MARLEY®

user manual

AIO control panel

INSTALLATION - OPERATION - MAINTENANCE

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READ AND UNDERSTAND THIS MANUAL PRIOR TO OPERATING OR SERVICING THIS PRODUCT.

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Note

This manual contains vital information for the proper installation and operation of your cooling tower. Carefully read the manual before installation or operation of the tower and follow all instructions. Save this manual for future reference.

This manual is for the Marley AIO (All In One) control panel with an integrated VFD (Variable Frequency Drive) used to control a cooling tower fan motor. The AIO control panel will also include other job specific integrated options not covered in this manual. Refer to separate user manuals pertaining to integrated options. Examples include:

- Marley ABH basin heater controls
- Marley LLC conductivity water makeup controls
- Marley LLC+u ultrasonic water makeup controls

The following defined terms are used throughout this manual to bring attention to the presence of hazards of various risk levels, or to important information concerning the life of the product.

⚠ Warning

Indicates presence of a hazard which can cause severe personal injury, death or substantial property damage if ignored.

Note

Indicates special instructions on installation, operation or maintenance which are important but not related to personal injury hazards.

introduction

These instructions are intended to assure that field connections are completed properly and the control system serves you for the maximum possible time. Since product warranty may depend on your actions, please read these instructions thoroughly prior to operation.

If you have questions about the operation and/or maintenance of this control system and you do not find the answers in this manual, please contact your Marley sales representative.

⚠ Warning

Hazard of electrical shock or burn. Be sure to turn off power to the panel before servicing. If working on equipment out of site of panel disconnect, lockout using standard lockout procedure.

Safety First

The control system by Marley uses UL listed components installed in accordance with the National Electric Code. The location of the cooling tower and field installation of the control system can effect the safety of those responsible for installing, operating or maintaining the tower and controls. However, since Marley does not control the tower location, or field installation, we cannot be responsible for addressing safety issues that are affected by these items.

⚠ Warning

The following safety issues should be addressed by those responsible for installation, maintenance or repair of the tower and controls:

- ***Access to and from the control panel (including the disconnect switch).***
- ***Proper grounding of electrical control circuits.***
- ***Sizing and protection of branch circuits feeding the control panel.***
- ***Qualification of persons who will install, maintain and service the electrical equipment.***

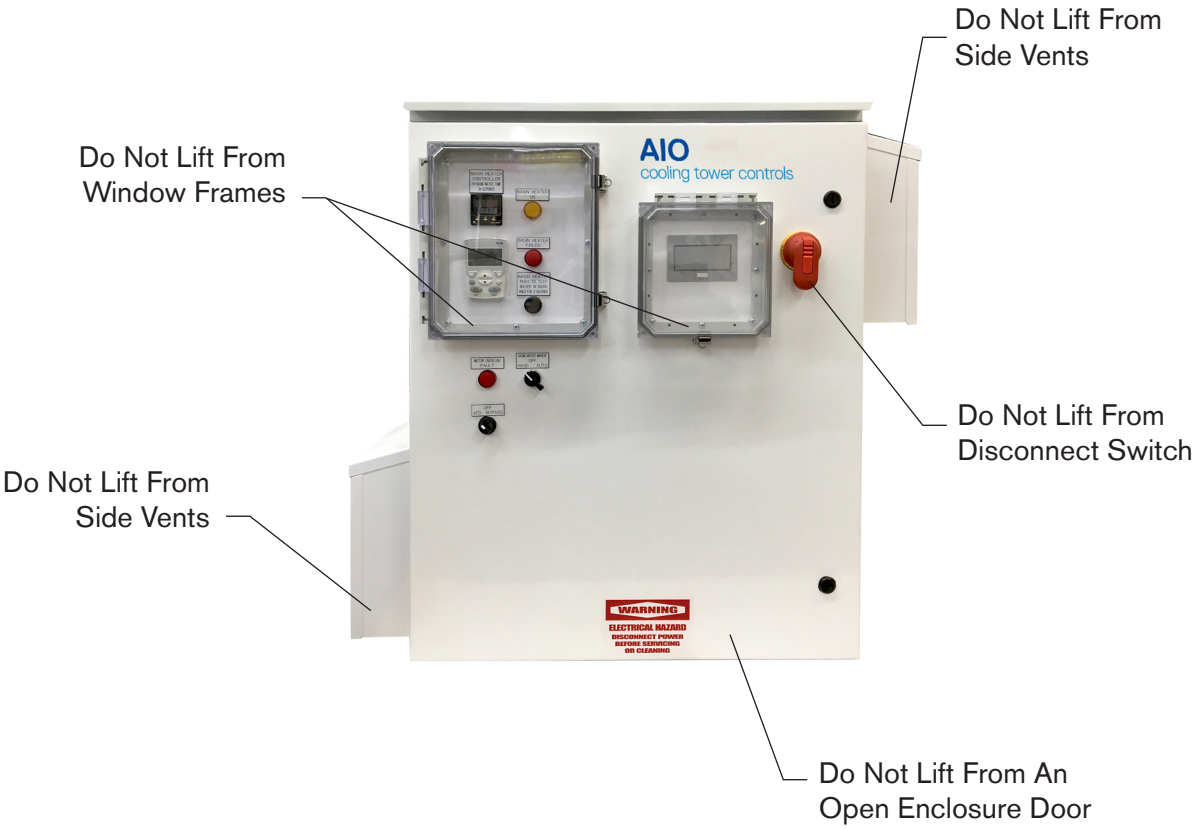
These are only some of the safety issues that may arise in the design and installation process. Marley strongly recommends that you consult a safety engineer to be sure that all safety considerations have been addressed.

Other safety issues are addressed in literature supplied with your tower. You should closely review the literature prior to installing, maintaining or repairing your tower.

introduction

Special Handling Instructions

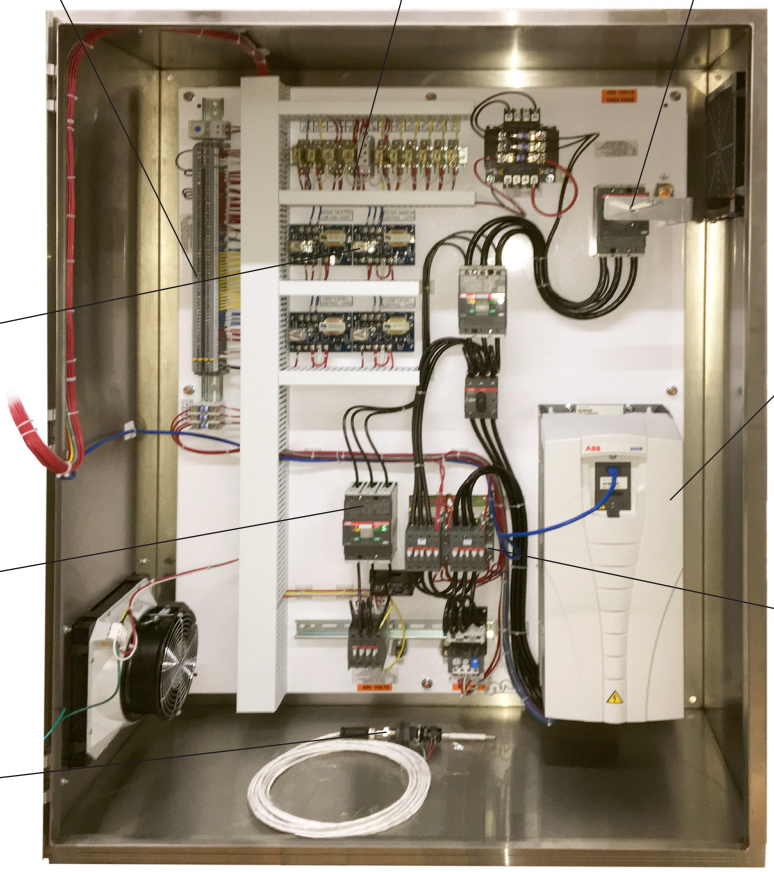
The AIO control panel is very heavy and installers have a tendency of using the side vents and keypad window frames as support when moving or positioning the control panel. The window frames and side vents are not designed to support the heavy weight of the control panel. Use other means to lift, transport and position the AIO control panel into position.



