CPX Trouble Shooting Guide

Application Summary

The basic theory behind a CPX drive is no different than any other drive. On the output they are identical so we will concentrate on where they are different which is on the input. The CPX is an 18 pulse drive. This means that the drive draws current off the line 18 times in a 360 degree cycle. The reason for this is to reduce current harmonics. A normal 6 pulse drive at full power will have 35-40% THID a 12 pulse normally somewhere around 15% and an 18 pulse will have about 5% (note that this is at full power, at less than full power the distortion goes up but its overall impact goes down).

The way this is accomplish this is with a phase shifting transformer on the front end of the drive. The transformer is designed to shift the input ahead 40 degrees and back 40 degrees. This gives us 9 phases into the drive that are 40 degrees apart. These then get fed into 3 separate 3 phase rectifiers. Depending on the size of the drive the location of the rectifiers will be different which I will go into later. Once past the rectifiers the drive is no different than any other drive.

Frame 9 and below rectification with 24V IT contactors:

The rectification in the FR9 and below CPX drives is all done external to the drive. The only thing that we use the internal rectifiers for is precharge so after the drive is done with precharge the internal rectifiers are completely taken out of the circuit. When you first power up the drive the precharge contactor is off and power is fed through 2 NC contacts on the precharge contactor. We are using a single phase (L1-L2) for precharge. This is fed through the precharge fuses which are branch protection fuses for the wires running to the drive. After the precharge fuses one of these lines will be fed through an external precharge resistor. This resistor was added in the circuit to stop the precharge fuses from blowing in a brown out or extended sag condition. From here it is fed into L1 and L2 of the drive. From this input the drive will go through its normal precharge and once the drive goes to a ready status it will output this on pin 20 which turns on the CRC relay which in turn turns on the precharge contactor. Once the precharge contactor pulls in it removes power from the input of the drive and applies power to the phase shifting transformer through the input reactor. The 9 phases are then applied to the external rectifiers (normally located directly beneath the drive). The external rectifiers rectify the input and the DC is applied directly to the DC bus of the drive.

Frame 9 and below rectification with 115V XT contactors:

The main rectification for the FR9 and below drives is done external to the drive. On this version of drive we do feed all 3 phases into the drive for precharge. Unlike the previous version of drive we leave these 3 phases connected to the drive for 3 phase monitoring. We are feeding this circuit off of the load side of the input fuses so we are monitoring the input up to this point to make sure we don’t lose a phase. When power is applied to the unit these 3 phases are fed into the drive to charge the drive. DO1 should be set for charge switch state which means once the DC bus reaches about 63% it will close the inverter contactor applying power to the phase shifting transformer. This then phase shifts the input and feeds it to the 3 3 phase external rectifiers. The external rectifiers are hooked directly up to the DC bus of the drive. The drive is now ready for operation.

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Frame 10 and above rectification:

On frame 10 and above the rectification is slightly different. On these drives we use a 12 pulse drive and add one external 3 phase rectifier. Because we are using the drives rectification and have full power running to the drive the precharge contactor is not before the phase shifting transformer but instead is on 3 of the 9 phases coming out of the transformer. When you apply power to the drive you are immediately applying power to the phase shifting transformer. Out of the phase shifting transformer 6 of the phases are fed to the drive. Once the drive goes through precharge it will turn on all of its internal rectifiers and will put an output on pin 20 which turns on the CRC relay which in turn pulls in the precharge contactor. The precharge contactor applies the last 3 phases to the external rectifier (normally located at the top of the drive). The DC from the external rectifier is then fed into the DC of the drive. From this point on the drive is the same as any other drive.

