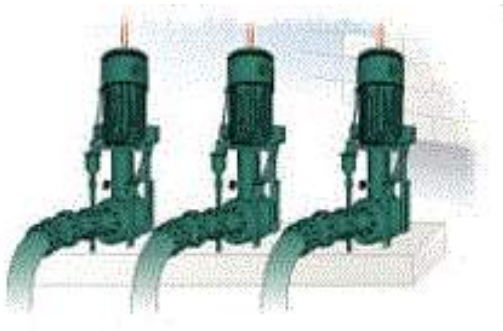
Applying Motor Data to Setup Motor Protective Relay



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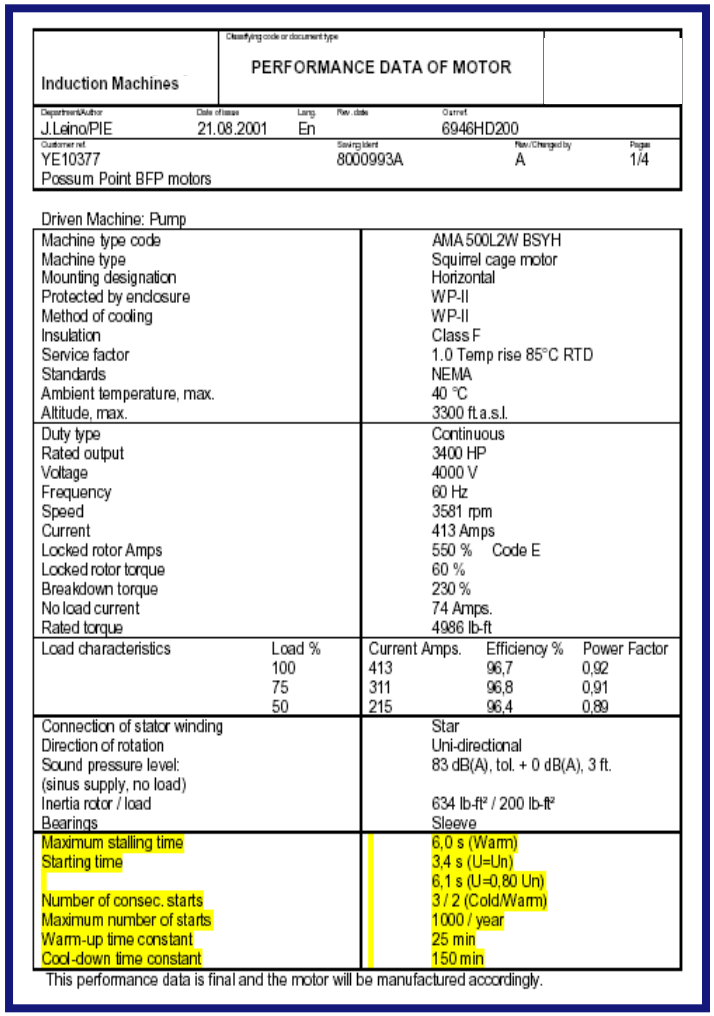
- Setting of the motor protection relay is based on the motor datasheets information and system configuration.
- Datasheets are normally provided by motor manufacturer.
- System configuration data can be obtained from single line diagram.

Motor Data Sheets



Induction Machines

PERFORMANCE DATA OF MOTOR

Department/Author	Date of issue	Lang.	Rev. date	Current
J.Leino/PIE	21.08.2001	En		6946HD200

Customer ref.	Saving label	Rev./Changed by	Pages
YE10377	8000993A	A	1/4

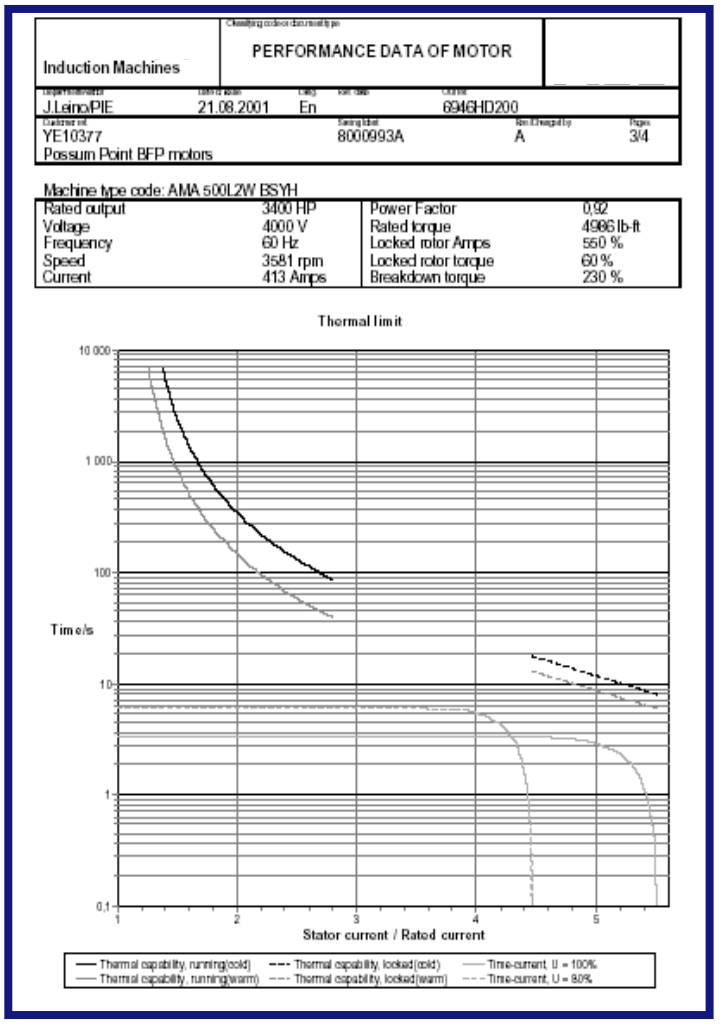
Possum Point BFP motors

Driven Machine: Pump

Machine type code		AMA 500L2W BSYH		
Machine type		Squirrel cage motor		
Mounting designation		Horizontal		
Protected by enclosure		WP-II		
Method of cooling		WP-II		
Insulation		Class F		
Service factor		1.0 Temp rise 85°C RTD		
Standards		NEMA		
Ambient temperature, max.		40 °C		
Altitude, max.		3300 ft.a.s.l.		
Duty type		Continuous		
Rated output		3400 HP		
Voltage		4000 V		
Frequency		60 Hz		
Speed		3581 rpm		
Current		413 Amps		
Locked rotor Amps		550 % Code E		
Locked rotor torque		60 %		
Breakdown torque		230 %		
No load current		74 Amps.		
Rated torque		4986 lb-ft		
Load characteristics	Load %	Current Amps.	Efficiency %	Power Factor
	100	413	96,7	0,92
	75	311	96,8	0,91
	50	215	96,4	0,89
Connection of stator winding		Star		
Direction of rotation		Uni-directional		
Sound pressure level:		83 dB(A), tol. + 0 dB(A), 3 ft.		
(sinus supply, no load)				
Inertia rotor / load		634 lb-ft² / 200 lb-ft²		
Bearings		Sleeve		
Maximum stalling time		6,0 s (Warm)		
Starting time		3,4 s (U=Un)		
		6,1 s (U=0,80 Un)		
Number of consec. starts		3 / 2 (Cold/Warm)		
Maximum number of starts		1000 / year		
Warm-up time constant		25 min		
Cool-down time constant		150 min		

This performance data is final and the motor will be manufactured accordingly.

