Documentation Update

NOTICE **Please Note that the following content of the manual, highlighted in red, has changed within the MotorStart chapter compared to the provided manual on this CD.**

MStart - Motor Starting and Control [48,66]

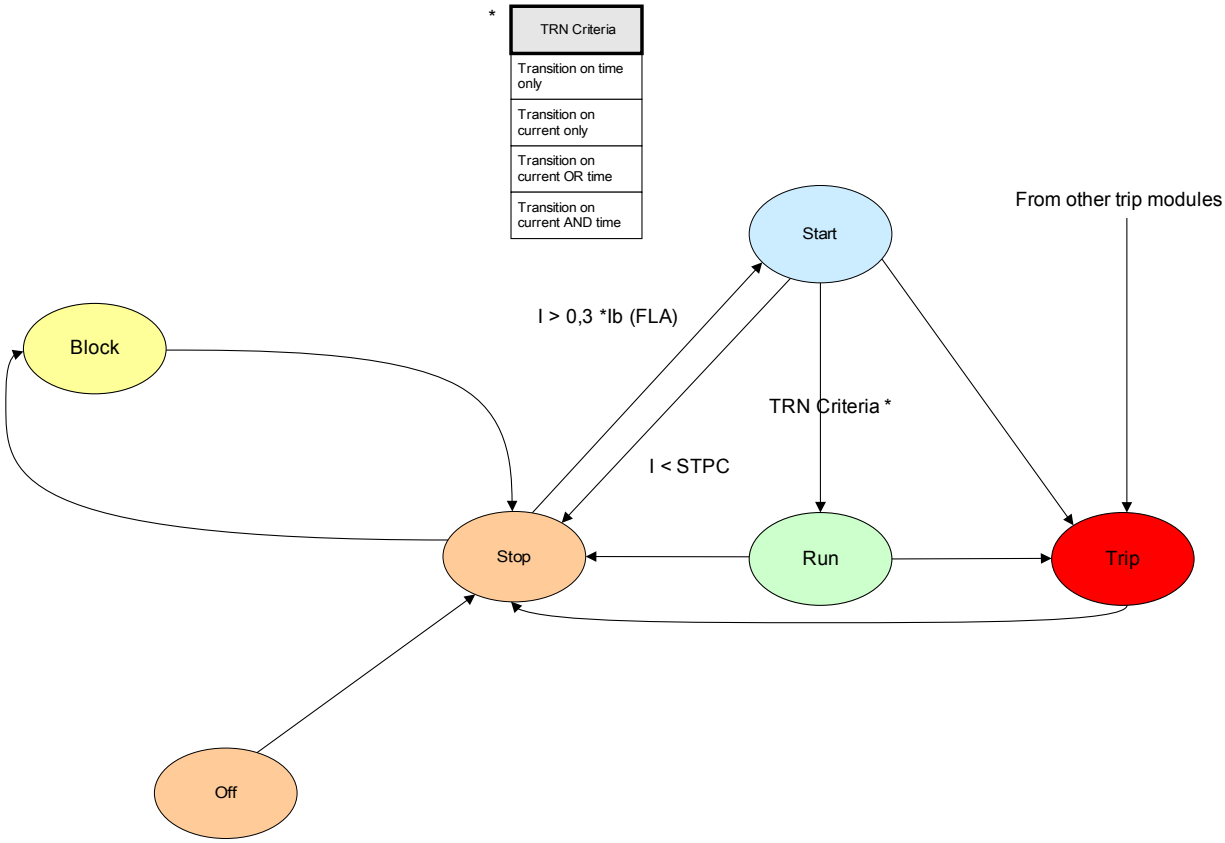
General – Principle Use

The motor start control logic is the core control and protective function for a motor protection device. The logic comprises:

- Motor Operation States,
- Motor Start Control
- Motor Start Blockings
- Motor Start / Transition Trips
- Motor Cold Warm Detection
- Emergency Override.

Motor Operation States

Motor Operation States



The basic motor operation states can be classified as four states that include:

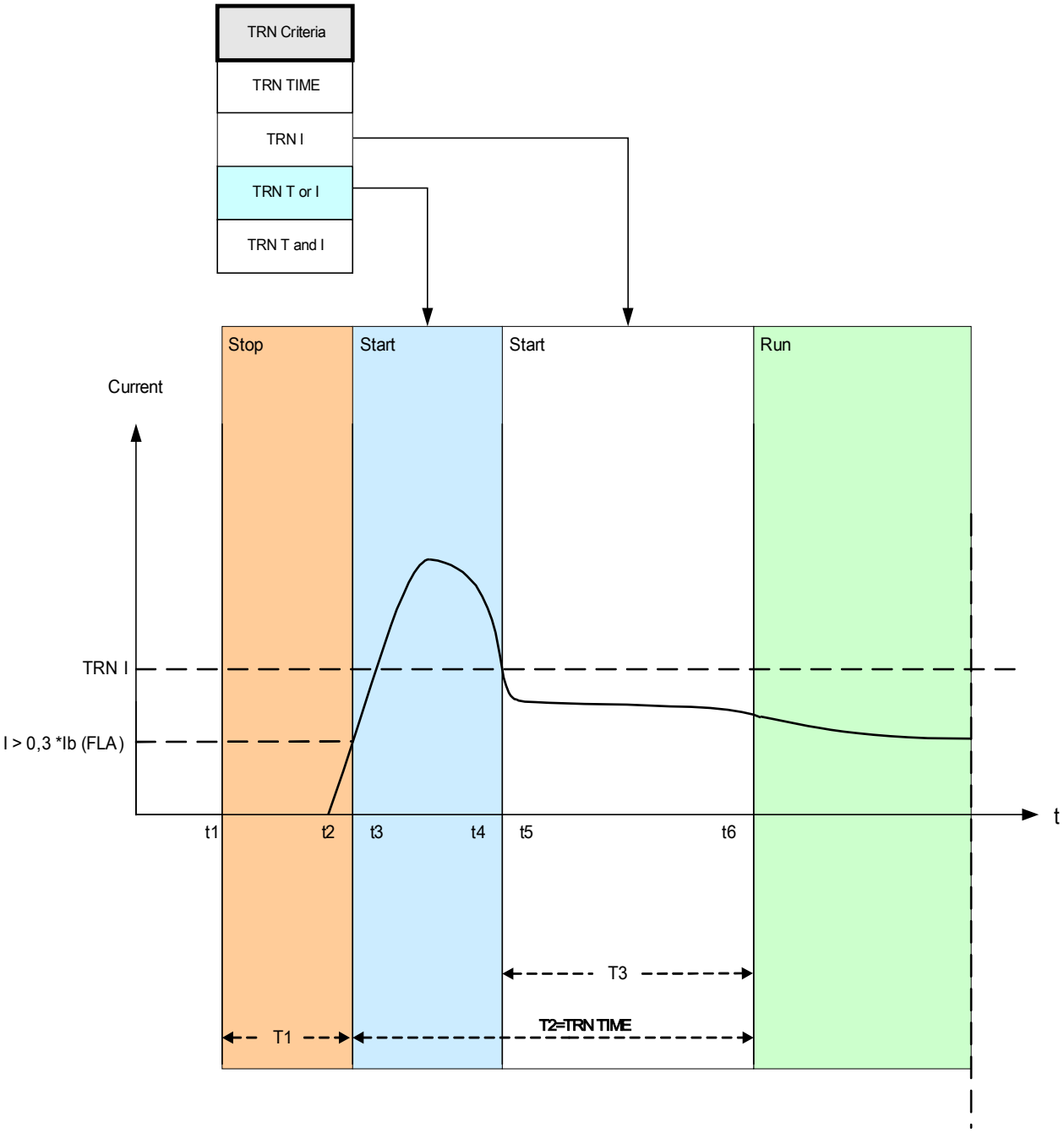
1. Start cycle;
2. Run cycle;
3. Stop cycle; and
4. Trip state.

Under normal conditions, the motor operations should go through »stop«, »start«, »run«, and »stop« cycles that are referred to as a complete operation sequence; while under certain abnormal conditions, the motor could go from »start« to »stop«, or »start« to »trip«, or »run« to »trip«.

If other protection trips occur at either the »start« or »run« cycle, the motor will be forced to go to »trip« mode. After motor currents are terminated, the motor will go into the »stop« cycle.

Start Control

The parameters for the Start Control have to be set within menu [Protection Para\MStart\StartControl]



T1: Stop Cycle

t4-t3: Start Cycle if TRNC is selected

t6-t3: Start Cycle if TRNT is selected

The Start Control Module drawing shows an example of how the protective device reacts to a normal operating-cycle current profile. Initially, the motor is stopped and the current is zero. As long as the protective device is not in a »trip« state, it permits contactor energization by closing its trip contact in series with the contactor. The contactor

is energized by the operator or process control system through a normal two-wire or three-wire motor control scheme, external to the protective device. The protective device declares a motor start when it senses a motor current that exceeds 30% of the »*Ib*« (FLA) setting. Meanwhile, the transition timer »*TRNT*« begins to run. The protective device also monitors the large starting current, noting when the current falls below the transition level »*TRNC*«.

The Start to Run transition is based on the setting »*TRN Criteria*«, which has four transition behaviors for the User to select:

- •TRN T - Transition to RUN after time setting TRNT only. Current is ignored.
- •TRN C - Transition when starting current drops below the setting only. If the time set in TRNT expires before the current transition, the motor trips.
- •TRN T or C - Transition on time or current, whichever comes first.
- •TRN T and C - Transition on time and current. Both must occur, and the current must drop below the setting before the time delay expires. If the timer expires before the current falls below the set transition level, the motor trips.

If there is no transition trip, the protective device relay declares a successful transition to »RUN« cycle and the corresponding transition signal(s) (current or time, or both, depending on the settings and motor current) is set. The transition signal(s) is the part of the global output list, which can be assigned to any module input or relay output. If it is assigned to a relay output, it can control a reduced-voltage starter, switching to full running voltage.