Troubleshooting:

Over current (F1):

There are 2 kinds of over current trips and to find out which one you will need to check the sub codes in fault history. A sub code S1 is a hardware trip. A hardware trip mean the output current has exceeded 2.5-4 times the CT rating of the drive. Normally the smaller the drive the closer this rating is to 4, the larger the closer to 2.5. This is an instantaneous trip. The other kind of trip is a software trip, sub code S3. A software trip will happen .6 seconds after the drive has gone into a current limit that has brought its output freq down to 0. What the drive does when it hits current limit to try to reduce the current the drive reduces its output freq. If it has brought the freq all the way to 0Hz and its still in current limit it will trip .6 seconds later on an output current trip.

We will address both of these faults the same way although normally a hardware trip indicates more of an insulation breakdown whereas software can indicate more of a locked rotor condition.

1. The first step is to remove the motor and start the drive. If the drive trips with nothing connected the drive has failed and will have to be repair or replaced.
2. If the drive doesn't trip go through "checking the drives output voltages" at the bottom of this document. If the drive fails this test, repair or replace.
3. Insulation test the motor and the output run. If this tests alright see if the motor can be uncoupled.
4. If the drive trips on an uncoupled motor connect a test motor to the drive and see if it can run this motor. For this purpose it is nice to have the test motor be the same size as the original motor although even a small motor will tell us certain things. If you can run the drive on a known good application this works the best. If the drive trips on the test motor or known good application repair or replace the drive.
5. If the drive can run the uncoupled motor try to spin what the motor was coupled to by hand to make sure it is not stuck. If you can spin the application re-couple the motor and try to start it again. The most likely place for the output to short is in the motor connection box, it is not a bad idea to have these connections reinsulated as a precaution. This problem can come and go and will normally get worse over time.

Over voltage fault (F2):

The over voltage fault is taken from the DC bus (trip level is 437V for 230V drives, 911V for 480V drives and 1200V for 575V drives). Being taken from the DC bus this trip isn't an extremely fast trip as the DC bus is filtered which will slow the rise and fall of the DC bus. An over voltage fault can come from either the input or the output of the drive so to troubleshoot this we need to figure out where it is coming from. The over voltage trip is turned on whether the drive is running or not.

For an over voltage to come from the output you have to have either regenerative feedback or induced voltage. For there to be regenerative power the drive either has to be running or there is a PM motor (PM motors are not very common). If you have a PM motor and the DC bus is higher than it should be see if the motor is spinning or power the drive down and check to see if there is any voltage across the motor windings. With a PM motor there should be an isolation contactor on it to stop regen back into the drive. For all asynchronous motors there has to be a magnetic field applied to the motor for it to regenerate power back into the drive and it gets this field from the drive, this means that if the drive is not running there really can't be regenerative power. For a synchronous motor there also needs to be a voltage applied to the motor but this does not need to come from the drive so please make sure what type you have before troubleshooting.

For regenerative power to occur the drive has to be going slower than what the application is. This phenomenon normally occurs during ramp down of the unit. If you try to ramp down too fast you will regenerate power back into the drive. If the over voltage controller is on in the drive the drive will speed up to try to shed the excess voltage, for example on a 480V drive when the DC bus reaches about 750VDC the drive will speed up or it will reduce how fast it is decelerating to try to keep the DC bus below this level. If your deceleration time is too fast the drive will not react fast enough and you will trip out on an over voltage trip. A trip that comes from regenerative power will almost always have negative power and the drive will not be at reference. These are normally pretty good indicators that you have regeneration occurring.

The other place for a drive to get voltage from the output is induced voltage. This can occur at any time but is most likely to occur if the drive is powered up but not running. The source of this induced voltage is normally from another running drive whose output is run too close to the drive in question. I have actually seen this induce enough voltage to power up a drive with no input voltage applied. There are a couple ways to fix this the best way is to make sure that there is enough space between the outputs (12"). Running the outputs in shielded cable will allow you to run the outputs closer together or putting a sine filter on the output of the drive will eliminate the high freq component and allow the outputs to be run closer together.

