A note about solar powered pumps:

Solar powered pumps vary their speed in direct proportion to the amount of sun on the solar panel. For instance a 12 Volt pump powered by solar can operate from 4 to 18 Volts. This can actually improve system performance over a fixed speed pump such as an AC, or battery powered pump. The reason is that in lower light levels the slower pump rate allows the fluid to stay in the collectors longer, thus absorbing more heat. Conversely in full sun the pump runs faster, extracting the heat more efficiently.

It does seem kind of silly to use an AC circulation pump - why pay your electric utility for Kilowatts of peak use energy when you can get it for free from the sun? The relatively small investment in a solar panel (and DTC-1) will be recovered in a few years. Solar power is more reliable than our aging power grid which could fail in the middle of a hot sunny day potentially causing a catastrophic system failure. If the collectors heat the glycol fluid above 250 degrees or so it will turn acidic and eventually eat through the pipes. Of course the P/T valve may also blow, dumping fluid and depressurizing the system.

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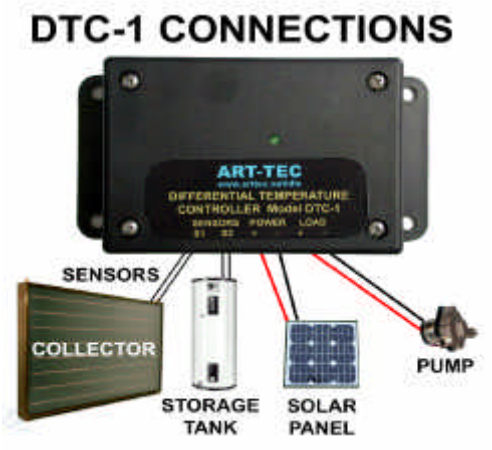
ART • TEC
Solar Differential Temperature Controller DTC-1 Manual

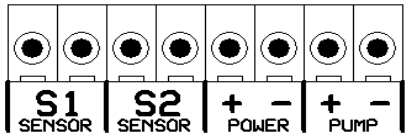
This controller is designed specifically for solar heating applications where the circulation pump is powered by a solar panel or DC power.

The DTC-1 will improve the performance of any DC powered solar heating system. It will switch power to the pump when it determines that one sensor (S1) is hotter than the other (S2). More importantly, it shuts off the pump when the reverse is true.



Mount the DTC-1 indoors where it will be protected from weather.

Remove the cover (4 screws) to access the terminals inside and simply connect power, your pump and 2 10K temperature sensors.



S1 - hot sensor - 10K thermistor. This sensor reads the temperature of the incoming solar generated heat. Attach to pipe with a hose clamp, and wrap with insulation.

Wrap the sensor with insulation to protect it from ambient temperatures. Solder all wire conections and weatherproof them carefully to prevent corrosion of the connections. DO NOT use wire nuts or crimp terminals outside!

S2 - cool sensor - 10K thermistor reads the stored heat. Attach to pipe with a hose clamp, or affix to tank surface and insulate from ambient air.

Try to locate the DTC-1 to minimize the wire length to the sensors. If the wires running to the sensor are more than 6 feet long, they should be twisted as a pair, or use pre-twisted wire. Solder and insulate all wire connections.

POWER - connect to solar panel, battery or any 12 to 24VDC source.

Use at least 18 gauge wire for up to 20 foot runs, heavier wire for longer runs. Outdoor wiring should be rated for exterior use Observe polarity!

PUMP - 12V or 24DC load. Observe polarity!

The DTC-1 will operate from 3.5 to 30 Volts and power a pump rated up to 6 Amps (72 Watts as 12 Volts). Most pumps will begin to operate at 4 Volts.

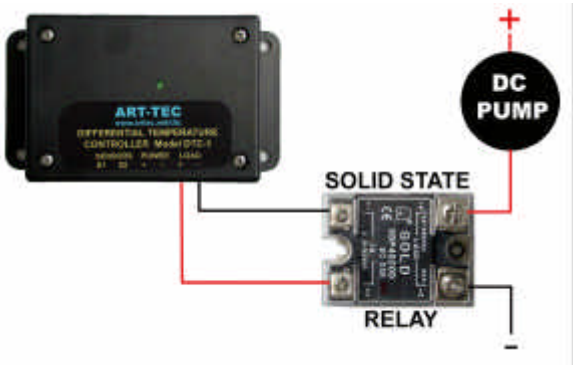
High Temperature Limiting

If you live in a warm climate, you may wish to add a thermal snap switch against the wall of your storage tank. This switch will open at a preset temperature such as 190F and stop the pump. Do not use this approach with glycol filled collectors. Stagnating the collector fluid will cause the antifreeze to fail.

On double pumped glycol systems it is OK to shut off the secondary pump (between HX and storage), but the collector pump must be connected directly to a solar panel.

High Power pumps

For larger pumps that exceed the 6 Amp capacity of the DTC-1, an external solid state relay is required. Mechanical relays should not be used as they will not turn on at the lower voltages put out by the solar panel.



PV powered pumps

There are basically 2 types of DC pumps used in solar heating. Regular DC pumps made by March etc. and electronic pumps like the El-Sid pumps made by Ivan Labs.