Even if the transition control output contact is not used, the transition function can provide clear indications of the actual state of the motor (»START« versus »RUN«) on the front panel display and via data communications. A good way to do this is to use the settings of TRN Criteria = TRN T or C and TRNC = 130% of »*Ib*« (FLA). Modify the latter, if needed, to lie at a transition value between the starting current and post-start maximum load current. Set the transition timer well beyond the normal start time to avoid a transition trip.

Start Delays

The parameters for the Start Delays have to be set within menu [Protection Para\MStart\Start Delay Timer]

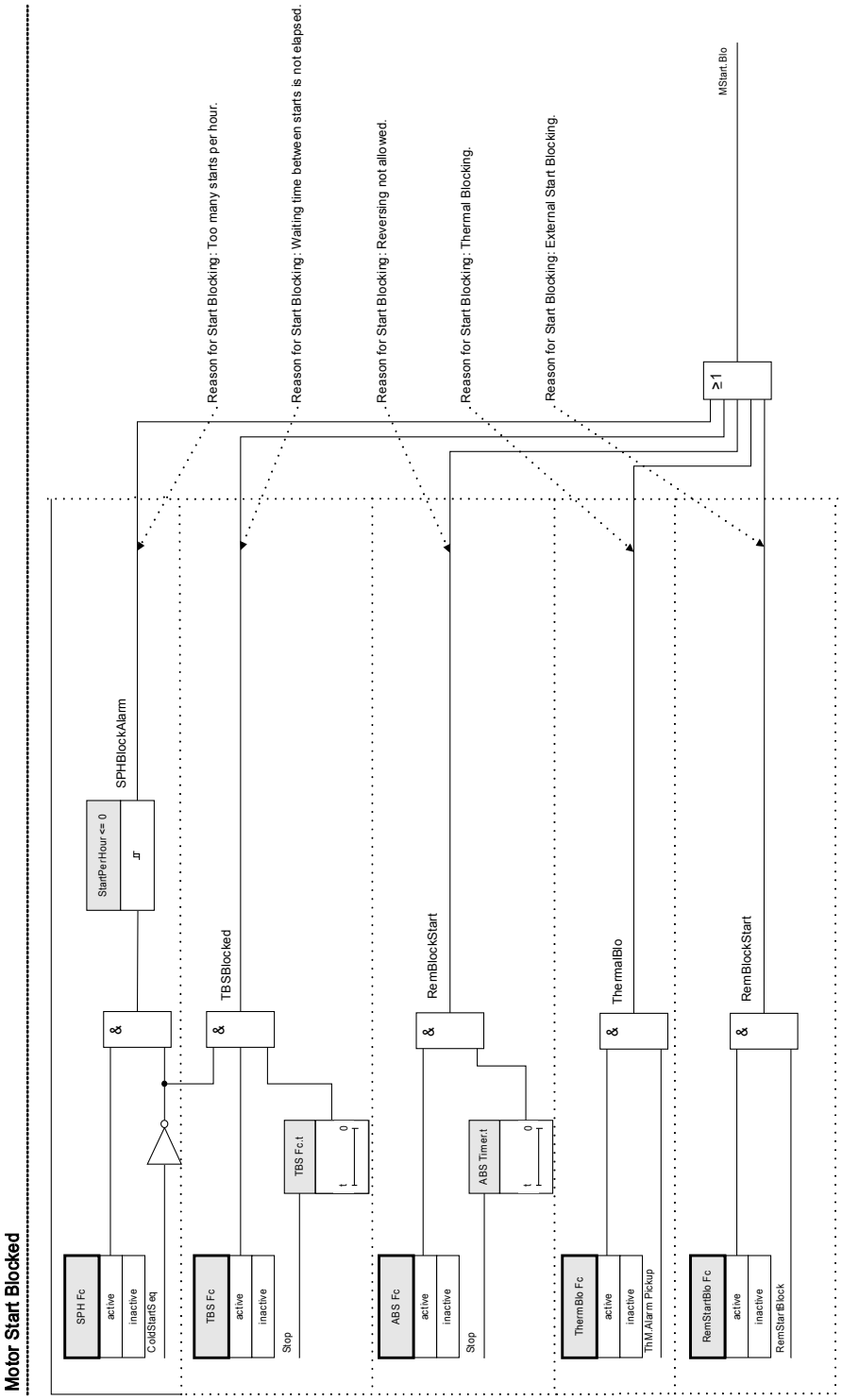
When the protective device declares a »START«, all start timers of the enabled functions begin to time. Each of these timers blocks the respective function until the set delay expires. These start timers are affected by transitions - they run for the set time, which may be less than or greater than the time of transition. These start delay timers include:

- IOC (Instantaneous overcurrent start delay);
- GOC (Ground fault start delay);
- UnderLoad (Underload trip and alarm start delay);
- IUnbalance (Current unbalance trip and alarm start delay);
- JAM (Jam trip and alarm start delay); and
- Generic1 to Generic5 (Generic start delay).