Terminal strip used to connect optional field devices. Examples include, Marley RTD temperature sensor, VFD speed control signal, basin heater thermal cutout, water level probes to name a few. Additional points are included to connect remote alarm and control circuits as needed.

Status and control relays

Route incoming power cable from the bottom of the enclosure up into the top (line) side of the main circuit breaker.



Optional water level control cards

Standard VFD

Optional basin heater controller

Optional bypass starter for VFD circuit

Optional temperature probe for basin heater controller

Note

Route all field wiring into the bottom of the enclosure and seal the insides of the conduits with expanding foam creating a moisture barrier preventing water condensation from entering the enclosure .

Other control and alarm circuits included with this panel may be utilized as needed based on job site requirements. Always refer to the wiring diagram on the inside of the control panel door.

installation

Description

The Marley AIO cooling tower control panel combines the cooling tower fan motor VFD along with other optional circuits i.e. water level and basin heater controls into a single enclosure feed by a common main circuit breaker. The advantage being only one power source run is required per cooling tower cell reducing expense and complexity of running multiple power sources to each cooling tower cell. The AIO panel may also interface with other cooling tower options including oil level switches and vibration devices. Configuration options in the AIO panel are preselected when purchased and vary from project to project.

The main circuit breaker provides magnetic short circuit and thermal overload protection for the control panel. A through-the-door operator is provided with provisions for lock-out tag-out padlocks providing a means to isolate the load side of the main circuit breaker from incoming power.

The VFD is factory preprogrammed with Marley cooling tower operation parameters along with motor and speed control parameters specific to the job site as selected when purchased. If program changes to the speed control method are required consult with SPX Cooling Technologies for programming parameters.

Operation Sequence

A main thermal magnetic circuit breaker disconnect is used to power ON the control panel or power OFF the control panel for servicing. Provision on the operating handle are provided to accept a padlock for lock-out tag-out requirements.

The VFD powers the cooling tower fan motor varying its speed based on cooling demand and the speed signal received.

installation

The VFD is preprogrammed with Marley cooling tower operation parameters with one of the following typical speed signals.

- Marley RTD for stand-alone operation
- 4-20mA speed signal from customers remote BMS
- 0-10 VDC speed signal from customers remote BMS

An optional VFD bypass motor starter circuit allows the motor to operate at full speed in the event the VFD can no longer operate. The bypass circuit is used for temporary operation providing cooling pending VFD service.

A three position door mounted selector switch is used to select:

- VFD mode
- OFF
- Bypass mod

An optional vibration switch circuit is common providing a means to shut off the VFD or its bypass starter circuit in the event of excessive cooling tower vibration. Field connections for the vibration switch are located on the vertical terminal strip.

Options listed below, see additional Marley user manuals for information.

- A basin heater circuit is used to keep water in the cold water basin from freezing during non-operational times. The basin heater circuit is interlocked with the VFD and its optional bypass starter so neither the VFD or bypass starter can be turned on at the same time as the basin heater circuit. This interlock keeps the basin heater from competing with cooling operation.
- A water makeup circuit is used to add water back into the cooling loop as the system evaporates water during normal operation. Additional level circuits such as high alarm and low alarm may be provided for connecting back to a customer's BMS system. High and low cutoff circuits may be provided to stop a circulating pump when the water level is out of operational limits protecting the pump.

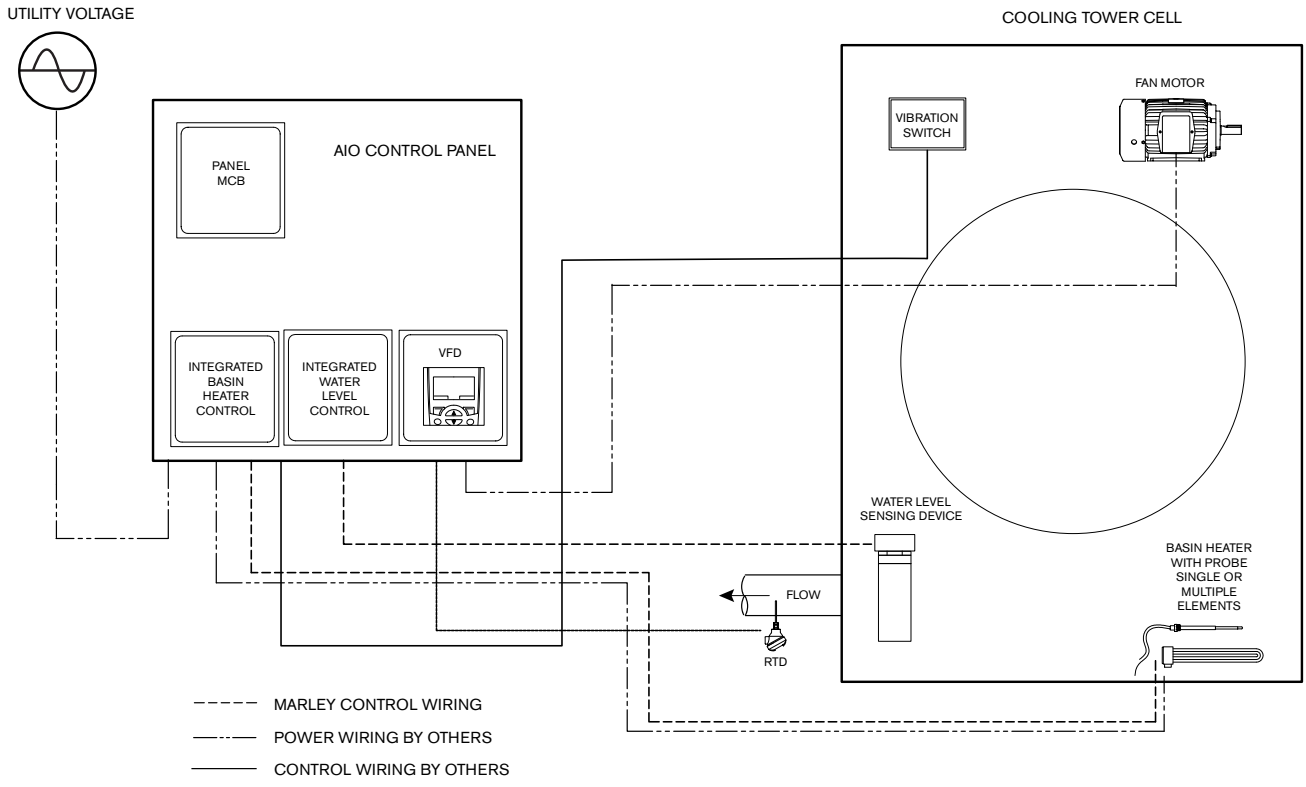
Typical One Line Diagram

Example of a system one line block diagram for general explanation of electrical runs.

