1 ATEX ETR Thermal Monitoring Function

1.1 Introduction

The FC 302 with firmware version V6.3x or higher is equipped with an "ATEX ETR thermal monitoring" function for operation of specially approved Ex-e motors according to EN-60079-7. When combined with an ATEX approved PTC monitoring device like the MCB 112 PTC option the installation does not need an individual approval from an approbated organisation, i.e. no need for matched pairs.

The feature makes it easier to apply Ex-e motors instead of the more expensive, larger and heavier Ex-d motors. This is possible by ensuring that the frequency converter will limit the motor current to prevent the motor to heat up.

⚠CAUTION

The following instructions must be followed in order to ensure a safe installation.

1.2 Safely Operating an Ex-e Motor in an ATEX Area

The Ex-e motor must be approved for operation in hazardous zones (ATEX zone 1/21, ATEX zone 2/22) in combination with frequency inverters. The motor must be certified for the particular hazardous zone.

NOTE

The motor can be placed in zone 1/21 or 2/22 according to motor approval. The frequency converter must always be installed outside of the hazardous zone.

1.2.1 MCB 112 ATEX PTC Thermistor Card

The motor must be monitored by an ATEX approved motor protection device in order to monitor the temperature in the motor windings and switch off the motor in case of a critical temperature level or a malfunction. The B-option MCB 112 PTC Thermistor option offers ATEX approved monitoring of motor temperature, if the frequency converter is equipped with 3-6 PTC thermistors in series according to DIN 44081 or 44082. Alternatively, an external ATEX approved PTC protection device can be used.

1.2.2 Motor Limits and Rules

For every certified motor with “increased safety” a data list including limits and rules is supplied by the motor manufacturer. These rules can be found on the data sheet or the motor name plate and have to be followed during planning, installation, commissioning, operation, and service.

- Minimum switching frequency
- Maximum current
- Minimum motor frequency
- Maximum motor frequency

Furthermore, the following must be respected.

- The maximum allowable ratio between frequency converter size and motor size may not be exceeded. The typical value is $I_{VLT,\,n} \leq 2 \times I_{m,n}$
- All voltage drops from frequency converter to motor have to be considered. If the motor is running with lower voltage than listed in the u/f characteristics, current might increase and cause an alarm
- Multi motor applications are not allowed. Only one motor may be connected to the frequency converter

NOTE

Attention in case of long cables (voltage peaks) or increased line voltage. The maximum allowable voltage at motor terminals might be exceeded. In this case a sinus filter might be necessary.

⚠CAUTION

The instructions for installation and parameter settings must be followed carefully.

1.3 Maximum Current

To activate the ATEX ETR monitor function, par.1-90 Motor thermal protection must set to “[20] ATEX ETR”. This will enable *1-94 ATEX ETR cur.lim. speed reduction*, *1-98 ATEX ETR interpol. points freq.*, and *1-99 ATEX ETR interpol points current* and limit *4-18 Current Limit* to 150%.

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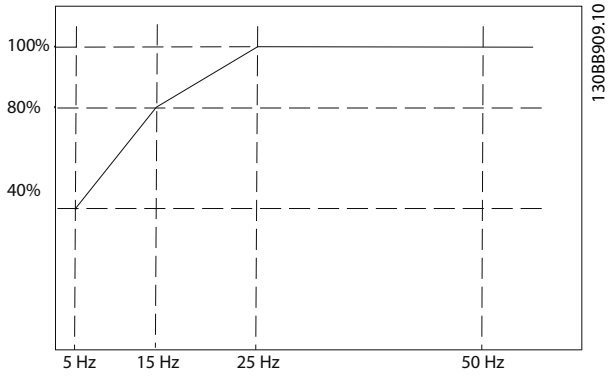
1.3.1 Thermal Limitation Curve

The output current/motor speed is permanently monitored and limited depending on the characteristic given by the motor manufacturer on the motor nameplate and datasheets. The characteristic values have to be programmed as frequency/current pairs in parameters *1-98 ATEX ETR interpol. points freq.* and *1-99 ATEX ETR interpol points current*.



Example of ATEX ETR thermal limitation curve

1-98 ATEX ETR interpol. points freq.	1-99 ATEX ETR interpol points current
[0] = 5Hz	[0] = 40%
[1] = 15Hz	[1] = 80%
[2] = 25Hz	[2] = 100%
[3] = 50 Hz	[3] = 100%

Use the four current points [A] from the motor name plate. Calculate the values as percentage of nominal motor current and enter into the array.
$\left(\frac{Ix \times 100}{Im,\ n}[\%]\right)$

NOTE

All frequency/current limit points from the motor name plate or motor data sheet have to be programmed.
***1-98 ATEX ETR interpol. points freq.* must be entered in Hz, never RPM.**

1.3.2 Maximum Current Limit

The operation above the thermal characteristic curve is permitted for a limited period of 60 sec.

The actual thermal overload is calculated on the basis of the ETR function selected in *1-90 Motor Thermal Protection* and is displayed in *16-18 Motor Thermal*.

When running above the characteristic curve for more than 50 sec. warning 163 ATEX ETR cur.lim. warning is triggered.

The reaction for operating in Ex-e current limit is configured in *1-94 ATEX ETR cur.lim. speed reduction*.

- 0%: the frequency converter does not change anything besides issuing warning 163 ATEX ETR cur.lim.warning
- >0%: the frequency converter issues warning 163 and reduces motor speed following ramp 2 (parameter group 3-5* *Ramp 2*)

Example:
Actual reference = 200 RPM
1-94 ATEX ETR cur.lim. speed reduction = 20%
Resulting reference = 160 RPM

Operating above the characteristic curve for more than 60 sec. within a period of 600 sec. will lead to Alarm 164 ATEX ETR cur.lim. and the frequency converter will trip.