Note that the generic start delays are not tied to anything, and they can be used to block anything at the User's choice.

Motor Start Blocked

A Motor Start can be blocked by certain events, if any of the following conditions are noted - motor starts limit, starting frequency, thermal and mechanical constraints. The User may choose to use the states to block the motor from starting or use it as an alarm or indication.



Blocking Conditions

The reasons for a Motor Start Blocking are as follows:

The Motor Start will be blocked due to:

- There are too many starts per hour (if configured).
- The waiting time between starts is not elapsed (if configured).
- If the Anti Backspin protection detects a reversing of the motor (reversing not allowed, if configured).
- The thermal model blocks the motor (if configured).
- External Blocking becomes active (if configured).

When any of Anti-Backspin, thermal, and external blocks are on, the »*MStart.Blo«* signal will be set. The »*TBS«* and »SPH« can turn on the »*MStart.Blo«* signal only if the motor is not in a cold start sequence; »*NOCS«* block can not cause the »*MStart.Blo«* signal to be set.

Start Limits

Because motor starting consumes a considerable amount of thermal energy compared to its normal load conditions, the number of starts in a given time period must be monitored and controlled. The protective device has three functions that contribute to the start limits monitoring. These are:

- TBS (Time between Starts);
- SPH (Starts per Hour); and
- NOCS (Number of Cold Starts).

Most motors can tolerate some number of consecutive cold starts before the time between starts is enforced. The protective device treats a start as the first in a sequence of cold starts if the motor has been stopped for at least the time period that is the greatest of »*one hour«* and »*TBS*«. Subsequent starts are treated as additional cold starts in the same sequence, only if they run no more than ten minutes, until the set number of cold starts is reached. Once the motor is in the cold starting sequence, it will ignore »*TBS«* and »*SPH*« limits. The cold start sequence will be terminated if the motor has run for more than ten minutes for a cold start before it exhausts »*NOCS«*, then starts after this are subject to time and count limits imposed by »*TBS«* and »*SPH«*. If the motor reaches the »*NOCS«* limit in a cold start sequence, »*NOCS«* block signal will be set and »*TBS«* will start to time. When »*TBS«* reaches its limit while the »NOCS« block signal is still set, the cold start sequence will be terminated and the »*NOCS«* block will be released. Meanwhile, the »*SPH«* will start to count at the last start in the complete cold start sequence.

Stop Cycle

The run cycle continues until the motor current level falls below the Stop Current Threshold setting current on all three phases. Then a stop is declared. The start limits (also referred as Jogging start limits) and the anti-backspin time delay (ABS) are checked. If blocking conditions exist, the protective device can be configured to block a motor from starting. Remaining jogging block times are displayed and counted down, indicating how long to wait. If there are no such starting block conditions in effect, the protective device is ready for a new start.

Anti-Backspin Delay Time (ABS)

»ABS« sets the time in seconds before a motor restart is permitted after a trip or stop condition. This function can

be set to »*inactive*«.

This function is used with a motor driving a pump working into a head, or any other load that tends to spin in a reverse direction (backspin) when the motor is de-energized. It blocks starting during the time when the motor might be rotating in reverse following a trip. Also, this function may be used simply to set idle time (time between stop and start) before a restart is permitted.

External Start Blocking

A motor can be blocked through a digital input. If this feature is enabled, the User must make sure that both the Motor Start and Digital Input modules are configured properly.

Thermal Block

Besides the previously mentioned start monitoring and controlling means, the motor can be blocked if the thermal capacity used exceeds the alarm level. It is the User's choice to turn on or off this feature and set an appropriate alarm level in the thermal model module.