[Motor Performance Data]



Induction Machines

PERFORMANCE DATA OF MOTOR

Department/Author	Date of issue	Lang.	Rev. date	Current
J.Leino/PIE	21.08.2001	En		6946HD200

Customer ref.	Saving label	Rev./Changed by	Pages
YE10377	8000993A	A	3/4

Possum Point BFP motors

Machine type code: AMA 500L2W BSYH

Rated output	3400 HP	Power Factor	0,92
Voltage	4000 V	Rated torque	4986 lb-ft
Frequency	60 Hz	Locked rotor Amps	550 %
Speed	3581 rpm	Locked rotor torque	60 %
Current	413 Amps	Breakdown torque	230 %

[Thermal Limit Curves]

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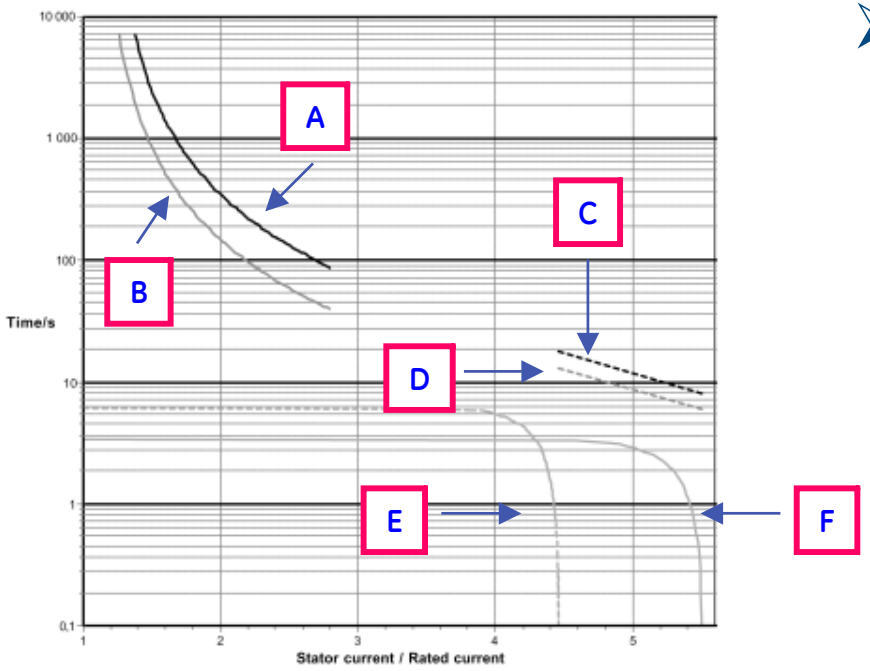
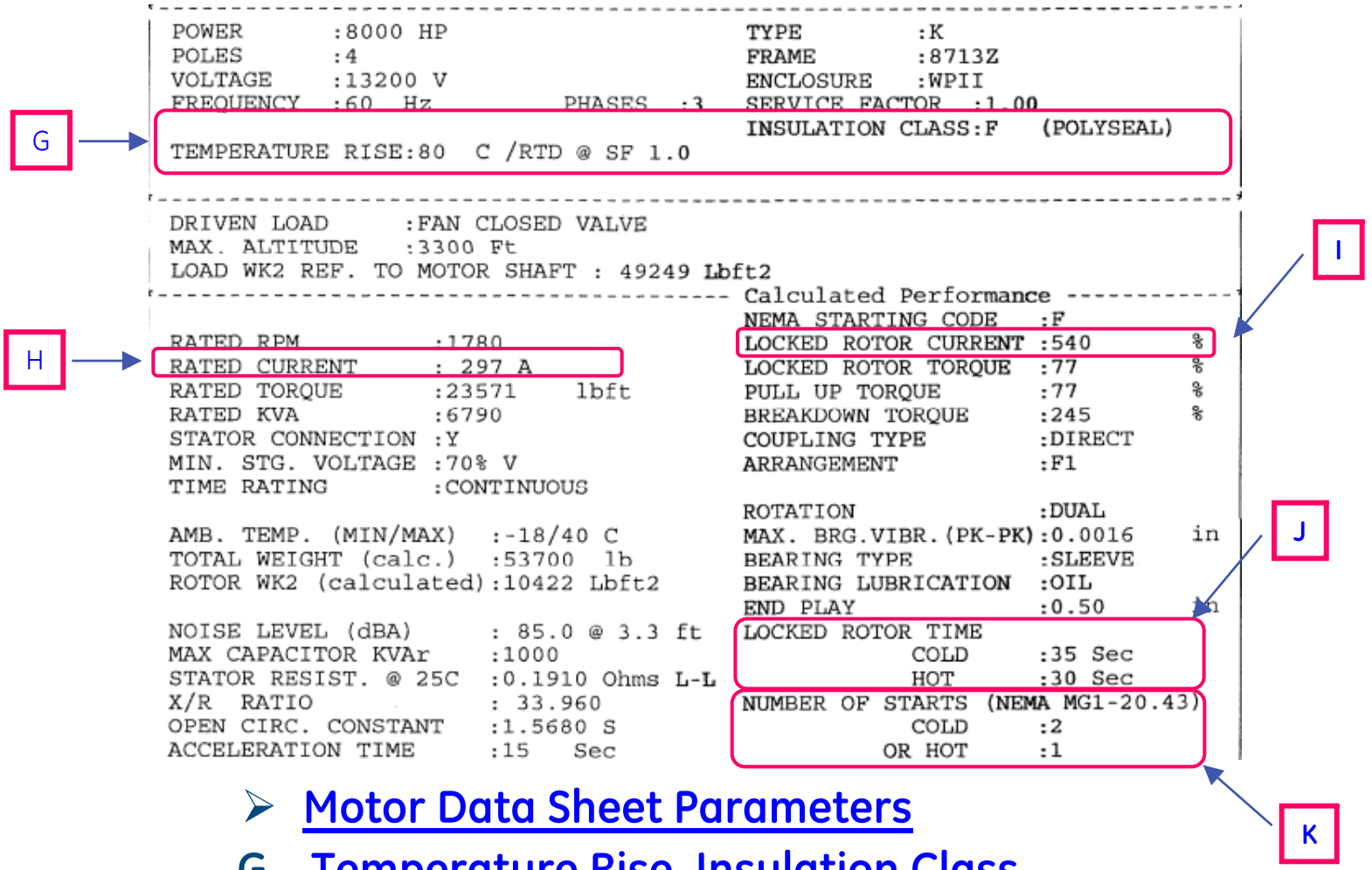
Motor Thermal Limit Curves



- **Thermal Limit Curves:**

  A. Cold Running Overload
  B. Hot Running Overload
  C. Cold Locked Rotor Curve
  D. Hot Locked Rotor Curve
  E. Acceleration curve @ 80% rated voltage
  F. Acceleration curve @100% voltage

Motor Thermal Parameters



```
POWER          :8000 HP                          TYPE          :K
POLES          :4                                FRAME         :8713Z
VOLTAGE        :13200 V                          ENCLOSURE     :WPII
FREQUENCY      :60  Hz          PHASES  :3       SERVICE FACTOR  :1.00
                                                 INSULATION CLASS:F    (POLYSEAL)
TEMPERATURE RISE:80  C /RTD @ SF 1.0

DRIVEN LOAD      :FAN CLOSED VALVE
MAX. ALTITUDE    :3300 Ft
LOAD WK2 REF. TO MOTOR SHAFT : 49249 Lbft2
---------------------------------------- Calculated Performance ------------
                                          NEMA STARTING CODE    :F
RATED RPM            :1780                LOCKED ROTOR CURRENT :540        %
RATED CURRENT        : 297 A              LOCKED ROTOR TORQUE  :77         %
RATED TORQUE         :23571     lbft      PULL UP TORQUE       :77         %
RATED KVA            :6790                BREAKDOWN TORQUE     :245        %
STATOR CONNECTION    :Y                   COUPLING TYPE        :DIRECT
MIN. STG. VOLTAGE    :70% V               ARRANGEMENT          :F1
TIME RATING          :CONTINUOUS
                                          ROTATION             :DUAL
AMB. TEMP. (MIN/MAX)   :-18/40 C         MAX. BRG.VIBR.(PK-PK):0.0016     in
TOTAL WEIGHT (calc.)   :53700  lb        BEARING TYPE         :SLEEVE
ROTOR WK2 (calculated):10422 Lbft2       BEARING LUBRICATION  :OIL
                                          END PLAY             :0.50       in
NOISE LEVEL (dBA)      : 85.0 @ 3.3 ft    LOCKED ROTOR TIME
MAX CAPACITOR KVAr     :1000                        COLD      :35 Sec
STATOR RESIST. @ 25C   :0.1910 Ohms L-L             HOT       :30 Sec
X/R  RATIO             : 33.960          NUMBER OF STARTS (NEMA MG1-20.43)
OPEN CIRC. CONSTANT    :1.5680 S                    COLD      :2
ACCELERATION TIME      :15    Sec                 OR HOT      :1
```

G

H

I

J

K

- Motor Data Sheet Parameters

G. Temperature Rise, Insulation Class

H. Full Load Current

I. Locked Rotor Current

J. Locked Rotor Time; Cold/Hot

K. Number of Starts; Cold/Hot

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Motor Specifications

Information required to set Thermal Model:

- Motor FLA
- Locked Rotor Current
- Locked Rotor Time Hot
- Locked Rotor Time Cold
- Service Factor
- Motor Damage Curves

Settings Example

- CT Rating, Voltage Sensing
- FLA & Ground CT
- Thermal Model Settings
  - Overload Pickup, Overload Curve, Unbalance Bias K Factor, Stopped & Running Cooling Time Constants Hot/Cold Safe Stall Ratio, RTD Bias
- Short Circuit Trip
- Current Unbalance Alarm & Trip
- Ground Fault
- Acceleration Trip
- Start Inhibit
- Starts per hour, Time Between Starts
- RTD Alarm & Trip
- Phase Differential Trip
- Undervoltage, Overvoltage Trip

The following is example of how to determine the relay setpoints for a specific motor that has been applied conservatively. This is only an example for teaching purposes and may not address all issues relating to your specific application. It is recommended that the setpoints for your motor protective relaying application be determined by your local protection engineer.