The more likely place for an over voltage to come from is the input of the drive. There is not much the drive can do about high input line voltages. If the drive is running the over voltage controller will try to bleed this off but it is not likely it will succeed in doing this. There are a couple of events on the front of the drive that will cause the DC bus to go up. The first event is high input voltage. To get roughly what the DC bus should be for any given voltage multiply your measured input voltage by 1.414. As an example if you measured your input at 476VAC your DC bus should be about 673VDC. This will lower as you go up in power as you are drawing down the DC bus slightly and you are dropping voltage across the input reactor. With this formula to reach the trip limit on a 480V drive the input voltage would have to be about 644VAC.

Another thing on the input that can cause a rise in DC voltage is if there is a ringing circuit created. What happens here is that the drives RFI filters react with an external component to create a tuned circuit. This is something that is not easily detected with a normal DMM. The drive is affected more greatly by this if it is not active. The most likely place to look for this is in any passive filters on the front end, normally a 5^{th} harmonic filter. If there is a filter on the front end deactivate this filter and see if the problem goes away.

Ground fault (F3):

The ground fault is a software function that monitors the sum of all of the output currents. The drive is looking for this to be less than 50% of the motor nameplate current. The first step is to disconnect the motor and run the drive. If the drive faults more than likely the problem is in the drive but you should check the ground connections to make sure there is a solid ground as noise can cause this fault. If the drive does not trip it is best to try the drive on a test motor to see if it can run this. If the drive trips on a test motor again this problem is likely to be in the drive so the drive should be replaced. If the drive works on the test motor hook back up to the motor in question and monitor the output with a zero sum CT. If you do not see the zero sum current get above the trip level but the drive is tripping this would also likely be the drive. If you do see the zero sum current get above the trip level the problem is outside of the drive and the motor and its cabling will need to be checked out.

Saturation fault (F7):

The F7 saturation fault is looking at the voltage from the collector to the emitter of the IGBT when the device is turned on. If the drive monitors greater than 7VDC when the device is on it sees this as too great of a voltage for the IGBT to be working properly. This fault is only active on the FR4-9 frame sizes. There are a few things that can cause this trip.

- IGBT did not turn on due to defective firing circuit or IGBT
- Monitoring circuitry is not monitoring the voltage correctly giving false trips
- A short on the output of the drive can make the IGBT the highest impedance load
- Poor grounding can cause noise that will trip the drive

Most of the problems occur inside of the drive but not all of them. Do the static checks and DC balance checks listed below. This should tell you whether the problem is inside or outside of the drive.

System fault (F8):

The system fault has many sub codes to it that will lead you in different directions. This fault covers a lot of things in the drive so it is important to look at the sub codes for the fault. The following is what the #s mean for the “module” and “sub module”:
Module: 1=power, 2=power1, 3=power2 and 4=control
Sub-module: 1=unit, 2=board, 3=U, 4=V and 5=W.
On all F8 faults you should make sure the fault is repeatable before replacing any parts.

Sub codes for F8:
S1:

1. On all sizes check the IGBTs and the driver board.
2. On FR8 and below drives try a new control board
3. On FR9 and above check the fiber optic connections and order.
4. On FR9 and above if no work was previously done to the unit replace the ASIC board.

S2/S3: These have been disabled but if they do appear do the following.

1. Check the grounding. Bad grounding will cause noise the can cause these trips.
2. Reload the system software to see if it will get rid of the fault. If the fault happens again replace the control board.

S4: This has also been disabled if it appears do the following.

1. Check the grounding.
2. This is more likely to be caused by an ASIC so this is the first board to try if that does not work try the control board.

S5: This fault is an internal communication issue, this fault should only occur in the drives that use fiber optics but not star coupled drives.

1. Check all of the fiber optics for routing and correct order.
2. The boards most likely to cause this failure are the bus coupler (VB00228) and the ASIC board. The bus coupler is easier to replace although less likely to fail but it where I would start.

