Submittal Data Information

301-1898

Advantage VFD Pump Controller Card (model VW3A3521S0M) for Advantage 61 VFD

EFFECTIVE: October 1, 2011 SUPERSEDES: New

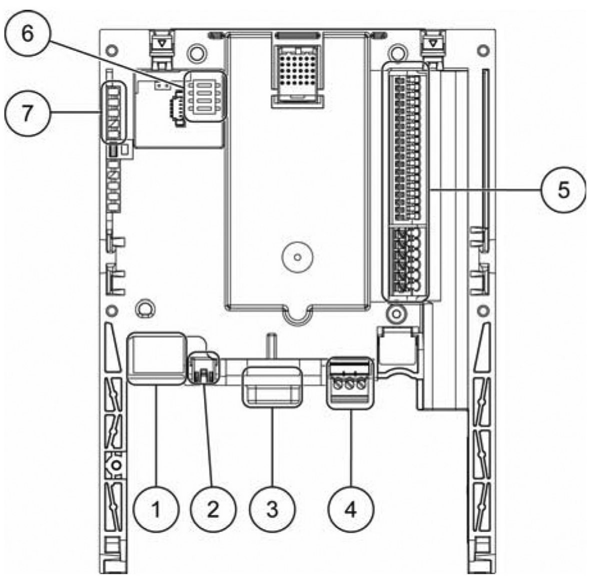
JOB ______________________ ENGINEER ______________________

CONTRACTOR ______________________ REP. ______________________

ITEM NUMBER ______________________

1.1 Description

Parts Description Diagram



Parts Description Keys

1 - Ethernet port used for programming with SoMachine and for Modbus TCP communication.

2 - Mini-USB B port used for programming with SoMachine.

3 - 9-pin male SUB-D connector for connection to the CANopen bus.

4 - Connector with removable screw terminals, 3 contacts intervals of 3.81 mm (0.15 in.) for the 24 VDC power supply.

5 - 10 logic inputs, 6 logic outputs, 2 analog inputs, 2 analog outputs and 5 commons.

6 - Block of 4 configuration switches.

7 - 5 LEDs comprising:
- 1 LED G/Y **ETH** (Ethernet Activity)
- 1 LED G/R **NS** (Network Status)
- 1 LED G/R **MS** (Module Status)
- 1 LED G/R **CAN** (CANopen)
- 1 LED G/R **USER** programmable from the customer

1.2 Hardware Setup

Description of Terminals

TERMINAL	FUNCTION
24 V	Power supply for the Advantage VFD Controller Card, logic outputs and analog outputs. The Advantage VFD Controller Card should preferably be turned on before the drive. However, the Advantage VFD Controller Card must without fail be turned on no more than 2 seconds after the drive is turned on. Failure to follow this instruction locks the drive in card fault mode ILF). This fault cannot be reset and the only way to acknowledge it is to turn off the drive. Catalog number for a Telemecanique power supply (24 VDC, 2 A): ABL7 RE 24 02
COM	Common ground and electrical 0 V of the Advantage VFD Controller Card power supply, logic inputs, (LI••), outputs (LO••), analog inputs (AI••) and analog outputs (AO••). This ground and electrical 0 V are common with the drive ground and electrical 0 V.
LI51 to LI60	24 VDC logic inputs
LO51 to LO56	24 VDC logic outputs
AI51 to AI52	0 ... 20 mA analog inputs
AO51 and AO52	0 ... 20 mA analog outputs

In order to provide the most efficient pump solution to our customers, Taco is now working with Schneider Electric.

This collaboration brings together Taco's pump technology with Schneider Electric Variable Frequency Drives and the drive packaging of Square D enclosures to offer the best overall pumping solution for our customers.

