Application Note - AN-111

Solar Water Heater Control

NOTICE

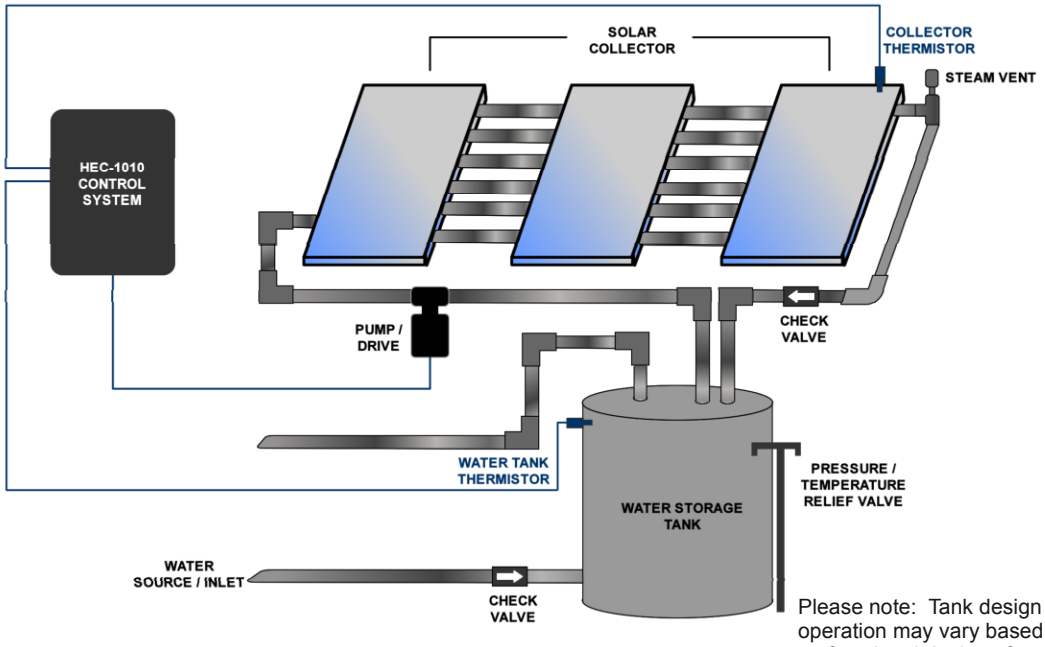
This application note is provided for use as a general example and a guide. Divelbiss assumes no responsibility, liability or warranty regarding this application, its use, functionality or reliability to meet application needs. User assumes all responsibility to ensure all safety precautions are taken when using this application note. This application must not be used alone in applications which would be hazardous to personnel in the event of a failure. Precautions must be taken by the user to provide mechanical and/or electrical safeguards external to this application and controllers shown.

Application Description

This application utilizes the Divelbiss HEC-1020 to control an open loop solar water heating system using off-the-shelf components. The HEC-1020 constantly monitors the temperature of the water tank and the collector and when the temperature differential between the two is achieved, a small pump is energized to circulate the water from the collector into the tank. This system may be used as a pre-heater to another water heating system or stand-alone.

This application software is focused on simple operation, although it may be modified to operate with additional control parameters and features. As this application focuses on control, it is important that all safeguards be used including but not limited to pressure release valves, anti-scald valves and all other safety devices. The system design shown is for example only. Any system design should be evaluated by a qualified professional for operation, safety and to verify all laws and local requirements are satisfied.

Application Diagram



Please note: Tank design operation may vary based on functional design of system.

Application Theory

When the temperature differential of the Water Storage Tank and Solar Collector reaches a pre-determined value, the Pump begins operating, thus re-circulating water from the storage tank into the Solar Collector and from the Solar Collector into the Water Storage Tank. The Pump will stop operating when the differential temperature of the Water Storage Tank and Solar Collector reaches a pre-determined value. The water in the tank is now the heated water previously in the Solar Collector while the water previously in the Water Storage Tank is now in the Solar Collector being warmed by sunlight.

As water is used, fresh water is added from the water source.