Settings Example

Select CT Rating, Voltage Sensing

```
POWER        :8000 HP                        TYPE          :K
POLES        :4                              FRAME         :8713Z
VOLTAGE      :13200 V                        ENCLOSURE     :WPII
FREQUENCY    :60  Hz          PHASES  :3     SERVICE FACTOR  :1.00
                                             INSULATION CLASS:F   (POLYSEAL)
TEMPERATURE RISE:80  C /RTD @ SF 1.0

DRIVEN LOAD      :FAN CLOSED VALVE
MAX. ALTITUDE    :3300 Ft
LOAD WK2 REF. TO MOTOR SHAFT : 49249 Lbft2
------------------------------------ Calculated Performance ------------
                                             NEMA STARTING CODE   :F
RATED RPM          :1780                     LOCKED ROTOR CURRENT :540        %
RATED CURRENT      : 297 A                   LOCKED ROTOR TORQUE  :77         %
RATED TORQUE       :23571    lbft            PULL UP TORQUE       :77         %
RATED KVA          :6790                     BREAKDOWN TORQUE     :245        %
STATOR CONNECTION  :Y                        COUPLING TYPE        :DIRECT
MIN. STG. VOLTAGE  :70% V                    ARRANGEMENT          :F1
TIME RATING        :CONTINUOUS
                                             ROTATION             :DUAL
AMB. TEMP. (MIN/MAX)   :-18/40 C             MAX. BRG.VIBR.(PK-PK):0.0016     in
TOTAL WEIGHT (calc.)   :53700  lb            BEARING TYPE         :SLEEVE
ROTOR WK2 (calculated):10422 Lbft2           BEARING LUBRICATION  :OIL
                                             END PLAY             :0.50       in
NOISE LEVEL (dBA)      : 85.0 @ 3.3 ft       LOCKED ROTOR TIME
MAX CAPACITOR KVAr     :1000                       COLD      :35 Sec
STATOR RESIST. @ 25C   :0.1910 Ohms L-L            HOT       :30 Sec
X/R  RATIO             : 33.960              NUMBER OF STARTS (NEMA MG1-20.43)
OPEN CIRC. CONSTANT    :1.5680 S                   COLD      :2
ACCELERATION TIME      :15   Sec                 OR HOT      :1
```

Phase CT

The phase CT should be chosen such that the FLA is 50% to 100% of CT primary. Since the FLA is 297 a 300:5 CT may be chosen.

CT: 50% <FLA <100%

300/5

Voltage Sensing

Enter the connection type and ratio. Enter motor nameplate voltage. In this case, a 14400/120 PT will be used, so 120:1 ratio.

Current Sensing

SETTING	PARAMETER
Phase CT Primary	300 A
Motor Full Load Amps	297 A
Ground CT Type	5 A Secondary
Ground CT Primary	50 A
Phase Differential CT Type	5 A Secondary
Phase Differential CT Primary	300 A
Enable Two Speed Motor Option	Off/No

Voltage Sensing

SETTING	PARAMETER
VoltageTransformer Connection Type	Open Delta
Enable Single VT Connection	Off
Voltage Transformer Ratio	120.00 :1
Motor Nameplate Voltage	13200 V

Settings Example

Select FLA, Ground CT

POWER	:8000 HP	TYPE	:K
POLES	:4	FRAME	:8713Z
VOLTAGE	:13200 V	ENCLOSURE	:WPII
FREQUENCY	:60 Hz PHASES :3	SERVICE FACTOR	:1.00
		INSULATION CLASS	:F (POLYSEAL)
TEMPERATURE RISE	:80 C /RTD @ SF 1.0		
DRIVEN LOAD	:FAN CLOSED VALVE		
MAX. ALTITUDE	:3300 Ft		
LOAD WK2 REF. TO MOTOR SHAFT	: 49249 Lbft2		
		Calculated Performance	
RATED RPM	:1780	NEMA STARTING CODE	:F
RATED CURRENT	: 297 A	LOCKED ROTOR CURRENT	:540 %
RATED TORQUE	:23571 lbft	LOCKED ROTOR TORQUE	:77 %
RATED KVA	:6790	PULL UP TORQUE	:77 %
STATOR CONNECTION	:Y	BREAKDOWN TORQUE	:245 %
MIN. STG. VOLTAGE	:70% V	COUPLING TYPE	:DIRECT
TIME RATING	:CONTINUOUS	ARRANGEMENT	:F1
		ROTATION	:DUAL
AMB. TEMP. (MIN/MAX)	:-18/40 C	MAX. BRG.VIBR.(PK-PK)	:0.0016 in
TOTAL WEIGHT (calc.)	:53700 lb	BEARING TYPE	:SLEEVE
ROTOR WK2 (calculated)	:10422 Lbft2	BEARING LUBRICATION	:OIL
		END PLAY	:0.50 in
NOISE LEVEL (dBA)	: 85.0 @ 3.3 ft	LOCKED ROTOR TIME	
MAX CAPACITOR KVAr	:1000	COLD	:35 Sec
STATOR RESIST. @ 25C	:0.1910 Ohms L-L	HOT	:30 Sec
X/R RATIO	: 33.960	NUMBER OF STARTS (NEMA MG1-20.43)	
OPEN CIRC. CONSTANT	:1.5680 S	COLD	:2
ACCELERATION TIME	:15 Sec	OR HOT	:1

Motor FLA

Set the Motor Full Load Amps to 297A, as specified by the data sheets.

Ground CT

For high resistive grounded systems, sensitive ground detection is possible with the 50:0.025 CT. On solidly grounded or low resistive grounded systems where the fault current is much higher, a 1A or 5A secondary CT should be used. If residual ground fault connection is to be used, the ground fault CT ratio most equal the phase CT ratio. If residual connection is used, pickup levels and timers must be set with respect to the acceleration time. The zero sequence CT chosen needs to be able to handle all potential fault levels without saturating.

Set:

FLA = 297 A

GF = System

Current Sensing

SETTING	PARAMETER
Phase CT Primary	300 A
Motor Full Load Amps	297 A
Ground CT Type	5 A Secondary
Ground CT Primary	50 A
Phase Differential CT Type	5 A Secondary
Phase Differential CT Primary	300 A
Enable Two Speed Motor Option	Off/No

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Settings Example

Thermal Overload Pickup

POWER	:8000 HP	TYPE	:K
POLES	:4	FRAME	:8713Z
VOLTAGE	:13200 V	ENCLOSURE	:WPII
FREQUENCY	:60 Hz PHASES :3	SERVICE FACTOR	:1.00
		INSULATION CLASS:F	(POLYSEAL)

TEMPERATURE RISE:80 C /RTD @ SF 1.0

DRIVEN LOAD :FAN CLOSED VALVE
MAX. ALTITUDE :3300 Ft
LOAD WK2 REF. TO MOTOR SHAFT : 49249 Lbft2

		Calculated Performance		
		NEMA STARTING CODE	:F	
RATED RPM	:1780	LOCKED ROTOR CURRENT	:540	%
RATED CURRENT	: 297 A	LOCKED ROTOR TORQUE	:77	%
RATED TORQUE	:23571 lbft	PULL UP TORQUE	:77	%
RATED KVA	:6790	BREAKDOWN TORQUE	:245	%
STATOR CONNECTION	:Y	COUPLING TYPE	:DIRECT	
MIN. STG. VOLTAGE	:70% V	ARRANGEMENT	:F1	
TIME RATING	:CONTINUOUS			
		ROTATION	:DUAL	
AMB. TEMP. (MIN/MAX)	:-18/40 C	MAX. BRG.VIBR.(PK-PK)	:0.0016	in
TOTAL WEIGHT (calc.)	:53700 lb	BEARING TYPE	:SLEEVE	
ROTOR WK2 (calculated)	:10422 Lbft2	BEARING LUBRICATION	:OIL	
		END PLAY	:0.50	in
NOISE LEVEL (dBA)	: 85.0 @ 3.3 ft	LOCKED ROTOR TIME		
MAX CAPACITOR KVAr	:1000	COLD	:35 Sec	
STATOR RESIST. @ 25C	:0.1910 Ohms L-L	HOT	:30 Sec	
X/R RATIO	: 33.960	NUMBER OF STARTS (NEMA MG1-20.43)		
OPEN CIRC. CONSTANT	:1.5680 S	COLD	:2	
ACCELERATION TIME	:15 Sec	OR HOT	:1	

Overload Pickup

This setting defines the current level at which the motor is considered to be overloaded.