SQUARE D by Schneider Electric

1.3 Characteristics

ELECTRICAL CHARACTERISTICS			
Power	Voltage	V	24 VDC (minimum 19, maximum 30)
Current Consumption	Maximum	A	2
	No Load	mA	80
	Using logic output	mA	200 maximum (see Note 1)
Analog Inputs (see Note 1)	AI51, AI52		2 current analog inputs 0 - 20mA, impedance 250 Ω Resolution: 10 bits Accuracy: ±1% for a temperature variation of 60°C Linearity: ±0.2% of the maximum value Common point for all the card I/O (see Note 2)
Analog Outputs	AO51, AO52		2 current analog outputs 0 - 20mA, impedence 500 Ω Resolution: 10 bits Accuracy: ±1% for a temperature variation of 60°C Linearity: ±0.2% of the maximum value Common point for all the card I/O (see Note 2)
Logic Inputs (see Note 2)	LI51 . . . LI60		10 logic inputs, 2 of which can be used for 2 counters or 4 of which can be used for 2 incremental encoders Impedence 4.4 kΩ Maximum voltage: 30 VDC Switching thresholds: State 0 if ≤ 5 V or logic input not wired State 1 if ≥ 11 V Common point for all the card I/O (see Note 2)
Logic Outputs	LO51 . . . LO66		Six 24 VDC logic outputs, positive logic open collector type (source), compatible with level 1 PLC, standard IEC 65A-68 Maximum switching voltage: 30 V Maximum current: 200 mA Common point for all the card I/O (see Note 2)
I/O Connection	Type of contact		Screw, at intervals of 3.81 mm
	Maximum wire	mm2	1.5 (AWG 16)
	Tightening torque	Nm	0.25
Lithium Battery	Life		12 years (approximate)

Note 1: If the power consumption table does not exceed 200mA, this card can be powered by the drive. Otherwise, an external 24 VDC power supply must be used.

Note 2: This common point is also the drive 0 V (COM).

Note 3: When the controller card is installed, the analog inputs may be configured for 4-20mA in screens **[<EXPANSION>] ~ [CONFIG] ~ [CI_AI51 Type**] and **[<EXPANSION>] ~ [CONFIG] ~ [CI_AI52 Type]**. Please See **"[1.14 - WATER SOLUT.] ~ [<EXPANSION>] ~ [CONFIG] ~"** (see Section 2.9.16, page 44).

1.4 Data Backup Battery

The Advantage VFD Controller Card has a non-volatile RAM (NVRAM) which is needed to store variables. A lithium battery is mounted on this nonvolatile RAM to avoid this data being lost when the card is turned off.

2.1 Introduction

This program provides a fully featured control algorithm for a pumping system comprising of up to four variable speed pumps. Provisions also exist for a Jockey pump.

Each pump is controlled via ATV61 (or 71) with a Pre-Programmed Altivar-IMC card fitted. The four pump drives are connected via a CANopen network.

The drive with the ATV-IMC card attached is in control of the system operation. This is known as the Duty pump. The Duty pump will determine how many pumps need to be operating for the present demand and will operate the Duty pump at a variable speed to make up the demand requirement.

The control algorithm provides a PID function for the Duty pump speed reference. The system set point can be entered into the Pump Controller Display Unit. The pressure or temperature feedback is connected to one of the Analog Inputs. In the case of delta-T and delta-P systems, the set point is set on the screen of the display unit and the feedback signals are wired as noted in the system wiring diagram.

Under normal operating conditions, the control algorithm will respond to an increase in demand by initially increasing the speed of the Duty pump. If the Duty pump is unable to fulfill the demand and has already reached full capacity, the control algorithm will switch in one of the External pumps. The Duty pump will then reduce in speed as it shares with the External pump to take up the demand.

The control algorithm will respond to a decrease in demand by initially decreasing the speed of the Duty pump. If the demand decreases further the control algorithm will switch out one of the External pumps. The Duty pump will then increase in speed to take up the demand.

2.2 Operational Modes

There are three modes of operation for the Pump Controller:

2.2.1 Protected Manual Mode is selected by closing digital input IMC_LI51. When in Protected Manual mode the Pump Controller will run at the manual speed reference. All pump related protection algorithms are active and may stop the pump (e.g. Hi Pressure, Cycling, etc).

2.2.2 Override Manual Mode is selected by closing digital input IMC_LI52. When in Override Manual mode the Pump Controller will run at the manual speed reference, but no pump related control functions are active. It is the operator's responsibility to ensure the pump and installation are not operated outside of the normal operating conditions. Typically, the Override Manual function would be used to test motor rotation without the pump protection interfering.

