure by navigating to *Security Status* (Pr 0.010/11.044) and changing it to “All Menus”.
2. Navigate to *On Board User Program Enable* (Pr 0.054/11.047) and change it to “Stop” to stop the application software.
3. Navigate to *Auto Tune* (Pr 5.012), and change it to a value of “1”.
4. Navigate to *Run Forward* (Pr 6.030), and change it to “On”. As long as the STO signal is closed to the drive, the auto tune will begin and last 10 – 20 seconds. When the autotune is complete, *Auto Tune* (Pr 5.012) will display “0” and the keypad will display “Inhibit”. When the auto tune is complete, navigate back to *Run Forward* (Pr 6.030), and change it back to “Off”. **NOTE** : Be sure to also turn the STO signal “Off” and then “On” again for the drive to completely exit the auto tune, or turn *Drive Enable* (Pr 6.015) “Off” and the “On” again.
5. Navigate to *On Board User Program Enable* (Pr 0.054/11.047) and change it to “Run” to restart the application software.

4.2.4 Configure Pressure Feedback Device

The M400 Multiplex system has the ability to use redundant pressure sensors in the multiplex system, meaning that individual sensors can be fitted to each drive on the system, or a single sensor can be fitted one drive (or electrically looped between the drives) on the system and be shared across the network, not matter what drive is acting as lead on the system. A calibrated 4-20 mA pressure feedback device will come with recommended min/max pressure readings that correspond to the min/max feedback output signal of the device. Set the following parameters to make sure that the pressure feedback device is correctly scaled and filtered.

Menu 0 Location	Parameter	Units	Description	Range
0.013	30.022	0.1 PSI	Minimum Pressure Feedback Scaling	0.0 – 3276.7
0.014	30.023	0.1 PSI	Maximum Pressure Feedback Scaling	0.0 – 3276.7
0.017	12.015	0.01 S	Pressure Transducer Filter	0.00 – 100.00

For further description of information related to configuring the pressure feedback device, see Section 6.5 of this user guide.

4.2.5 Configure Lead/Lag Pump Sequencing

One of the goals of the M400 Multiplex system is to efficiently match the amount of power consumed by the pumps to the current level of pressure demand on the output of the system. On a full 3 pump system (although the same applies for any 2 pump systems) this includes setting up appropriate frequency and pressure thresholds, as well as time delays to keep any momentary system transients from adversely affecting pump operation. Additionally, the application software will transfer the work of the lead pump after a user defined time duration

to provide even wear to the pumps on the system. Set the following parameters to the system to correctly configure the sequencing of the lead and lag pumps:

Menu 0 Location	Parameter	Units	Description	Range
0.018	30.013	0.1 PSI	Low Pressure (Wake) Set Point	0.0 – 3276.7
0.019	30.059	0.1 S	Start Delay Time	0.0 – 3276.7
0.021	30.051	0.01 Hz	Minimum Sleep Frequency	0.00 – 60.00
0.022	30.052	0.1 S	Sleep Start Time	0.0 – 6553.5
0.042	30.002	0.01 Hz	Add Lag Frequency	0.0 – 60.0
0.043	30.004	S	Add Lag Timer Time	0 – 255
0.044	30.005	S	Remove Lag Timer Time	0 – 255
0.045	30.006	1/10 th Hr	Alternation Time	0 – 32767
0.053	30.053	0.1 S	No Flow Delay	0.0 – 6553.5

For further description of “Lead/Lag Pump Sequencing,” see Section 6.3 of this user guide.

4.2.6 Configure Fault Detection and Response

An integral part of the M400 Multiplex system is the ability to automatically detect destructive and fault conditions in the system. These faults include overpressure detection, dry well/low suction detection, system total pressure transducer loss detection, as well as dozens of other standard faults unique to the Unidrive M400. To configure the responses to the faults unique to the M400 Multiplex System, enter the desired values into the following set of parameters. Again, further descriptions of these parameters can be found in Section 5 of this user guide.

Menu 0 Location	Parameter	Units	Description	Range
0.015	30.017	Type	Transducer Loss Action	0 - 1
0.016	1.027	0.01 Hz	Transducer Loss Speed Setting	0.00 – 60.00
0.027	30.021	0.1 PSI	Over Pressure Trip Level	0.0 – 3276.7
0.033	10.034	Attempts	Number of Auto Resets	0 – 5, Infinite
0.034	10.035	0.1 S	Auto Reset Delay	1.0 – 600.0
0.046	30.063	%	Speed/Torque Low Load Point	0.0 – 100.0
0.047	30.018	Type	Dry Well Mode Selection	0 – 2
0.048	30.062	0.1 S	Dry Well Detection Delay	0.0 – 6553.5
0.049	30.064	%	Low Suction Frequency Decrement	0.0 – 100.0
0.056	30.065	Type	Network Loss Response	ON/OFF

4.2.7 Configure Pipe Fill Operation

An important feature of the M400 Multiplex system is priming the output of the pump system with a “pipe fill” operation, in order to prevent saturation of the pressure control PID on start-up, which could result in erratic operation. Once the pipe fill operation is complete on the

system, the operation will not run again until the system wakes up from sleep mode, or all drives are turned off. The following parameters should be set to configure the pipe fill operation.

Menu 0 Location	Parameter	Units	Description	Range
0.028	30.057	0.1 Hz	Max Frequency Bandwidth	0.0 – 60.0
0.035	1.026	0.1 Hz	Pipe Fill Speed Setting	0.0 – 60.0
0.036	30.061	0.1 S	Pipe Fill Time	0.0 – 6553.5
0.037	30.029	0.1 PSI	Pipe Fill Max Pressure	0.0 – 3276.7

For further description of “Pipe Fill Operation,” see section 6.7 of this user guide.

4.2.8 Configure Pressure PID and Pressure Set Point

The primary goal of the M400 Multiplex system is to achieve and maintain a pressure set point on the output of the system based upon pressure feedback. The speed and number of pumps running will change the pressure on the output, where the speed of the pumps is controlled via an internal PID loop in the acting lead drive which runs as a result of the pressure set point of the system and the pressure feedback on the output of the system. The following parameters will configure the PID control as well as set the pressure set point for the output of the system.

Menu 0 Location	Parameter	Units	Description	Range
0.032	30.030	0.1 PSI	Pressure Main Setpoint	0.0 – 3276.7
0.038	14.010	Gain	Kp Proportional Gain	0.000 – 4.000
0.039	14.011	0.001 S	Ki Integral Time	0.000 – 4.000
0.040	14.012	d/dt	Kd Differential Rate	0.000 – 4.000

For further information on “PID Pressure Control,” see section 6.6 of this user guide.

4.2.9 Configure HAND/AUTO Operation

By default, HAND/AUTO operation is controlled by two digital inputs on the drive (See section 3.3 of this user guide):

HAND Select	Digital Input #4 (Terminal 13)
AUTO Select	Digital Input #3 (Terminal 12)

AUTO select will always have priority over HAND select, where if both inputs are active, the drive will run in AUTO mode, and if neither input is active the drive will not run. If it is desired that HAND/AUTO select be controlled from the keypad or from a fieldbus (e.g. Modbus TCP/IP), the hardware inputs need to be unassigned from the software register locations. This can be done through the following process:

1. On the keypad, navigate to parameter 8.023, and change the value to “0.000”.
2. On the keypad, navigate to parameter 8.024, and change the value to “0.000”.
3. Press the red “Reset” button for the new assignments to take effect.
4. Perform a “Save” on the drive as described in Section 5.1.1.

At this point the following parameters control HAND/AUTO selection. The speed setting listed will always act as the HAND speed set point, no matter how HAND/AUTO is selected. If the settings for HAND/AUTO select are left at default, the above table can be used to monitor HAND/AUTO IO status on those digital inputs.

Menu 0 Location	Parameter	Units	Description	Range
0.023	1.023	0.1 Hz	HAND Speed Setting	0.0 – 60.0
0.024	18.031	NA	AUTO Select	ON/OFF
0.025	18.032	NA	HAND Select	ON/OFF

.If an external controller will be controlling HAND/AUTO select, it should address 18.031 to select AUTO mode, and address 18.032 to select HAND mode. If the settings for HAND/AUTO select are left at default, the above table can be used to monitor HAND/AUTO IO status on those digital inputs

4.2.10 Running the System

At this point, **perform a save** on the drive as described in Section 5.1.1 to save all settings unique to the drive. Once all drives in the system have been configured and parameter sets have been saved to the drive, place all drives in “AUTO” mode and power cycle the system. The M400 Multiplex sequencing will now control the system (based upon pressure feedback and setpoint); its operation is further illustrated in Section 6 of this user guide. During healthy operation, pressing the upper left “Escape” button on the keypad will display 2 lines of information, as listed below:

Top:	Current Output Drive Frequency	(Pr 2.001, <i>Post Ramp Reference</i>)
Bottom:	System Pressure Feedback	(Pr 30.009, <i>System Pressure Feedback</i>)



5 PARAMETER DESCRIPTIONS

5.1 Unidrive M400 Parameters

The following parameters listed are relevant to the M400 Multiplex system (in Open Loop Mode). A short description of the parameter is given, for more information please refer to the Unidrive M400 Parameter Reference Guide.

5.1.1 Saving Parameters

To save parameters to non-volatile memory, perform 1 of the following 2 operations:

1. Enter 1001 to any of the MM.000 parameters and press the red “Reset” button on the keypad.
2. Navigate to any of the MM.000 parameters and press the upper right “Enter” button. Press the “Up” arrow so that the drive displays “Save Parameters”, then press the red “Reset” button.

5.1.2 Menu 0 Application Parameters (0.001 – 0.059)

In Menu 0, Parameters 0.001 – 0.059 are links to parameters within the drive that will allow the user to configure the operation of the local drive and other features of the multiplex system, as well as observe its status. Other parameters related to drive and motor configuration are available in the remaining menus of the drive, all of which are further described in the *Unidrive M400 Parameter Reference Guide*.

0.001 Minimum Set Speed (1.007)	
Coding	RW, DINT
Range	0.00 - 60.00
Units	0.01 Hz
Default Setting	0.00

Defines drive absolute minimum frequency reference.

0.002 Maximum Set Speed (1.006)	
Coding	RW, DINT
Range	0.00 - 60.00
Units	0.01 Hz
Default Setting	60.00

Defines drive absolute maximum frequency reference.

0.003 Acceleration Rate (2.011)	
Coding	RW, DINT
Range	0.0 – 3200.0
Units	0.1 s/100Hz
Default Setting	5.0

This sets the acceleration rate for the ramp generator. It limits the rate of change of speed when *Post Ramp Reference* (Pr 2.001) is less than *Pre Ramp Reference* (Pr 1.001).

