

This supplement describes alarm and set point relay configurations for certain special situations and general gradient setting guidelines.

Pump or Fan Stage Always On

In some situations, the utility may want one or more cooling stages to operate for an extended period. The most common application is activation of the first stage cooling to run for the entire summer season. The Transformer Advantage CT series (CT, CTX & CT/LTC) models can be configured to automatically energize a cooling stage based on the calendar date and / or time of day. If, however, a cooling stage is activated independently of the Advantage; for example using a manual override, the Advantage must still “know” when this stage is operating in order to correctly calculate the winding temperature. For example, if the Advantage doesn’t know that the first cooling stage is on and the actual winding temperature is below the first stage set point, it will compute the winding temperature for an ONAN condition. This may result in a winding temperature indication that is much higher than the actual winding temperature.

To configure the Advantage for an externally activated, ‘always on’ cooling stage, setup an alarm relay as if the ‘always on’ stage were connected to it:

Set *Connected Equipment* to fan, pump or spray as appropriate.

Set *Source* to winding, *Sequencing* to off.

Adjust *Setpoint* below the lowest temperature expected at this location (e.g.-20C)

On Advantage CT series models equipped with the LCAM module and connected for cooling auxiliary monitoring, the Advantage will detect active and inactive cooling apparatus, and the above procedure is unnecessary.

Low Temperature Pump Lockout

Some transformers are susceptible to a condition called static electrification. This condition is most prevalent below 20°C. To minimize this problem, the Advantage can lock out pump operation below a specified temperature. This can be done as follows:

1. Wire a spare setpoint relay’s normally closed contact in series with the Advantage relay used for pump control.
2. Configure this relay for *Source* = fluid, *Sequencing* = off, *Setpoint* = minimum fluid temperature for pump operation
3. Set *Hysteresis* = 1, *Coil* = energize, *Sense Fail* = on, *Sense Fail Effect* = deenergize.

The relay’s normally closed contact will be open below the setpoint temperature (it is closed above the setpoint, during power off and during a sense fail condition).

Parallel Cooling Stages

It may be desirable to activate the same cooling stage based on both the fluid and winding temperatures. This practice was frequently employed when one gauge was used to measure fluid temperature and a second gauge was used to measure winding temperature. The concept provides redundancy in the event of the failure of one of the gauges. Models in the Advantage CT series can be used to replace both gauges, however; for the CT algorithm to indicate the proper winding temperature, no more than one relay

per cooling stage can be defined as having fans, pumps or spray as its connected equipment. Therefore, when connecting cooling relay contacts in parallel, configure them as follows:

Set the connected equipment option for the relay with the “winding” signal source to fan, pump or spray, as appropriate to the actual cooling equipment.

Set the connected equipment option for the relay with the “fluid” signal source to ~~“REDNT” (redundant)~~ or ALARM (alarm) and adjust the setpoint to a temperature that is below the winding set point by ½ of the ONAN gradient. For example, if the winding temperature set point is 85 degrees and the ONAN gradient is 20 degrees, set the fluid temperature set point to $85 - (20/2) = 75$ degrees.

ONAN Transformers (No Fans or Pumps)

The Transformer Advantage can be used to monitor temperatures of a transformer with no forced cooling. There are two methods of accomplishing this, depending upon whether it is allowed to have alarm annunciators displayed on the front panel display, when no alarms are actually tripped. Since Advantage CT-series monitors were designed primarily to control cooling stages, the winding temperature algorithm must be made to “think” it is controlling at least one stage, by defining a virtual stage whose set point is beyond any temperature that will actually be experienced. Either of the following two methods will result in the same winding temperature indication.

For both methods, the air circulation variable (ACIRC) must be set to “FORCE”.

To set up a virtual cooling stage that will not result in alarm annunciators on the front panel display, a set point is defined that is above any expected actual operating temperature. Enter the *GRDON* parameter in the user setup. The GRDON value in this case will be the nameplate ONAN (winding rise over top oil temperature) rated value divided by 1.414 (square root of 2). Set the following parameters on the alarm’s unused relay:

SOURC = FLUID	TRGER = NONE	SEQNO	CHKDI	SETPT = 150
SETBK = DISAB	COIL = DE-EN	SNEFF = DE-EN	SNFAL = OFF	
CNEQP = FAN	HYSTS = 1.0			

When no cooling is activated, as would be the case with the 150 degree C fluid set point, the winding temperature algorithm will internally calculate the ONAN gradient as the GRDON value that you entered, times 1.414. Since you entered the ONAN gradient divided by 1.414 as the GRDON value previously, when the Advantage does its calculations it will restore the nameplate ONAN gradient value and correctly apply it to the calculation of winding temperature.

In the second method, a virtual cooling stage is set up below any expected actual operating temperature. Enter the nameplate rating ONAN gradient (winding rise over top oil temperature) as the GRDON value. Configure a spare relay with the following settings:

SOURC = FLUID	TRGER = NONE	SEQNO	CHKDI	SETPT = -40
SETBK = DISAB	COIL = ENER	SNEFF = DE-EN	SNFAL = OFF	
CNEQP = FAN	HYSTS = 1.0			

With this technique the winding temperature algorithm “thinks” it has activated a forced-air cooling stage when the fluid temperature is above -40 degrees and properly applies the **value** of the ONAN gradient to all internal winding temperature calculations. The only drawback of this method is that the spare alarm will always show up as being tripped on the front panel.

