ABB

ABB MEASUREMENT & ANALYTICS | TECHNICAL DESCRIPTION

ScreenMaster SM500F

Field mountable paperless recorder

Using the SM500F for chilled water BTU calculations in chiller cooling applications

Measurement made easy

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ScreenMaster SM500F

Introduction

Energy calculations are used in a variety of applications to calculate the amount of energy used to heat a system or process. Often this information is then used to calculate a total value that is used for billing purposes. But energy calculations are also used to calculate the amount of energy that is required to cool a process.

An example of a cooling application where this type of calculation is used are Data Centers. A Data Center is a dedicated space used by a business to house its computer systems and associated components. Large server racks produce a lot of heat while in operation and if the racks are allowed to overheat the entire system fails. This is clearly unacceptable so expensive climate control systems must be installed in Data Centers to prevent overheating

It is not unusual for a single building (or group of buildings) managed by a single provider to house Data Centers for multiple businesses. In this case, each individual company has its own area within the building that contains their servers. This area is seperated from other parts of the building and the company responsible for managing the building treats each section as a self-contained unit. Like apartments in an apartment building, all utilities into the building originate from the same source so to provide accurate billing to their customers, the building management company must be able to calculate the amount of energy being used by each section. In a domestic setting, each apartment has its own meters (fitted after the main incoming supply) that accurately monitor the usage of electricity, water and gas. Similarly, the building management company must fit meters to individual sections to ensure that each section is billed correctly and accurately.

The SM500F can be programmed with a basic equation used to calculate the total energy used. The equation is:

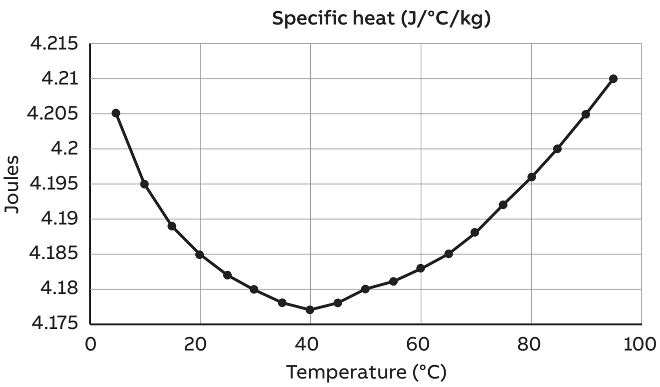
Return temperature – supply temperature × flow × specific heat capacity

Specific heat capacity

The specific heat capacity of a substance is described as the amount of heat a sample of that substance can hold, divided by the mass of that sample. In simple terms it is the amount of energy that must be added, in the form of heat, to one unit of mass of the substance to cause an increase of 1 unit in its temperature. Specific heat capacity is measured in joule per kelvin per kilogram (J/K/kg) but as an increment of 1 kelvin is the same as 1 °C (1.8 °F), it can also be expressed as J/°C/kg for an increment of 1 °C (1.8 °F) per unit.

Specific heat capacity varies with temperature and is different for each state of matter. For example, liquid water has one of the highest specific heats at approximately 4.182 J/°C/kg @ 20 °C; but the specific heat of ice at just below 0 °C is only 2.093 J/°C/kg.

The curve in the graph below demonstrates that the specific heat of water changes across a very small range. Therefore, a constant of 4.19 can be used for the chilled water specific heat in this energy calculation.