Your project may vary depending on options.

Refer to the as-built shop drawing on the inside of the enclosure door for your job specific information.

An electronic file of the as-built drawing is also available from your Marley sales representative.



Check List

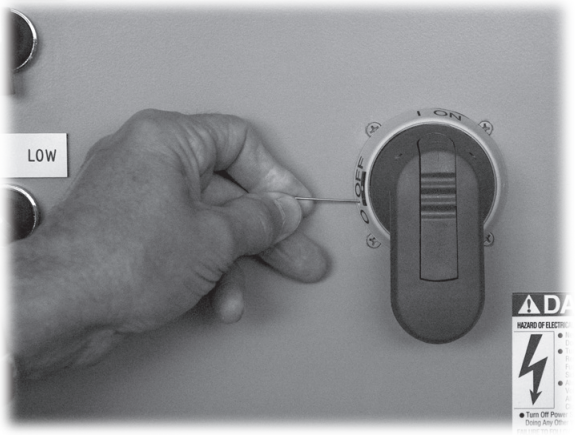
✔	Mount AIO control panel away from direct southern exposure to the sun. Use the cooling tower as a means to provide shade.
	Run all power circuits through bottom of enclosure
	Connections are located on the user terminal strip typically located top left. Refer to door mounted wiring diagram for power and control wiring connections
	Add expanding foam to inside of all conduits at the AIO panel providing a vapor barrier to resist moisture formed by condensation from entering the control panel.
	Main Power
	Confirm supply voltage matches AIO control panel voltage
	Connect main power feed to line side of main circuit breaker
	Fan Motor Power
	Connect motor feed to fan motor VFD or fan motor overload relay
	Optional Fan Motor Space Heater Circuit
	If specified connect motor space heater circuit. Some cooling tower duty motors include a motor space heater which may be run in same conduit as motor power
	Speed Reference Signal
	VFD is factory programmed with a speed reference signal - confirm speed signal is correct by referring to the speed reference signal method shown on the VFD schematic of the AIO wiring diagram. If the speed signal is different consult the Marley sales representative for new program parameters.
	Wire speed reference signal or Marley RTD to user terminal points
	Vibration Switch Option
	Connect vibration switch VFD shutdown contact to user terminal strip
	Connect optional output contacts from vibration switch to customers remote monitoring system
	ABH Basin Heater Controller Option
	Connect basin heater element to basin heater contactor in AIO control panel (Note: Wire multiple heater elements in parallel bringing 3 wires and ground back the AIO control panel
	Connect TCO (thermal cutout wiring two white wires) located in head unit of the basin heater element to points C1 and C2 located in the AIO control panel (Note: This wiring may be run in same conduit used for the power feed)
	Connect basin temperature probe (note: this is a combination temperature and low water cut out sensor)
	LLC Conductivity Water Level Controller Option using hanging probes (not all systems are configured the same, refer to AIO wiring diagram for optional configurations)
	Connect power from AIO control panel to makeup solenoid (not all systems have a makeup solenoid)
	Connect probe wiring to AIO control panel (Note: Marley probe wiring is printed with wire numbers for matching to connection points on the user terminal strip)
	Connect output alarm contacts to customers monitoring system
	Connect output control contacts to customers pump circuits
	LLC+u Ultrasonic Water Level Controller Option
	Connect power to optional makeup solenoid
	Connect ultrasonic sensor wiring to AIO control panel
	Connect output alarm contacts to customers monitoring system
	Connect output control contacts to customers pump circuits
	Program water level height set points per Marley recommendation
	LLC+u+bms Ultrasonic Water Level Option
	Connect ultrasonic water level sensor to AIO control panel
	Connect ultrasonic water level sensor output to customers water level control system
	Oil level switch Option
	Connect power to oil level switch (power may be available from the AIO control panel)
	Connect output alarm contacts to AIO panel or directly to customers control system (When connected to the AIO panel this device does not shut off the VFD)

operation

Disconnect

To open the panel door, first turn off the fan and turn the disconnect switch to “OFF”. Loosen hold-down screws.

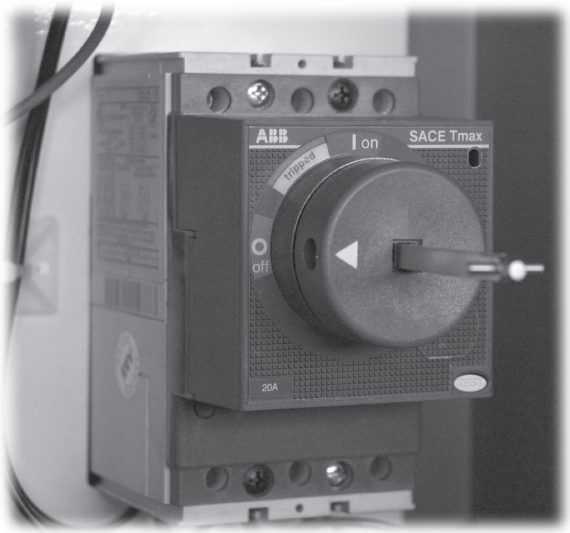
The panel door will not open with the disconnect in the “ON” position. To defeat the safety feature and open the door with the handle in the “ON” position insert a small pin such as a paper clip in the hole located in the yellow bezel. With the pin inserted, swing the door open. To close the door with the handle in the on position insert the pin in the hole then swing the door closed.



operation

When servicing the cooling tower, power to the fan motor and other options must be off. To do this, turn the disconnect switch to OFF and from behind the pistol-grip handle push the locking mechanism outward exposing a slot. Add your padlock and follow lock out tag out safety processes.

The main disconnect is a thermal magnetic circuit breaker which does not require adjustment.



operation

VFD Overview

Two ways to use the VFD keypad

- **HAND** manual motor speed control
  - – Use buttons on the key pad to start, stop and vary speed manually
- **AUTOMATIC** control motor speed via a remote speed signal automatically
  - – 4-20mA speed signal from customers BMS (Method 1 AIO)
  - – 0-10 VDC speed signal from customers (Method 2 AIO)
  - – Marley RTD speed signal (Method 3 AIO)

If the VFD speed signal is different than the Marley programming shipped with the unit refer to parameter setup list later in this manual to make changes.

Refer to the wiring diagram VFD box symbol inside the door of the AIO control panel to determine which speed control method is programmed into the VFD. Terminal points for connecting the remote speed signal or Marley RTD are located on the user terminal strip of the AIO panel.

Starting the cooling tower fan motor

⚠ Warning

Make sure all personal are clear of the tower before starting the fan motor

VFD operation using the VFD keypad to start, stop and vary motor speed using three buttons.

- OFF
- HAND
- AUTO

operation

The following steps are used to start the tower fan motor

Step 1–Power on the AIO panel

Rotate the main disconnect handle on the AIO control panel to the ON position and allow time for the VFD to boot up.

The word OFF should be shown in the upper left portion of the VFD key pad.

If the AIO control panel is already powered ON and you don't see OFF on the screen press the OFF button.

Note

If a start command is disabled the display will cycle showing an alarm screen.

ALARM 2021
Start enable 1 missing

Alarm 2021 means the vibration switch contact is open or someone may have their remote start contact open not allowing the VFD to start.

Once the start enable alarm is corrected alarm 2021 will no longer display.

Step 2–OFF mode

While in OFF mode make note of the start speed located in upper right of screen. Using the down arrow key move the start speed to 14HZ. This commands the VFD to start and run the motor at 14HZ.