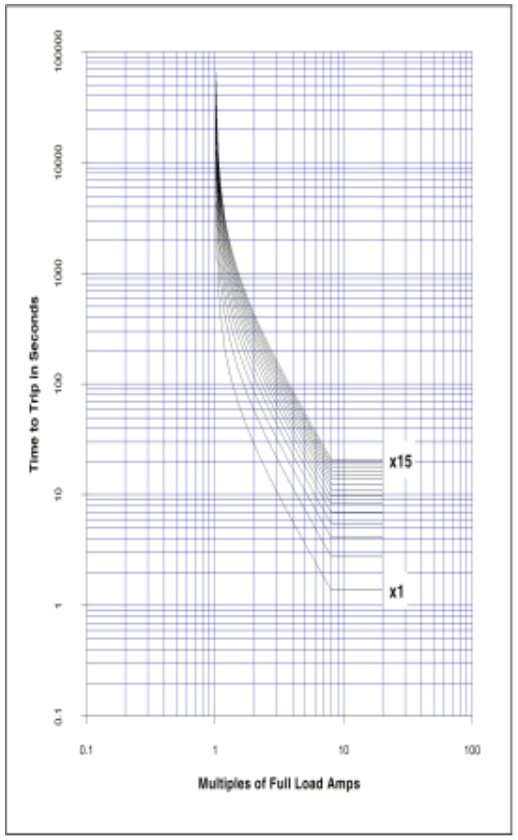
Motor Thermal Overload function can not be disabled.

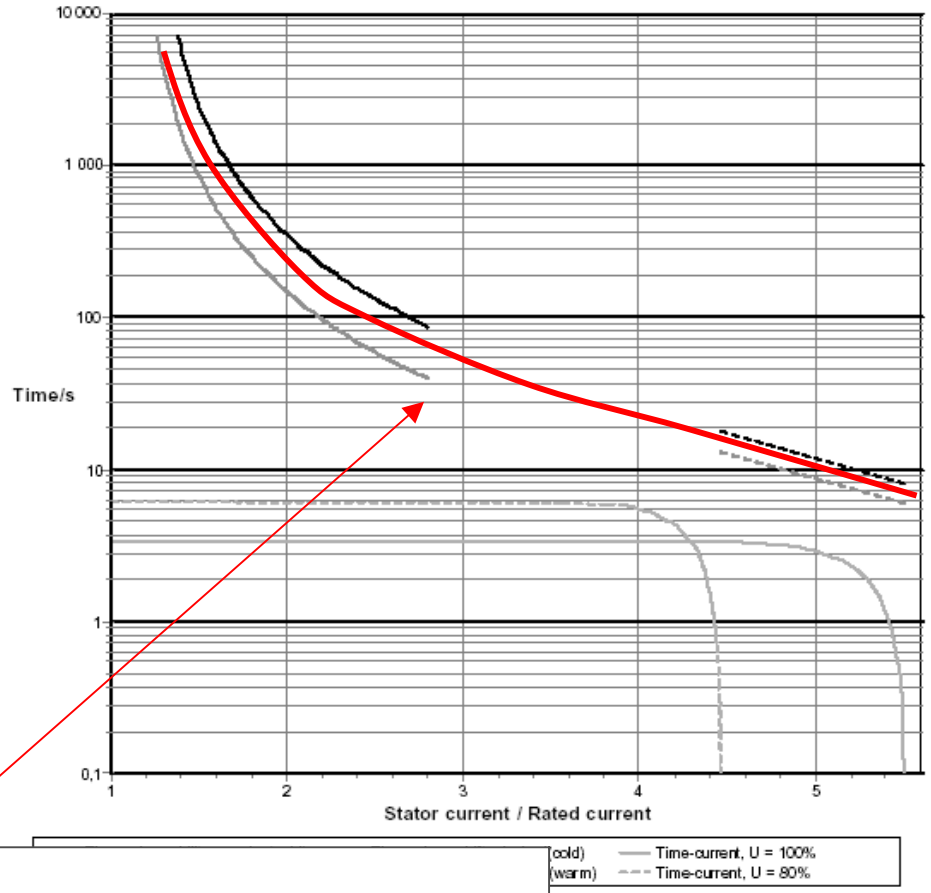
469 Thermal Model

SETTING	PARAMETER
Curve Style	Standard
Overload Pickup Level	1.15 FLA
Unbalance k Factor	8
Cool Time Constant Running	15 min
Cool Time Constant Stopped	30 min
Hot/Cold Safe Stall Ratio	0.86
RTD Biasing	On/Yes
RTD Bias Minimum	40 °C
RTD Bias Center Point	130 °C
RTD Bias Maximum	155 °C
Thermal Capacity Alarm	Latched
Thermal Capacity Alarm Relays	Alarm
Thermal Capacity Alarm Level	75 % used
Thermal Capacity Alarm Events	On/Yes
Overload Trip Relays	Trip

Settings Example

Select Overload Curve for Thermal Model





Overload Curve

Set the overload curve below cold thermal limit and above hot thermal limit. If only hot curve is provided by mfgr, then must set at or below hot thermal limit

The best fitting curve is curve # 9 in this example.

Overload Curve

SETTING	PARAMETER
Standard Overload Curve Number	9

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Settings Example

Determine Unbalance Bias K Factor for Thermal Model

```
POWER       :8000 HP                        TYPE          :K
POLES       :4                              FRAME         :8713Z
VOLTAGE     :13200 V                        ENCLOSURE     :WPII
FREQUENCY   :60  Hz          PHASES  :3     SERVICE FACTOR  :1.00
                                            INSULATION CLASS:F   (POLYSEAL)
TEMPERATURE RISE:80  C /RTD @ SF 1.0

DRIVEN LOAD      :FAN CLOSED VALVE
MAX. ALTITUDE    :3300 Ft
LOAD WK2 REF. TO MOTOR SHAFT : 49249 Lbft2
---------------------------------- Calculated Performance ------------
                                            NEMA STARTING CODE   :F
RATED RPM           :1780                   LOCKED ROTOR CURRENT :540        %
RATED CURRENT       : 297 A                 LOCKED ROTOR TORQUE  :77         %
RATED TORQUE        :23571     lbft         PULL UP TORQUE       :77         %
RATED KVA           :6790                   BREAKDOWN TORQUE     :245        %
STATOR CONNECTION   :Y                      COUPLING TYPE        :DIRECT
MIN. STG. VOLTAGE   :70% V                  ARRANGEMENT          :F1
TIME RATING         :CONTINUOUS
                                            ROTATION             :DUAL
AMB. TEMP. (MIN/MAX)   :-18/40 C            MAX. BRG.VIBR.(PK-PK):0.0016     in
TOTAL WEIGHT (calc.)   :53700  lb           BEARING TYPE         :SLEEVE
ROTOR WK2 (calculated):10422 Lbft2          BEARING LUBRICATION  :OIL
                                            END PLAY             :0.50       in
NOISE LEVEL (dBA)      : 85.0 @ 3.3 ft      LOCKED ROTOR TIME
MAX CAPACITOR KVAr     :1000                        COLD         :35 Sec
STATOR RESIST. @ 25C   :0.1910 Ohms L-L             HOT          :30 Sec
X/R  RATIO             : 33.960             NUMBER OF STARTS (NEMA MG1-20.43)
OPEN CIRC. CONSTANT    :1.5680 S                    COLD         :2
ACCELERATION TIME      :15   Sec                 OR HOT         :1
```

Unbalance Bias Of Thermal Capacity

Enable the Unbalance Bias of Thermal Capacity so that the heating effect of unbalance currents is added to the Thermal Capacity Used.