There are several models of El-Sid pump, and some are optimized for solar vs battery power, be sure to choose the correct one for your system. It is recommended that if you live north of Florida that you use a panel with twice the wattage of the pump, e.g. 20 Watt solar panel for 10 Watt pump. This ensures optimal performance early and late in the day.

An option for DC pumps is to use a power optimizer like the PPT line of products made by Solar Converters. These units can let you use a smaller PV panel for the pump. The disadvantage is these devices will start a pump in lower light, which makes the DTC-1 even more necessary!

Surge Protection is Built in

Note that the DTC-1 contains a surge protector which will protect the electronic motors and other electronics like power optimizers. Any voltage over 40 Volts will be clamped inside the DTC - and shorted back to the PV panel.

DC power sources

The input to the DTC-1 can come from any source of DC voltage including a solar panel, battery or a Wall power adapter (wall wart). If powering a 10 Watt pump the wall wart should be sized about double the wattage of the pump. So a 10 Watt pump would need a 12 Volt 1.5 Amp adapter.

FEATURES

- **Operates from 3.5 to 24 Volts. *30V MAX!***
- **Uses standard 10K thermistor temperature sensors**
- **Ambient Operating Temperature 32 - 158F (0 - 70C)**
- **Manual override switch has ON/AUTO/OFF to simplify testing**
- **Green LED load power indicator**
- **Switches up to 6 Amps (72 Watts)**
- **Replaceable 6 amp 3AG type fuse inside**
- **Built in surge protection protects electronic motors**
- **Under 3mA power consumption (when load is off)**

CONTROLS

Inside the unit there is a switch with 3 positions:

ON - load is always on.

AUTO - load only powered if S1 is hotter than S2.

OFF - load is off.

The switch is intended primarily for testing, and should be left in the AUTO position for normal operation. The green LED will light to let you know when the load should be operating. When replacing the cover - be sure that the LED aligns with the hole in the cover.

TROUBLESHOOTING

Indicator lights, but load does not operate:

- **Check the fuse.**
- **Check load wiring, and polarity.**
- **Check to ensure that there is light on the solar panel, most pumps will not operate/start at low voltages, however the indicator light will come on at 3.5 Volts.**

Load does not operate:

- **Check the fuse.**
- **Is the green indicator light on? If not, there isn't enough solar power to run the load. In general use a panel with at least 2 times the rated wattage of the pump. E.g.: 20 Watt panel with a 10 Watt pump.**
- **Check the LOAD switch, switch it to ON to see if pump runs, and OFF to be sure it does turn off. Leave it on AUTO for normal operation.**
- **Check for at least 4 Volts at the POWER terminals.**
- **Are the sensors correctly installed? Remove the sensor wires and test for resistance, it should read 10K at 77F, or higher resistance at lower temperatures and lower resistance at Higher temperatures. E.G. 200F = 829 Ohms and 50F = 19.9K Ohms.**

Flat plate vs. evacuated tube collectors.

There is an inherent mis-match between the efficiency of PV panels and solar thermal collectors such that the PV will have enough power to run a pump when the collector is not hot enough to be useful. This is most pronounced in cold climates. This is less true of evacuated tube collectors which are more efficient and do not radiate heat the way that flat plate collectors can.

Late in the day when your storage tank has accumulated a lot of heat on a cold sunny day is the point at which you may need to shut off your pump. The collectors are not getting enough sun to generate a higher temperature than the stored water. What happens if the pump continues running is that your stored heat is radiated out from flat plate collectors. With evacuated tubes you are likely to be pumping cooler water into the tank. The DTC-1 is designed to prevent this from happening.

Delta-T (aka hysteresis)

What does this mean? Delta is Greek symbol used to denote Difference, and T = temperature. Many other (AC powered) DTC's on the market have an adjustable Delta-T that sets the difference beween the sensor temperatures before the pump is activated. The DTC-1 does not, it simply switches the pump on the moment one sensor (S1) is hotter than the other (S2) and turns it off the moment that S1 is cooler than S2. This makes the design simple and guarantees that you are never lowering the temperature of your stored water - even by a fraction of a degree.

Placement of the sensors must be carefully considered to account for temperature drops across both sides of a heat exchanger, see next page.

Sensor location

Pressurized glycol systems.

On single pumped systems (where the heat exchenager is inside the storage tank) the hot (S1) sensor should be mounted to the pipe within 6" of the exit at top of the collector. This ensures a rapid response.

On double pumped systems where one pump circulates the collector to HX and another circulates from HX to storage, the hot (S1) sensor should be attached to the pipe that comes from the collectors about 2-3 feet before it enters the heat exchanger. The DTC-1 should then be used to switch the secondary pump.

The cool sensor (S2) should be located where it accurately measures the average temperature of the stored water. This can be the pipe that returns to the heat exchanger from the storage tank, or if you can access the surface of the tank, then attach the sensor to the tank wall about 1/4 from the top.

Be sure the sensors are insulated from exposure to ambient air, since this will affect the reading. On pipe runs the sensors can be attached with a pipe clamp and wrapped with insulation.

Drain back systems

The DTC-1 is not recommended for drain back systems because a Delta-T control is needed. As the water first comes out of the collector, the pipe temperature will drop which will confuse the DTC-1 and shut off the pump. This will cause rapid cycling that will prevent the system from working and could damage the pump. Most drain-back pumps are AC powered, so the DTC-1 would not be appropriate in any case.