Note

Depressing the OFF button will stop the VFD in either AUTO or HAND mode.

Step 3–HAND OPERATION (manual) start mode

Pressing the HAND key will start the fan motor.

HAND mode is used to manually start and control motor speed from the keypad. Use the up and down arrow keys to increase or decrease motor speed. The requested speed is shown in upper right hand corner of the screen.

It is always best to start at a low speed of 14HZ then slowly ramp up the speed listening and observing for possible critical tower vibration frequencies.

Note

While running the motor, observe cooling tower fan rotation. If the fan is rotating in reverse direction have a qualified electrician swap any two motor cable phases on the load side of the motor overload relay.

Step 4–Press the OFF button to stop the fan motor

Step 5–AUTO OPERATION (automatic) start mode

Pressing the AUTO button puts the VFD in automatic mode. Speed control is accomplished using a remote speed signal from the customers BMS or Marley RTD. When in AUTO mode the word AUTO is shown in the upper left corner of the keypad display.

Note

Pressing the AUTO key may start the fan motor.

If a remote BMS signal is being used the VFD will not run unless the speed signal is high enough to command the VFD to run. The controls contractor can force this signal to prove operation.

operation

Method 3–AIO using a Marley RTD transmitter for standalone application

For this method a Marley RTD is used with a drywell and built in 2 wire 4-20mA transmitter scaled at 0-160°F. The RTD should be installed into the customer's cold water discharge pipe near the cooling tower. Orientation of the RTD in the pipe should be into the side making sure the tip of the RTD probe is submersed in water at all times. The RTD should be located as close as possible to the cooling tower cell it serves avoiding artificial time delay responses. The VFD powers the transmitter loop so no other voltage source is required. The RTD terminal points 6 and 7 are field wired to the user terminal strip located in the AIO control panel. Use 18 gauge 2 wire stranded copper instrumentation wire with a shield to make the connection between the RTD and the VFD.

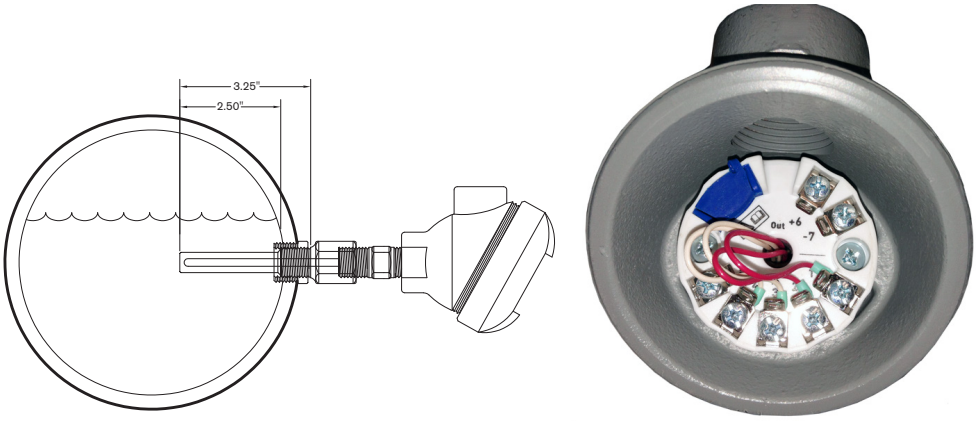
The VFD's internal PI regulator receives temperature information from the RTD and compares this value with the set point temperature on line #1 of the VFD's keypad making speed adjustments automatically to maintain set point temperature.

Sleep mode–Once the set point temperature is satisfied the VFD runs the fan at 14 HZ for 10 minutes then the VFD will go into sleep mode shutting off the motor until needed later for cooling. If during the 10 minute delay temperature rises above the set point the fan will rotate again until the temperature is satisfied and repeat the cycle.

When in sleep mode the screen will cycle with an alarm notification 2018. This is normal and is more of a notification than an alarm.

ALARM 2018
PID sleep

As the cold-water temperature rises above set point the VFD will start rotating the fan and the alarm notification will go away.



operation

Method 1–4-20mA speed signal from BMS

Requested speed from keypad or remote source
Active fan motor running speed
Active fan motor amp draw
Active speed signal from remote source

OFF

- VFD is not being requested to run the fan motor
- OFF button stops fan motor

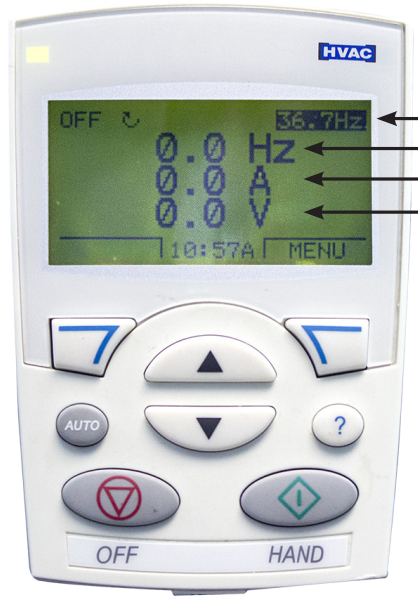
HAND

- HAND button starts fan motor
- User up and down arrow keys to change speed

AUTO

- AUTO button puts the VFD in automatic mode – motor speed will be determined by the remote 4-20mA speed signal

Method 2–10VDC speed signal from BMS



Requested speed from keypad or remote source
Active fan motor running speed
Active fan motor amp draw
Active speed signal from remote source

OFF

- VFD is not being requested to run the fan motor
- OFF button stops fan motor

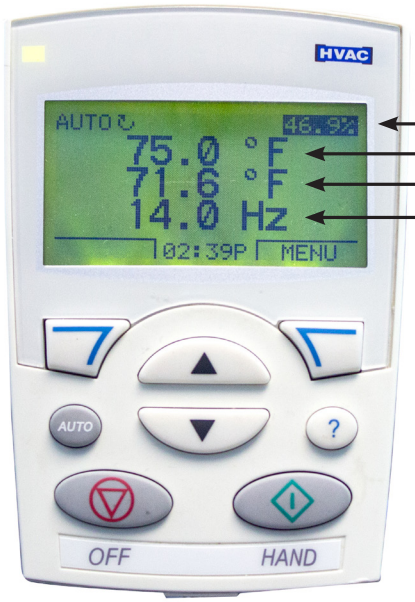
HAND

- HAND button starts fan motor
- User up and down arrow keys to change speed

AUTO

- AUTO button puts the VFD in automatic mode – motor speed will be determined by the remote 0-10VDC speed signal

Method 3–Marley RTD speed signal



Requested speed from keypad or % of 0-160°F scaling from RTD
Setpoint cold-water temperature
Actual cold-water temperature signal from RTD
Active fan motor speed

OFF

- VFD is not being requested to run the fan motor
- OFF button stops fan motor

HAND

- HAND button starts fan motor
- User up and down arrow keys to change speed

AUTO

- AUTO button puts the VFD in automatic mode – motor speed will be determined by the RTD speed signal

Bypass operation (optional circuit)

This feature is common in the cooling tower industry and is used to operate the cooling tower fan motor at full speed manually, typically when the VFD is out of service or during startup. In Bypass mode the fan run continually with no automatic cycling. Use the HAND and OFF buttons to manually cycle the motor ON and OFF. The bypass circuit is a full voltage non-reversing motor starter with no speed control other than OFF and ON at full speed.

To operate in bypass mode slowly move the selector switch to BYPASS position. This procedure will start the cooling tower fan motor and run it at full speed.

