MOTOR STARTER PROTECTION SYSTEM TYPICAL SEQUENCE OF OPERATION

(See drawing 2305-1604 or page 5 of MPCA-10M-1)

Upon a call for a start from the unit control panel power to terminal 14 (line 1) in the fault trip indicator module (A13) power flows through the fault trip indicator contacts (line 1). Power flows on to energize pilot relay K23 (line 1). It also flows through the S22 timer NC contact (line 3) to energize pilot relay K24 (line 2). Power also feeds through the K30 relay NC contact (line 4) to energize the K30 relay.

The K30 NC contacts (line 4) open leaving the K30 relay (line 3) to be held energized through the low control voltage potentiometer R2 (line 3). The K30 NO contacts (line 2) close holding pilot relay K24 (line 2) energized and power to the low control voltage potentiometer R2 (line 3). Two sets of K30 NO contacts (line 7) close energizing the S22 timer (line 7).

Both pilot relays K23 and K24 are now energized. The K23 NO contacts (line 6) which are wired in series with the K24 NO contacts (line 7) both close allowing power to flow between terminal F (line 5) and terminal G (line 7) causing the starter contactors to begin the unit start sequence.

A set of NO auxiliary contacts (line 12) on the main starter contactor close causing the Motor Protection Module A1 to begin to monitor locked rotor current draw and begin timing the motor acceleration time.

The K23 and K24, NO and NC, self monitoring contacts (lines 5 and 6) switch preventing the "Starter Circuit" fault indicator CB13 (line 5) from tripping.

The S22 timer NC contact (line 3) opens requiring that power be held to pilot relay K24 (line2) and the potentiometer R2 (line 3) through the relay K30 contact (line 2).

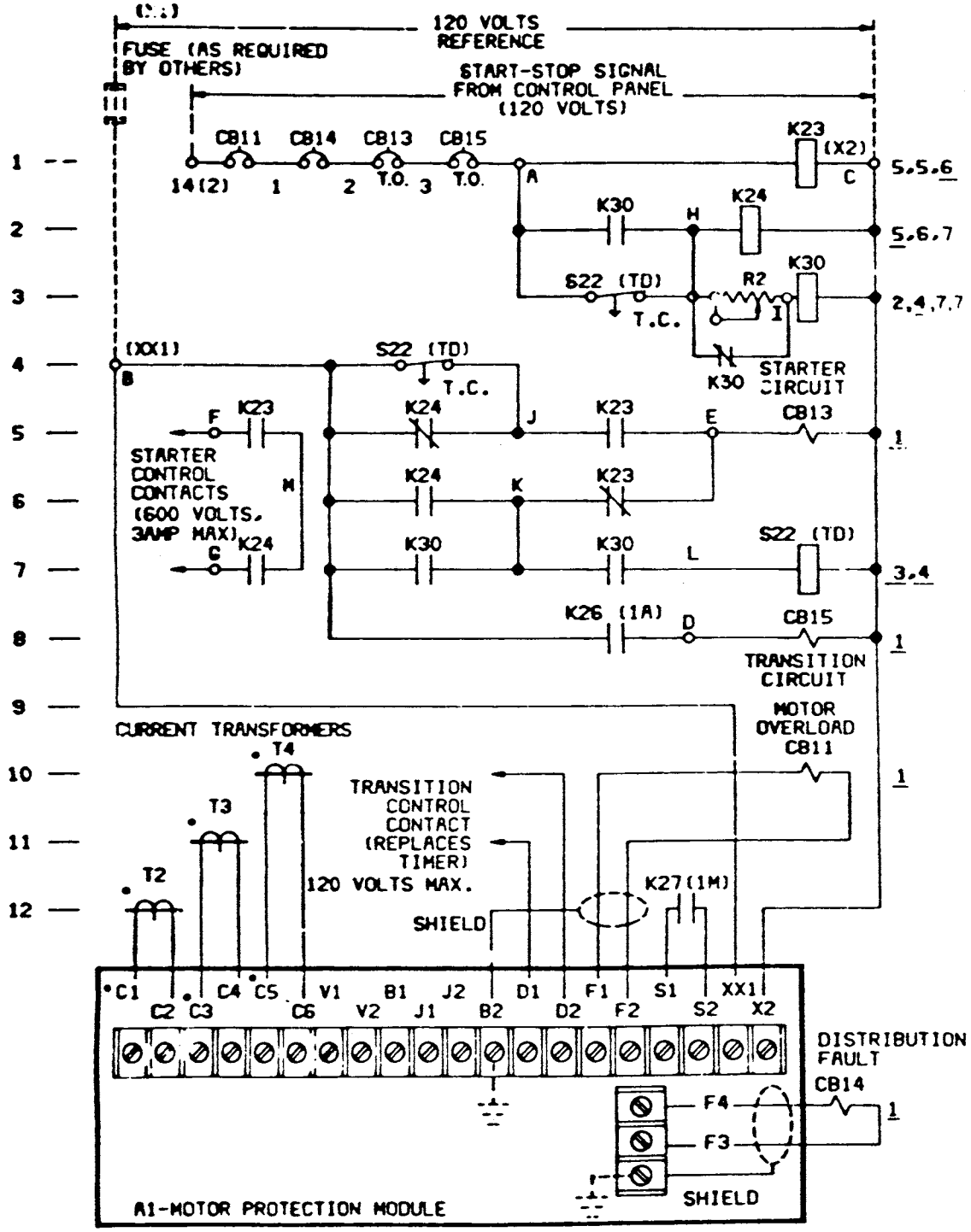
An S22 timer NC contact (line 4) opens to remove power from terminal J (line 5), this prevents the "Starter Circuit" fault indicator (line 5) from tripping.