469 Thermal Model

SETTING	PARAMETER
Curve Style	Standard
Overload Pickup Level	1.15 FLA
Unbalance k Factor	8
Cool Time Constant Running	15 min
Cool Time Constant Stopped	30 min
Hot/Cold Safe Stall Ratio	0.86
RTD Biasing	On/Yes
RTD Bias Minimum	40 °C
RTD Bias Center Point	130 °C
RTD Bias Maximum	155 °C
Thermal Capacity Alarm	Latched
Thermal Capacity Alarm Relays	Alarm
Thermal Capacity Alarm Level	75 % used
Thermal Capacity Alarm Events	On/Yes
Overload Trip Relays	Trip

$K=175/LRA^2 = 175/5.4^2 = 6$

(Typical)

$K=230/LRA^2 = 230/5.4^2 = 8$

(Conservative)

Settings Example

Stopped & Running Cool Time Constants

```
POWER       :8000 HP                        TYPE         :K
POLES       :4                              FRAME        :8713Z
VOLTAGE     :13200 V                        ENCLOSURE    :WPII
FREQUENCY   :60  Hz          PHASES  :3     SERVICE FACTOR  :1.00
                                            INSULATION CLASS:F   (POLYSEAL)
TEMPERATURE RISE:80  C /RTD @ SF 1.0

DRIVEN LOAD      :FAN CLOSED VALVE
MAX. ALTITUDE    :3300 Ft
LOAD WK2 REF. TO MOTOR SHAFT : 49249 Lbft2
---------------------------------------- Calculated Performance ------------
                                            NEMA STARTING CODE   :F
RATED RPM          :1780                    LOCKED ROTOR CURRENT :540        %
RATED CURRENT      : 297 A                  LOCKED ROTOR TORQUE  :77         %
RATED TORQUE       :23571    lbft           PULL UP TORQUE       :77         %
RATED KVA          :6790                    BREAKDOWN TORQUE     :245        %
STATOR CONNECTION  :Y                       COUPLING TYPE        :DIRECT
MIN. STG. VOLTAGE  :70% V                   ARRANGEMENT          :F1
TIME RATING        :CONTINUOUS
                                            ROTATION             :DUAL
AMB. TEMP. (MIN/MAX)   :-18/40 C            MAX. BRG.VIBR.(PK-PK):0.0016     in
TOTAL WEIGHT (calc.)   :53700  lb           BEARING TYPE         :SLEEVE
ROTOR WK2 (calculated):10422 Lbft2          BEARING LUBRICATION  :OIL
                                            END PLAY             :0.50       in
NOISE LEVEL (dBA)      : 85.0 @ 3.3 ft      LOCKED ROTOR TIME
MAX CAPACITOR KVAr     :1000                        COLD      :35 Sec
STATOR RESIST. @ 25C   :0.1910 Ohms L-L             HOT       :30 Sec
X/R  RATIO             : 33.960             NUMBER OF STARTS (NEMA MG1-20.43)
OPEN CIRC. CONSTANT    :1.5680 S                    COLD      :2
ACCELERATION TIME      :15   Sec                 OR HOT      :1
```

469 Thermal Model

SETTING	PARAMETER
Curve Style	Standard
Overload Pickup Level	1.15 FLA
Unbalance k Factor	8
Cool Time Constant Running	15 min
Cool Time Constant Stopped	30 min
Hot/Cold Safe Stall Ratio	0.86
RTD Biasing	On/Yes
RTD Bias Minimum	40 °C
RTD Bias Center Point	130 °C
RTD Bias Maximum	155 °C
Thermal Capacity Alarm	Latched
Thermal Capacity Alarm Relays	Alarm
Thermal Capacity Alarm Level	75 % used
Thermal Capacity Alarm Events	On/Yes
Overload Trip Relays	Trip

Stopped and Running Cool Time Constants

This information is usually supplied by the motor manufacturer but is not part of the data that was given with this motor. If RTD's are present and will be wired to the relay biasing of the thermal model will be used so it is not critical to have these cooling times from the manufacturer: the default values of 15 and 30 minutes can be used for the running and stopped cool times respectively.

Settings Example

Determine Hot/Cold Safe Stall Ratio for Thermal Model (method 1)

```
POWER       :8000 HP                        TYPE          :K
POLES       :4                              FRAME         :8713Z
VOLTAGE     :13200 V                        ENCLOSURE     :WPII
FREQUENCY   :60  Hz          PHASES  :3     SERVICE FACTOR  :1.00
                                            INSULATION CLASS:F   (POLYSEAL)
TEMPERATURE RISE:80  C /RTD @ SF 1.0

DRIVEN LOAD      :FAN CLOSED VALVE
MAX. ALTITUDE    :3300 Ft
LOAD WK2 REF. TO MOTOR SHAFT : 49249 Lbft2
---------------------------------------- Calculated Performance ------------
                                            NEMA STARTING CODE   :F
RATED RPM           :1780                   LOCKED ROTOR CURRENT :540        %
RATED CURRENT       : 297 A                 LOCKED ROTOR TORQUE  :77         %
RATED TORQUE        :23571     lbft         PULL UP TORQUE       :77         %
RATED KVA           :6790                   BREAKDOWN TORQUE     :245        %
STATOR CONNECTION   :Y                      COUPLING TYPE        :DIRECT
MIN. STG. VOLTAGE   :70% V                  ARRANGEMENT          :F1
TIME RATING         :CONTINUOUS
                                            ROTATION             :DUAL
AMB. TEMP. (MIN/MAX)   :-18/40 C            MAX. BRG.VIBR.(PK-PK):0.0016     in
TOTAL WEIGHT (calc.)   :53700  lb           BEARING TYPE         :SLEEVE
ROTOR WK2 (calculated):10422 Lbft2          BEARING LUBRICATION  :OIL
                                            END PLAY             :0.50       in
NOISE LEVEL (dBA)      : 85.0 @ 3.3 ft      LOCKED ROTOR TIME
MAX CAPACITOR KVAr     :1000                        COLD      :35 Sec
STATOR RESIST. @ 25C   :0.1910 Ohms L-L             HOT       :30 Sec
X/R  RATIO             : 33.960             NUMBER OF STARTS (NEMA MG1-20.43)
OPEN CIRC. CONSTANT    :1.5680 S                    COLD      :2
ACCELERATION TIME      :15   Sec                 OR HOT      :1
```

$$HCR = \frac{LRT_{HOT}}{LRT_{COLD}}$$

Hot/Cold Ratio = 30/35

=> 0.86

469 Thermal Model

SETTING	PARAMETER
Curve Style	Standard
Overload Pickup Level	1.15 FLA
Unbalance k Factor	8
Cool Time Constant Running	15 min
Cool Time Constant Stopped	30 min
Hot/Cold Safe Stall Ratio	0.86
RTD Biasing	On/Yes
RTD Bias Minimum	40 °C
RTD Bias Center Point	130 °C
RTD Bias Maximum	155 °C
Thermal Capacity Alarm	Latched
Thermal Capacity Alarm Relays	Alarm
Thermal Capacity Alarm Level	75 % used
Thermal Capacity Alarm Events	On/Yes
Overload Trip Relays	Trip

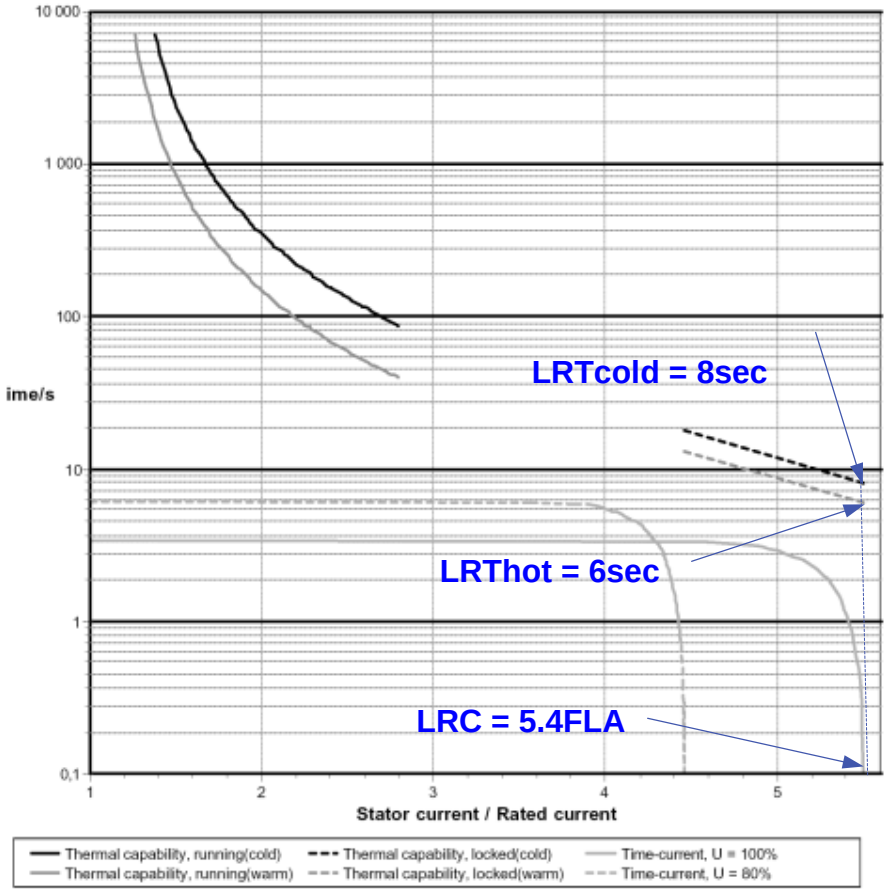
Hot/Cold Curve Ratio

The hot/cold curve ratio is calculated by simply dividing the hot safe stall time by the cold safe stall time or use the motor thermal limits curve. For this example, both are available. Using the data sheets the Hot/Cold Curve Ratio equals 30 / 35 = 0.86

Settings Example

Determine Hot/Cold Safe Stall Ratio for Thermal Model (method 2)