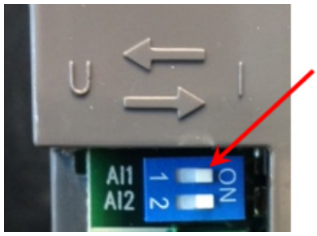
Note

If the fan motor does not spin in same direction as VFD correct the motor rotation following this procedure. Make sure proper lock out tag out rules are followed.

1– Operate fan motor in VFD mode and notice fan direction. If the fan is spinning in reverse direction swap any two power phases on load side of the motor overload relay.

2– Operate fan motor in BYPASS mode and notice fan direction. If fan is spinning in reverse direction swap any two power phases on line side of the AIO panel's main circuit breaker (be sure to turn off upstream supply device before making this change).

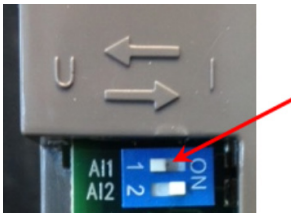
AIO VFD parameters for ABB ACH550 VFD 4-20mA BMS speed signal



Method 1–Marley program parameters for ACH550 VFD with or without traditional bypass using BMS 4-20mA speed signal. See DIP switch J1 on VFD terminal board. Slide top slider switch # 1 towards the right or I position for a 4-20 ma type speed signal wired to analog input AI1 on the VFD terminal strip.

✔	Keypad	Parameter	Title on keypad screen	Enter Value	Comment
	VFD	TIME & DATE	CLOCK VISIBILITY	Show clock	Setting up the clock captures the time and day when a fault occurs
	VFD	TIME & DATE	TIME FORMAT	12-hour	
	VFD	TIME & DATE	DATE FORMAT	mm/dd/yyyy	
	VFD	TIME & DATE	SET TIME	Today's time	
	VFD	TIME & DATE	SET DATE	Today's date	
	VFD	9902	APPLIC MACRO	HVAC	Do not use any other macro
	VFD	9906	MOTOR NOM CURR	Motor Nameplate Current at 1.00 S.F.	
	VFD	9908	MOTOR NOM SPEED	Motor Nameplate Speed	Do not enter a value such as 3600, 1800, 1200 or 900. Use the slip speed value on the motor nameplate
	VFD	1001	EXT1 COMMANDS	DI1,2	DI1=Start and DI2=Reverse
	VFD	1003	DIRECTION	REQUEST	Rotation direction can be changed on command
	VFD	1104	REF1 MIN	14 Hz	Prevents VFD operation less than 14Hz in either AUTO or HAND mode. This protects the gear box from running dry.
	VFD	1201	CONST SPEED SELECT	DI2	Activates constant speed
	VFD	1202	CONST SPEED 1	30 HZ	30 HZ speed
	VFD	1401	RELAY OUTPUT 1	SUPRV 1 UNDER	Sets minimum speed signal is 4-20mA
	VFD	1405	RO1 OFF DELAY	3.0 S	Delays start of drive for 3 seconds after greater than 4.7mA input on AI1.
	VFD	1610	DISPLAY ALARMS	NO	Hides (4) alarms. Eliminates call back when in current limit.
	VFD	20 03	MAX CURRENT	Motor nameplate Full Load Amps at a Service Factor of 1.00	MAX CURRENT keeps the motor amps at or below motor nameplate while in VFD mode during cold weather operation by limiting fan speed. Some motors also list a value of amps at a service factor higher than 1.00 do not these values.
	VFD	2007	MINIMUM FREQ	14 Hz	Prevents VFD operation less than 14Hz in either AUTO or HAND mode. This protects the gear box from running dry.
	VFD	2601	FLUX OPT ENABLE	OFF	
	VFD	2609	NOISE SMOOTHING	ENABLE	
	VFD	3028	EARTH FAULT LVL	3 (HIGH)	Defines protection level for ground (earth) fault
	VFD	3201	SUPERV 1 PARAM	AI1	Selects AI1 as input Supervised.
	VFD	3202	SUPERV 1 LIMIT LOW.	20%	Sets the low limit for the first supervised parameter to 4mA.
	VFD	3203	SUPERV 1 LIMIT HIGH	20.5%	Sets the high limit for the first supervised parameter. BAS signal ignored until minimum speed (14hz.) signal about 4.7mA.
	VFD	3404	OUTPUT1 DISPLAY	DIRECT	
	VFD	3405	OUTPUT1 UNIT	HZ	This changes the text field on line 1 of VFD display to show HZ.
	Check correct fan rotation in VFD mode				
	Check correct fan rotation in bypass mode				
	VFD	PAR BACKUP		Upload to panel	Motor must be stopped during this process
	VFD	1603	PASS CODE	358	To lock or open the keypad 358 must always be entered first
	VFD	1602	PARAMETER LOCK	Locked	Lock up the key pad to avoid call backs
Notes					
A	Select the SAVE button to save parameter changes				
B	Do not change the macro from factory default of HVAC				
C	Critical fan speeds should be identified and locked out using program group 25				

AIO VFD parameters for ABB ACH550 VFD 0-10VDC BMS speed signal



Method 2–Marley program parameters for ACH550 VFD with or without traditional bypass using a remote 0-10 VDC speed reference signal from customers BMS See DIP switch J1 on VFD terminal strip. Slide top slider switch # 1 towards the left or U position for a 0-10 VDC type speed signal wired to analog input AI1 on the VFD terminal strip.

✔	Keypad	Parameter	Title on keypad screen	Enter Value	Comment
	VFD	TIME & DATE	CLOCK VISIBILITY	Show clock	Setting up the clock captures the time and day when a fault occurs
	VFD	TIME & DATE	TIME FORMAT	12-hour	
	VFD	TIME & DATE	DATE FORMAT	mm/dd/yyyy	
	VFD	TIME & DATE	SET TIME	Today's time	
	VFD	TIME & DATE	SET DATE	Today's date	
	VFD	99 02	APPLIC MACRO	HVAC	Do not use any other macro
	VFD	99 06	MOTOR NOM CURR	Motor Nameplate Current at 1.00 S.F.	
	VFD	99 08	MOTOR NOM SPEED	Motor Nameplate Speed	Do not enter a value such as 3600, 1800, 1200 or 900. Use the slip speed value on the motor nameplate
	VFD	10 01	EXT1 COMMANDS	DI1,2	DI1=Start and DI2=Reverse
	VFD	10 03	DIRECTION	REQUEST	Rotation direction can be changed on command
	VFD	11 04	REF1 MIN	14 Hz	Long term operation below 14HZ may damage a gear box
	VFD	12 01	CONST SPEED SELECT	DI2	Activates constant speed
	VFD	12 02	CONST SPEED 1	30 HZ	30 HZ speed
	VFD	14 01	RELAY OUTPUT 1	SUPRV 1 UNDER	Sets minimum speed signal is 0 minimum -10 VDC
	VFD	14 05	RO1 OFF DELAY	3.0 S	Delays start of drive for 3 seconds after greater than 2.2 volt input on AI1.
	VFD	16 10	DISPLAY ALARMS	NO	Hides (4) alarms. Eliminates call back when in current limit.
	VFD	20 03	MAX CURRENT	Motor nameplate Full Load Amps at a Service Factor of 1.00	MAX CURRENT keeps the motor amps at or below motor nameplate while in VFD mode during cold weather operation by limiting fan speed. Some motors also list a value of amps at a service factor higher than 1.00 do not these values.
	VFD	20 07	MINIMUM FREQ	14 Hz	Prevents VFD operation less than 14Hz in either AUTO or HAND mode. This protects the gear box from running dry.
	VFD	26 01	FLUX OPT ENABLE	OFF	
	VFD	26 09	NOISE SMOOTHING	ENABLE	
	VFD	30 28	EARTH FAULT LVL	3 (HIGH)	Defines protection level for ground (earth) fault
	VFD	32 01	SUPERV 1 PARAM	AI1	Selects AI1 as input Supervised.
	VFD	32 02	SUPERV 1 LIMIT LOW.	20%	Sets the low limit for the first supervised parameter to 2 volts.
	VFD	32 03	SUPERV 1 LIMIT HIGH	20.5%	Sets the high limit for the first supervised parameter. BAS signal ignored until minimum speed (14hz.) signal about 2.2 volts.
	VFD	34 04	OUTPUT1 DISPLAY	DIRECT	
	VFD	34 05	OUTPUT1 UNIT	HZ	This changes the text field on line 3 of VFD display to show Hz.
	VFD	34 19	OUTPUT3 UNIT	V	This changes the text field on line 3 of VFD display to show Volts for a remote 0-10 volt speed signal. Allows you to see the actual speed signal from the controls contractor.
	VFD	34 21	OUTPUT3 MAX	10V	
	Check correct fan rotation in VFD mode				
	Check correct fan rotation in bypass mode				
	VFD	PAR BACKUP		UPLOAD TO PANEL	Motor must be stopped during this process
	VFD	16 03	PASS CODE	358	To lock or open the keypad 358 must always be entered first
	VFD	16 02	PARAMETER LOCK	LOCKED	Lock up the key pad to avoid call backs