If the starter is a reduced voltage or current type (eg. Star-Delta or Auto transformer) which requires transition to occur this is initiated by the Motor Protection Module A1 when motor current drops below 80 percent of unitrated load current draw, indicating the motor is up to full running speed. It initiates transition by closing a set of contacts giving a transition signal (lines 10 and 11).

If the unit does not complete transition once initiated, that is one of the transition contactors (the transition resistor contactor on a Star-Delta type starter) indicated by a set of K26 (1A NO contact (line 8) remains closed too long, the "Transition Circuit" fault indicator will trip shutting down the machine.

Upon completion of transition the Motor Protection Module A1 monitors the rated load current of the unit to prevent overloads.

2305-1604
Schematic Diagram



CenTraVac Motor Starter Protection System Sequence of Operation for Each Fault Condition

(See Drawing 2305-1604 or MPCA-IOM-1 page 5)

Following are the descriptions of the conditions which will cause each fault trip indicator to trip when the Motor Protection System is operating correctly.

Motor Overload CB-11 – There are three faults which will cause the Motor Protection Module (MPM) to trip the "Motor Overload" fault indicator. They include:

1. Current draw in excess of rated load amperes. If at any time after the point when the MPM calls for transition to occur the unit current draw exceeds 107% of the rated load amperes the MPM is calibrated for, the MPM will send a signal to trip the "Motor Overload" fault indicator..
2. Current draw in excess of normal lock rotor amperes. If at any time during the time between the point when the motor is first energized and the point when the (MPM) calls for transition to occur the unit current draw exceeds the value set on the LRA potentiometer in the MPM, the MPM will send a signal to trip the "Motor Overload" fault indicator.
3. Excessive acceleration time – If the unit current draw does not drop to below 80% of rated load amperes following energization of the starter, indicating that the motor never reached full speed in the time set on the maximum acceleration time switches in the MPM, the MPM will send a signal to trip the Motor Overload" fault indicator.

Distribution Fault CB-14 – The MPM will trip the "Distribution Fault" fault indicator whenever there is a loss of line voltage to the unit when it is running. It is impossible to sense the actual loss of line voltage because as soon as the voltage loss occurs, the compressor motor begins to act as a generator and will product enough power to support all control functions for approximately 60 cycles.