S6/S7: This is the charging relay feedback. It is only on FR9 and above drives and is likely to mean that the rectifier did not turn on. If there is an external precharge there may be a sequencing issue with this otherwise it is likely that the ASIC board is not working correctly. Pins 21&23 are the external contacts for the charging circuit, this is a dry normally open contact. If it doesn't work replace the ASIC card.

S8: This fault is the power OK signal coming back from the power boards. The best way to see this is with a PUT2 tester. With this you should be able to pin point the fault to the board that is causing it. This fault is only on the large drives (FR9 and above). The fault is likely coming from a power board and hopefully between the "module" & "sub module" that was captured in fault history it will tell you which one. There is a chance this fault is coming from the ASIC card but it is a lot more likely to be in the power board. Again the best way is to use a PUT2 as with this you should be able to see what board is causing the problem.

S9: This is a loss of communication between the ASIC board and the control board. Make sure that there is a good connection between the fiber adaptor and the control board but the most likely place for this failure is between the fiber adaptor and the ASIC board. The first thing to check is to make sure all of the fiber optics are plugged in and OK. The main ones to concentrate on are fibers 5-7. If you can't find a problem with the fibers the problem is likely in either the fiber adaptor board or the ASIC board.

S10: This is about the same fault as S9 except it is on a star coupled drive. The module in the fault history should tell you whether it is in the master or slave. 2=master and 3=slave. Troubleshoot basically the same as S9.

S11: This is a loss of communications between the ASIC board and the control board. The most likely place for this failure is the bus coupler but insure that the fiber optics are good specifically fibers 5-7. If this all checks out good the next component to try is the ASIC board (on FR9 drives this is the power module).

S12: This is a loss of communications to the D or E communications slot of the control module. This will always display as the E slot even if the fault is in the D slot. This fault would occur with a communication board that is linking multiple drives together. This would be a CANBUS card. The first thing to do is make sure the fiber optics or com cables are hooked up properly. After you insure the installation try switching slots to get the board working. If this works it means the slot the card was in is faulty and the control board will have to be replaced if you need the slot. If switching slots does not work try a different com card. The next thing to try would be a new control board.

S30-48: All of these sub codes have to do with the safe disable board (OPTAF).

Under voltage (F9):

The under voltage fault is taken from the DC bus (trip level is 183V for 230V drives, 333V for 480V drives and 461V for 575V drives). This fault will only occur if the drive is running when the DC bus gets to the trip level. This problem predominately is a loss of input power which the drive is running. The only thing that I have seen in the drive to cause an under voltage is an incorrect reading of the DC bus. This is usually pretty easy to diagnose as you can take a DC bus reading and compare this to the monitored value of the drive. If these readings aren't really close to each other you may have a monitoring problem in the drive.

Input phase fault (F10):

The input phase fault is looking for notches in the rectified 3 phase input. When a notch comes through it lowers this signal so if enough notches come through in a row it will lower this signal enough that it will fall below the trip point. This is a relative slow trip as the drive is capable of running with a missing input phase for a short period of time. This trip can be turned off but it is a good idea to have this on as the input current goes up 1.73 times on a single phase and the DC bus caps now have to filter out a ripple that goes all the way down to 0V. For this fault the first thing that you check is to make sure that all 3 phases are present on the input of the drive. If they are not you will need to troubleshoot upstream to see where you lost one of the phases. If all 3 phases are present reset the fault. If the fault resets it may have been a temporary loss of a phase on the input that the utilities have corrected. If the fault does not reset and you have all 3 phases present on the input of the drive there is something wrong with the monitoring circuit of the drive. Turn off this protection to see if the fault can be cleared. If there is something else monitoring the 3 phase that can shut the drive down the drive can be run this way. If there is no other monitoring circuitry for the 3 phase the drive should be repaired or replaced.

Output phase fault (F11):

The output phase fault is looking for the loss of current draw or a significant difference in current draw on the output of the drive. The drive will look for this fault when it gets above .5Hz and the output current exceeds 2.5% of the high overload (VT) rating of the drive. It will get this fault if a phase is less than 1/8 the sum of all the filtered output currents. If this condition lasts for more than 2 seconds you will get an output phase loss.