0.004 Deceleration Rate (2.021)	
Coding	RW, DINT
Range	0.0 – 3200.0
Units	0.1 s/100Hz
Default Setting	10.0

This sets the deceleration rate for the ramp generator. It limits the rate of change of speed when post ramp reference, (2.01) is greater than pre-ramp reference, (01.01).

0.005 Motor Rated Frequency (5.006)	
Coding	RW, DINT
Range	0.00 - 550.00
Units	0.01 Hz
Default Setting	60.00

The motor nameplate rated frequency.

0.006 Motor Rated Current (5.007)	
Coding	RW, DINT
Range	Drive Size Limited
Units	0.01 Amps

Default Setting	Determined By Drive Size
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The motor nameplate rated current.

0.007 Motor Rated Speed (5.008)	
Coding	RW, DINT
Range	0.0 – 36000.0
Units	0.1 RPM
Default Setting	1800.0

The motor nameplate rated speed. If set greater than 0 in open loop this will enable slip compensation.

0.008 Motor Rated Voltage (5.009)	
Coding	RW, INT
Range	Drive Size Limited
Units	1 Volt
Default Setting	Determined By Drive Size

The motor nameplate rated voltage.

0.009 Motor Power Factor (5.010)	
Coding	RW, INT
Range	0.00 – 1.00
Units	NA
Default Setting	0.85

The motor nameplate rated Power factor. This automatically set when an auto-tune is performed. When set manually it is suggested that the motor nameplate value divided by 0.95 is used to allow for the effect of motor leakage inductance.

0.010 Security Status (11.044)	
Coding	RW, SINT
Range	0 – 5
Units	Level
Default Setting	0 (Menu 0)

This parameter is used to select menu accessibility from the keypad as follows:

- 0 Menu 0**
- 1 All Menus
- 2 Read Only Menu 0
- 3 Read Only

- 4 Status Only
- 5 No Access

0.011 Total Pump Runtime (30.001)	
Coding	RO, DINT
Range	0.0 - 214748364.7
Units	0.1 Hrs
Default Setting	NA

This parameter indicates the total accumulated run time of the individual pump in 0.1 hours.

0.012 Analogue 1 Input Mode (7.007)	
Coding	RW, DINT
Range	-6 – 6
Units	Input Type
Default Setting	4 (4 – 20 mA)

The *Analogue 1 Input Mode* is used to set the type of signal that is supplied to Analogue Input 1 on the drive, along with any signal loss response, as follows:

- 6 4 – 20 mA Stop
- 5 20 – 4 mA Stop
- 4 4 – 20 mA Low
- 3 20 – 4 mA Low
- 2 4 – 20 mA Hold
- 1 4 – 20 mA Hold
- 0 0 – 20 mA
- 1 20 – 0 mA
- 2 4 – 20 mA Trip
- 3 20 – 4 mA Trip
- 4 4 – 20 mA
- 5 20 – 4 mA
- 6 Voltage

0.013 Minimum Pressure Feedback Scaling (30.022)	
Coding	RW, INT
Range	0.0 – 3276.7
Units	0.1 PSI
Default Setting	0.0

The *Minimum Pressure Feedback Scaling* defines the value in engineering units (PSI) that aligns with the lowest level of signal from the pressure feedback device. (e.g. pressure at 4 mA for a 4 – 20 mA device).

0.014 Maximum Pressure Feedback Scaling (30.023)	
Coding	RW, INT
Range	0.00 – 3276.7
Units	0.1 PSI
Default Setting	145.0

The *Maximum Pressure Feedback Scaling* defines the value in engineering units (PSI) that aligns with the maximum level of signal from the pressure feedback device. (e.g. pressure at 20 mA for a 4 – 20 mA device).

0.015 Transducer Loss Action (30.017)	
Coding	RW, USINT
Range	0 - 1
Units	Action Type
Default Setting	0 (User Trip 81)

The *Transducer Loss Action* provides the response of the drive on a total system transducer loss (i.e. all drives in M400 Multiplex system have failed transducers).

0 User Trip 81

1 Run At Fixed Speed

0.016 Transducer Loss Speed Setting (1.027)	
Coding	RW, DINT
Range	0.00 - 60.00
Units	0.01 Hz
Default Setting	50.00

The *Transducer Loss Speed Setting* defines the speed that will be commanded to the motor (in 0.01 Hz) if 30.017 (*Transducer Loss Action*) is set to “1” and there is a total system pressure transducer loss. This value should be higher than the value entered in *Sleep Frequency* (Pr 0.021/30.051) so that the system does not sleep on transducer loss.

0.017 Pressure Transducer Filter (12.015)	
Coding	RW, INT
Range	0.00 – 100.00
Units	0.01 seconds
Default Setting	1.00

The *Pressure Transducer Filter* defines the sample time by which the pressure feedback value will be filtered. When set appropriately, it will help eliminate frequent transients from being fed into the pressure control PID, therefore smoothing the speed response.

0.018 Low Pressure (Wake) Setpoint (30.013)	
Coding	RW, INT
Range	0.0 – 3276.7
Units	0.1 PSI
Default Setting	20.0

The *Low Pressure (Wake) Setpoint* defines the pressure threshold that the feedback must be below before the first drive in the sequence (whether from a power cycle or from falling into sleep mode) will provide output frequency to the motor.

0.019 Start Delay Time (30.059)	
Coding	RW, UINT
Range	0.0 – 6553.5
Units	0.1 Seconds
Default Setting	5.0

The *Start Delay Time* provides the time duration for which the feedback pressure must be below the *Low Pressure (Wake) Setpoint* before the drive will provide output frequency to the motor.

0.020 Dynamic V To F Select	
Coding	RW, USINT
Range	0 - 1
Units	Select
Default Setting	0

Dynamic V To F Select optimizes the required motor voltage based on load, and therefore increases energy savings when set to “1”.

0.021 Sleep Frequency (30.051)	
Coding	RW, UINT
Range	0.00 - 60.00
Units	0.01 Hz
Default Setting	45.00

Sleep Frequency defines the output frequency threshold below which:

1. When a single drive is running, the pump can enter sleep mode, or
2. When multiple drives are running, a lag pump will be stopped in the system.

0.022	Sleep Start Time (30.052)
Coding	RW, UINT
Range	0.0 – 6553.5
Units	0.1 Seconds
Default Setting	5.0

The *Sleep Start Time* defines the duration for which the output frequency must be below the *Sleep Frequency* before a single running drive will enter sleep mode.

0.023	HAND Mode Speed (1.023)
Coding	RW, DINT
Range	0.00 - 60.00
Units	0.01 Hz
Default Setting	60.00

The *HAND Mode Speed* is the frequency at which the motor will be commanded when the drive is placed into HAND Mode. This will bypass any speed references from trip responses or PID references when the drive is a lag drive on the system.

0.024	AUTO Select (18.031)
Coding	RW, BOOL
Range	0 – 1
Units	NA
Default Setting	0

AUTO Select will place the drive into AUTO mode. The drive speed reference will be a result of the current state of the system and the output of the pressure correction PID.

0.025	HAND Select (18.032)
Coding	RW, BOOL
Range	0 – 1
Units	NA
Default Setting	0

HAND Select will place the drive into HAND mode. The drive speed reference will be provided from *HAND Mode Speed*.

0.026	Analogue Input 1 Current Loop Loss (7.028)
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Coding	RO, BOOL
Range	0 – 1
Units	NA
Default Setting	NA

Analogue Input 1 Current Loop Loss indicates that when a 4 – 20mA pressured feedback sensor is used; the current feedback has fallen below 3 mA. When this occurs, it signifies that the sensor has failed, and the system pressure feedback should look to another device.

0.027	Over Pressure Trip Level (30.021)
Coding	RW, INT
Range	0.0 – 3276.7
Units	0.1 PSI
Default Setting	40.0

The *Over Pressure Trip Level* provides the pressure threshold at which the system will trip and stop the motors to prevent damage to the system due to high pressure.

0.028	Max Frequency Bandwidth (30.057)
Coding	RW, UINT
Range	0.00 - 60.00
Units	0.01 Hz
Default Setting	1.00

Max Frequency Bandwidth gives the range below *Maximum Reference Clamp* (Pr 1.006) that will identify the output frequency of the drive to be at maximum frequency. In order for a dry well/low suction condition to be identified under normal operating conditions, this condition must be satisfied.

0.029	Elapsed Local Pump Lead Time (30.066)
Coding	RO, INT
Range	0.0 – 3276.6
Units	0.1 Hrs
Default Setting	NA

Elapsed Local Pump Lead Time displays the current elapsed time that the drive has been running as the lead drive on the system. If the drive is not the lead drive on the system, this value will display “0.0”.

0.030 Symmetrical Current Limit (4.007)	
Coding	RW, INT
Range	0.0 – 1000.0
Units	0.1 %
Default Setting	165.0

The *Symmetrical Current Limit* sets the symmetrical current limit as a percentage of Motor rated current.

0.031 Control Mode (5.014)	
Coding	RW, SINT
Range	0 - 5
Units	Control Type
Default Setting	2 (Fixed)

This parameter determines the output mode of the drive, as listed below:

0	Ur S	Stator Ω and V offset measured at each start
1	Ur	No measurements
2	Fixed	Fixed boost mode
3	Ur Auto	Stator Ω and V offset measured at first drive enable
4	Ur I	Stator Ω and V offset measured at each power up
5	Square	Square law characteristic

0.032 Pressure Main Setpoint (30.030)	
Coding	RW, INT
Range	0.0 – 3276.7
Units	0.1 PSI
Default Setting	30.0

The *Pressure Main Setpoint* in the drive provides the pressure setpoint on the output of the system which will be controlled by varying the speed and quantity of running pumps.

0.033 Number Of Auto Resets (10.034)	
Coding	RW, SINT
Range	0 – 5, Infinite
Units	Quantity

Default Setting	5
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If this parameter is set to zero then no auto reset attempts are made. Any other value will cause the drive to automatically reset following a trip for the number of times programmed. Pr 10.35 defines the time between the trip and the auto reset. The reset count is only incremented when the trip is the same as the previous trip, otherwise it is reset to 0. When the reset count reaches the programmed value, any further trip of the same type will not incur an auto-reset. If there has been no trip for 5 minutes then the reset count is cleared.

0.034 Auto Reset Delay (10.035)	
Coding	RW, INT
Range	1.0 – 600.0
Units	0.1 Seconds
Default Setting	10.0

See Pr 10.034 (*Number of Auto Resets*).