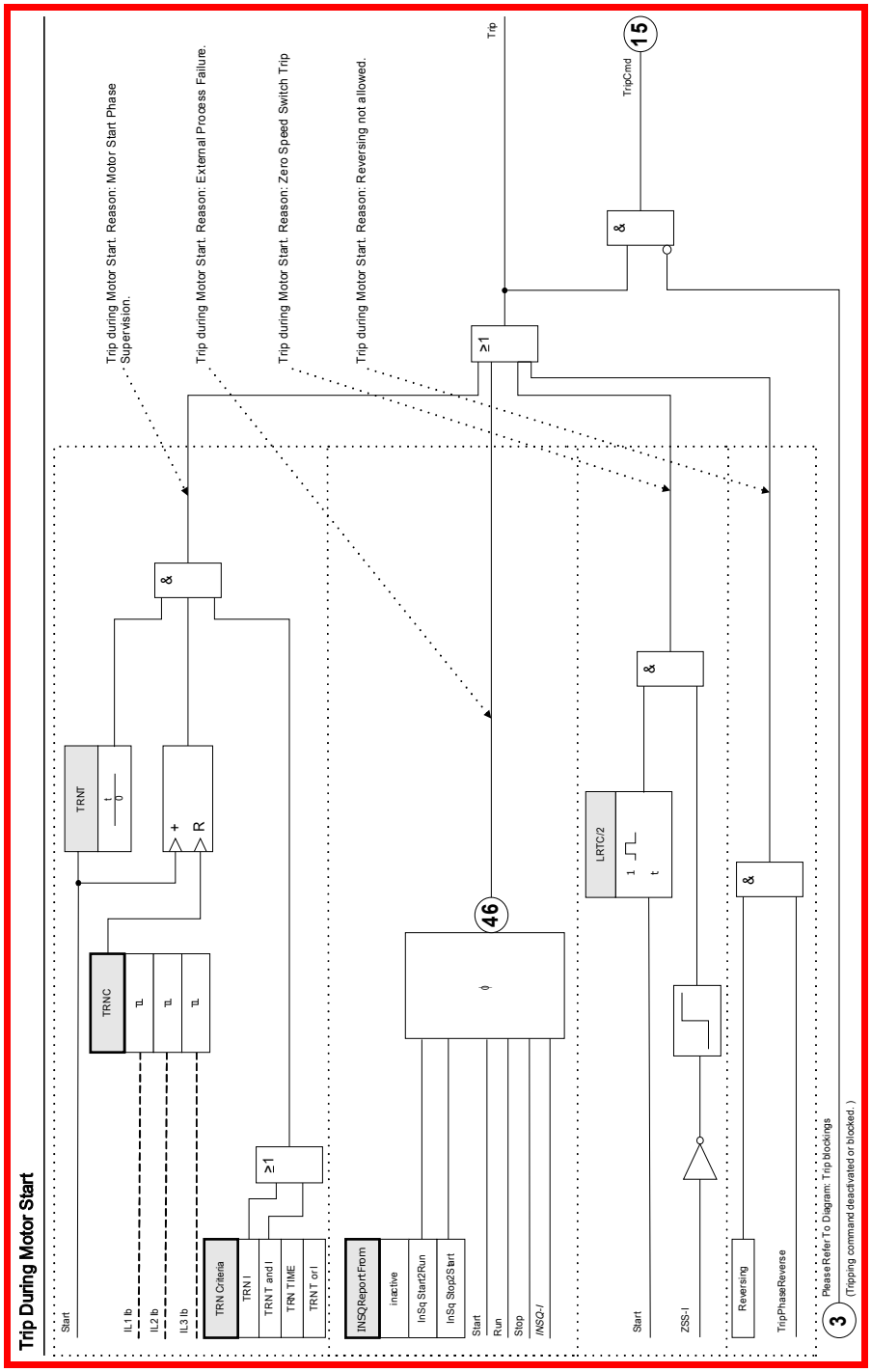
Forced Starting

It is recommended that the User wires the »MSTART.BLO« output to the motor trip circuit for preventing the motor from starting under these blocked conditions. If the User chooses not to do this for their applications, a Forced Starting signal will be set when the motor is started with the blocked conditions. This signal can only be reset manually though *Smart view* or from the front panel (please refer to section Emergency Override).

Motor Start / Transition Trips

The Motor will be tripped during the start phase, in case that:

- The Start Control detects an unsuccessful Start. (Please see section Start Control Module)
- There is an Incomplete Start Sequence. The device detects via an digital input, that the external process is not properly started.
- If a reverse direction is detected but reversing is not allowed.
- If case of a Zero Speed Switch trip.