For this reason the way the voltage loss is sensed is by monitoring current draw. The fact that makes this possible is that even when completely unloaded an induction motor draws at least 15% - 20% of its rated load amperes. On this basis, the Motor Protection Module monitors the main starter contactor to determine if the unit is running and the current draw of the unit to determine if it is drawing less than 15% of its rated load amperes. The main contact must be monitored so the MPM knows when the current is below 15% because of normal shutdown. If the contactor is closed and the current is below 15% of rated load amperes the MPM will send a signal to trip the "Distribution Fault" fault indicator.

Starter Circuit – CB-13. There are five faults which will cause the "Starter Circuit" fault indicator to trip. They include:

1. Intermittent control voltage or a fluttering flow switch (see Drawing 2305-1604 or page 5 of MPCA-IOM-1) The sequence of operation to protect against this is as follows: The unit is operating in a normal manner and control power flickers at terminal 14 (line 1) . Upon loss of power pilot relays K23 (line1) and K24 (line 2), relay K30 (line3) and timer S22 (line 7) will drop out. If control power returns to terminal 14 (line 1) in less than 10 seconds pilot relay K23 (line 1) will pull in. Relay K30 and pilot relay K24 will not be able to pull in because the S22 timer contact (line 3) is timed too close, it takes 10 seconds to close following a control power loss. The pilot relay K23 NO contact (line 5) will close and because the pilot relay K24 NC contact (line 5) does not open power will be applied to trip the "Starter Circuit" fault indicator CB13 (line 5) locking the machine off until manually reset. The S22 timer uses a 10 second timing period because if control power has been off for this period of time, the standard control panel will have locked the unit off and will not allow a restart until it has gone through a post lube & prelube period which eliminates any danger of compressor or starter damage because of rapid recycling.
2. Low Control Voltage – the sequence of operation to protect against this is as follows: The unit is operating in a normal manner and the control voltage drops to the trip level set with the Low Control Voltage Protection potentimeter R2. At this point, the low control voltage protection relay K30 drops out. The K30 relay NO contact (line 2) opens deenergizing pilot relay K24 (line 2). Both pilot relay K24 NO contacts (line 7) open dropping out the starter and sending power to "Starter Circuit" CB13 (line7) fault indicator causing it to trip.
3. Pilot Relay Failure – The sequence of operation to protect against pilot relay failure, either failure to pull in or drop out, is as follows: The unit calls for a start and the pilot relay K23

(line 1) pulls in correctly, but the pilot relay K24 (line 2) does not pull in; this could be for any reason, burned out coil, loose wire, etc. The pilot relay K23 NO contact (line 5) closes but the pilot relay L24 NC contact (line 5) will not open. This will send power to the "Starter Circuit" CB13 (line 7) fault indicator causing it to trip. The other pilot failure mode would be if one of the relays would not drop out i.e., it was welded in. This is protected against as follows: The fact that a pilot relay is welded in will be caught on the next unit shutdown. Assume for this example that the pilot relay K24 will not drop out. When the unit shuts down the pilot relay K23 NC contact (line 6) will close. The pilot relay K24 NO contact will hang in the closed position. This will send power to the "Starter Circuit" CB13 (line 7) fault indicator causing it to trip.

4. Interminent Control Voltage Protection Timer (S22) Failure. The timer could fail in two modes, either contacts open or contacts closed. If the Timer S22 fails with contacts open, upon a call for a start the pilot relay K23 (line 1) will be energized. The pilot relay K24 (line 2) will not be energized because the Timer S22 NC contact (line 3) is open and holding pilot relay K24 out. The pilot relay K23 NO contact (line 5) closes and pilot relay K24 NC contact (line 5) will remain closed. This will send power to the "Starter Circuit" CB13 fault indicator (line 5) causing it to trip.n

   If the timer S22 fails with contacts closed upon a call for a start the pilot relays K23-K24 will pull in normally. The Timer S22 NC contact (line 4) will not open, this will send power through the pilot relay K23 contacts (line 5) causing it to trip.