Notes	
A	Select the SAVE button to save parameter changes
B	Do not change the macro from factory default of HVAC
C	Critical fan speeds should be identified and locked out using program group 25

AIO VFD parameters for ABB ACH550 VFD Marley RTD 4-20A speed signal

Method 3–Marley program parameters for ACH550 VFD with or without a traditional bypass. Marley item E16086 RTD transmitter for PI temperature control is provided. RTD includes a integrated transmitter in the conduit head providing a 4-20 mA signal representing water temperature scaled at 0-160°F directly to the drive. Configured with RTD, the following parameters allow the ACH550 drive to operate the cooling tower fan in a regulated "stand alone" independently controlled operation. (No external speed control needed). See dipswitch J1 on VFD terminal strip. Slide bottom dipswitch 2 towards right or 1 position for RTD type speed signal wired to analog input A12 on VFD terminal strip

✔	Keypad	Parameter	Title on keypad screen	Enter Value	Comment
	VFD	TIME & DATE	CLOCK VISIBILITY	Show clock	Set time for where it is going. Setting up the clock captures the time and day when a fault occurs
	VFD	TIME & DATE	TIME FORMAT	12-hour	
	VFD	TIME & DATE	DATE FORMAT	mm/dd/yyyy	
	VFD	TIME & DATE	SET TIME	Today's time	
	VFD	TIME & DATE	SET DATE	Today's date	
	VFD	99 02	APPLIC MACRO	HVAC	Do not use any other macro
	VFD	99 06	MOTOR NOM CURR	Motor Nameplate Current AT 1.00 S.F.	Use NEC FLA
	VFD	99 08	MOTOR NOM SPEED	Motor Nameplate Speed	Do not enter a value such as 3600, 1800, 1200 or 900. Use the slip speed value on the motor nameplate. For example 1775 RPM.
	VFD	11 02	EXT1/EXT2 SEL	EXT2	
	VFD	11 07	REF2 SELECT	23%	While in AUTO Sets min speed to 13.8HZ when RTD ref is 4mA
	VFD	14 01	OUTPUT 1	PID SLEEP	
	VFD	16 10	DISPLAY ALARMS	NO	Hides (4) alarms. Eliminates call back when in current limit.
	VFD	20 03	MAX CURRENT	Motor Nameplate Full Load Amps at a Service Factor of 1.00	MAX CURRENT keeps the motor amps at or below motor nameplate while in VFD mode during cold weather operation by limiting fan speed. Some motors also list a value of amps at a service factor higher than 1.00 do not these values.
	VFD	20 07	MINIMUM FREQ	14 Hz	Prevents VFD operation less than 14Hz in either AUTO or HAND mode. This protects the gear box from running dry.
	VFD	26 01	FLUX OPT ENABLE	OFF	
	VFD	26 09	NOISE SMOOTHING	ENABLE	
	VFD	30 01	AI<MIN FUNCTION	LAST SPEED	Relates to 3022
	VFD	30 22	AI2 FAULT LIMT	15%	If RTD signal to VFD is lost then motor will run at last speed (3001) until signal is restored. VFD keypad will show alarm 2007 AI2 loss.
	VFD	30 28	EARTH FAULT LVL	3 (HIGH)	Defines protection level for ground (earth) fault
	VFD	34 01	SIGNAL1 PARAM	PID1 SETPNT	Line 1 on keypad displays the cold water set point temperature. This value is selectable by the customer using the up and down arrow keys. Marley default temperature is 75°F.

AIO VFD parameters for ABB ACH550 VFD Marley RTD 4-20A speed signal

✔	Keypad	Parameter	Title on keypad screen	Enter Value	Comment
	VFD	34 04	OUTPUT1 DSP FORM	DIRECT	
	VFD	34 05	OUTPUT1 UNIT	°F	
	VFD	34 07	OUTPUT1 MAX	160.0 °F	
	VFD	34 08	SIGNAL2 PARAM	PID 1 FDBK	Line 2 on the keypad displays the actual cold water temperature the RTD is seeing.
	VFD	34 15	SIGNAL3 PARAM	OUTPUT FREQ	Line 3 on the keypad displays motor speed in hertz
	VFD	34 19	OUTPUT3 UNIT	Hz	
	VFD	34 21	OUTPUT3 MAX	600 Hz	
	VFD	40 01	GAIN	2	
	VFD	40 02	INTEGRATION TIME	5.0 s	
	VFD	40 05	ERROR VAL INV	YES	
	VFD	40 06	UNITS	°F	
	VFD	40 09	100% VALUE	160.0 °F	
	VFD	40 22	SLEEP SELECTION	INTERNAL	If sleep function is not desired this feature may be turned off by changing to NOT SEL
	VFD	40 23	PID SLEEP LEVEL	14.0 Hz	
	VFD	40 24	PID SLEEP DELAY	600.0 s	Use 10 seconds for test.
	VFD	40 25	WAKE-UP DEVIATION	3.0 °F	
	VFD	40 26	WAKE-UP DELAY	10.00 s	
	Check correct fan rotation in VFD mode				
	Check correct fan rotation in bypass mode				
	VFD	PAR BACKUP		UPLOAD TO PANEL	Motor must be stopped during this process
	VFD	16 03	PASS CODE	358	To lock or open the keypad 358 must always be entered first
	VFD	16 02	PARAMETER LOCK	LOCKED	Lock up the key pad to avoid call backs
Notes					
A	Select the SAVE button to save parameter changes				
B	Do not change the macro from factory default of HVAC				
C	Critical fan speeds should be identified and locked out using program group 25				

AIO control panel

Overview

Marley AIO (all in one) Control Panel combines various cooling tower fan cell electrical component controls into a stand-alone package with a single-point power connection. The main circuit breaker accepts a single power feed at the highest voltage then internally distributes and reduces the voltage to power the various integrated control features.

Integrated controls are customer selectable and typically include VFD for the fan motor, basin heater controls and water level controls.