0.035 Pipe Fill Speed Setting (1.026)	
Coding	RW, DINT
Range	0.00 - 60.00
Units	0.01 Hz
Default Setting	55.00

The *Pipe Fill Speed Setting* is the frequency at which the first pump will attempt to fill the output sections of the pump system from standstill, until either a pressure or a time threshold is reached.

0.036 Pipe Fill Time (30.061)	
Coding	RW, UINT
Range	0.0 – 6553.6
Units	0.1 Seconds
Default Setting	3.0

The *Pipe Fill Time* is the duration for which the first pump will run from system standstill to fill the output sections of the pump system. If *Pipe Fill Max Pressure* (Pr 30.029) is set to a nonzero value, the pipe fill procedure will stop when the output feedback pressure (Pr 30.009) reaches this value. Otherwise, the pipe fill procedure will run the full duration of the *Pipe Fill Time* before switching to PID speed control.

0.037 Pipe Fill Max Pressure (30.029)	
Coding	RW, INT
Range	0.0 – 3276.7
Units	0.1 PSI
Default Setting	0.0

If Pipe Fill Max Pressure is set to “0.0”, the indication that the pipe is filled (based upon pressure) is disabled. See *Pipe Fill Time* (Pr 30.061).

0.038 PID1 Proportional Gain (14.010)	
Coding	RW, INT
Range	0.000 – 4.000
Units	0.001
Default Setting	2.000

The Kp Proportional Gain of the pressure control PID.

0.039 PID1 Integral Gain (14.011)	
Coding	RW, INT
Range	0.000 – 4.000
Units	0.001
Default Setting	1.000

The Ki Integral Gain of the pressure control PID.

0.040 PID1 Differential Gain (14.012)	
Coding	RW, INT
Range	0.000 – 4.000
Units	0.001
Default Setting	0.000

The Kd Differential Gain of the pressure control PID.

0.041 Pressure PID Error (30.010)	
Coding	RO, INT
Range	-3276.8 – 3276.7
Units	0.1 PSI
Default Setting	NA

This is the error between the *Pressure Main Setpoint* (30.030) and the *System Pressure Feedback* (30.009).

0.042 Add Lag Frequency (30.002)	
Coding	RW, INT
Range	0.0 – 60.0
Units	0.01 Hz
Default Setting	59.00

Add Lag Frequency is the frequency threshold that must be exceeded by the latest pump that was started in order for the Add Lag Timer to be started to indicate that an additional lag pump must be called on to maintain system pressure.

0.043 Add Lag Timer Time (30.004)	
Coding	RW, USINT
Range	0 – 255
Units	1 Second
Default Setting	3

The *Add Lag Timer Time* is the time duration for which the output frequency must exceed the *Add Lag Frequency* (30.004) in order for an additional lag pump to be called on to maintain system pressure.

0.044 Remove Lag Timer Time (30.005)	
Coding	RW, USINT
Range	0 – 255
Units	1 Second
Default Setting	3

The *Remove Lag Timer Time* is the time duration for which the output frequency must fall below the *Sleep Frequency* (30.051) in order for the highest lag pump in sequence to be stopped in order to maintain system pressure without using more power than necessary. The lag pump to be removed will be the highest node in sequence that is running in AUTO mode, regardless of the order in which they were started.

0.045 Alternation Time (30.006)	
Coding	RW, INT
Range	0 – 32767
Units	1/10 th Hour
Default Setting	240 (24 Hours)

The *Alternation Time* is the consecutive runtime in 0.1 hours that need to elapse for the lead pump will change to the next healthy node ID in sequence that is in AUTO mode. When the *Alternation Time* expires, the number of active pumps will remain the same as the lead pump is passed.

0.046 Speed/Torque Low Load Point (30.063)	
Coding	RW, UINT
Range	0.0 – 100.0
Units	0.1 %
Default Setting	50.0 %

The *Speed/Torque Low Load Point* is the threshold for *Percentage Load* (Pr 4.020), where for when *Percentage Load* falls below this threshold for a time period defined in *Dry Well Detection Delay* (Pr 30.062), a dry well/low suction condition will become active.

0.047 Dry Well Mode Selection (30.018)	
Coding	RW, USINT
Range	0 – 2
Units	Type
Default Setting	1 (User Trip 84)

This parameter provides the response of the drive when a dry well/low suction condition is detected.

- 0 No Response
- 1 User Trip 84**
- 2 Limit Max PID Output (via 0.049)

0.048 Dry Well Detection Delay (30.062)	
Coding	RW, UINT
Range	0.0 – 6553.6
Units	0.1 Seconds
Default Setting	3.0

Dry Well Detection Delay is the time duration for which a dry well condition must be met to signal a dry well/low suction response. (See *Speed Torque Low Load Point* (Pr 30.03))

0.049 Low Suction Frequency Decrement (30.064)	
Coding	RW, INT
Range	0.00 – 100.00
Units	0.01 %
Default Setting	10.00

Low Suction Frequency Decrement defines the amount that the *PID1 Output Upper Limit* (Pr 14.013) will be decremented by if a dry well/low suction condition is triggered, and the *Dry Well Mode Selection* (Pr 30.018) is set to “2”.

0.050 Trip Log #0 (10.020)	
Coding	RO, USINT
Range	0 – 255
Units	Trip Type
Default Setting	NA

Register 0 of the trip log.

0.051 Trip Log #1 (10.021)	
Coding	RO, USINT
Range	0 – 255
Units	Trip Type
Default Setting	NA

Register 1 of the trip log.

0.052 Trip Log #2 (10.022)	
Coding	RO, USINT
Range	0 – 255
Units	Trip Type
Default Setting	NA

Register 2 of the trip log.

0.053 No Flow Delay (30.053)	
Coding	RW, UINT
Range	0.0 – 6553.5
Units	0.1 S
Default Setting	0.0

No Flow Delay is the time duration for which the no flow switch must be open for the system to issue a “no flow” response. If this value is set to a time greater than 0, and that time elapses without the flow switch being set while the drive is active, the entire pumping system will enter a sleep state. If this value is set to “0.0”, the no flow switch will be ignored, which is useful if one is not used in the system.

0.054 Onboard User Program Enable (11.047)	
Coding	RW, BOOL
Range	0 – 1
Units	Action
Default Setting	1 (Run)

Used to control the state of the on board program.

0.055 Software Version (30.003)	
Coding	RO, UINT
Range	0 – 65536
Units	Version, Revision
Default Setting	NA

The *Software Version* displays the version of the M400 Multiplex Software in Version.Revision (VRRR).

0.056 Network Loss Response (30.065)	
Coding	RW, USINT
Range	0 – 1
Units	Response Type
Default Setting	1 (User Trip 83)

This parameter provides the response of the drive when a network loss is detected (no other drives networked to local drive):

- 0 Run in Simplex Mode
- 1 User Trip 83**

0.057 Output Frequency (5.001)	
Coding	RO, DINT
Range	-60.00 – 60.00
Units	0.01 Hz
Default Setting	NA

This is the current output frequency of the drive to the motor.

0.058 Current Magnitude (4.001)	
Coding	RO, DINT
Range	-327.68 – 327.67
Units	0.01 A
Default Setting	NA

This is the current level of current provided from the drive to the motor.

0.059 System Pressure Feedback (30.009)	
Coding	RO, INT
Range	0.0 – 3276.7
Units	0.1 PSI
Default Setting	NA

The *System Pressure Feedback* is the pressure feedback provided from the lead drive of the system, scaled based upon the *Minimum Pressure Feedback Scaling* (Pr 30.022) and *Maximum Pressure Feedback Scaling* (30.023). If the pressure feedback sensor from the lead drive fails, the pressure feedback sensor from the next drive in sequence will be used.

5.1.3 Menu 0 Multiplex Network Parameters (0.060 – 0.080)

In Menu 0, Parameters 0.060 – 0.080 are a sequential listing of parameters for each drive that should not be edited by the user, but are used for network data transfer among the drives of the system. Parameters 0.060 – 0.066 are dedicated to Drive #1, 0.067 – 0.073 are dedicated to Drive #2, and 0.074 – 0.080 are dedicated to Drive #3. Each set of parameters are written to over the Ethernet network from the respective drive, and will display values of “0” if that drive does not exist or becomes disconnected.

0.060 Node ID 1 (18.011)	
Coding	RW, INT
Range	1 – 3
Units	Node Number
Default Setting	1

This is the sequence/network node ID of Drive #1 on the system.

0.061 Status Word 1 (18.012)	
Coding	RW, INT
Range	0 – 256 (8 bit)
Units	NA
Default Setting	NA

This parameter provides the current status of Drive 1 in the Multiplex network to be read by other drives on the network. The bits of the status word are defined as follows:

- Bit 0 On Network (Watchdog)
- Bit 1 Auto Run Ready
- Bit 2 Drive Auto Running
- Bit 3 Drive Active
- Bit 4 Pressure Sensor Loss
- Bit 5 Hand Selected

Bit 6 Auto Selected

Bit 7 Pipe Fill Done

0.062 PID Output Speed Reference 1 (18.013)	
Coding	RW, INT
Range	0.0 – 60.0
Units	0.1 Hz
Default Setting	NA

This is the output frequency as a result of the pressure correction PID in Drive 1.

0.063 Drive Run Control Word 1 (18.014)	
Coding	RW, INT
Range	0 – 8 (3 bit)
Units	NA
Default Setting	NA

This is the drive run signal control word that is used when Drive 1 is the lead drive on the system. Bits 0-2 correspond to a commanded run signal on drives 1-3.

0.065 Lead ID 1 (18.015)	
Coding	RW, INT
Range	0 – 3
Units	NA
Default Setting	NA

The *Lead ID* shows which drive that Drive 1 identifies as the lead drive.

0.066 Pressure Feedback 1 (18.016)	
Coding	RW, INT
Range	0 – 32767 (15 bit)
Units	NA
Default Setting	NA

Pressure Feedback 1 gives the pressure feedback value from the local pressure feedback input, scaled 0 – Max as 0 – 32767.

0.067 Node ID 2 (18.017)	
Coding	RW, INT
Range	1 – 3
Units	Node Number
Default Setting	2

This is the sequence/network node ID of Drive #2 on the system.