5. Low Control Voltage Protection Control Relay (K30) Failure
   The relay K30 could fail in two modes, either contacts open or contacts closed. If the relay K30 fails with the contacts open upon a call for a start, the pilot relay K23 (line 1) will be energized. The relay K30 contacts (line 7) will not close and so the timer S22 (line 7) will not be energized. The Timer S22 NO contact (line 4) will not open, this will send power through the pilot relay K23 contacts (line 5) and to the "Starter Circuit" CB13 fault indicator (line 5) causing it to trip.

If the relay K30 fails with the contacts closed, when the unit shuts down, the relay K30 NO contacts (line 7) will not open. This will allow power to flow through the pilot relay K23 NC contacts (line 6) to the "Starter Circuit" CB13 fault indicator (line 5) causing it to trip.

6. Low Control Voltage Protection Potentiometer (R2) Failure

If the low voltage pot. (R2) (line 3) fails, it will fail open. If the unit is running in a normal manner when the low voltage potentiometer R2 fails this will cause the relay K30 (line 3) to drop out. The relay K30 NO contacts (line 2) open dropping the pilot relay K24 (line 2). The pilot relay K24 NC contacts (line 5) close sending power through the pilot relay K23 NO contact (line 5) which will remain closed, to the "Starter Circuit" CB13 fault indicator (line 5) causing it to trip.

Transition Circuit CB 15 – The "Transition Circuit" CB15 fault indicator (line 8) will be tripped whenever the transition contactor auxiliary K26 (line 8) remains closed for a period of time longer than that allowed by the "Transition Circuit" CB15 fault indicator (1.5 seconds). This indicates that the unit did not complete transition properly.

A1 - Motor Protection Module

This module contains the electronic circuitry to monitor the following and protect against the following faults.

1. Running motor overload
2. Locked rotor motor overload
3. Excessive acceleration time
4. Distribution fault

It also initiates transition based on motor current draw when the motor is up to speed.

See Service Bulletin CTV-SB-22A for detailed information on operation and calibration.

A12 - Starter Protection Module

This module contains the following components.

1. The pilot relays(K23 and K24)
2. The low control voltage protection control relay(K30)
3. The low control voltage protection potentiometer(R2)
4. The interminent control voltage protection timer(S22)

It provides protection against the following faults.

1. Interminent control voltage/flow switch flutter
2. Low control voltage
3. Pilot relay malfunction
4. S22 timer failure(fail safe)

A13 - Fault Trip Indicator Module

This module contains the four manual reset circuit breakers which lock the machine out in the event of a fault occurrence signal from the

Motor Protection Module or Starter Protection Module. These circuit breakers include:

1. Motor overload(CB11)
2. Starter circuit(CB13)
3. Distribution fault(CB14)
4. Transition circuit(CB15)

Motor Protection Retrofit Component Description

*CB11 - Motor Overload Fault Indicator

This is an instantaneous trip manual reset fault trip circuit breaker which is tripped by the Motor Protection Module(A1) in the event of a motor overload. See the description covering the Motor Protection Module for faults included under the description "Motor Overload."

*CB13 - Starter Circuit Fault Indicator

This is a time to trip manual reset fault trip circuit breaker which is tripped in the event of:

1. A pilot relay malfunction(burn out or weld in)
2. An occurrence of intermintent control voltage or fluttering flow switch
3. Low control voltage
4. S22 timer failure
5. K30 relay failure

The breaker trips after a period of approximately 1.5 seconds of power to the circuit breaker coil.

*CB14 - Distribution Fault Indicator

This is an instantaneous trip manual reset fault trip circuit breaker which is tripped by the Motor Protection Module(A1) in the event of a distribution fault. See the description covering the Motor Protection

Module for faults included under the description "Distribution Fault."

*CB15 - Transition Circuit Fault Indicator

This is a time to trip manual reset fault trip circuit breaker which trips in the event of the transition resistor contactor or contact auxiliary staying in too long. This breaker trips after a period of approximately 1.5 seconds of power to the circuit breaker coil.

NOTE: All fault indicator circuit breakers are designed to be shunt trip devices not current sensitive devices as normally applied.