One Convenient Control Panel per Cooling Tower Fan Cell

Functionally tested and operated at the factory

Single-point power connection

- Uses a main circuit breaker with short circuit protection
- No upstream MOCP-rated device required
- Fewer power feeds

Includes VFD and other cooling tower controls:

- Conductivity or ultrasonic water level controls
- Basin heater control with readout and element test functions
- Power for solid-state vibration switch and gearbox oil level switch

Standard Features:

- Built and marked to UL508A Industrial Control Panel standards
- Main circuit breaker (MOCP device) with thermal and magnetic over current protection
- Through the door operating handle with provisions for lock-out and tag-out procedures
- Wiring clearly labeled
- As-built wiring diagram showing internal and field connection points
- NEMA rated enclosure with swing and latch door

ACH550 vfd standard features

- UL, cUL labeled and CE marked
- EMI/RFI Filter (1st Environment, Restricted Distribution)
- Start-Up Assistants
- Maintenance Assistants
- Diagnostic Assistants
- Real Time Clock
  - Includes Day, Date and Time
- Operator Panel Parameter Backup (read/write)
- Full Graphic and Multilingual Display for Operator Control, Parameter Set-Up and Operation
- Data Display:
  - Output Frequency (Hz)
  - Speed (RPM)
  - Motor Current
  - Calculated % Motor Torque
  - Calculated Motor Power (kW)
  - DC Bus Voltage
  - Output Voltage
  - Heatsink Temperature
  - Elapsed Time Meter (resetable)
  - kWh (resetable)
  - Input/Output Terminal Monitor
  - PID Actual Value (Feedback) and Error
  - Fault Text
  - Warning Text
  - Three (3) Scalable Process Variable Displays
  - User Definable Engineering Units
- Two (2) Programmable Analog Inputs
- Six (6) Programmable Digital Inputs
- Two (2) Programmable Analog Outputs
- Up to Six (6) Programmable Relay Outputs
  - (Three (3) Standard)
- Adjustable Filters on Analog Inputs and Outputs
- Mathematical Functions on Analog Reference Signals
- All Control Inputs Isolated from Ground and Power
- Four (4) Resident Serial Communication Protocols
  - Johnson Controls N2
  - Siemens Building Technologies FLN (P1)
  - Modbus RTU
  - BACnet (MS/TP)
- Input Speed Signals
  - Current 0 (4) to 20 mA
  - Voltage 0 (2) to 10 VDC
  - Increase/Decrease Reference Contacts (Floating Point)
  - Serial Communications
- Start/Stop
  - 2-Wire (Dry Contact Closure)
  - 3-Wire (Momentary Contact)
  - Application of Input Power
  - Application of Reference Signal (PID Sleep/Wake-Up)
  - Serial Communications
- Start Functions
  - Ramp
  - Flying Start
  - Premagnetization on Start
  - Automatic Torque Boost
  - Automatic Torque Boost with Flying Start
  - Auto Restart (Reset) – Customer Selectable and Adjustable
  - Stop Functions
  - Ramp or Coast to Stop
  - Emergency Stop
  - DC Braking/Hold at Stop
  - Flux Braking
- Accel/Decel
  - Two (2) sets of Independent Ramps
  - Linear or Adjustable S-Curve Accel/Decel Ramps
- HVAC Specific Application Macros
- Separate Safety (2) and Run Permissive Inputs
- Damper Control
- Override Input (Fire Mode)
- Timer Functions
  - Four (4) Daily Start/Stop Time Periods
  - Four (4) Weekly Start/Stop Time Periods
  - Four (4) Timers for Collecting Time Periods and Overrides
- Seven (7) Preset Speeds
- Supervision Functions
- Adjustable Current Limit
- Electronic Reverse
- Automatic Extended Power Loss Ride Through (Selectable)
- Programmable Maximum Frequency to 500 Hz
- PID Control
  - Two (2) Integral Independent Programmable PID Setpoint Controllers (Process and External)
  - External Selection between Two (2) Sets of Process PID Controller Parameters
  - PID Sleep/Wake-Up
- Motor Control Features
  - Scalar (V/Hz) and Vector Modes of Motor Control
  - V/Hz Shapes
    - Linear
    - Squared
  - Energy Optimization
  - IR Compensation
  - Slip Compensation
  - Three (3) Critical Frequency Lockout Bands
- Preprogrammed Protection Circuits
  - Overcurrent
  - Short Circuit
  - Ground Fault
  - Overvoltage
  - Undervoltage
    - Input Phase Loss
  - Output Device (IGBT) Overtemperature
  - Adjustable Current Limit Regulator
  - UL508C Approved Electronic Motor Overload (I^2T)
- Programmable Fault Functions for Protection Include
  - Loss of Analog Input
  - Panel Loss
  - External Fault
  - Motor Thermal Protection
  - Stall
  - Underload
  - Motor Phase Loss
  - Ground Fault
- 5% Input Impedance
  - Equivalent 5% Impedance with Internal Reactor(s)
  - Patented Swinging Choke Design for Superior Harmonic Mitigation (R1 to R4)

Optional Features

- Fieldbus Adapter Modules
  - LonWorks
  - Profibus
  - Ethernet

ACH550 vfd specifications

Input Connection

Input Voltage (U_1)	208/220/230/240 VAC 3-phase +/-10% 208/220/230/240 VAC 1-phase +/-10% 380/400/415/440/460/480 VAC 3-phase +/-10% 500/600 VAC 3-phase +/-10%
Frequency	48 - 63 Hz
Line Limitations	Max +/-3% of nominal phase to phase input voltage
Fundamental Power Factor ($\cos\varphi$)	0.98 at nominal load
Connection	U_1, V_1, W_1 (U_1, V_1, 1-phase)
Output (Motor) Connection	
Output Voltage	0 to U_1, 3-phase symmetrical, U_2 at the field weakening point
Output Frequency	-500 to 500 Hz
Frequency Resolution	0.01 Hz
Continuous Output Current	
Variable Torque	1.0 I_{2N} (nominal rated output current, variable torque)
Short Term Overload Capacity	
Variable Torque	1.1 I_{2N} (1 min/10 min)
Peak Overload Capacity:	
Variable Torque	1.35 I_{2N} (2 sec/1 min)
Base Motor Frequency Range	10 to 500 Hz
Switching Frequency	1, 4, 8 or 12 kHz
Acceleration Time	0.1 to 1800s
Deceleration Time	0.1 to 1800s
Efficiency	0.98 at nominal power level
Short Circuit Withstand Rating	100,000 AIC (UL) w/o fuses
Connection	U_2, V_2, W_2
Enclosure Style	UL (NEMA) Type 1,
Agency Approval Listing and Compliance	UL, cUL, CE

Ambient Conditions, Operation

0 to 40°C (32° to 104°F), above 40°C the maximum output current is derated 1% for every additional 1°C (up to 50°C(122°F)) maximum limit.
5 to 95%, no condensation allowed, maximum relative humidity is 60% in the presence of corrosive gasses
Contamination Levels

IEC	60721-3-1, 60721-3-2 and 60721-3-3
Chemical Gasses	3C1 and 3C2
Solid Particles	3S2

0 to 1000 m (3300 ft) above sea level. At sites over 1000 m (3300 ft) above sea level, the maximum power is derated 1% for every additional 100 m (330 ft).
If the installation site is higher than 2000 m (6600 ft) above sea level, please contact your local ABB distributor or representative for further information.
Max 3.0 mm (0.12 in) 2 to 9 Hz, Max 10 m/s^2 (33 ft/s^2) 9 to 200 Hz sinusoidal