0.068 Status Word 2 (18.018)	
Coding	RW, INT
Range	0 – 256 (8 bit)
Units	NA
Default Setting	NA

See description for Pr 0.061. (Relative to Drive 2)

0.069 PID Output Speed Reference 2 (18.019)	
Coding	RW, INT
Range	0.0 – 60.0
Units	0.1 Hz
Default Setting	NA

See description for Pr 0.062. (Relative to Drive 2)

0.070 Drive Run Control Word 2 (18.020)	
Coding	RW, INT
Range	0 – 8 (3 bit)
Units	NA
Default Setting	NA

See description for Pr 0.063. (Relative to Drive 2)

0.072 Lead ID 2 (18.021)	
Coding	RW, INT
Range	1 – 3
Units	NA
Default Setting	NA

See description for Pr 0.065. (Relative to Drive 2)

0.073 Pressure Feedback 2 (18.022)	
Coding	RW, INT
Range	0 – 32767 (15 bit)
Units	NA
Default Setting	NA

See description for Pr 0.066. (Relative to Drive 2)

0.074 Node ID 3 (18.023)	
Coding	RW, INT
Range	1 – 3
Units	Node Number
Default Setting	3

This is the sequence/network node ID of Drive #3 on the system.

0.075 Status Word 3 (18.024)	
Coding	RW, INT
Range	0 – 256 (8 bit)
Units	NA
Default Setting	NA

See description for Pr 0.061. (Relative to Drive 3)

0.076 PID Output Speed Reference 3 (18.025)	
Coding	RW, INT
Range	0.0 – 60.0
Units	0.1 Hz
Default Setting	NA

See description for Pr 0.062. (Relative to Drive 3)

0.077 Drive Run Control Word 3 (18.026)	
Coding	RW, INT
Range	0 – 8 (3 bit)
Units	NA
Default Setting	NA

See description for Pr 0.063. (Relative to Drive 3)

0.079 Lead ID 3 (18.027)	
Coding	RW, INT
Range	1 – 3
Units	NA
Default Setting	NA

See description for Pr 0.065. (Relative to Drive 3)

0.080 Pressure Feedback 3 (18.028)	
Coding	RW, INT
Range	0 – 32767 (15 bit)
Units	NA
Default Setting	NA

See description for Pr 0.066. (Relative to Drive 3)

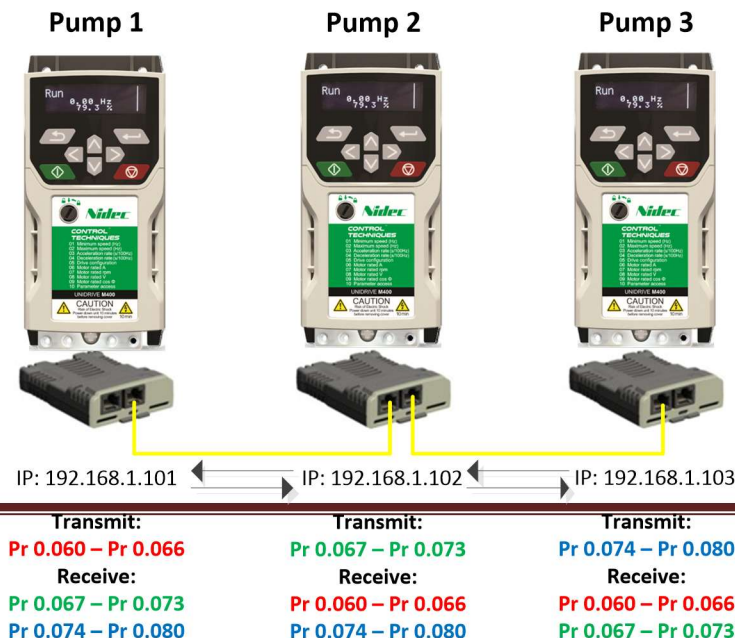
6 FUNCTIONAL DIAGRAMS AND DESCRIPTIONS

6.1 Overview

This section describes in greater detail the various functions of the M400 Multiplex system, as well as locations of diagnostic information that are pertinent to observe current system status. The following descriptions and flow diagrams can be used in conjunction with Section 4: “Getting Started” to better understand how to appropriately configure the M400 Multiplex System.

6.2 Network Operation

In order to create and maintain control of a multiplex system, a robust drive to drive communication network must exist. In this case, the Unidrive M400 utilizes SI Ethernet modules and “Easy Links” on a peer to peer Ethernet network to read and write information to and from the entire system. This is possible by assigning separate IP Addresses to each SI Ethernet module that correspond to the pump identification within the system, and configuring fixed links on each drive. The IP Address for each SI Ethernet module corresponds to the drive node ID by the last value in the address (e.g. 192.168.1.102 is Node #2), and this has been configured and populated by the parameter file downloaded to the drive. This network and the exchange of information are illustrated as follows:



Each drive on the network is sending the same 6 elements of information relative to its own status and control to the same parameter locations that they are located at in the other drives. This allows the each drive to read the same information from the same Menu 0 parameter as it relates to the same drive on the network. This is illustrated in the table shown below, along with parameter descriptions.

Drive 1 Information	Drive 2 Information	Drive 3 Information	Description
0.060	0.067	0.074	Drive Node ID (1,2, or 3)
0.061	0.068	0.075	Drive Status Word
0.062	0.069	0.076	Drive PID Speed Reference
0.063	0.070	0.077	Drive Run Command Control Word
0.065	0.072	0.079	Lead Drive ID
0.066	0.073	0.080	Drive Pressure Feedback (Scaled 15 bit value)

Further descriptions of these parameters can be found in Section 4 of this user guide. To confirm continuity on the network, the first bit of each status word is always “ON” when it is broadcasted to the network. If the network is ever broken, all of the incoming information from that node is automatically set to “0”, indicating a network loss from that node. Reading the status word from the keypad of the other drives on the network is a quick way to check network continuity to those drives.

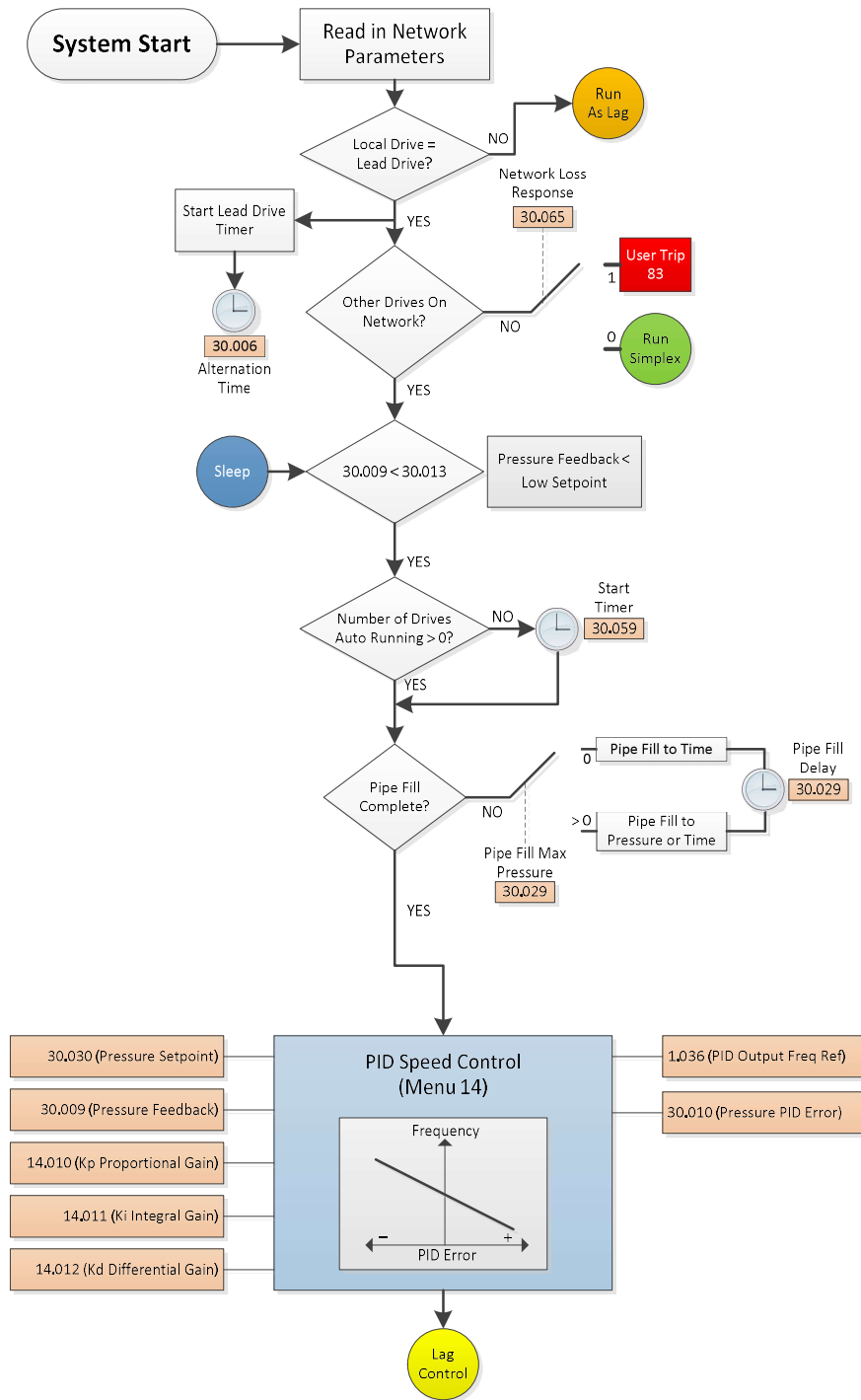
If a drive is not the lead drive in the system, it will receive its speed reference and run command from the “Drive PID Speed Reference” and “Drive Run Command Control Word”, respectively, of the lead drive. Conversely, if the drive is the lead drive on the system (i.e. Drive Node ID = Lead Drive ID), it will receive its speed reference and run command internally. If for any reason a drive falls off the network (network failure), it will run in simplex mode or provide a user trip, as selected by *Network Loss Response* (Pr 0.056/30.065). For more information and further parameter descriptions for the SI Ethernet module, see the *SI Ethernet User Guide*.

6.3 Lead, Lag, Sleep, and Alternation Operation

One of the chief functions of the M400 Multiplex system is to control the speed and quantity of pumps that are running to efficiently control the pressure on the output of the system. This may include all 3 pumps running in a triplex system (or 2 in a duplex system), or down to none when the demand goes to zero and the system sleeps. The M400 Multiplex system controls this by adding and removing pumps in a sequential order as they are healthy and available, as a result of a pressure control PID which controls the speed of the system.

Upon providing power to an installed and configured system, if all drives are healthy they will immediately look to Drive #1 (Node ID #1) to be the lead of the system. If Drive #1 is healthy and on the

network, and the pressure demand is greater than the pressure feedback from the system, it will begin its pipe fill operation as configured after the *Start Delay Time* (Pr 0.019/30.059) time has elapsed. Once the start delay time has elapsed and the pipe fill operation is complete, Drive # 1 will begin to operate according to the speed reference generated from the pressure control PID. At the same time, the internal alternation timer will have begun, and will continue to increment until the alternation time is met, signalling that the lead drive responsibility should pass to Drive #2 (Node ID #2), as available. If the demand on the output of the system never causes the need for an additional pump to be added to the system, Drive #1 will continue to operate according to the PID output reference until the alternation time has elapsed. This “System Start” operation is illustrated in the following flow diagram.