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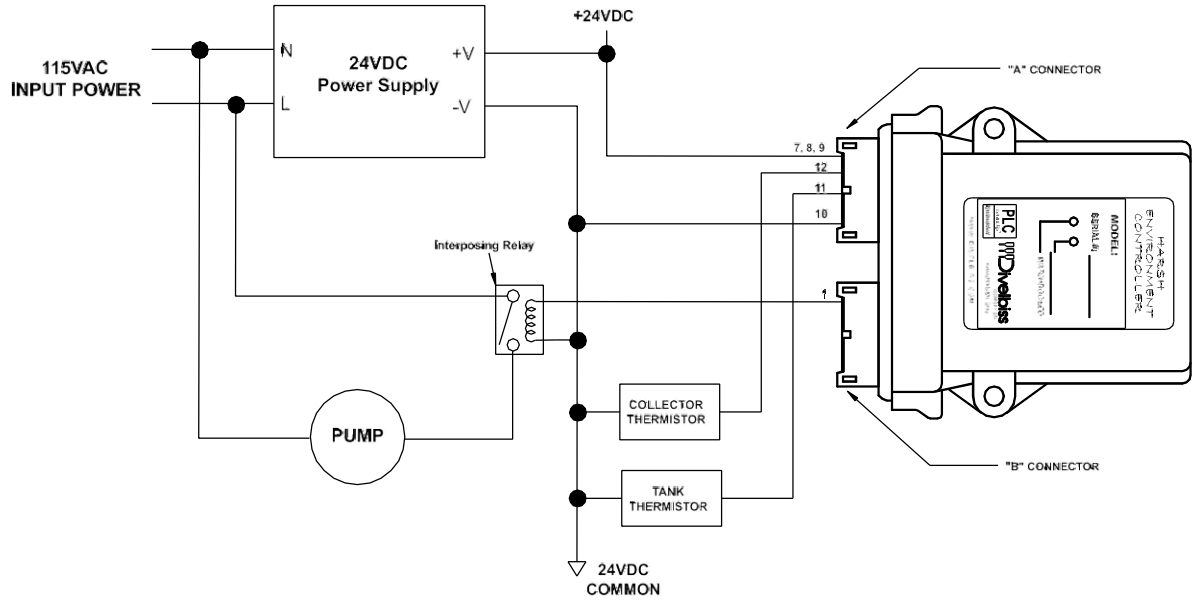
Connection Diagrams



Control Parts List

Item	Qty	Part Number	Description
Collector Thermistor, Tank Thermistor	2	TS4015	Automotive Thermistors
Controller	1	HEC-1020	Harsh Environment Controller with 6 Inputs, 6 Outputs and 2 Themistor Inputs
A Cable	1	HEC-100	HEC Connection Cable with Flying leads - 'A' Connector
B Cable	1	HEC-110	HEC Connection Cable with Flying leads - 'B' Connector
Program Breakout Cable	1	HEC-910	HEC Programming Breakout Cable
Programming Cable	1	ICM-CA-34	Null Modem Programming Cable
EZ LADDER Programming Software	1	EZLDCD-01	EZ LADDER Standard Edition on CD
24VDC Power Supply	1	130-105868	Power Supply with 115VAC Input, 24VDC Output, 1.5ADC Maximum
Interposing Relay	1	TBD	Power Relay, based on Pump Specifications, SPST .
Pump	1	TBD	Per Design and Specifications for each installation / application
Solar Collector Assembly	1	TBD	Per Design and Specifications for each installation / application
Water Storage Tank	1	TBD	Per Design and Specifications for each installation / application

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Input / Output Description

GPO0: General Purpose Real World Output. Connects to Interposing Relay for Pump Control.

AN0: Real World Analog Input. Connects to Thermistor in water tank.

AN1: Real World Analog Input. Connects to Thermistor in Solar Collector.

STATUS: Status LED on HEC-1000. Indicates the current status of the solar collector application.

Program Variables

GPO0: Boolean variable. Pump Control Real World Output. When true, the pump will circulate the heated water from the collector into the tank and the cooler water from the tank to the collector.

AN0: Integer variable. Analog Input 0. Returns an integer value (0-1023) based on the current temperature of the water tank.

AN1: Integer variable. Analog Input 1. Returns an integer value (0-1023) based on the current temperature of the solar collector.

AN0Avg: Integer variable. Analog Input 0, averaged over 20 samples.

AN1Avg: Integer variable. Analog Input1, averaged over 20 samples.

RAN0Avg: Real variable. Averaged Analog Input 0, converted to a Real variable type.

RAN1Avg: Real variable. Averaged Analog Input 1, converted to a Real variable type.

RCollTemp: Real variable. Calculated solar collector temperature based on AN1.

RTankTemp: Real variable. Calculated water tank temperature based on AN2.

RIntercept: Real variable. Variable used to calculate temperature based on specifications of the thermistors.

RSlope: Real variable. Variable used to calculate temperature based on specifications of the thermistors.

RTankLockout: Real variable. System / Tank Lockout Temperature. Currently set to 110 degree F.

RTemp1: Real variable. Temporary Real Variables used in program for calculations, etc.

RTemp2: Real variable. Temporary Real Variables used in program for calculations, etc.

RTempDiff: Real variable. Calculated temperature differential between the solar collector temperature and the water tank temperature.

TempFall: Real variable. Temperature fall setpoint. Used to control pump. When differential temperature falls below this setpoint, the pump is de-energized.

TempRise: Real variable. Temperature rise setpoint. Used to control pump. When differential temperature rises above this setpoint, the pump is energized.

Flash: Boolean variable. Internal contact used to flash the Status indicator.

FlashReset: Boolean variable. Internal contact used to reset the timer source for the Flash variable.

PumpEnable: Boolean variable. Internal Coil used to control the GPO0 Real World Output for pump operation. When true, the pump will energize and false, the pump will de-energize.