The status will display **PRO MAN (Pmm)** while in Protected Manual Mode and **OVER MAN (Omm)** while in Override Manual mode.

2.2.3 Auto Mode is selected by closing digital input IMC_LI57. When in Auto Mode the following applies:

The Start and Stop commands and the speed reference are generated within the pump's control algorithm. When the pump is not pumping and not in sleep mode the status will display **RDY (RDY)**.

2.3 Operational Features

The following features are available in the Pump Controller:

2.3.1 Duty Sharing

This Multi-Pump control software is configured so that the Duty Pump will treat the other VSD's as External pumps in a lead pump configuration.

The External pumps will respond to the Duty pump start signal and will then match the speed of the Duty pump. The External Pump "ramp up to speed time" can be adjusted to suit the application.

The control algorithm will respond to an increase in demand by initially increasing the speed of the Duty pump. If the Duty pump is unable to fulfill the demand and has already reached full capacity, the control algorithm will switch in one of the External pumps.

If Duty Sharing is disabled, under increasing demand conditions, the External pumps will be turned on in numerically increasing order, based on CAN network addressing. Under decreasing demand conditions, the External pumps will be turned off in numerically decreasing order. This means External pump 1 always turns on first and off last. However, an External pump that is in an error condition (as detected via CANopen) will be skipped.

If Duty Sharing is enabled, then the External pumps will be selected based on their Run Time counters.

Under increasing demand the External pumps will be selected in order of the lowest Run Time counters. Under decreasing demand, the External pumps are progressively switched off in order of the highest Run Time counters. This means the least used External pump always turns on first and turns off last. However, an External pump that is faulted (via the digital input) will be skipped.

2.3.2 General Fault Segregation

The Pump Controller will respond to a fault condition in one of three ways, depending on the nature of the fault.

1. Drive or motor fault – This is a standard fault and the relevant drive manual should be consulted for further information. If a drive fault does occur however, the system will switch off all external pumps and ramp the Duty pump down before stopping.

2. Resettable System Fault – This is a pump system related fault that is expected to be cleared if the pump (system) shuts down temporarily. Depending on setup, a high pressure detected on the pressure feedback (analog input) or a loss of feedback signal, a pump cavitation condition, or a Flow Switch activation while at high speed will all result in the pump tripping. A relevant fault message will be displayed and pushing key F1 (help) will result in further fault help messaging. If configured for such the system will automatically reset a certain amount of times for each individual fault.

3. Non-Resettable System Fault - This is a pump system fault that is considered too serious to allow the pump to continue operating. Cycling of the pump (starting too often), activation of the Low Water digital input, or the minimum pressure detection will all result in the pump (system) tripping and remaining off until reset. A relevant fault message will be dis-

played and pushing key F1 (help) will result in further fault help messaging.

2.3.3 Signal Loss Detection (Fault Tolerant Control)

If a loss of a feedback signal is detected, the system will automatically revert to a preset speed of ¾ of the high speed setting. Loss of signal is characterised by a 0 V or 0mA feedback value and applies to delta-T , delta-P and pressure feedback signals and does not apply to flow feedback signals. The function remains active as long as the system is in run mode.

2.3.4 External Pump Control – increasing demand (staging)

The Duty pump will respond to an increase in demand by initially increasing speed. If the demand is too great for the Duty pump to fulfill, the Duty pump will start an External pump.

A **high demand** condition can be detected by either:

- High Duty pump speed
- High Duty pump speed + delay
- Increasing system error (system error = setpoint – feedback)
- Increasing system error + delay
- High Duty pump speed and increasing system error
- High Duty pump speed and increasing system error + delay

This allows the response mode to be setup to suit the system requirements. By default, the “system error + delay” method is used to make a stage/destage decision.

2.3.5 External Pump Control – decreasing demand (destaging)

The Lead pump will respond to a decrease in demand by initially decreasing speed. If the demand is too low for the number of pumps running, the Lead pump will stop an External pump.