If the system output demand grows to a point that additional pumps are needed to satisfy that demand, the lead pump will request that the next pump in Node ID sequence to start. This excess demand condition is met when the *System Pressure Feedback* (Pr 0.059/30.009) is less than the *Low Pressure*

(Wake) Setpoint (Pr 0.018/30.013) and the *Output Frequency* (Pr 0.057/5.001) of the lead drive is greater than *Add Lag Frequency* (Pr 0.042/30.002) for the time duration defined in *Add Lag Timer Time* (Pr 0.043/30.004). When this occurs, the lead drive will check to see if the next drive in sequence (If lead drive is Drive #1, Drive #2 will be checked) is on the network, in auto mode (no running), and healthy. If all of these conditions are satisfied, the drive will be started and match the PID output speed reference of the lead drive. This process will occur again if the demand continues at a high level to necessitate an additional pump.

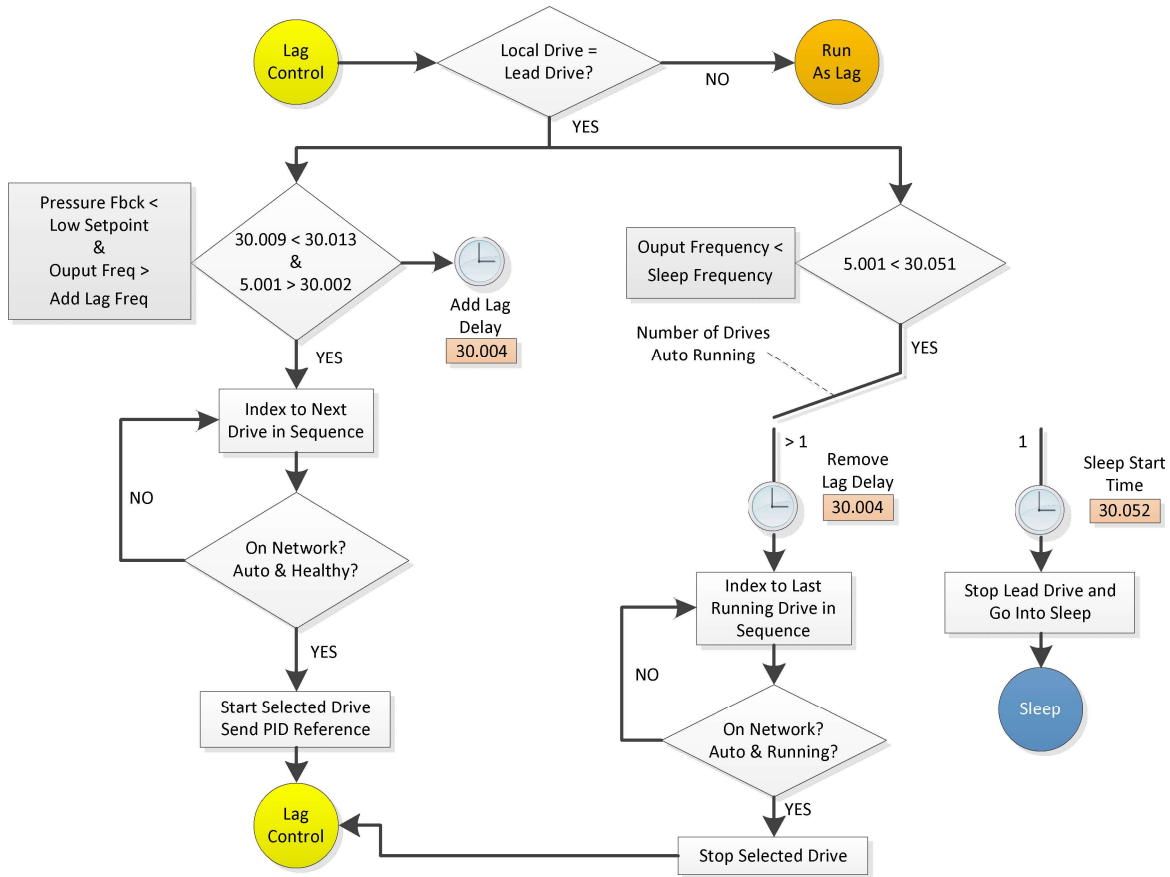
If a lag pump is being added by the lead drive, and the next pump in sequence is not on the network, not in auto mode (or already running in auto mode), or is faulted, the lead drive will increment to the next node ID in sequence and alternatively start that drive. For example, if Drive #2 was faulted while Drive #1 was the lead drive, Drive #1 will see that Drive #2 is unavailable, and command Drive #3 to start. If the demand on the output stays at a level that requires an additional pump while it is still the lead drive, Drive #1 will check Drive #2 again to see if it can be added.

Conversely, if there are multiple drives running and the *Output Frequency* (Pr 0.057/5.001) falls below the *Minimum Sleep Frequency* (Pr 0.021/30.051) for the time duration defined in *Remove Lag Timer Time* (Pr 0.044/30.005), the lead drive will attempt to stop the drive *furthest in sequence* from the lead drive that is currently running as a lag drive in auto mode. The sequence follows a circular path from 1 to 3 for a triplex system (1 to 2 for a duplex system), so if Drive #2 was the lead drive, it would start Drive #3 next as demand increases, followed by Drive #1. When stopping drives as demand decreases, it would stop Drive #1 first, followed by Drive #3. The action of stopping drives is independent of the order in which they started in, and is decided upon which drive is running as a lag drive that is the furthest upstream in sequence. See the following table to illustrate the attempted lead/lag order for a triplex system after the lead drive has started, depending up which drive is the lead:

Lead Drive	Starting		Stopping	
	1 st	2 nd	1 st	2 nd
1	2	3	3	2
2	3	1	1	3
3	1	2	2	1

If there is only the lead drive running and the *Output Frequency* (Pr 0.057/5.001) falls below the *Minimum Sleep Frequency* (Pr 0.021/30.051) for the time duration defined in *Sleep Start Time* (Pr 0.022/30.052), the lead drive will go into sleep mode and provide no frequency or current to the motor. Be sure that the *Minimum Sleep Frequency* is set high enough to prevent the system from running when the output of the system is closed and the mechanics of the system create a condition that the pressure could be maintained against the blocked valve. This is an energy saving function that will keep the drive from running at low speeds when the demand is not high enough to require it. For the lead drive to come back into operation and “wake up”, the *System Pressure Feedback* (Pr 0.059/30.009) must fall back below the *Low Pressure (Wake) Setpoint* (Pr 0.018/30.013), after which it will continue to operate

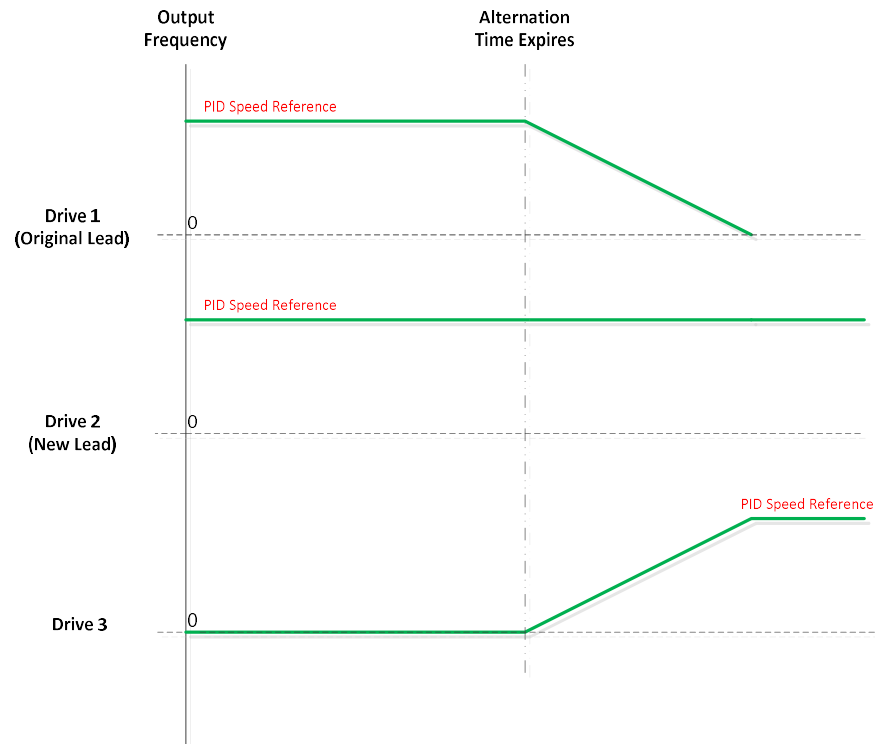
according to its pressure feedback PID speed reference. The operation of lead/lag control is illustrated in the following flow diagram:



If *No Flow Delay* (Pr 0.053/30.053) is set to a value greater than “0” and the defined delay expires while the drive is active, the entire system will go directly into sleep mode (overriding the current lead/lag condition of the system) until conditions occur based upon demand to restart the sequence. If *No Flow Delay* (Pr 0.053/30.053) is set to “0”, there is no effect on the system from a no flow switch, and the system will operate as previously described.

While the lead drive is controlling the frequency and number of lag drives on the system, it continues to increment its lead time counter in *Elapsed Local Pump Lead Time* (Pr 0.029/30.066). Once the elapsed time has reached the *Alternation Time* (Pr 0.045/30.006), the lead drive will attempt to pass the lead responsibility to the next drive in sequence that is in AUTO mode, on the network, and healthy. When the lead is passed and drives are currently running, the system will create a “bump-less” transfer of the lead drive. For example, if two pumps are currently required to satisfy the demand of the system, and the alternation time expires while Drive #1 is the lead drive, Drive #2 will assume the new lead and immediately give a run signal to Drive #3 so that Drive #3 is accelerating while Drive #1 is decelerating.

This reduces transients on the output pressure of the system while this transfer is being made (see timing diagram below).