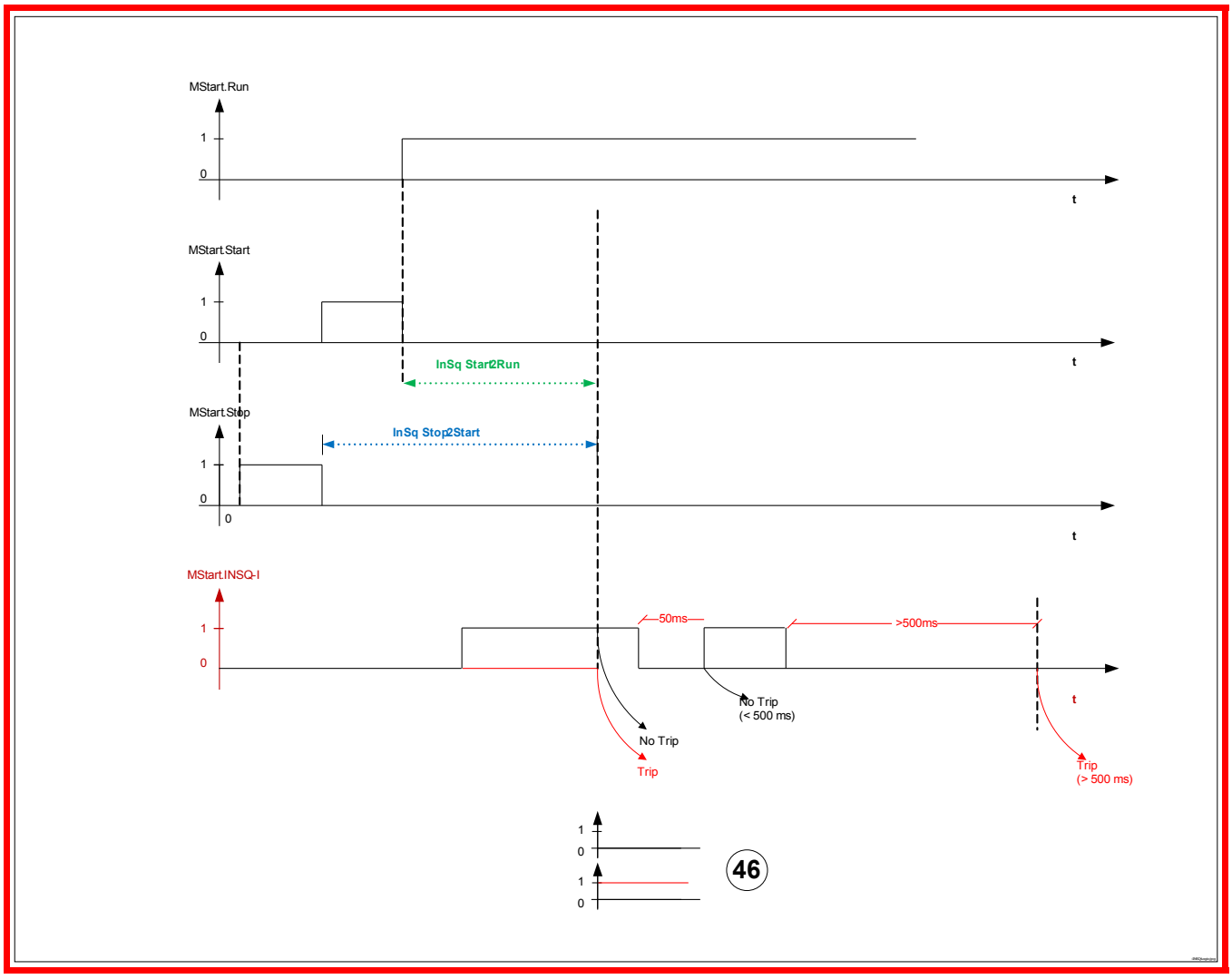


Incomplete Sequence Report Back Time (INSQ)

The incomplete sequence function requires an input from the report back contact from the process that the motor is running. Shortly after the motor starts, the report back contact provides an indication that the process has started to operate as expected. If the process does not start up correctly, the contact does not close within the expected time. If a problem develops later on, the report back contact opens. In either case, the open contact state indicates that the motor should be tripped.

To use this function, set a time limit for report back here and define the start of report back timing. Connect the report back contact to one of the protective device Discrete Inputs. If this input is not energized before the set time expires, the relay will trip on an “Incomplete Sequence”.

Note that the input must be energized continuously after the time delay has expired to hold off this trip. Otherwise, if the incomplete sequence report back contact changes state for a period greater than 0.5 seconds, the relay will trip on an incomplete sequence. This delay allows for any momentary transient switching that may occur in the process report back contact, such as that which can occur in an open transition reduced voltage start.