Overload Curve Method



Hot/Cold Curve Ratio

If the thermal limits curves are being used to determine the HOT/COLD ratio proceed as follows:

- From the thermal limits curves run a line perpendicular to the current axis that intersects the hot and cold curves at the stall point
- Draw lines from each points of intersection to the time axis.
- Record the corresponding times. In this case, 6 and 8 seconds respectively.
- The Hot/cold ratio can now be calculated as follows: = 6s/8s = 0.75

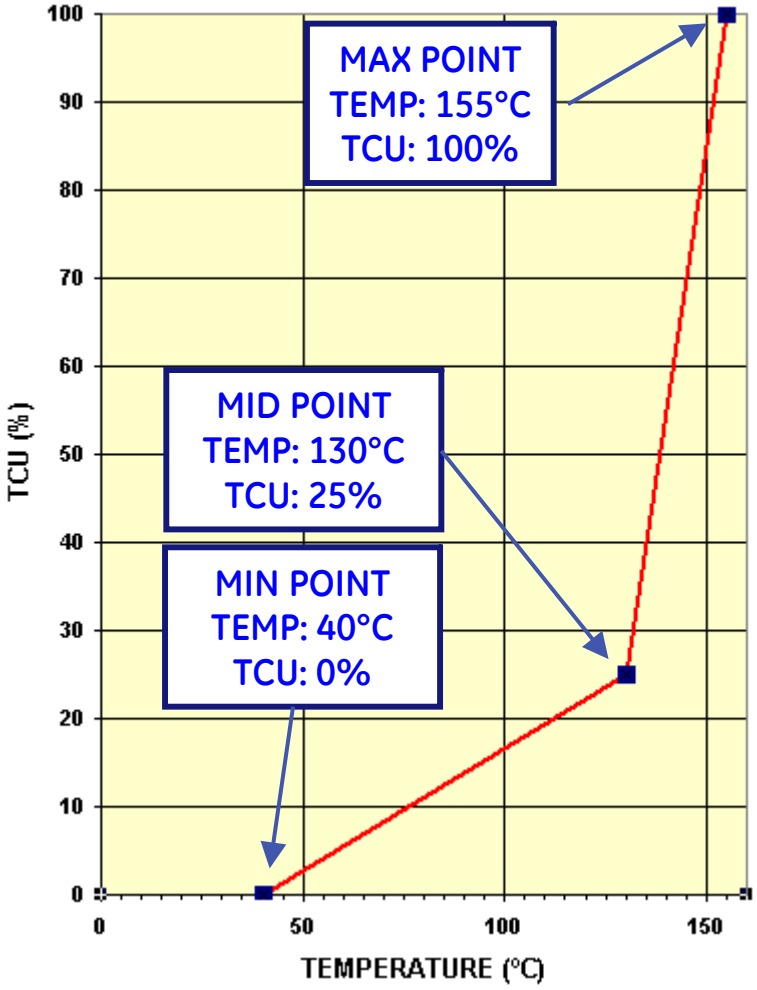
NOTE:

- If hot and cold times are not provided and only one curve is given verify with the manufacturer that it is the hot curve (which is the worst case), then the Hot/ Cold ratio should be set to 1.0

imagination at work

Settings Example

Determine RTD Bias Setpoints for Thermal Model



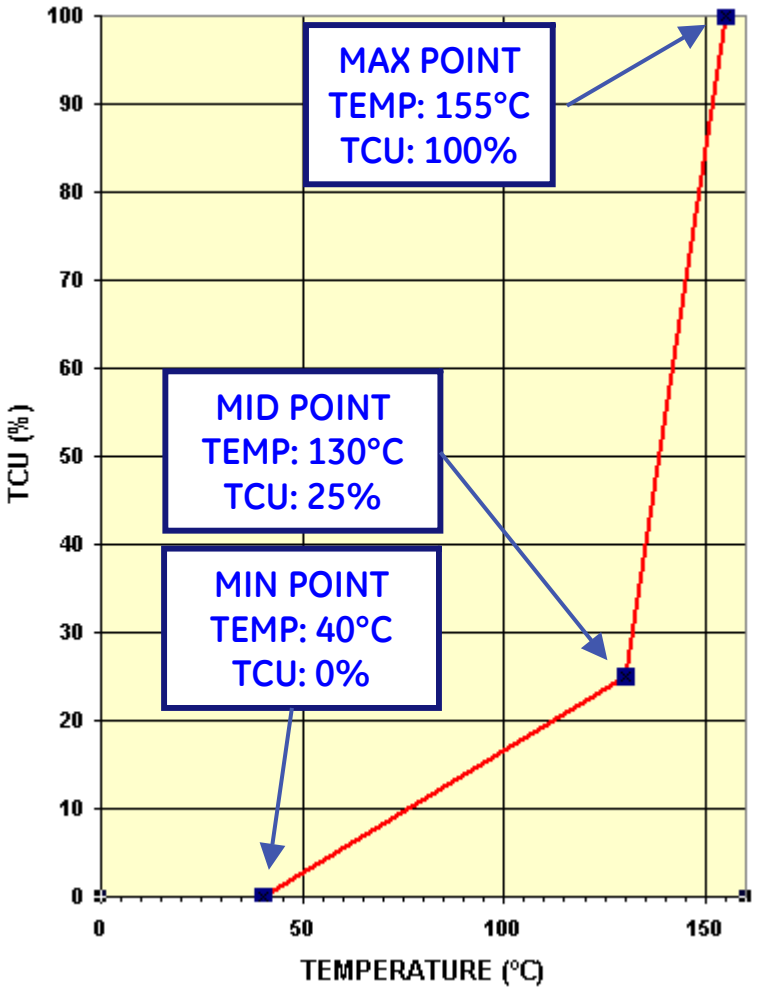

```
POWER       :8000 HP                        TYPE          :K
POLES       :4                              FRAME         :8713Z
VOLTAGE     :13200 V                        ENCLOSURE     :WPII
FREQUENCY   :60  Hz          PHASES  :3     SERVICE FACTOR :1.00
                                            INSULATION CLASS:F    (POLYSEAL)
TEMPERATURE RISE:80  C /RTD @ SF 1.0

DRIVEN LOAD      :FAN CLOSED VALVE
MAX. ALTITUDE    :3300 Ft
LOAD WK2 REF. TO MOTOR SHAFT : 49249 Lbft2
------------------------------------ Calculated Performance ------------
                                            NEMA STARTING CODE   :F
RATED RPM          :1780                    LOCKED ROTOR CURRENT :540        %
RATED CURRENT      : 297 A                  LOCKED ROTOR TORQUE  :77         %
RATED TORQUE       :23571    lbft           PULL UP TORQUE       :77         %
RATED KVA          :6790                    BREAKDOWN TORQUE     :245        %
STATOR CONNECTION  :Y                       COUPLING TYPE        :DIRECT
MIN. STG. VOLTAGE  :70% V                   ARRANGEMENT          :F1
TIME RATING        :CONTINUOUS
                                            ROTATION             :DUAL
AMB. TEMP. (MIN/MAX)   :-18/40 C            MAX. BRG.VIBR.(PK-PK):0.0016     in
TOTAL WEIGHT (calc.)   :53700  lb           BEARING TYPE         :SLEEVE
ROTOR WK2 (calculated):10422 Lbft2          BEARING LUBRICATION  :OIL
                                            END PLAY             :0.50       in
NOISE LEVEL (dBA)      : 85.0 @ 3.3 ft      LOCKED ROTOR TIME
MAX CAPACITOR KVAr     :1000                          COLD      :35 Sec
STATOR RESIST. @ 25C   :0.1910 Ohms L-L               HOT       :30 Sec
X/R  RATIO             : 33.960             NUMBER OF STARTS (NEMA MG1-20.43)
OPEN CIRC. CONSTANT    :1.5680 S                      COLD      :2
ACCELERATION TIME      :15   Sec                   OR HOT      :1
```

Enable RTD Biasing

This will enable the temperature from the Stator RTD sensors, to be included in the calculations of Thermal Capacity. RTD bias model determines the Thermal Capacity Used based on the temperature of the Stator and is separate from the overload model for calculating Thermal Capacity Used. RTD biasing is a back up protection element which accounts for such things as loss of cooling or unusually high ambient temperature. This measured temperature is used to bias or modify the thermal capacity value stored in the motor relay.

Settings Example

Determine RTD Bias Setpoints for Thermal Model



- Motor relay will use the calculated thermal capacity unless the RTD thermal capacity is higher.
- This feature will not trip the motor at the max point temp unless the average current is greater than the overload pickup setting

RTD Bias Function

Set to Enabled/YES

RTD Bias Minimum

Set to 40 ° C which is the ambient temperature obtained from the data sheets.