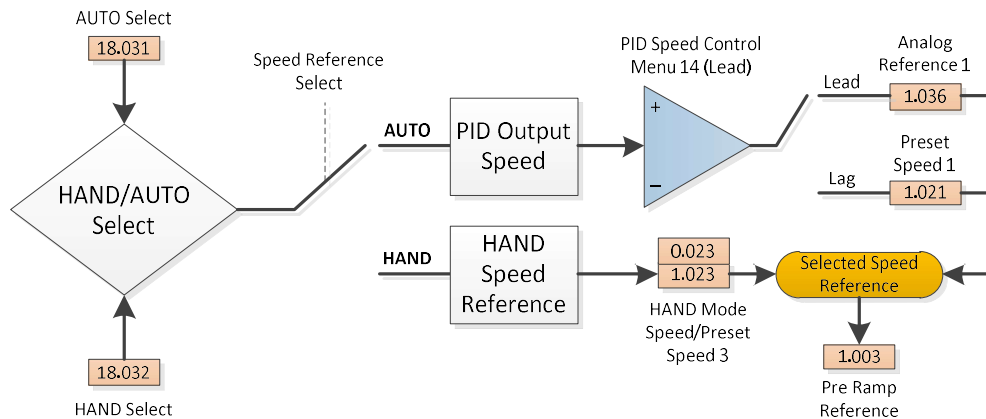
Note that if the system is powered down, the elapsed alternation time will reset to “0”, and Drive #1 will become the lead drive again on a power cycle. If it is not desired that Drive #1 becomes the lead drive on a power cycle, make sure that it is not in AUTO mode when the system powers on, and the system will automatically look for the first drive that is in AUTO mode in sequential order starting with Drive #1, followed by the next lowest node ID on the system (Drive #2).

6.4 HAND/AUTO Operation

Through the use of digital inputs, from the keypad, or over a fieldbus, each drive can be placed into HAND, AUTO, or OFF modes. When in OFF mode, the run signal to the drive cannot be turned on, and the drive cannot be set as a lead or a lag pump on the system, even if it is on the network.

If HAND mode is selected through *Hand Select* (Pr 0.025/18.032), the drive will receive its *Pre Ramp Reference* (Pr 1.003) from *Hand Mode Speed* (0.023/1.023). When in HAND mode, the drive cannot become a lead or a lag drive on the system, and is essentially running independent from what the other drives are doing on the system. Note that if a drive is in HAND mode and running at a set frequency, it still provides supply to the load demand and could raise the pressure on the output of the system.

If AUTO mode is selected through *Auto Select* (Pr 0.024/18.031), the drive will receive its speed reference directed to a parameter in the drive based upon its lead or lag status. If the drive is running as the lead on the system, the local PID in Menu 14 is controlling the speed reference for the system, and will be writing that reference internally to *Analog Reference 1* (Pr 1.036) which is used as the selected speed reference when a drive is the lead drive. If the drive is running as a lag on the system, the PID from the lead drive is controlling the speed reference for the system, and will be writing the speed reference over the network to *Preset Speed Reference 1* (Pr 1.021) on all of the lag drives. In the lag drive then, this value is used for the speed reference in the drive. When in AUTO mode (as in HAND mode) when the selected speed reference receives the result of the HAND/AUTO logic, it is applied to the *Pre Ramp Reference* (Pr 1.003) and controlled afterwards by the ramp rates defined by the user. Note that a drive can only be selected as a lead or lag on the system if it is in AUTO mode. See logic diagram below:



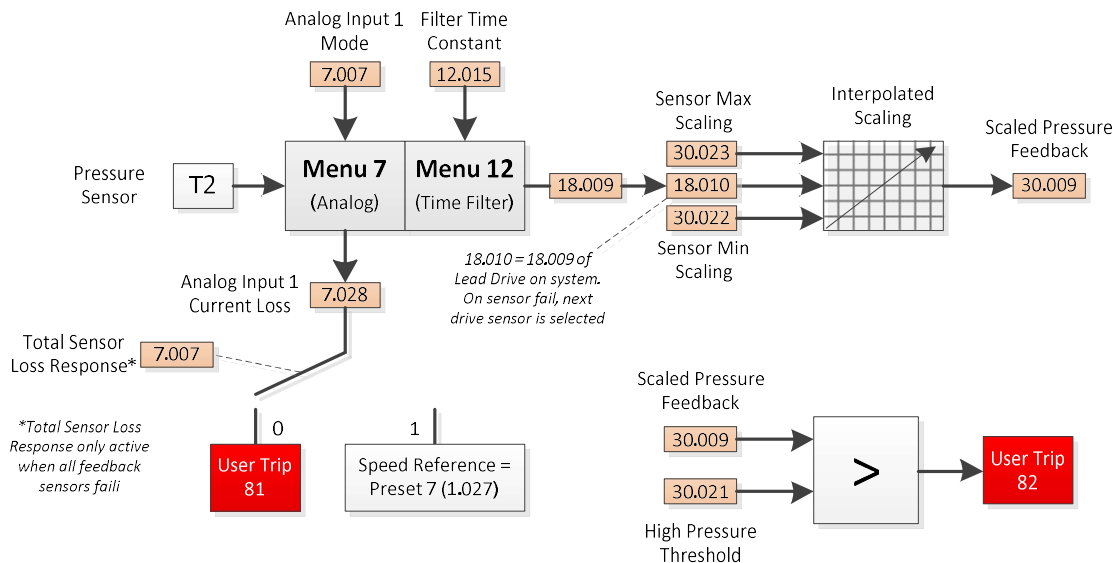
6.5 Analogue Pressure Sensor Feedback Scaling and Selection

For pressure sensor feedback, the M400 Multiplex system requires a 4-20 mA pressure sensor signal attached to Analogue Input 1 on the drive. The application software allows the user to configure the limits of the sensor through the *Minimum Pressure Feedback Scaling* (Pr 0.013/30.022) at its minimum threshold and the *Maximum Pressure Feedback Scaling* (Pr 0.014/30.023) at its maximum threshold, and will in turn linearly interpolate the pressure feedback between those limits. Since rapid transients in the sensor feedback would be undesirable (due to noise, etc.) and induce rapid transients in the speed reference of the system through the pressure control PID, a software filter has been applied to the input signal through the *Filter Time Constant* (Pr 0.017/12.015) to smooth out transients from the sensor. Every drive that has a feedback sensor connected to it will transfer the current value of the feedback to Pr 18.009 as an unsigned 15 bit value (0 – 32767), and transfer it to the network through local parameter 0.066/18.016, 0.073/18.022, or 0.080/18.028, depending on which drive it is (Drive 1, 2, or 3, respectively).

If multiple drives on the network have pressure sensor feedback connected, each drive will read the pressure sensor feedback from the lead drive on the network and write it into Pr 18.010 as a 15 bit value (0 – 32767), then scale it according to the defined minimum and maximum threshold. This result is displayed in the *System Pressure Feedback* (Pr 0.059/30.009). If a pressure feedback device does not exist on the lead drive on the network, all drives will look to the next drive in positive sequence order for pressure feedback. For example, if only Drive #2 has a feedback device and Drive #1 is the lead drive, all drives will first check Drive #1 for system feedback and upon finding none, will check Drive #2 for pressure feedback and continue with scaling that signal. As long as a drive is on the network (even if the drive is faulted, in HAND mode, or not in HAND or AUTO), its pressure sensor is available for use to other drives on the network if it is called upon.

In the case that there are no feedback sensors available, which can occur if all sensors on the system fail or if a drive falls off of the network and does not have any sensor attached to it, the response to a total pressure feedback loss is configured through the *Transducer Loss Action* (Pr 0.015/30.017). If this is set to “0”, the drive will supply a “User Trip 81”, disabling the drive. If this is set to “1”, the drive will run at the speed defined in *Transducer Loss Speed Setting* (Pr 0.016/1.027).

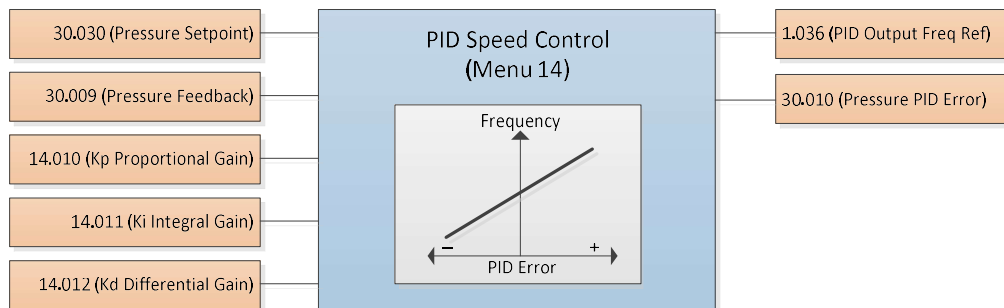
A “User Trip 82” indicates an over pressure condition on the system, and this threshold is defined in *Over Pressure Trip Level* (Pr 0.027/30.021). The following flow diagrams illustrate how the pressure feedback is handled in an M400 Multiplex system.



PID Pressure Control

The desired pressure on the M400 Multiplex system is maintained through the use of the M400 on board PID function (Menu 14). Once the pressure feedback from the analogue signal has been properly scaled and filtered into the *System Pressure Feedback* (Pr 0.059/30.009), it is compared against the *Pressure Main Setpoint* (Pr 0.032/30.030). When errors are detected, the speed of the pump(s) is varied in order to resolve that error. When the system pressure is too high, the error fed to the PID is a

negative value (Pressure Setpoint - Pressure Feedback < 0), which will drive the motor speed to a lower value therefore reducing the pressure. When the system pressure is too low, the error fed to the PID is a positive value (Pressure Setpoint - Pressure Feedback > 0), which will drive the motor speed to a higher value therefore increasing the pressure. Since the output of the PID is linked to the speed setpoint in the drive, the response will be affected by the *Acceleration Rate* (Pr 0.003/2.011) and the *Deceleration Rate* (Pr 0.004/2.021). If these rates are set too low, the PID output may appear to have a delayed response. The inputs and outputs for the PID function are illustrated as follows:



With regards to gains on a PID control system, the *Kp Proportional Gain* (Pr 0.038/14.010) is the instantaneous amplification factor that is applied to the process error.

$$\text{Proportional PID Output} = K_p * \text{Error}$$

The proportional term must have an error to produce an output and the magnitude of the output is dependent on the magnitude of the error and the amount of proportional gain.

The *Ki Integral Gain* (Pr 0.039/14.011) is the amplification factor of the error over time.

$$\text{Integral PID Output} = (K_i * \int \text{Error} * dt) / 10$$

The integral term accumulates any error over time to help reduce offsets or long-term errors, where the Ki gain is a multiplication co-efficient of the integrated error value.

The *Kd Derivative Gain* (Pr 0.040/14.012) is the amplification factor of the rate of change of error.

$$\text{Derivative PID Output} = (K_d * d\text{Error}/dt) / 10$$

The differential term is the rate of change of the error multiplied by the Kd co-efficient. This is responsive during transient conditions and therefore is zero during a steady state condition. It is useful to reduce the overshoot during large disturbances, but is rarely used in this application, as it will amplify any unwanted noise on the system and cause instability. The speed demand to the motor is the summation of these 3 PID terms, therefore providing continual correction to the system based upon load demand.