A **low demand** condition can be detected by either:

- Low Lead pump speed
- Low Lead pump speed + delay
- Decreasing (or negative) system error (over pressure)
- Decreasing system error + delay
- Low Lead pump speed and decreasing system error
- Low Lead pump speed and decreasing system error + delay

This allows the response mode to be setup to suit the system requirements.

In some instances, a decreasing demand condition may be required to turn the Lead pump off while one or more External Speed pumps are still running. Due to the flexibility of the Lead pump system, it is possible to configure the Lead pump to turn off due to the No Demand permissive while the External pumps continue to run.

2.3.6 No Demand Operation

During a period of decreasing demand, the control algorithm will turn off the External pumps and the Lead pump speed will decrease. When a No Demand condition is detected, the Lead pump will continue running but revert to the low speed as set up by the user.

A **no demand** condition can be detected by any combination of:

- Low Lead pump speed
- Low Lead pump current
- Low flow rate (flow meter)
- Low flow rate (flow switch)

2.3.7 PID Bypass Speeds

During pump switching, better performance may be achieved if the **PID** is bypassed, rather than relying on the PID response alone to adjust the pump speed to accommodate for the increased or decreased flow capacity. There are two bypass speeds available.

1. Stage Bypass – When the Lead pump requests an External pump to start, the Stage Bypass Speed is used to decrease the Lead pump speed to accommodate for the increased flow capacity of the additional pump.

2. Destage Bypass – When the Lead pump requests an External pump to stop, the Destage Bypass Speed is used to increase the Lead pump speed to accommodate for the decreased flow capacity.

The Lead pump’s status will display **BYP** while any of the Bypass speeds are active.

2.3.8 Setpoint Ramp

On initial starting or after a period of no demand, the feedback pressure may be below the setpoint pressure. To avoid the effects of the resultant feedback error on the PID, the Setpoint Ramp algorithm overrides the pressure setpoint and applies a derived setpoint to the PID controller. The derived setpoint commences at the present feedback pressure (resulting in no error being applied to the PID controller) and ramps up to the desired setpoint. The rate at which the setpoint ramp occurs is adjustable.

The setpoint ramp is considered complete if the system error reduces to 0, (system error = setpoint - feedback) i.e. the system has successfully started and the feedback pressure has risen to the setpoint pressure.

The Lead pump’s status screen will indicate **RAMP** during a Setpoint Ramp.

2.3.9 Pulse Flow Meter Input

The Pump Controller will accept direct connection from a pulse emitter type flow meter. This pulse signal is directly converted into a flow rate within the Pump Control software.

The pump Controller will also accept a flow signal via the analog inputs if required.

2.3.10 Flow Limiting

When the flow must be restricted to a particular level, the Flow Limit algorithm may be used. If the flow reaches the Flow Limit, the motor speed is ramped down. Once the flow is below the Flow Limit, the motor speed is held at its present value (or allowed to decrease if required). The Flow Limit algorithm will release the motor speed once the flow has dropped below the Flow Limit Reset. The rate at which the motor speed is ramped down is adjustable.

While the Flow Limit is active, the status will display **QLT**.

2.3.11 Pipe Fill

On initial start up, it is possible that there is minimal or no fluid in the downstream pipe. To avoid the effects of the resultant feedback error on the PID, the Pipe Fill algorithm may override the PID when the Lead pump starts. The Lead pump will run at a preset speed until the system pressure increases to indicate the presence of fluid in the pipe.

The Lead pump’s status will display **FILL** while the Pipe Fill is active.

2.3.12 Multiple Acceleration and Deceleration Rates

The system uses different rates depending on status. One rate of acceleration and one of deceleration can be configured for times when the speed is below minimum (LSP). This is used to meet pump manufacturer specifications for pumps that require a minimum speed for pump cooling. There are also rates used when the system is under PID control that allows optimum performance. A third deceleration rate is used when the flow limit algorithm is active and a fourth when a fault condition is present.

2.3.13 Automatic Turn-On Turn-Off (Set Time Pumping)

The pump system can be configured to run automatically based on time. The system can be allowed to start at a user specified time and also turn off at a user specified time. This allows for such things as nighttime irrigation.