PumpLockout: Boolean variable. Internal contact used to disable (lockout) all pump operation based on tank temperature being too high (lockout)

PumpOn: Boolean variable. Internal Coil used to control the Status indicator. The PumpOn will always be the same state as the GPO0 output.

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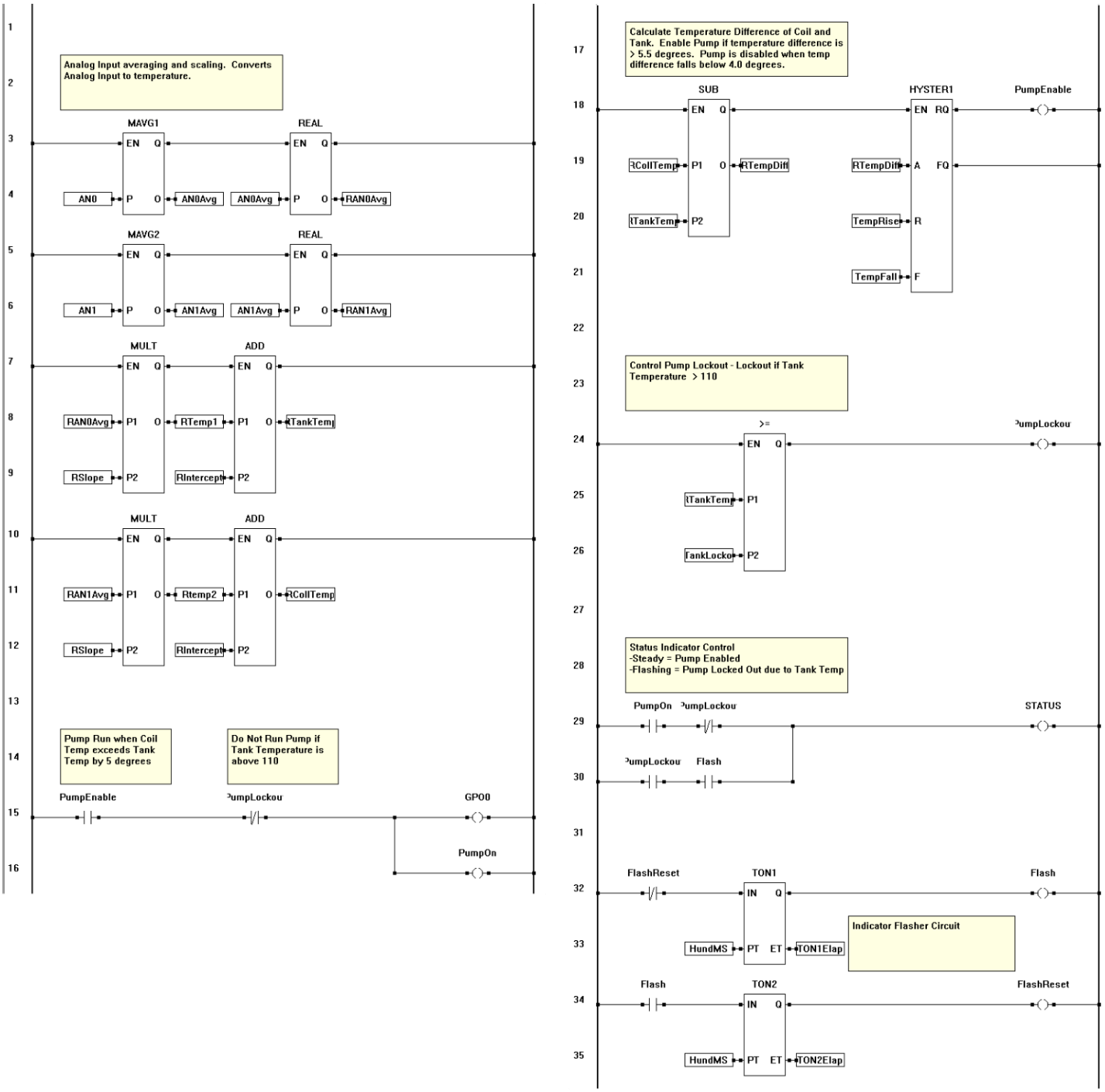
Program Description

The solar collector and water tank temperatures are constantly monitored and the difference between the two is calculated. When the difference (RTempDiff) rises above the setpoint TempRise (currently 5.5 degrees), the pump is energized, causing the heated water to circulate to the water tank and the cooler water from the water tank to be circulated to the solar collector. When the difference falls below the setpoint TempFall (currently 4 degrees), the pump is de-energized stopping the water from circulating.

If at any point the water tank temperature (RTankTemp) is greater than or equal to the TankLockout setpoint (currently 110 degrees), the Pump is locked out and will not energize.

When the pump is energized, the Status Indicator is on-steady. If the pump is locked-out due to water tank temperature, the Status Indicator will flash.

Ladder Diagram



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