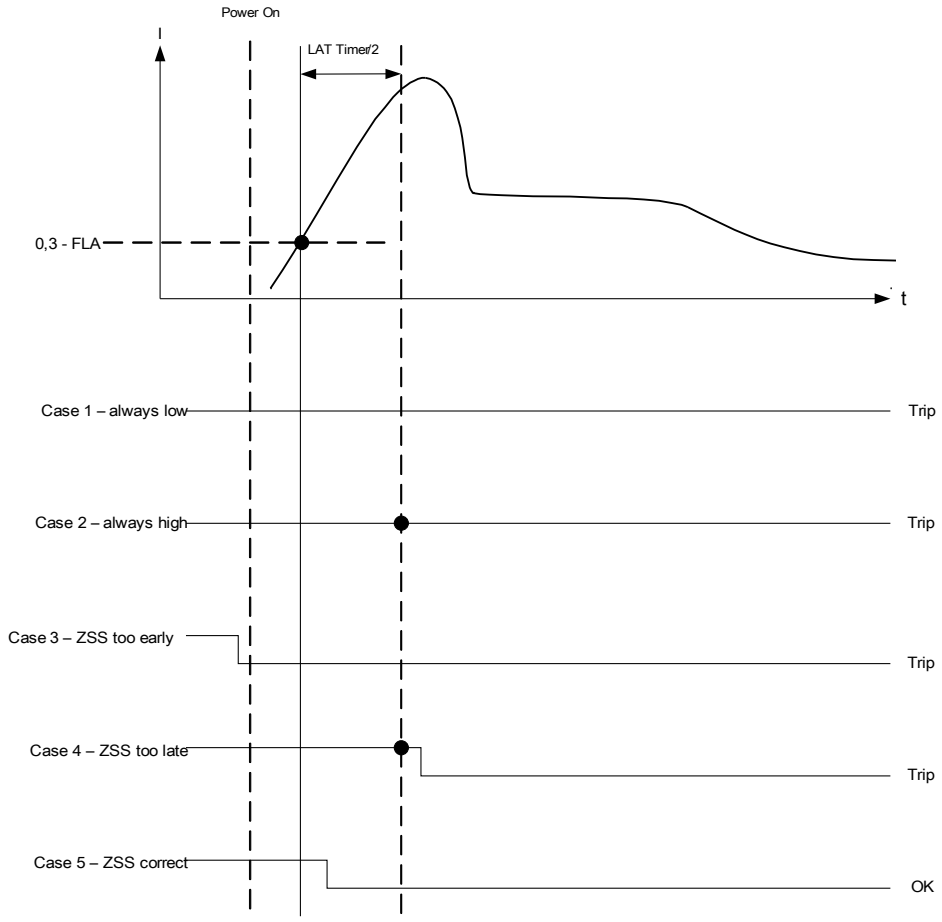


Zero Speed Switch (ZSS ON or OFF)

ZSS enables the function that verifies if the motor begins to physically spin after a start. It requires a zero-speed switch (digital switch) on the motor, which is closed at rest and opens as the rotor reaches (5%-10%) its normal speed. Connect the zero-speed switch contact to one of the protective device Digital Inputs. If the contact fails to open within »*LRT/2*« (one-half of locked-rotor time) after a start, the relay trips with a zero-speed switch trip message.

This protection is always useful, but is essential if the Long Acceleration Time (LAT) function setting is used.

With ZSS being enabled and being mapped to one of the digital inputs, the protective device checks the ZSS input status at the very moment it sees a start - it wants to sense the initially closed zero-speed switch, which opens shortly thereafter as the motor spins. If it fails to find the closed contact, it trips immediately. Check the wiring and contact for problems.



Long Acceleration Time (LAT)

When the LAT function is enabled, the »*LAT*« timer is used to set a time interval during which the motor is permitted to accelerate a high-inertia load, which is longer than the locked-rotor time. This function can be (and usually should be) set to »*inactive*«. If the thermal-model accumulator bucket fills to 100% during the long acceleration time, it is limited to that value and the thermal trip is held off until the LAT timer expires. By then, the thermal bucket level must have decreased (thermal model cooled) below 100% or the motor trips.

The LAT function should be used but not limited only on motors with a zero-speed switch (a normally-closed contact

that opens when the motor actually begins to spin). Connect the zero-speed switch contact to one of the protective device Digital Inputs. The Zero-Speed Switch function must be enabled (ZSS ON). The protective device requires the zero-speed switch to open within LRT/2 (one-half of locked-rotor time) after a start, or the motor is tripped by the ZSS function. This protects a completely stalled motor from being damaged when the LAT timer blocks the locked-rotor thermal trip.

CAUTION

The long acceleration time (LAT) function can block the critical LRC-LRT rotor thermal protection during a start and destroy the motor. Turn LAT OFF unless absolutely needed and the motor's suitability for this starting duty has been confirmed. Use only with zero speed switch function ZSS ON and switch input connected to protect a stalled motor.

The User can temporarily defeat the I2t thermal protection limit after a start by setting a Long Acceleration Time delay. This can be a dangerous setting that blocks thermal tripping and holds the bucket at a 100% level if the load takes a long time to reach running speed. An example is a motor spinning a large centrifuge. In using LAT, the User can take advantage of the partial cooling from airflow produced by the motor spinning at below-normal speed, as compared to unfanned heating of a locked rotor. The motor must be rated for this severe starting duty. Also, the User must ensure that the motor actually has begun to spin well before the locked-rotor time has expired. This is accomplished by connecting a zero-speed switch to a Digital Input and turning on ZSS function. The zero-speed switch is a contact that is closed when the motor is at rest, and opens as the motor begins to spin, usually at 5-10% of running speed. If ZSS is set to ON and the protective device relay does not sense the contact open in one-half the locked-rotor time setting, it trips the motor.

⚠WARNING

Turn OFF LAT unless the application specifically demands it. Use a zero speed switch with LAT. Using an LAT setting greater than locked rotor time without a zero speed switch temporarily defeats thermal protection and damages the motor if the rotor actually is locked.

If »*LAT*« is used, check the settings of transition time »*TRNT*« and jam start delay to be sure they are coordinated with the prolonged starting cycle.

Anti-Backspin Delay Time (ABS)