6.6 Pipe Fill Operation

A Pipe Fill operation is an important part to priming a pumping system in preparation for PID pressure control. In the M400 Multiplex system, there are 2 options for performing a pipe fill:

1. **Pipe Fill to Time:** Pipe Fill to Time will run the pump at a frequency set by *Pipe Fill Speed Setting* (Pr 0.035/1.026) for a time duration set by *Pipe Fill Time* (Pr 0.036/30.061). Once *Pipe Fill Time* has elapsed, the drive will switch to PID pressure control.
2. **Pipe Fill to Pressure:** Pipe Fill to Pressure will run the pump at a frequency set by *Pipe Fill Speed Setting* (Pr 0.035/1.026) until the feedback pressure exceeds *Pipe Fill Max Pressure* (Pr 0.037/30.029) or the time duration set by *Pipe Fill Time* (Pr 0.036/30.061) has elapsed. Once either of these conditions is met, the drive will switch to PID pressure control.

If *Pipe Fill Max Pressure* (Pr 0.037/30.029) is set to “0”, the M400 Multiplex system will automatically use “Pipe Fill to Time” to complete the pipe fill operation. If *Pipe Fill Max Pressure* is set to a value greater than “0”, the system will use “Pipe Fill to Pressure” to complete the pipe fill operation. The pipe fill operation is shared across the system network, and will not repeat unless all drives become inactive at the same time as a result of neither HAND nor AUTO being selected, a system fault that stops all drives, or the system enters sleep mode.

6.7 Dry Well Detection

Dry well detection is created to protect the motor and pump from damage in a situation of low suction or no flow from the supply due to a dry supply or a blockage on the input of the system. This is detectable by monitoring the drive for a condition of high output frequency, but low load. In order for a “Dry Well” to be detected, two conditions must exist:

1. *Percentage Load* (Pr 4.020) must fall below the *Speed Torque Low Load Point* (Pr 0.046/30.063) for the time duration defined in *Dry Well Detection Delay* (Pr 0.048/30.062).
2. The *Output Frequency* (Pr 0.057/5.001) must be within the bandwidth defined by the *Maximum Speed* (Pr 0.002/1.006) – *Max Frequency Bandwidth* (Pr 0.028/30.057) up to the *Maximum Speed*.

If both of these conditions are satisfied, the system has entered a Dry Well/Low Suction state. *Dry Well Mode Selection* (Pr 0.047/30.018) determines the response of the system to this state, of which there are 3 possible options, shown below.

Value of *Dry Well Mode Selection* (Pr 0.047/30.018)

- 0 **Disabled;** there is no response to this state and the drive will continue to run as normal.
- 1 **User Trip 84;** the drive will trip in this condition and stop the pump.
NOTE: If a User Trip 84 occurs twice (and is reset) while the drive is powered, the drive will remain tripped until the drive is power cycled.
- 2 **Limit PID Output;** the drive will limit the output of the PID by the % defined in *Low Suction Frequency Decrement* (Pr 0.049/30.064), therefore limiting the speed of the motor. Once the *Percentage Load* (Pr 4.020) once again meets or exceeds the *Speed*

Torque Low Load Point (Pr 0.046/30.063), the system will remove the limit to the output of the PID, allowing the motor to once again reach full speed.

NOTE: Dry Well is not detected during a pipe fill operation

6.8 Other Features

In addition to the previously listed functions and features of the M400 Multiplex system the following parameters and features are available, which will help with successful operation and troubleshooting of the system:

Total Pump Run Time (Pr 0.011/30.001) displays the total amount of time in hours that the pump has been active and running whether in AUTO or HAND mode. This parameter accumulates as the pump runs, and is automatically saved and stored each time the drive shuts down. If a new pump is installed, this value can be set to "0" to restart the timer.

Trip Log #0 - #2 (Pr 0.050 – 0.052/10.020 – 10.022) displays the most recent 3 trips that have occurred on the drive, with Trip #0 being the most recent. If the trip was not a "User Trip" as defined in this user guide, descriptions and troubleshooting of all other trips can be found in Section 13 of the *Unidrive M400 User Guide*.

A motor/pump thermistor trip will be indicated on the drive keypad through the phase *External Trip*. The default setting for this trip assumes that the thermistor is a normally open signal that will close on the event of a trip. If the thermistor is normally closed, and opens on the event of a trip, *Analogue Input 2 Invert* (Pr 7.013) should be changed from "OFF" to "ON" to accurately reflect the trip state.

Dynamic V to F Select (Pr 0.020/5.013) can be used to save energy on a system, especially under lower loading conditions. When selected, the output voltage at any given frequency will be lowered to match the current load conditions instead of following the typical V to F characteristic of the motor and drive. Limiting the voltage when the excess output voltage is not needed will reduce the amount of power consumed by the drive.

Maximum Switching Frequency (Pr 5.018) can be increased to reduce audible noise in a motor, but can produce more heat in the IGBT's of the drive. By default this is set to "8 kHz", but can be increased to "12 kHz" if necessary. If necessary, consult the *Unidrive M400 User Guide* for more information regarding this parameter setting.

The "Auto Reset" feature allows a drive attempt to self-reset in the event of a drive trip. In the event of a trip, the drive will attempt to reset the trip the number of times defined by *Number of Auto Resets* (Pr 0.033/10.034) starting after a delay of *Auto Reset Delay* (Pr 0.034/10.035) from the time of the trip and will continue to attempt the reset in time increments of *Auto Reset Delay* until the number of attempts reaches *Number of Auto Resets*.

The *Software Version* (Pr 0.055/30.003) displays the installed version of the M400 Multiplex system software in the system. Be sure to keep updated with the most recent software releases to confirm that the latest features and bug fixes are utilized.

This software can also be used for running a drive as a simplex pump, without an SI Ethernet module attached. If this is desired, be sure to set *Network Loss Response* (Pr 0.056/30.065) to a value of “0” so that when the drive is not on a network, it will run in Simplex mode. Additionally, after loading the software and parameter file, be sure that parameter 0.067 – 0.080 are set to “0” so that there are no leftover values indicating that other drives are on the network.

7 M400 MULTIPLEX QUICK REFERENCE

7.1 Menu 0 Network Parameters

The following parameters are the parameters mapped in Menu 0 that are exchanged on the Ethernet network among the drives:

Menu 0	Parameter	Type	Units	Description	Default	Range
0.060	18.011	Prog Ctrl	NA	Node ID 1	-	1
0.061	18.012	Prog Ctrl	NA	Status Word 1	-	0 - 256 (8 bit)
0.062	18.013	Prog Ctrl	0.1 Hz	PID Output Speed Reference 1	-	0.0 - 60.0
0.063	18.014	Prog Ctrl	NA	Drive Run Control Word 1	-	0 - 8 (3 bit)
0.064						
0.065	18.015	Prog Ctrl	NA	Lead ID 1	-	1 - 3
0.066	18.016	Prog Ctrl	15 bit	Pressure Feedback 1	-	0 - 32767 (15 bit)
0.067	18.017	Prog Ctrl	NA	Node ID 2	-	2
0.068	18.018	Prog Ctrl	NA	Status Word 2	-	0 - 256 (8 bit)
0.069	18.019	Prog Ctrl	0.1 Hz	PID Output Speed Reference 2	-	0.0 - 60.0
0.070	18.020	Prog Ctrl	NA	Drive Run Control Word 2	-	0 - 8 (3 bit)
0.071						
0.072	18.021	Prog Ctrl	NA	Lead ID 2	-	1 - 3
0.073	18.022	Prog Ctrl	0-32767	Pressure Feedback 2	-	0 - 32767 (15 bit)
0.074	18.023	Prog Ctrl	NA	Node ID 3	-	3
0.075	18.024	Prog Ctrl	NA	Status Word 3	-	0 - 256 (8 bit)
0.076	18.025	Prog Ctrl	0.1 Hz	PID Output Speed Reference 3	-	0.0 - 60.0
0.077	18.026	Prog Ctrl	NA	Drive Run Control Word 3	-	0 - 8 (3 bit)
0.078						
0.079	18.027	Prog Ctrl	NA	Lead ID 3	-	1 - 3
0.080	18.028	Prog Ctrl	0-32767	Pressure Feedback 3	-	0 - 32767 (15 bit)

7.2 User Trip Assignments

The following table shows the definitions of the various “User Trips” that could occur in the drive during M400 Multiplex operation. These “User Trips” will only occur if the drive is in “Auto” mode:

TRIP ASSIGNMENTS	
User Trip	Description
81	Pressure Transducer Sensor Loss
82	Over Pressure
83	Network Failure
84	Dry Well Detection

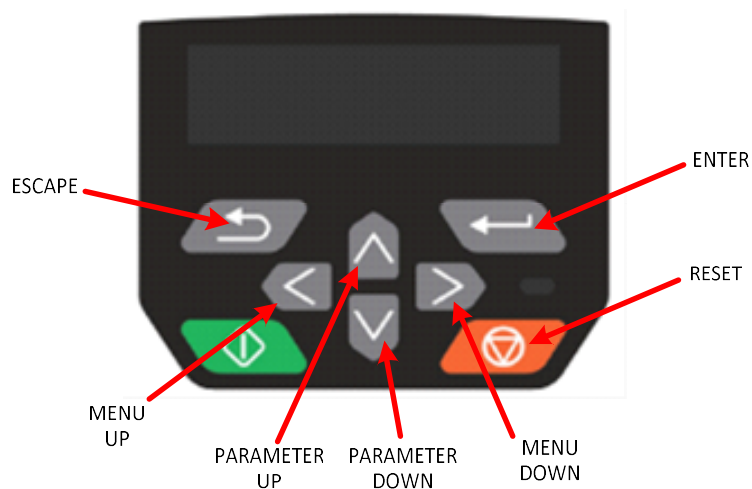
7.3 Preset Speed Reference Assignments

The following table lists the uses of the preset speed references (Menu 1) for the M400 Multiplex system:

Preset Speed Assignments			
Menu	Parameter	Preset/Application Reference	Type
1	21	Preset 1 / Lag PID Follower	INT
1	22	Preset 2	INT
1	23	Preset 3 / Hand Mode	INT
1	24	Preset 4	INT
1	25	Preset 5	INT
1	26	Preset 6 / Pipe Fill	INT
1	27	Preset 7 / Transducer Loss	INT

7.4 M400 Keypad Quick Reference

Use the following keypad button assignments to operate the M400 keypad:



7.5 Menu 0 Application Parameters

For ease of setup and operation, the following parameters are made available in Menu 0:

Menu 0	Parameter	Type	Units	Description	Default	Range
0.001	1.007	RW	0.01 Hz	Minimum Set Speed	30.00	0.00 - 60.00
0.002	1.006	RW	0.01 Hz	Maximum Set Speed	60.00	0.00 - 60.00
0.003	2.011	RW	0.1 s/100Hz	Acceleration Rate	1.0	0.0 - 3200.0
0.004	2.021	RW	0.1 s/100Hz	Deceleration Rate	1.0	0.0 - 3200.0
0.005	5.006	RW	0.01 Hz	Motor Rated Frequency	60.00	0.00 - 550.00
0.006	5.007	RW	Amps	Motor Rated Current	-	Model Limited
0.007	5.008	RW	RPM	Motor Rated RPM	-	0.0 - 36000.0
0.008	5.009	RW	Volts	Motor Rated Voltage	-	Model Limited
0.009	5.010	RW	-	Motor Power Factor	0.85	0.00 - 1.00
0.010	11.044	RW	-	Security Status	Menu 0	See M400 Manual
0.011	30.001	RO	0.1 Hours	Total Pump Run Time	-	0.0 - 214748364.7
0.012	7.007	RW	-	Analog 1 Input Mode	4-20 mA	See M400 Manual
0.013	30.022	RW	0.1 PSI	Minimum Pressure Feedback Scaling	0.0	0.0 - 3276.7
0.014	30.023	RW	0.1 PSI	Maximum Pressure Feedback Scaling	150.0	0.0 - 3276.7
0.015	30.017	RW	-	Transducer Loss Action	0 - Trip 81	0 - Trip 81, 1 - Fixed Speed
0.016	1.027	RW	0.01 Hz	Transducer Loss Speed Setting	0.00	0.00 - 60.00
0.017	12.015	RW	0.01 S	Pressure Transducer Filter	1.00	0.00 - 100.00
0.018	30.013	RW	0.1 PSI	Low Pressure (Wake) Setpoint	20.0	0.0 - 3276.7
0.019	30.059	RW	0.1 s	Start Delay Time	5.0	0.0 - 6553.6
0.020	5.013	RW	-	Dynamic V To F Select	0	0 - 1
0.021	30.051	RW	0.01 Hz	Minimum Sleep Frequency	45.00	0.00 - 60.00
0.022	30.052	RW	0.1 s	Sleep Start Time	5.0	0.0 - 6553.6
0.023	1.023	RW	0.1 Hz	HAND Mode Speed	60.00	0.0 - 60.0
0.024	18.031	RW	-	Auto Selected	-	BOOL
0.025	18.032	RW	-	Hand Selected	-	BOOL
0.026	7.028	RO	-	Analog Input 1 Current Loop Loss	-	BOOL
0.027	30.021	RW	0.1 PSI	Over Pressure Trip Level	40.0	0.0 - 3276.7
0.028	30.057	RW	0.01 Hz	Max Frequency Bandwidth	1.00	0.00 - 60.00
0.029	30.066	RO	0.1 Hrs	Elapsed Local Pump Lead Time	-	0.0 - 214748364.7
0.030	4.007	RW	%	Symmetrical Current Limit	165.0	0.0 - 1000.0
0.031	5.014	RW	-	Control Mode	Fixed	See M400 Manual
0.032	30.030	RW	0.1 PSI	Pressure Main Setpoint	30.0	0.0 - 3276.7
0.033	10.034	RW	-	Number of Auto Resets	5	0-5, Infinite
0.034	10.035	RW	0.1 s	Auto Reset Delay	10.0	1.0 - 600.0
0.035	1.026	RW	0.01 Hz	Pipe Fill Speed Setting	55.00	0.0 - 60.0
0.036	30.061	RW	0.1 s	Pipe Fill Time	3.0	0.0 - 6553.6
0.037	30.029	RW	0.1 PSI	Pipe Fill Max Pressure	0.0	0.0 - 3276.7
0.038	14.010	RW	Gain	Kp Proportional Gain	2.000	0.000 - 4.000
0.039	14.011	RW	s	Ki Integral Time	1.000	0.000 - 4.000
0.040	14.012	RW	d/dt	Kd Differential Rate	0.000	0.000 - 4.000
0.041	30.010	RO	0.1 PSI	Pressure PID Error	-	Read Only
0.042	30.002	RW	0.01 Hz	Add Lag Frequency	59.00	0.0 - 60.0
0.043	30.004	RW	s	Add Lag Timer Time	3	0 - 255
0.044	30.005	RW	s	Remove Lag Timer Time	3	0 - 255
0.045	30.006	RW	0.1 Hrs	Alternation Time	24.0	0 - 3276.7
0.046	30.063	RW	%	Speed/Torque Low Load Point	50.0	0.0 - 100.0
0.047	30.018	RW	-	Dry Well Mode Selection	1 - Trip 84	0 - Disable, 1 - Trip 84, 2 - Limit Max PID Output
0.048	30.062	RW	0.1 s	Dry Well Detection Delay	3.0	0.0 - 6553.6
0.049	30.064	RW	%	Low Suction Frequency Decrement	10.00	0.0 - 100.0
0.050	10.020	RO	-	Trip Log #0	-	Read Only
0.051	10.021	RO	-	Trip Log #1	-	Read Only
0.052	10.022	RO	-	Trip Log #2	-	Read Only
0.053	30.053	RW	-	No Flow Delay	0.0	0.0 - 6553.5
0.054	11.047	RW	-	On Board User Program Enable	RUN	Run, Stop
0.055	30.003	RO	-	Software Version	-	Read Only
0.056	30.065	RW	-	Network Loss Response	1 - Trip 83	0 - Run Simplex, 1 Trip 83
0.057	5.001	RO	0.01 Hz	Actual Motor Frequency	-	0.00 - 60.00
0.058	4.001	RO	Amps	Actual Current Magnitude	-	Model Limited
0.059	30.009	RO	0.1 PSI	System Pressure Feedback	-	0.0 - 3276.7

7.6 Custom Menu 30 Parameter Guide

The following parameters will not be listed in the *Unidrive M400 Parameter Reference Guide*, but are available on the drive for this application. Many of these parameters are linked to Menu 0 for easy access, a listing of all Custom Menu 30 parameters are shown below:

Parameter	Menu 0	Type	Units	Variable Name	Default	Range	Description
30.001	0.011	RW	0.1 Hrs	RunTimer	0.0	0.0 - 214748364.7	Total pump runtime
30.002	0.042	RW	0.01 Hz	AddLagFrequency	59.00	0.00 - 60.00	Frequency threshold to run timer to add lag pump
30.003	0.055	RO	NA	SoftwareVersion	0	0 - 65536	Multiplex pump software version
30.004	0.043	RW	S	AddLagTimerTime	3	0 - 255	Lag timer time delay to add lag pump
30.005	0.044	RW	S	RemoveLagTimerTime	3	0-255	Remove lag timer time delay to remove lag pump
30.006	0.045	RW	0.1 Hrs	AlternationTime	24.0	0.0 - 3276.7	Lead drive alternation time
30.009	0.059	RO	0.1 PSI	PressureFeedback	0	0.0 - 3276.7	System pressure feedback
30.010	-	RO	0.1 PSI	PressurePIDError	0	-3276.8 - 3276.7	Pressure PID error
30.013	0.018	RW	0.1 PSI	PressureLowSetpoint	20.0	0.0 - 3276.7	Low pressure start level for pump
30.017	0.015	RW	NA	PressureTransducerLossAction	0	0-1	On system transducer loss : 0 - Trip 81, 1 - Fixed Speed
30.018	0.047	RW	NA	DryWellModeSelection	1	0-2	On dry well : 0 - Disabled, 1 - Trip 84, 2 - Limit Max PID Output
30.021	0.027	RW	0.1 PSI	PressureHighFault	40.0	0.0 - 3276.7	High pressure trip setpoint
30.022	0.013	RW	0.1 PSI	PressureMinScaling	0.0	0.0 - 3276.7	Pressure transducer minimum scaling
30.023	0.014	RW	0.1 PSI	PressureMaxScaling	145.0	0.0 - 3276.7	Pressure transducer maximum scaling
30.029	0.037	RW	0.1 PSI	PipeFillMaxPressure	0	0.0 - 3276.7	Pipe fille complete pressure threshold, 0.0 will disable
30.030	0.032	RW	0.1 PSI	PressureMainSetpoint0	30.0	0.0 - 3276.7	System pressure setpoint
30.051	0.021	RW	0.01 Hz	SleepFrequency	45.00	0.00 - 60.00	Sleep/Remove Lag frequency threshold
30.052	0.022	RW	0.1 S	SleepDelay	5.0	0.0 - 6553.6	Sleep delay timer time
30.053	0.053	RW	0.1 S	No Flow Delay	0.0	0.0 - 6553.6	No flow switch delay time
30.057	0.028	RW	0.01 Hz	MaxFrequencyBandwidth	1.00	0.00 - 60.00	Maximum frequency bandwidth limit
30.059	0.019	RW	0.1 S	StartDelay	5.0	0.0 - 6553.6	Delay after pressure low setpoint to start pump or exit sleep
30.061	0.036	RW	0.1 S	PipeFillDelay	3.0	0.0 - 6553.6	Pipe fill duration if not filling to pressure
30.062	0.048	RW	0.1 S	DryWellDelay	3.0	0.0 - 6553.6	Delay time to respond to a dry well condition
30.063	0.046	RW	0.1 %	SpeedTorqueLowLoadPoint	50.0	0.0 - 100.0	Current level to detect a dry well or blocked input
30.064	0.049	RW	0.1 %	LowSuctionFreqDecrement	10.00	0.00 - 100.00	Amount to decrement on dry well or blocked input state
30.065	0.056	RW	NA	NetworkLossResponse	1	0 - 1	On network loss : 0 - Run Simplex, 1 = Trip 83
30.066	0.029	RO	0.1 Hrs	CurrentLeadElapsedTime	0	0 - 32767	Current elapsed time of local drive as system lead drive

7.7 Document References

The following part numbers can be used to order/access documents that have been referenced throughout this user guide.

Manual Description	Control Techniques Part Number
Unidrive M400 User Guide	0478-0044-XX
Unidrive M400 Parameter Reference Guide	HTML Download
SI Ethernet User Guide	0478-0137-XX

The *Unidrive M400 Parameter Reference Guide* can be found and downloaded as and HTML file at www.controltechniques.com.

8 USER NOTES

For more information about Nidec Control Techniques products and services, call (800) 893-2321 or contact our website at www.controltechniques.com.

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