Spray Cooling

The gradient value on the manufacturer's test report does not include the effect of auxiliary cooling, such as water spray, added by the utility. Dynamic testing must be performed in order to make an accurate determination of the change in load capacity, or winding hottest spot gradient, due to the addition of this type of cooling. Water spray is an emergency measure with widely varying degrees of predictability, which are greatly affected by the method of fluid circulation and surface upon which the spray is directed.

To determine the effect that spray cooling has on fluid and winding temperatures, it is recommended that the fluid and winding temperatures be recorded with and without the spray on, with the transformer running at or above full load capacity. Set the hysteresis of the relay with the fluid source to $\frac{3}{4}$ of the difference between the fluid temperature with and without the spray on. Set the hysteresis of the relay with the winding source to $\frac{3}{4}$ of the difference between the winding temperature with and without the spray on. The actual set points of the relays will depend upon the user's standard practice for protection of transformers operating in emergency overload conditions.

It is recommended that the activation of this emergency measure depend upon fluid **and** winding temperature, not fluid **or** winding temperature alone. See "Parallel Cooling Stages" above for details on how to set up parallel cooling stages. Any relay, which activates a spray cooling stage, must have its connected equipment variable set to "SPRAY".

If the fluid circulation is natural (ON) and the spray is directed at the transformer tank, it will act to lower the top oil temperature directly and the winding temperature in direct fractional proportion. This is because the temperature of the fluid circulating in the windings will be affected much less than the fluid circulating close to the walls and top of the tank. Therefore, because the top oil temperature is reduced in whole degrees, but the winding temperature is only reduced fractionally, the gradient must be increased to account for this method of spray cooling. The effect on the winding hottest spot gradient will typically be less than five degrees.

If the fluid circulation is ON and the spray is directed at the heat exchangers, the capacity of the transformer will increase, but the hottest spot gradient will not be significantly affected.

If the method of fluid circulation is forced (OF) or directed (OD) and the spray is directed on the tank or heat exchangers, the load capacity will be increased, but the hottest spot gradient will not be significantly affected.

Indication-Only Operation (No cooling control)

Customers may want to use an Advantage CT series instrument in the indication-only mode for alarms, or to send information to a SCADA system, while the existing temperature gauges continue to control the cooling. For proper indication, the Advantage models employing the calculated winding technique must control or be aware of active and inactive transformer cooling stages. Therefore, only Advantage CT series models equipped with the LCAM module and connected for cooling auxiliary monitoring are recommended for the indication-only mode. Where a heated thermowell is available, another good choice is one of the simulated winding models, Advantage SC, DC or TC.

The Weschler Transformer Advantage measures temperature more accurately than an analog gauge and setpoint control is more precise. In applications with redundant gauges, IEEE PC57-140 states that the electronic indicator should be configured for cooling control and alarm functions, while the legacy mechanical gauge is used as a redundant alarm source.

Other Considerations

As shown in the above examples, any relay with the *Connected Equipment* parameter set to fans, pumps or spray will affect the winding temperature indication. Therefore any unused relays should be disabled if the user has the Advantage Configuration Software, or, if setup is being done from the front panel, set the *Connected Equipment* parameter on unused relays to NONE.

The gradient parameters GRDON, GRDOF and GRDOD can be found in the USER loop, when performing front panel setup. When using the configuration software they can be found by clicking the Advantage Parameters drop down menu, then the Transformers Parameters flyout. The *GRDON* parameter is utilized by the winding temperature algorithm for ONAF or ONAN cooling, and in transformers with other cooling configurations, when cooling apparatus has not yet been activated. For transformers with ONAN and ONAF cooling, set FCIRC to NATUR (natural), the GRDON value to the data plate (rated) ONAN value and GRDOF and GRDOD values to 0.

On transformers with OF or OD cooling, the ON gradient is used in proportion to full-capacity, until an OF or OD cooling stage has been activated. Thus, an ON gradient for full load must be specified, in order that cooling stage loss can be accommodated by the winding temperature algorithm. The ON gradient for transformers with OF and OD cooling may not be included in the data plate information or heat run reports, but the transformer manufacturer should be able to provide a value. In the event that the value cannot be obtained from the transformer manufacturer, the following general rule can be used:

- OF Cooling:
 - Set the GRDOF value to the data plate value corresponding to the highest load capacity. Set the GRDON value to two times the GRDOF value or 40 degrees C, whichever is higher. Set the GRDOD value to 0.
- OD Cooling:
 - Set the GRDOD value to the data plate value corresponding to the highest load capacity. Set the GRDON value to three times the GRDOD value or 50 degrees C, whichever is higher. Set the GRDOF value to 0.

When any relay has *Connected Equipment* set to pumps, FCIRC must be set to either Forced or Directed.

For assistance with other applications of the Transformer Advantage, please contact the Weschler Sales team by phone (440 238 2550), fax (440 238 0660) or email (sales@weschler.com).