Date: 7/29/03

Subject: Explanation of issues reguarding Over/Under Voltage (Code 7) Shutdown situations.

Over/Under Voltage Shutdowns (Code 7 Shutdowns) can occur if:

1. Voltage delivered to CXM/DXM is "out of range".
2. Voltage delivered to CXM/DXM is a "distorted sine wave".

Regarding Item #1 above.
Voltage "out of range" means that the voltage at the job-site is not within standard specifications of ±10%. For example, technicians have come across job-sites where the delivered voltage is supposed to be 230V ±10% (207V-253V); but the actual measured voltage at the site is 255V. When the delivered voltage is consistently near the upper (253V) or lower (207V) range limits, then this suggests that with slight power fluctuations, over voltage or under voltage shutdowns can occur.

In this situation of 255V delivered to the heat pump, the CXM or DXM control will measure the secondary voltage and will determine that the voltage to the CXM or DXM is above the 30V RMS trip point and the CXM or DXM will enter Code 7 Shutdown. The CXM or DXM will remain in Code 7 Shutdown until the voltage goes 1V below the trip point (29V RMS).

Regarding Item #2 above.
"Distorted sine wave" means that when observing the voltage sine wave, with an oscilloscope, the technician will note that the sine wave has notches, thinning (simple elongation of the wave where the waveform is "thinner" than normal), or other distortions to the wave. A distorted sine wave has a hidden, negative affect on voltage measurements by the CXM or DXM control. The distorted sine wave will be transferred through the primary to secondary transformer and will cause the effective, secondary peak voltage to raise, but the RMS measurement with a standard voltmeter will NOT rise. What this means is that a CXM or DXM control will appear to trip at some voltage less than 30V RMS (29.2V RMS for example); however, the peak voltage has raised and therefore the CXM or DXM control has correctly entered Code 7 Shutdown to protect the compressor. This situation may confuse the field technician that the CXM or DXM is shutting down too quickly due to Code 7, but actually, the CXM or DXM is properly protecting the compressor.

Example:
Measurements at a given house showed that the incoming power was 243V (below the limit of 253V) but the peak voltage was 352V. Calculations show that the actual conversion from peak to RMS for this house is 1.45 (352/243 = 1.45) instead of 1.414. The net effect is that this

waveform distortion has lowered the effective trip point from 30V RMS to 29.26V RMS (42.42/1.45 = 29.26V RMS). The reset voltage is also altered from 29V RMS to 28.28V RMS.

Technical information about how the CXM and DXM controls operate:

A) The ClimateMaster CXM and DXM controls have an Over/Under voltage sensing routine which disables the compressor operation if the incoming voltage is at levels which may harm the compressor. Hence, with extremely low or high voltages, the compressor is disabled. The CXM and DXM cut out at voltages less than 18V RMS (25.45V peak of sine wave) and at voltages more than 30V RMS (42.42V peak of sine wave).

B) For Over/Under voltage sensing, the CXM and DXM do not measure RMS voltage, but measure "peak voltage" of the secondary voltage (24V) sine wave, which is coming from the primary to secondary transformer. This method is used because a compressor can be more completely protected by monitoring peak voltages rather than RMS voltages; this is due to the fact that in some cases the RMS voltage may not change while the peak voltage rises and potentially harms the compressor windings. It is easy to calculate the actual RMS voltage from peak voltage based upon a pure sine wave:
RMS volts = Peak voltage divided by 1.414.

C) The CXM and DXM controls have a 1-volt hysteresis between "trip" point and "reset" point. The trip point is 30V RMS and reset voltage is 29V RMS. Therefore, it is possible (and proper operation) that the secondary voltage could be 29.3V RMS (for example) and the CXM or DXM would remain shut down due to Over voltage. This is a result of the following steps:

a) The secondary voltage, at an earlier time, going above 30V RMS.
b) The CXM shutting down due to over voltage.
c) The secondary voltage later goes down to 29.3V RMS, which is NOT low enough to reset the CXM.
d) CXM remains in over voltage shut down state with secondary voltage at 29.3V RMS.

Thus the parameters for hysteresis are as follows:

- Over voltage trip level programmed into CXM/DXM is 42.42V peak (30V RMS).
- Over voltage reset level programmed into CXM/DXM is 41.0V peak (29V RMS).
- Under voltage trip level programmed into CXM/DXM is 25.45V peak (18V RMS).
- Under voltage reset level programmed into CXM/DXM is 26.87V peak (19V RMS).

Solutions to Code 7 Shutdown:

ClimateMaster is currently making changes to the CXM and DXM controls to help eliminate over/under voltage problems by better compensating for voltage input variations that can occur in the field. Below is a list of field fixes which can be used to help eliminate Code 7 problems. Item #1 can be used immediately in the field. Items #2-#4 can only be used with newly modified CXM or DXM controls (see schedule below).

NOTE: It is important to note that CXM or DXM controls which are NOT exhibiting Code 7 shutdowns, do not need to have any modifications or field fix procedures performed.

1) In most cases, the Code 7 situations have been the result of incoming voltage being very near or over the 30V RMS limit. If this is the case, then the secondary voltage can be lowered by changing the transformer.

For example: With a 230V system, where the "actual" incoming voltage from the power company is 245V; the secondary voltage will be approximately 28V. The secondary voltage can be lowered by removing the 230V to 24V transformer and installing a 277V to 24V transformer. This will lower the secondary voltage to approximately 25V; and now CXM or DXM will be less susceptible to Over Voltage Shutdowns. However, it must be noted that loss of compressor over voltage protection will occur when doing this.

2) The CXM controls are being changed to adjust the Over voltage Shutdown levels. Upcoming production of CXM controls will have the Over voltage Shutdown trip point increased from increased from 30V RMS to 31.5V RMS. CXM controls with date code 0302 (week 2 of year 2003) and later have the new Code 7 software (Revision 333).

3) The Over/Under voltage "reset" hysteresis will be changed from 1V to 0.5V.
This translates into new "reset" points of 31V RMS for over voltage; and 18.5V RMS for under voltage. CXM controls with date code 0302 and later have this change as well.

4) Over/Under voltage sensing will have a field disable feature by clipping a component on the CXM control.

- To disable Over/Under voltage sensing on the CXM control, power down the control and clip the right lead of Resistor 32 (R32) located near bottom/center of the control board.
- **NOTE: It must be noted that clipping these resistors is not recommended by ClimateMaster and if cut, the installer assumes responsibility for damages which may occur based upon over/under voltage situations.**

For repair parts, please use these part numbers:
50VA 277-24V Transformer – 15B0001N03
CXM Control Board – 17B0001N01 (date code 0302 and later – Revision 333)
CXM Replacement Chips – 17B0009N06 (Revision 333)