The first thing to do with this fault is disconnect the output of the drive and start the drive. If the drive faults on output phase loss there is something wrong with the current measurement on the output of the drive. If it does not fault ramp the drive up to 60 Hz and check the voltage on the output of the drive. Normally if the fault is coming from the drive it is because you are not firing one of the phases and you can see this by the voltage on the output. If you still do not see a problem run the drive on a test motor and check the 3 phase current on the output and compare that to the monitored value of all 3 phases. If this is all equal and everything looks good on a test motor hook the original motor back up and try this. If the drive trips right away you will need to use an oscilloscope on the output to be able to view the currents. If the currents are uneven at this point you will need to check the motor and its connections out.

Unit under temp (F13):

The trip level for this is -10C on both the IGBTs and the power board. See unit over temp for an explanation of where these temps come from. If the drive gets too cold we are concerned about there being condensation or frost on the boards. There is a great potential of shorting out the fine pitch circuitry on the printed circuit board so we trip the drive off. The other thing we are concerned about with low temperatures is solder connections cracking and causing a poor connection. If it is getting this cold around the drive you will have to raise this temperature somehow. In some of the large frame drives we have seen this be a false trip from the gate drivers or ASICs boards. This should be pretty simple to figure out if this is a false trip on not given the environment that the drive is in. If you have a star coupled drive the module should tell you which power unit the fault is coming from. If the fault is in the master drive it will display power1 and if it is in the slave it will display power2. You can go to the system menu and look in the power monitor to look at the temperatures fed up to the drive in the larger frame sizes. This will point you to what power module the issue lies in if it is a false temperature being fed up to the control module.

Unit over temp (F14):

The trip level for this is 90C for the IGBTs and 85C for the power board. Depending on the drive size there may be up to 8 different temps that can be read from the HMI. FR8 and below drive only have one sensor for the IGBTs and one for the power board. The power board is not read out on the HMI. On larger drives you have a sensor for every IGBT although only the highest from each phase is displayed on the HMI. It will also display the power board’s temperature. The temperature displayed in the monitor menu is the highest reading of the IGBTs. To see the individual reading you need to go to the multi-monitor which is normally located in the system menu.

When you have an over temp trip the first thing you need to figure out is whether you have a power module trip or a power board trip. In the fault history the fault will list a module and sub-module. The sub-module is the one that will say either module or board and this tells you where the fault is coming from. If it says module this is from the IGBTs and if it says board it is from the power board. If you have a star coupled drive the module should tell you which power unit the fault is coming from. If the fault is in the master drive it will display power1 and if it is in the slave it will display power2.

If the trip is from the module the first thing that you need to check is to see whether the cooling fans work. If the fans work the next thing to check is whether you have air flow through the drive. If you do not you may need to clean the cooling tunnel out on the drive. If you have air flow check the temp of the air flow to see if there is really hot air coming out of the drive or if it is cool air. If you have cool air flowing through the drive and it is still tripping out more than likely the temperature monitoring circuit is bad. This type of failure normally requires factory service to repair. Another thing to look for is the ambient temp that the drive is located in. The drive is meant to be in a location that does not exceed 40C and is no more than 1000 M above sea level. If either of these 2 conditions are exceeded the drive has to be de-rated.

If the trip is from the power board it can be caused by a couple of things. If the ambient temp around the boards is too high you can get this trip. More likely this trip will occur on FR10 and above drives. This trip is coming from the ASICs board and normally tells you the fan that cools the ASIC board is not working. Commonly just replacing this fan will fix this problem.

Something to note with this trip is that the drive will try to prevent this trip by changing its switching frequency. The drive will start to do this 1C before the warning level and will reduce its switching freq faster the closer it gets to the trip level. The drive will lower its switching frequency down to 2kHz.