K23-K24 Pilot Relays

These relays are used to energize the main contactor of the starter when a start is called for. They also are wired in such a way that if either one malfunctions the "Starter Circuit" (CB13) fault indicator will trip. The contact rating of these relays is 600 volts at 3 amperes maximum.

K30 - Low Control Voltage Protection Relay

This is a control relay which is used in combination with the R2 Potentiometer to provide protection against low control voltage.

R2 - Low Control Voltage Protection Potentiometer

This is a potentiometer which is used in combination with the K30 relay to provide an adjustable low voltage trip point. It is wired in series with the coil of the K30 relay and operates by dropping a set voltage prior to the K30 coil. This causes the K30 to drop out at some set voltage and trip the "Starter Circuit"(CB13) fault indicator. The rating of this variable resistor is 3.5 K at 3.25 watts.

S22 - Interminent Control Voltage Protection Timer

This is a solid state timer with two normally closed, instant open, time to close contacts.

When the timer is energized, its contacts open instantly and remain open as long as it is energized. When the timer is de-energized, its contacts remain open for 10 seconds and then close.

This timer is not adjustable.

T2 - T3 - T4 Current Transformers

These are three current transformers which feed a current signal to the Motor Protection Module to tell it what load the machine is operating at.

They must provide a 2.0 to 5.0 amp signal at unit rated load at a 0.02 V.A. burden.

MOTOR OVERLOAD TROUBLE ANALYSIS CHART

SYMPTOM						
MOTOR OVERLOAD TRIPS						
POSSIBLE CAUSE	At the Instant of First Contactor Hit	During Acceleration Before Transition	Transistion	After Transition	At Power Up of Control Circuit	
Incorrect LRA Trip Point Setting	1					Determine Proper Setting and Recalibrate
LRA TRIP Time Set Incorrectly	2	2			1*	+Determine Proper Setting and Recalibrate
Incorrect Current Calibrator Adjustment or Installation	3		1	1		Determine Proper Setting and Recalibrate
Current Transformers Incorrectly Wired (Dot Polarity Incorrect)	4	3	2			Rewire Current Transformers
Excessive Running Motor Current Draw	5	5		2**		Check Current Load Limiting Circuitry and Calibration
Faulty Circuit Breaker CB11	6	6	4	3		Replace Circuit Breaker
Defective MPM Module	7	7	6	5	2	Confirm Failure-Replace MPM
Frequency Selector Switch Incorrectly Set		4				Check Selector Setting
Motor Acceleration Time Too Long		+1				Contact La Crosse Service
MPM Module Sensitivity High			5			See Service Bulletin CTV-SB-65
Refrigerant Carryover Occurring When Machine is Up to Speed			3	4		Determine the Cause of Carryover - Correct

MOTOR OVERLOAD TROUBLE ANALYSIS CHART

* The Motor Overload Circuit Breaker will trip instantly at initial control circuit power up if all LRA Trip Time Switches are in the OFF position.

** If the LLR allows any overshoot to occur the unit may experience momentay overloads causing the Circuit Breaker to trip. If the LLR cannot be adjusted to prevent this overshoot a variable orifice restrictor(RSR-1)may be installed in the 2016 lbs main air supply line before the pilot positioner. This should be adjusted to slow the vane stroke as necessary to prevent overshoot.

+ See Charts below for nominal settings. On units which start with high evaporator temperatures these times may have to be extened to prevent nuisance trip outs.

TYPICAL MAXIMUM ACCELERATION TIME SETTINGS
FOR CVHA AND CVHB DESIGN MACHINES

STARTER TYPE	RECOMMENDED MAXIMUM ACCELERATION TIME SETTINGS
Star-Delta	12 Seconds
Auto-Transformer	8 Seconds
Across-The-Line	4 Seconds

TYPICAL MAXIMUM ACCELERATION TIME SETTINGS
FOR CVHE DESIGN MACHINES

STARTER TYPE	RECOMMENDED MAXIMUM ACCELERATION TIME SETTINGS
Star-Delta	40 Seconds
Auto-Transformer	22 Seconds
Across-The-Line	12 Seconds