Operation above 150% nominal motor current will trip the frequency converter after 1 sec. with Alarm 164.

Operation above 180% nominal motor current immediately trips the frequency converter with Alarm 164.

After first start-up (power up) the overload counter starts at a value that prevents resetting the thermal load value by power cycling. After start-up the overload warning is suppressed until the motor current exceeds the rated current limit for the first time.

1.4 Minimum Motor Frequency

The operation below the minimum frequency in *1-98 ATEX ETR interpol. points freq.* is allowed for a limited time only.

When running below the minimum frequency for more than 50 sec. Warning 165 ATEX ETR freq.lim.warning is triggered.

Operating below the minimum frequency for more than 60 sec. within a period of 600 sec. will lead to Alarm 166 ATEX ETR freq.lim.alarm and the frequency converter will trip.

1.5 Maximum Motor Frequency

The maximum allowable output frequency may not be exceeded. The maximum value is given by motor datasheet or nameplate.

NOTE

This value may need to be reduced in case of long motor cables, sinus filter or reduced supply voltage.

$$f_{max} = \frac{Un - Uloss}{Un} x\ fn$$

Example:
Nominal voltage = 480V
Nominal frequency = 50Hz
Voltage loss due to supply voltage of 450V = 30V
Resulting maximum frequency = 47Hz

Set *4-19 Max Output Frequency* to this value.

1.6 Minimum Switching Frequency

Thermal motor losses increase with lower switching frequencies. It must be ensured that the frequency converter switching frequency does not go below the value stated by the motor manufacturer

⚠CAUTION

It is mandatory to compare the minimum switching frequency requirement stated by the motor manufacturer to the minimum switching frequency of the frequency converter, the default value in *14-01 Switching Frequency*. If the frequency converter does not meet this requirement, a sine wave filter must be used.

1.6.1 Disable Protection Mode

In Protection Mode the frequency converter derates the switching frequency below the default in *14-01 Switching Frequency* (e.g. if the default value is 3kHz it may derate down to 2.5kHz, depending on EEPROM). Therefore, disable Protection mode in *14-26 Trip Delay at Inverter Fault*.

More information about derating can be found in the *Application Note on Derating*, MN.33.F1.02

1.7 Application Example

Parameters	
Function	**Setting**
1-90 Motor Thermal Protection	[20] ATEX ETR
1-94 ATEX ETR cur.lim. speed reduction	20%
1-98 ATEX ETR interpol. points freq.	Motor name plate
1-99 ATEX ETR interpol points current	
1-23 Motor Frequency	Enter the same value as for *4-19 Max Output Frequency*
4-19 Max Output Frequency	Motor name plate, possibly reduced for long motor cables, sinus filter or reduced supply voltage
4-18 Current Limit	Forced to 150% by 1-90 [20]
5-15 Terminal 33 Digital Input	[80] PTC Card 1
5-19 Terminal 37 Safe Stop	[4] PTC 1 Alarm
14-01 Switching Frequency	Check that the default value fulfils the requirement from Motor name plate. If not -use sine wave filter.
14-26 Trip Delay at Inverter Fault	0

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Sehr geehrte Damen und Herren,

bezugnehmend auf Ihr Schreiben vom 12.01.2011 teilen wir Ihnen hiermit die Ergebnisse der an dem Frequenzumrichter Typ Danfoss VLT Automation Drive FC 302, Serien-Nr. 010206G290 durchgeführten Bewertungen mit.

Beschreibung der bewerteten Funktionalität

Das Schutzkonzept umrichtergespeister, explosionsgeschützter Motoren (Kühlung über Eigenbelüftung) der Zündschutzart „Erhöhte Sicherheit“ besteht bei Verzicht auf die feste Kopplung Motor – Frequenzumrichter aus einer über den Frequenzumrichter realisierten drehzahlvariablen Strombegrenzung zur Abbildung der mit fallender Drehzahl abnehmenden Kühlwirkung des Lüfters in Kombination mit einer thermischen Maschinenüberwachung mittels Kaltleiter und einem gemäß Richtlinie 94/9/EG funktionsgeprüftem Auslösegerät.
Die Einstellwerte der Strombegrenzung des Frequenzumrichters in Abhängigkeit der Frequenz werden im Datenblatt der EG-Baumusterprüfbescheinigung des Motors festgelegt. Bei einem Motorstrom größer dem 1,5-fachen Motorbemessungsstrom muss eine unverzögerte Abschaltung erfolgen.

Bewertung der Funktion „Drehzahlvariable Strombegrenzung“

Die drehzahlvariable Strombegrenzung des untersuchten Frequenzumrichters Danfoss VLT Automation Drive FC 302 ab Firmwareversion 6.3 erfüllt uneingeschränkt die Anforderungen an die drehzahlvariable Strombegrenzung von Frequenzumrichtern zum Betrieb von explosionsgeschützten Motoren der Zündschutzart „Erhöhte Sicherheit“.

Diese Schutzfunktionalität des Umrichters ist jedoch KEINE Überwachungseinrichtung im Sinne der Richtlinie 94/9/EG. Zur Sicherstellung des Explosionsschutzes müssen die Motoren ZUSÄTZLICH über in die Wicklung eingebettete Kaltleiter zusammen mit einem gemäß Richtlinie 94/9/EG funktionsgeprüften und bescheinigten Auslösegerät thermisch überwacht werden.

Prüflaboratorium Explosionsschutz Braunschweig, 31. März 2011
im Auftrag

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