RTD Bias Center Point

The center point temperature is set to the motor's hot running temperature and is calculated as follows:

Temperature Rise of Stator + Ambient Temperature.

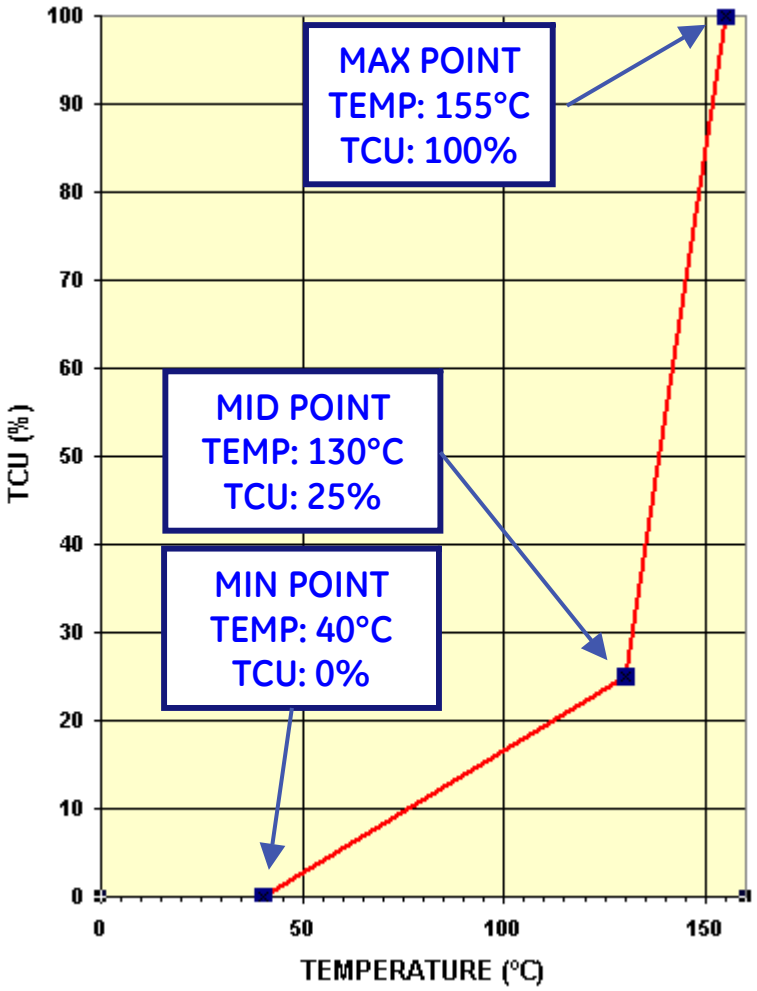
The temperature rise of the stator is 80 ° C + 10% hot spot allowance, obtained from the data sheets.
Therefore, the RTD Center point temperature is set to 90^0C + 40^0C or 130 ° C.

RTD Bias Maximum

This setpoint is set to the rating of the insulation or slightly less. A class F insulation is used in this motor which is rated at 155 ° C, so setting should be 155 ° C.

Settings Example

Determine RTD Bias Setpoints for Thermal Model



469 Thermal Model

SETTING	PARAMETER
Curve Style	Standard
Overload Pickup Level	1.15 FLA
Unbalance k Factor	8
Cool Time Constant Running	15 min
Cool Time Constant Stopped	30 min
Hot/Cold Safe Stall Ratio	0.86
RTD Biasing	On/Yes
RTD Bias Minimum	40 °C
RTD Bias Center Point	130 °C
RTD Bias Maximum	155 °C
Thermal Capacity Alarm	Latched
Thermal Capacity Alarm Relays	Alarm
Thermal Capacity Alarm Level	75 % used
Thermal Capacity Alarm Events	On/Yes
Overload Trip Relays	Trip

Settings Example

Determine Short Circuit Trip Settings

Short Circuit Trip

The short circuit trip should be set above the maximum locked rotor current but below the short circuit current of the fuses. The data sheets indicate a maximum locked rotor current of 540% FLA or 5.4 x FLA. A setting of 6 x FLA with a instantaneous time delay will be ideal but nuisance tripping may result due to the asymmetrical starting currents and DC offset. If asymmetrical starting currents limits the starting capability, set the S/C level higher to a maximum of 9.2 x FLA to override this condition (1.7 x 5.4 = 9.2 where 1.7 is the maximum DC offset for an asymmetrical current). With 300:5 CT, 9.2 x FLA = 9.2 x 297/300 = 9.10 CT

Short Circuit Trip

SETTING	PARAMETER
Short Circuit Trip	Latched
Overreach Filter	Off/No
Short Circuit Trip Relays	Trip
Short Circuit Trip Pickup	9.1 CT
Intentional Short Circuit Trip Delay	0 ms
Short Circuit Trip Backup	Off/No

Current Sensing

SETTING	PARAMETER
Phase CT Primary	300 A
Motor Full Load Amps	297 A
Ground CT Type	5 A Secondary
Ground CT Primary	50 A
Phase Differential CT Type	5 A Secondary
Phase Differential CT Primary	300 A
Enable Two Speed Motor Option	Off/No

Settings Example

Determine Current Unbalance Alarm/Trip Settings

Unbalance Alarm and Trip

The unbalance settings are determined by examining the motor application and motor design. The heating effect of unbalance will be protected by enabling unbalance input to thermal memory; described previously.

A setting of 10-15% x FLA for the Unbalance Alarm with a delay of 5-10 seconds would be appropriate.

Trip can be set to 20-25% x FLA with a delay of 2-5 seconds.

Current Unbalance

SETTING	PARAMETER
Current Unbalance Alarm	Unlatched
Current Unbalance Alarm Relays	Alarm
Current Unbalance Alarm Pickup	15 %
Current Unbalance Alarm Delay	6 s
Current Unbalance Alarm Events	On/Yes
Current Unbalance Trip	Latched
Current Unbalance Trip Relays	Trip
Current Unbalance Trip Pickup	20 %
Current Unbalance Trip Delay	2 s

Settings Example

Ground Fault & Acceleration Trip Settings

Ground Fault

Limit the ground fault current to less than 7.5 to 10amps.

In this example, use 0.15 x CT or 0.15 x 50 = 7.5A

Acceleration Trip

This setpoint should be set higher than the maximum starting time to avoid nuisance tripping when the voltage is lower or for varying loads during acceleration. A value greater than 15 seconds should be entered (based on motor data sheet).

Ground Fault

SETTING	PARAMETER
Ground Fault Alarm	Unlatched
Ground Fault Alarm Relays	Alarm
Ground Fault Alarm Pickup	0.10 CT
Intentional GF Alarm Delay	200 ms
Ground Fault Alarm Events	On/Yes
Ground Fault Trip	Latched
Ground Fault Trip Relays	Trip
Ground Fault Trip Pickup	0.15 CT
Intentional GF Trip Delay	0 ms
Ground Fault Trip Backup	Off/No
Ground Fault Overreach Filter	Off/No

Current Sensing

SETTING	PARAMETER
Phase CT Primary	300 A
Motor Full Load Amps	297 A
Ground CT Type	5 A Secondary
Ground CT Primary	50 A
Phase Differential CT Type	5 A Secondary
Phase Differential CT Primary	300 A
Enable Two Speed Motor Option	Off/No

Acceleration Timer

SETTING	PARAMETER
Accleration Timer Trip	Latched
Acceleration Timer Trip Relays	Trip
Acceleration Timer from Start	20.0 s