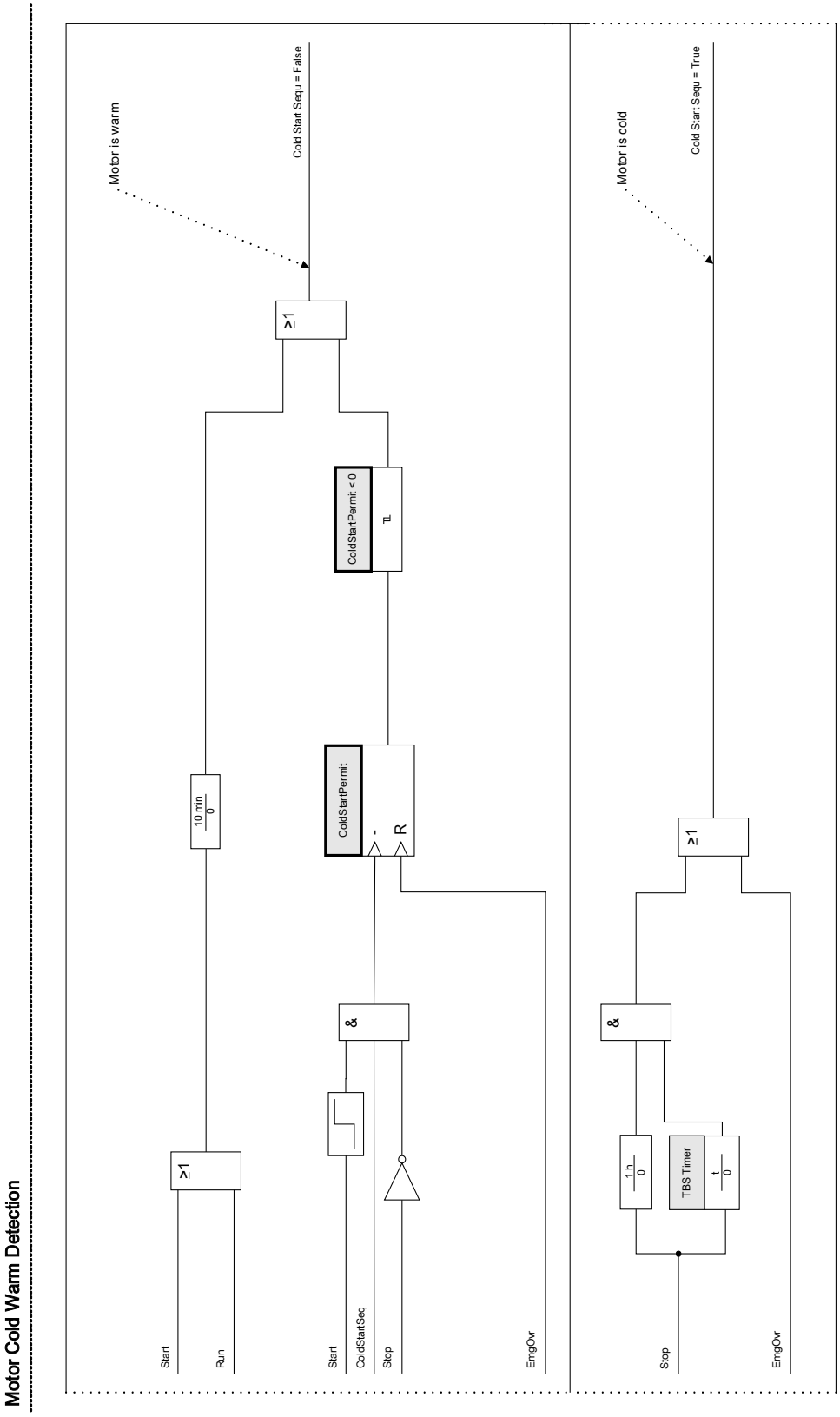
»*ABS*« sets the time in seconds before a motor restart is permitted after a trip or stop condition. This function can be set to »*inactive*«.

This function is used with a motor driving a pump working into a head, or any other load that tends to spin in a reverse direction (backspin) when the motor is de-energized. It blocks starting during the time when the motor might be rotating in reverse following a trip. Also, this function may be used simply to set idle time (time between stop and start) before a restart is permitted.

Motor Cold Warm Detection

The motor will be considered as cold (»COLD SEQU = TRUE«) after being in the »stop« mode for more than one hour if the time between starts timer is set to a lower value than 1 hour.

Else, the motor will fall back into the »cold« state if the time between starts timer is elapsed. By means of the Emergency Override function, the motor can be forced to switch to the cold state.



Emergency Override

The Emergency Override function can be enabled or disabled in the following menu [Protection Para\Global Prot Para\MStart\Start Control\EMGOVR]. Also it can be determined whether this function can be executed by a DI or by a softkey at the HMI or both.

If enabled, an emergency override can be executed by pushing the »*Emrg Override*« Softkey at the front panel. In any case, an emergency override can be performed by a remote contact connected to any one of the digital inputs programmed as »*EMG OVR*«, or via front panel under [Operations\Reset\EMGOVR] menu. The as-shipped setting is disabled.

Emergency override allows a panic restart of a tripped motor without completely disabling protection. When the override request is received, the thermal-model accumulator bucket is drained to its initial level of 40°C (104°F). Cold starts are fully restored.

The motor protection is now in the state it would be in if the motor had been standing for a long time prior to the moment of the override. This allows an immediate restart of the motor. The override can also delay an impending thermal trip of a running motor. The emergency override action is counted in the history record, and noted with its time tag in the logbook record.

CAUTION

The emergency override function clears and restarts all protective functions of the protective device. Using this function can damage the motor. Use it only for true emergencies, when it is known what caused the trip. Override permits the risk of motor damage to avoid an even more dangerous process situation caused by the tripping of the motor.