2.3.14 Pressure Display in Engineering Units

The pressure feedback signal can be displayed as a percentage value, or in the following engineering units:

- psi
- ft.hd
- m.hd
- Bar
- kPa

2.3.15 Flow (friction loss) Compensation

If a flow meter is installed, the flow compensation algorithm may be used to automatically adjust the setpoint pressure to compensate for losses due to the increasing flow. The friction loss that will occur may be determined empirically or the pressure drop measured at the outlet under a known flow condition.

The flow compensation algorithm uses this value to determine the compensation to be applied to the setpoint pressure at all flow rates.

This compensation algorithm is best suited for cold water piping systems, but will also generally provide acceptable compensation on most water systems.

Alternatively a fixed compensation may be utilized where a set amount of compensation is applied relative to the number of external pumps running and the dynamic speed of the leap pump sets the proportion of lead pump compensation.

2.3.16 System Shutdown Options

The lead pump stop type can be selected as either ramp stop or free wheel stop. If a fault condition is present and ramp stop is chosen the system will ramp down at the rate set as the fault ramp and then trip displaying the relevant fault message. If the fault is Resettable the system may restart after a time delay if so configured.

When the Lead pump turns off under No Demand conditions, the destage mode selected will determine the response of the External pumps at this time. If the Lead pump speed is a condition of destaging, then the External pumps will sequentially shutdown at intervals of the destage delay. If the Lead pump speed is not a requirement for destaging, the External pumps will remain running until a decreasing demand causes an over-pressure condition.

2.3.17 High Pressure

There are two High Pressure protection mechanisms.

1. If enabled or auto reset is selected for high pressure then DRIVE_LI3 is activated as a high-pressure switch. This input accepts a normally closed input. If this input is then not active for 1 second the drive will trip and display **HI PRESS**. This fault will not auto reset.

2. If enabled or auto reset is selected for high pressure then the analog pressure feedback signal can be used to protect for a high pressure condition. If a high pressure is detected and the digital protection level hasn't been exceeded (DRIVE_LI3 is still present) the system will shut down (including all external pumps) and display **HI PRESS**. If so configured the system will auto reset.

Note, this will not protect against a high pressure condition if the feedback signal fails or goes open circuit.

2.3.18 No Flow Protection

The system can be configured in many ways to protect against low flow. Digital protection can be used as well as, or instead of, a flow meter if one is installed. This protection can be set to operate during pipe fill or not. If low flow is detected the system will shut down and trip displaying **LOW PRESS**.

If so configured the system will auto reset.

2.3.19 Minimum Pressure (High Flow) Protection

If enabled the system will trip if a minimum pressure can't be met when the lead pump is running at a speed greater than that set. If minimum pressure (possible burst pipe) is sensed, the system will stop and trip displaying **MIN PRESS**. *This fault will not auto reset.*

2.3.20 Cavitation Protection

The Lead pump has a Cavitation protection algorithm. Cavitation is detected by high pump speed and low motor current. When cavitation is detected, the system will stop and trip displaying **CAVITATION**. If so configured the system will auto reset.

2.3.21 Low Level Lockout (Low Water) Protection

If enabled the system is unable to start until CI_LI60 is active. If CI_LI60 becomes inactive for longer than a user selectable time and the system is running the drive will trip and display **LOW LEVEL.**

If CI_LI60 is inactive and a start command is given the drive will remain off with the system status displaying **(LOW LEVEL) (LLEV)** periodically.

2.3.22 Cycling Protection

The Cycle Protection is designed to protect against the condition where the system fails to maintain pressure in the READY state and the Lead pump immediately restarts (i.e. a faulty NRV). A start is considered to have occurred every time the pump accelerates from zero speed, and the Cycle counter is incremented on each start.

If cycling is sensed the system will stop and trip displaying **CYCLING**. *This fault will not auto reset*.

2.3.23 Jockey Pump

During a period of no demand when the system has been in the READY state, a very low demand may cause the pump to cycle. The Jockey pump function is used to supply these very low demand requirements. Unless the pump is already running, the Jockey pump is turned on when the feedback pressure drops below the Jockey On Pressure. The Jockey pump will turn off if the feedback pressure increases above the Jockey Off Pressure or if the Lead pump starts.