Motor over temp (F16):

Motor over temp is a calculated trip in the drive. There are a quite a few factors that the drive takes into consideration when it is calculating this trip. The settings in the drive that affect this trip are: motor nameplate current, motor nameplate freq, motor ambient temp factor, motor zero freq current, motor heating time constant and duty cycle.

In normal circumstances the 2 settings that are set during a start up are the motor nameplate current and motor nameplate freq. The other settings in the drive are defaulted for a normal NEMA1 drip proof motor. What these settings are doing is setting up the heating curve of the drive. With these settings you can only run 100% current on the motor continuously at 100% speed. One thing to note here is that the motor has a service factor of 1 when running with a VFD due to the high freq heating of the VFD. Below is a list of what each of the setting do to the curve:

- Motor nameplate current: this sets the continuous current rating of the motor.
- Motor nameplate freq: on a motor that has a shaft driven fan this sets the freq at which the motor can continuously run motor nameplate current.
- Motor ambient temp: when the drive first starts up it uses its temp as the temp of the motor. When this setting is 0 it means the motor is at the same temp as the drive. If the motor is in a significantly different ambient temp than the drive you would use this to correct for this temp. An example of this would be if the motor is on a roof out in the desert with an ambient outside of 110F whereas the drive is in an air conditioned room at 70F you would set this to about 15%.
- Motor zero freq current: This is the % of FLA that the motor can run at zero speed. If the motor is cooled by an external blower or water jacket this can be drastically changed and put close to 100%. The thing that normally limits this is the cooling on the motor.
- Motor heating time constant: This is basically how long it takes the motor to heat up to 63% of 100% temp. Normally the bigger the motor the longer this time is. Unless you have this # from the motor manufacturer you should not change this value.
- Motor duty cycle: This is the duty cycle of the motor. This should be on the nameplate of the motor.

Motor over temp fault is normally an application fault although you will need to check all of the above values to make sure they are correct. Check the parameters that were captured when the drive faulted out. The main things that we are looking for is the freq of the drive and the output current. As I mentioned above the typical default motor curves is calculating this for a shaft driven fan so full current can only be run at full speed. What we are looking for is running too much current for the speed that we are running at. The trip level for this is 105%. Most of the time this fault is caused simply by drawing too much current for the speed that you are running at which is an application problem. At this point you need to try to figure out why this is happening in the application. The normal questions to ask are: How long has the application been running? Has anything changed lately? When do the trips happen? What kind of current did the application used to run?

EEprom Checksum (F22/23):

This fault means that the microprocessor failed the start-up check. This indicates that it lost some information which means you would probably have to reload the parameters to the drive. This could be caused by a voltage disturbance and may be a single occurrence. If this fault repeats you will have to replace the control board.

Watchdog fault (F25):

This is a fault of the microprocessor. First thing to do is try to reset the trip. If this is the first time it happened resetting it may work as it could have just been a voltage disturbance or the micro was overloaded for some reason. You should check the load on the microprocessor with the drive running and any communications working to see if it is possible the load is too high. We would consider anything in the 90 percentile to be of concern. If the micro is not being overloaded and if the trip has been repeated replace the control board.

IGBT over temp (F31):