Settings Example

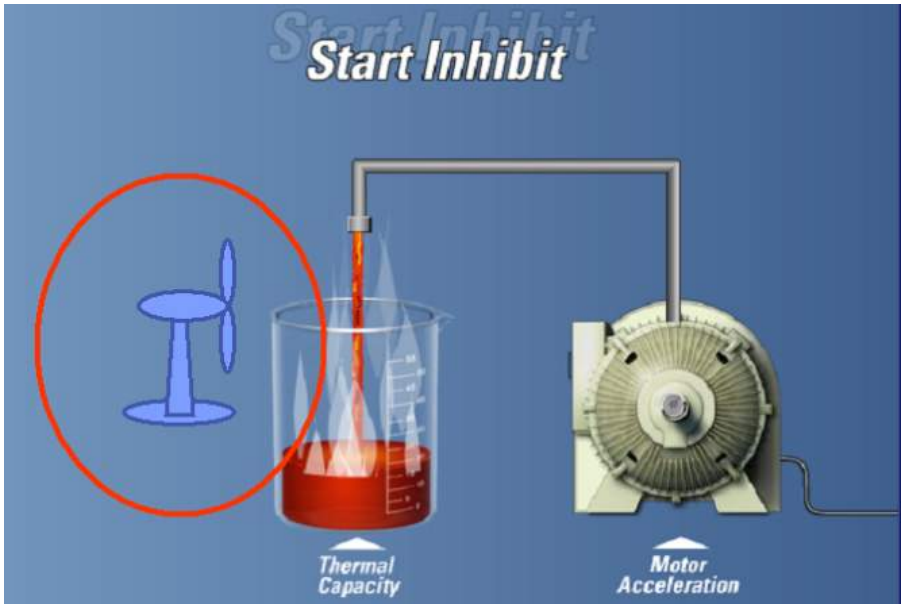
Enable Start Inhibit

Enable Start Inhibit

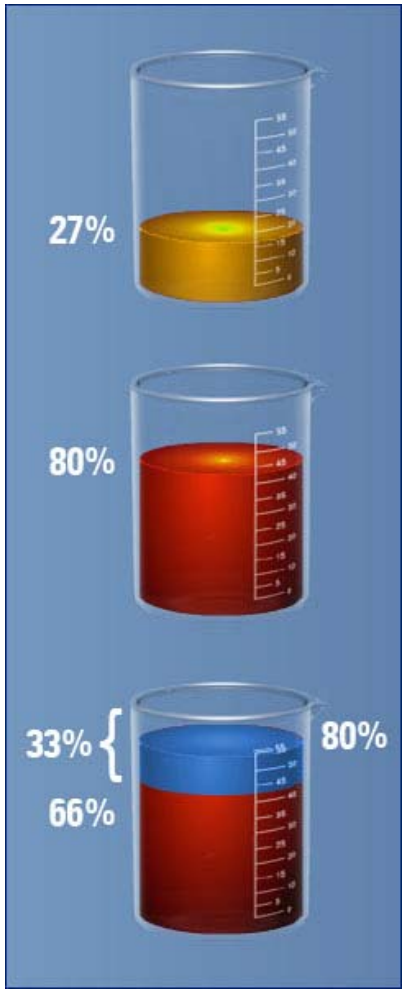
This function will limit starts when the motor is already hot. The motor relay learns the amount of thermal capacity used at start. If the motor is hot, thus having some thermal capacity used, the relay will not allow a start if the available thermal capacity is less than the required thermal capacity for a start.

If Start Inhibit is not used, must wait until Thermal Capacity Used (TCU) falls below 15% before the motor can be re-started.

Using Start Inhibit allows one to start a hot motor sooner.



TCU / Start Inhibit Example



Thermal Capacity required to start

For example, if the THERMAL CAPACITY USED for the last 5 starts is 24, 23, 27, 25, and 21% respectively, the LEARNED STARTING CAPACITY is 27% × 1.25 = 33.75% used.

Thermal Capacity used due to Overload

If the motor had been running in an overload condition prior to stopping, the thermal capacity would be some value; say 80%.

If Motor is Stopped:

When the motor has cooled and the level of thermal capacity used has fallen to 66%, a start will be permitted.

Start Inhibit

SETTING	PARAMETER
Start Inhibit Block	On/Yes
Thermal Capacity Used Margin	25 %

Settings Example

Starts/Hr, Time Between Starts

Starts/Hour

Starts/Hour can be set to the # of cold starts as per the data sheet.
For this example, it is 2

Time Between Starts

In some cases, the motor manufacturer will specify the time between motor starts. In this example, this information is not given so this feature can be disabled or set at a typical 20 min between starts.

Jogging Block

SETTING	PARAMETER
Jogging Block	On/Yes
Maximum Starts/Hour Permissible	2
Time Between Starts	20 min

Settings Example

RTD Alarm & Tripping

Stator RTDs

RTD trip level should be set at or below the maximum temperature rating of the insulation. For example, a motor with class F insulation that has a temperature rating of 155°C could have the Stator RTD Trip level be set between 140°C to 145°C, with 145° C being the maximum (155°C - 10°C hot spot). The RTD alarm level should be set to a level to provide a warning that the motor temperature is rising.

Bearing RTDs

The Bearing RTD alarm and trip settings will be determined by evaluating the temperature specification from the bearing manufacturer.

RTD #1

SETTING	PARAMETER
RTD #1 Application	Stator
RTD #1 Name	ST Ph A1
RTD #1 Alarm	Unlatched
RTD #1 Alarm Relays	Alarm
RTD #1 Alarm Temperature	130 °C
RTD #1 Alarm Events	On/Yes
RTD #1 Trip	Latched
RTD #1 Trip Voting	RTD #4
RTD #1 Trip Relays	Trip
RTD #1 Trip Temperature	145 °C
RTD #1 Hi Alarm	Off

Settings Example

Phase Differential

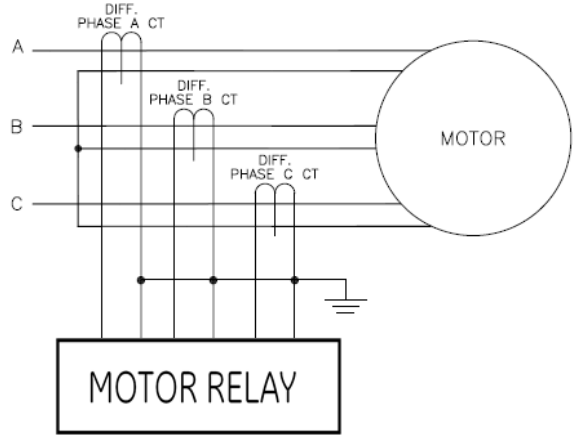
Core Balance Method

Phase Differential

SETTING	PARAMETER
Phase Differential Trip	Latched
Phase Differential Trip Relays	Trip
Differential Trip Pickup While Starting	0.10 CT
Differential Trip Delay While Starting	0 ms
Differential Trip Pickup While Running	0.10 CT
Differential Trip Delay While Running	0 ms

Current Sensing

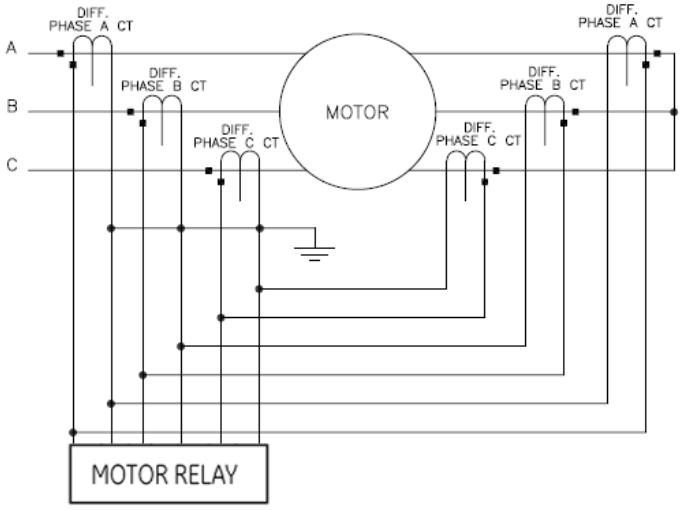
SETTING	PARAMETER
Phase CT Primary	300 A
Motor Full Load Amps	297 A
Ground CT Type	5 A Secondary
Ground CT Primary	50 A
Phase Differential CT Type	5 A Secondary
Phase Differential CT Primary	300 A
Enable Two Speed Motor Option	Off/No



Summation/Residual Method

Phase Differential

SETTING	PARAMETER
Phase Differential Trip	Latched
Phase Differential Trip Relays	Trip
Differential Trip Pickup While Starting	0.25 CT
Differential Trip Delay While Starting	200 ms
Differential Trip Pickup While Running	0.10 CT
Differential Trip Delay While Running	0 ms



To prevent nuisance tripping in this configuration, the differential level may have to be set less sensitive, and the differential time delay may have to be extended to ride through the CT differences during motor starting.

Settings Example

Undervoltage & Overvoltage Tripping

- The overall result of an under or overvoltage condition is an increase in current and motor heating and a reduction in overall motor performance.
- The undervoltage trip should be set to 80-90% of nameplate unless otherwise stated on the data sheets. Motors that are connected to the same source, may experience a temporary undervoltage when one of motors starts. To override these temporary sags, a time delay setpoint should be set.
- The overvoltage element should be set to 110% of the motors nameplate unless otherwise started in the data sheets.

Undervoltage

SETTING	PARAMETER
Undervoltage Active Only If Bus Energized	Off/No
Undervoltage Alarm	Off
Undervoltage Trip	Latched
Undervoltage Trip Relays	Trip
Undervoltage Trip Pickup	0.90 Rated
Starting Undervoltage Trip Pickup	OFF
Undervoltage Trip Delay	3.0 s

Overvoltage

SETTING	PARAMETER
Overvoltage Alarm	Off
Overvoltage Trip	Latched
Overvoltage Trip Relays	Trip
Overvoltage Trip Pickup	1.10 Rated
Overvoltage Trip Delay	3.0 s

Thanks for the time