The status will display **JKY** while the Jockey pump is on.

2.3.24 Priming Pump

The Jockey relay can be configured for a priming pump. In this situation the relay will switch on whenever demand is present.

The status will display **JKY** while the Jockey pump is on and the drive is off.

NOTE: The Priming Pump will not be enabled when the system is in Manual Mode.

2.3.25 Inlet Protection

This feature requires a pressure transducer to be installed on the suction side of the lead pump as well as one on the discharge. The applied setpoint is reduced when the suction pressure falls. This feature is typically used where the lead pump is operating as a pressure booster.

2.3.26 Drive Parameterization (Auto-Commissioning)

This feature is used to set up the motor parameters on all drives in the system (up to 4 drives) from the master drive. The motor parameters replicate the setup on the master drive.

2.3.27 High Temperature

This feature can be used to protect a Pump from over-temperature. A Digital input is used to trip the drive if this feature is used.

2.3.28 Delta-T

The Delta-T function sets the drive up to monitor two Taco iWorx Type III curve thermistors and calculates the differential temperature between these two temperature probes. The differential temperature is used as a feedback reference for the speed regulation PID loop in the controller.The function can be set up for hot or cold water systems.

2.3.29 Delta-P

The Delta-P function sets the drive up to monitor up to a 3 zone differential pressure system. The function determines the zone with the highest demand based on a pre-determined setpoint for each zone. It then regulates speed and staging/destaging based on the requirements of the most critical zone.

2.3.30 Delta-P Flow Reject

The Delta-P function incorporates provisions to enhance the efficiency of a system with the usage of flow meters. By configuring the flow value for a single pump system in the Delta-P menu, the system will destage all other pumps in operation if the flow value drops below the flow capabilities of a single pump. This destaging provision operates in addition to the standard destage function which may be based on feedback error.

2.3.31 Sleep Function

The Taco Pump Card is capable of invoking a sleep mode based on operation below a user defined speed for a user defined period of time. Upon invocation of the sleep mode, the system will stop running and the status would display SLEEP. The system will resume operation when the system feedback goes below a user defined value.

By default, the system sleep setpoint is automatically set to the low speed of the drive and as such the sleep function is not activated.

2.4 System I/O Configuration

The Inputs / Outputs configuration can be changed to allow more flexibility in the system.

The I/O maps are configured as follows.

2.4.1 I/O Map

INPUTS	DESCRIPTION
DIGITAL INPUTS	
IMC_LI51	Protected Manual Mode
IMC_LI52	Override Manual Mode
IMC_LI53	Low Flow Switch (N/C = Healthy)
IMC_LI54	
IMC_LI55	
IMC_LI56	
IMC_LI57	Auto Enable
IMC_LI58	Fault Reset
IMC_LI59	Pulse Flow Switch
IMC_LI60	Low Level Lockout (N/C = Healthy
Drive_LI1	
Drive_LI2	Alternate Reference/Setpoint
Drive_LI3	High Pressure Switch (N/C = Healthy)
Drive_LI4	
Drive_LI5	
Drive_LI6	
ANALOG INPUTS	
IMC_AI51	User Configurable for Level, Flow or Pressure (Current Only)
IMC_AI52	User Configurable for Level, Flow or Pressure (Current Only)
Drive_AI1	User Configurable for Level, Flow, Pressure or Temperature (Voltage Only)
Drive_AI2	User Configurable for Level, Flow, Pressure or Temperature (Current & Voltage)

OUTPUTS	DESCRIPTION
DIGITAL OUTPUTS	
IMC_LO51	
IMC_LO52	
IMC_LO53	
IMC_LO54	System Run
IMC_LO55	System Fault
IMC_LO56	Jockey Pump Run
Drive_Relay1	
Drive_Relay2	
ANALOG OUTPUTS	
IMC_AO51	Not Used by Pump Program.
IMC_AO52	Not Used by Pump Program.
Drive_AO1	Not used by Pump Program. See Drive Manual for configuration.

NOTE: For specific setup instructions, see Taco document number 302-064, *Advantage VFD Controller Card Instruction Sheet*.

Notes:

Notes:

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