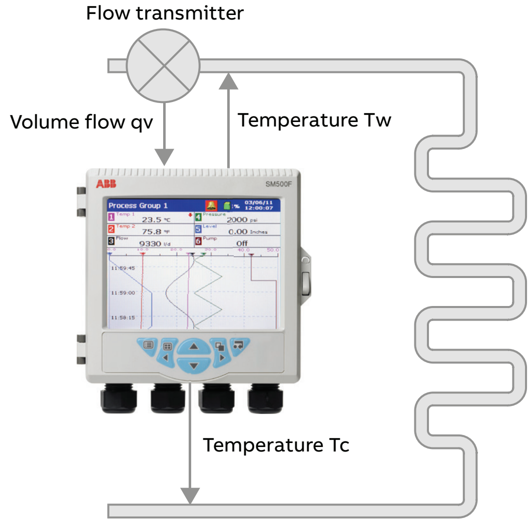


Chiller capacity

A chiller provides chilled water to air conditioning units within a building. The amount of cooling they provide varies and it is important to know how much cooling a chiller is producing or can produce, in order to calculate the energy that is being used to perform that cooling.
To be able to calculate this, some values must be known:

- The volume of water flowing into the evaporator
- The supply and return water temperature

Therefore the following system variables must be measured:



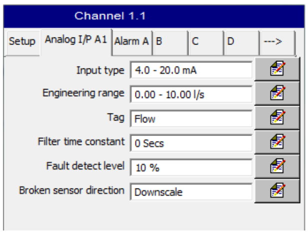
Temperature Tw is the temperature of the water in the supply side of the system. This is the water entering the chiller unit and providing the chilling function for the cold air. Temperature Tc is the temperature of the water in the return side of the system; this is the water that has been used to cool the air and is now at a higher temperature. Finally, qv is the flow of water through the system at the supply side.

SM500F configuration

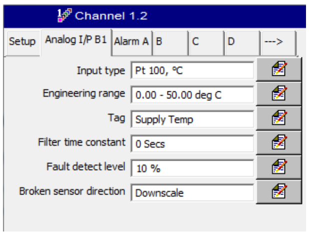
Analog inputs

The analog signals for flow and temperature are configured in the normal way. In this example the settings are:

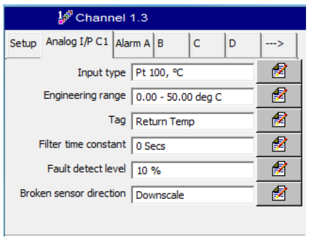
- Channel 1.1 (A1) is configured as the volume flow input (qv). This is a standard 4 to 20 mA signal with an engineering range of 0 to 10 l/s (though this may vary depending on application).



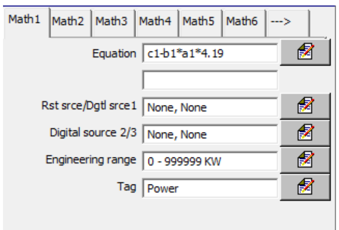
- Channel 1.2 (B1) is configured as the supply water temperature (Tw) input. A standard PT100 input type with a 0 to 50 °C engineering range has been configured.



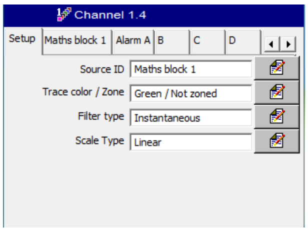
- Channel 1.3 (C1) is configured as the return water temperature (Tc) input. A standard PT100 input type with a 0 to 50 °C engineering range has been configured.



- A math block is configured using the inputs from A1, B1 and C1 and the specific heat capacity constant 4.19:

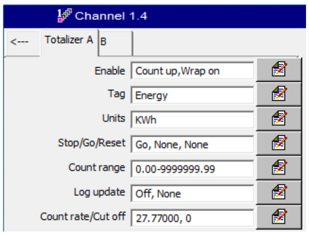


- Channel 1.4 is configured to show the energy value. Its source is the math block:

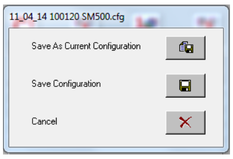


Totalizing the values

The calculation performed in the math block provides an instantaneous reading in KW of the power used within the air cooling system, based on the temperature and flow of the water. To calculate the total energy used, a totalizer is configured on Channel 1.4:



Once the SM500F has been configured, exit and select **Save as Current Configuration**:



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