Ambient Conditions, Storage (in protective shipping package)

Air Temperature	-40° to 70°C (-40° to 158°F)
Relative Humidity	Less than 95%, no condensation allowed
Vibration Tested to (IEC 60068-2-6)	In accordance with ISTA 1A and 1B specifications
Bump Tested to (IEC 60068-2-29)	Max 100 m/s^2 (330 ft/s^2) 11 ms (tested 500 times each axis, each pole; 3000 times total)

Ambient Conditions, Transportation (in protective shipping package)

Air Temperature	-40° to 70°C (-40° to 158°F)
Relative Humidity	Less than 95%, no condensation allowed
Atmospheric Pressure	60 to 106 kPa (8.7 to 15.4 psi)
Vibration Tested to (IEC 60068-2-6)	Max 3.0 mm (0.14 in) 2 to 9 Hz, Max 15 m/s^2 (49 ft/s^2) 9 to 200 Hz sinusoidal
Bump Tested to (IEC 60068-2-29)	Max 100 m/s^2 (330 ft/s^2) 11 ms (Tested 500 times each axis, each pole; 3000 times total)
Shock Tested to (IEC 60068-2-27)	R1: 76 cm (30 in), R2: 61 cm (24 in), R3: 46 cm (18 in), R4: 31 cm (12 in), R5 and R6: 25 cm (10 in)

Analog Inputs

Quantity	Two (2) programmable
Voltage Reference	0 (2) to 10 V, 250 kOhm, single-ended
Current Reference	0 (4) to 20 mA, 100 Ohm, single-ended
Potentiometer	10 VDC, 10 mA (1K to 10 KOhms)
Input Updating Time	8 ms
Terminal Block Size	2.3 mm^2/14 AWG

ACH550 vfd specifications

Cooling Information

Integral Fan(s) Power Loss	Approximately 3% of rated power

Reference Power Supply

Reference Voltage	+10 VDC, 1% at 25°C (77°F)
Maximum Load	10 mA
Applicable Potentiometer	1 kOhm to 10 kOhm
Terminal Block Size	2.3mm^2/14AWG

Analog Outputs

Quantity	Two (2) programmable current outputs
Signal Level	0 (4) to 20 mA
Accuracy	+/- 1% full scale range at 25°C (77°F)
Maximum Load Impedance	500 Ohms
Output Updating Time	2 ms
Terminal Block Size	2.3mm^2/14AWG

Digital Inputs

Quantity	Six (6) programmable digital inputs
Isolation	Isolated as one group
Signal Level	24 VDC, (10V Logic 0)
Input Current	15 mA at 24 VDC
Input Updating Time	4 ms
Terminal Block Size	2.3mm^2/ 4AWG

Internal Power Supply

Primary Us	Internal supply for digital inputs
Voltage	+24 VDC, max 250 mA
Maximum Current	250 mA
Protection	Short circuit protected

Relay Outputs

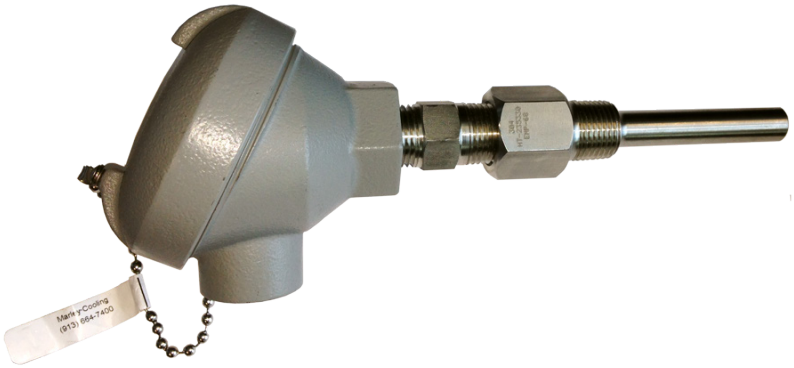
Quantity	Three (3) programmable relay (Form C) outputs
Switching Capacity	8 A at 24 VDC or 250 VAC, 0.4 A at 120 VDC
Max Continuous Current	2A RMS
Contact Material	Silver Cadmium Oxide (AgCdO)
Isolation Test Voltage	4 kVAC, 1 minute
Output Updating Time	12 ms
Terminal Block Size	2.3mm^2/14AWG

Protections

Single Phase	Protected (input and output)
Overcurrent Trip Limit	3.5 x I_{2N} instantaneous
Adjustable Current Regulation Limit	1.1 x I_{2N} (RMS) max.
Overvoltage Trip Limit	1.30 x U_N
Undervoltage Trip Limit	0.65 x U_N
Overtemperature (Heatsink)	+115°C (+239°F)
Auxiliary Voltage	Short Circuit Protected
Ground Fault	Protected
Short Circuit	Protected
Microprocessor Fault	Protected
Motor Stall Protection	Protected
Motor Overtemperature Protection (I_2t)	Protected
Input Power Loss of Phase	Protected
Loss of Reference	Protected
Short Circuit Current Rating	100,000 RMS symmetrical amperes
Input Line Impedance	Swinging choke 5% equivalent R1-R6, 3% equivalent R8

U_1 = Input Voltage U_N = Nominal Motor Voltage U_2 = Output Voltage f_N = Nominal Motor Frequency
P_N = Power – Normal Duty (hp) I_{2N} = Nominal Motor Current

RTD temperature sensor



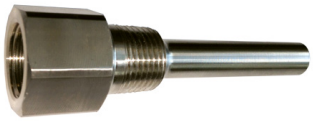
Benefits and Usage

- The Marley RTD (resistant temperature device) is an industrial process rated component used to measure fluid temperature in piping.
- The Marley RTD provides a means to capture temperature and feed this value back to a PI temperature controller. PI temperature controllers are used to vary cooling tower fan speeds maintaining a set-point water temperature back to the process loop.
- Marley RTDs are furnished with a stainless steel drywell.
- The 2-wire RTD includes an internal passive current loop transmitter which when powered by an external source provides a 4 to 20 mA analog signal. This signal may be used to represent water temperature with 4 mA being the lowest end of the range and 20 mA the highest. The RTD is typically used with a VFD where the VFD output provides source power and scaling is performed within the VFD.

RTD temperature sensor

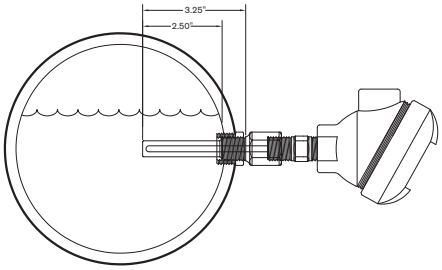
Drywell Specifications

- RTD may be removed from piping without having to drain piping
- 0.50" NPT pipe connection
- 4.50" total length
- 2.50" insertion length
- 304 stainless steel



RTD Specifications

- Cast iron weather-proof screw-cover connection head with threaded fitting for 0.75" conduit
- Platinum 100 Ohm element
- -50° to 100°C temperature range
- Spring loaded 316 stainless steel sheath
- Integrated 4-20mA tranmitter scaled 0-160°F

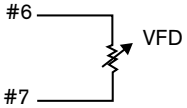


Recommended Installation Locations

- Tip of RTD must always be submerged in liquid even during reduced flow conditions

2 Wire 4-20 mA Transmitter

2-Wire



AIO control panel

USER MANUAL

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