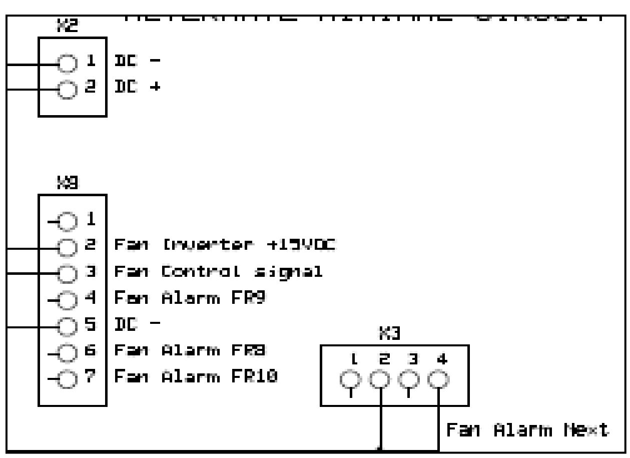
This is a hardware I2T function. This fault is only active on FR9 and above drives. This is a 4 stage circuit with each stage representing a higher current and quicker trip. When this fault is by itself if normally indicates a locked rotor. What you will find in fault history is a very low freq probably about 4 Hz with the current being at the current limit set in the drive. What this indicated is that the application went into a current limit when it started which means you either have a locked rotor or a hard starting application. If you have a locked rotor you should check this by spinning the motor manually. You may also want to confirm that you are not trying to start the motor backwards and you are hitting the anti-backspin. If you can spin the motor and there is nothing stopping the application from starting it is possible that the application takes a lot of starting torque. It may be a good idea to try the auto torque boost to get the starting torque needed. If there are other faults that occurred at the same time as this fault you should look at these faults first.

Fan fault (F32):

The F32 fault will only occur in FR8 or higher drives. There are 2 different types of fans, AC and DC. The more recent drives have DC fans and the previous models had AC fans. You can interchange the AC and DC fans but when you do so you have to change all of the fans and fan drivers in the drive. This means if you have a FR10 drive which has 2 main fans you need to change both fans and fan drivers. The DC fans are roughly 40% more efficient than the AC fans which is the reason for the change.

AC fan F32 fault:

These all have fan inverters that run the fan. See table later in this section for a list of the parts. The fault comes from the fan inverter. Below are the pin outs for the controls of the fan driver board.



- X2 pins 1 & 2 are DC bus input. This comes from the DC bus of the drive through a pair of fast acting 8A fuses.
- X3 pins 2 & 4 are for the alarm coming from the next board in the series. The last board in the series will have a jumper between these two pins. Most FR8 & 9 drives have a board that does not have this connector although if the FR9 drive has a board with an X3 connector there has to be a jumper installed or you will constantly get a F32 fault.
- X8 pin 2 is +15VDC control voltage. The VB00299 board creates its own 15V, all others are fed from the power board. Pin 3 is the control signal, this will be –DC bus. This control signal comes from the ASIC board on FR10 and above drives and from the power board on the FR8 and FR9 drives. When there is a 15VDC potential between pins 2 & 3 the fan driver turns on (-DC bus is applied to pin 3 to turn on and removed to turn off).
- Pins 4, 6 & 7 are the different alarm signal. 15VDC referenced to –DC bus is OK, 0V is alarmed. This is fed to the same place that the control signal comes from above.

There are really 2 types of failures that you get with this type of system. The first is that the fan is not spinning but the drive is able to run. This will normally end with the drive tripping in a F14 drive over temp trip. The second fault is a F32 fan fault. The difference between them is that in the first case the fan driver board thinks everything is OK, in the second case the fan driver board is faulted out. Below are the steps to follow when troubleshooting this.

- Fan control and LED status:

The first thing to do when troubleshooting a fan problem is to turn the fan control to continuous. To do this, go into programming mode and then go to the system menu\hardware\fan control. Select the fan control as continuous. If the fan still is not spinning look at the LEDs on the fan driver board. There are 2 LEDs on this board, a green one and a red one. One of these LEDs should always be on, if neither is on you should get a F32 fault and probably the fuses for this would be blown. If the board thinks it is running, you should get just a flashing green LED. If there is no control signal applied to the board you should get a solid on green and red LED. If the board is faulted you should see something other than the above statuses.

Fan driver LED status		
Green LED	**Red LED**	**Status**
On	On	Board is in standby mode
Flashing	Off	Board is running
Off	Off	Fuse is blown or board has failed
Any other combination		Should see a F32 fault when fan is asked to run

Checking the fuses (this step is skipped if there are LEDs lit on the fan driver):
If when the drive is powered up there are no LEDs lit on the fan driver board the most likely cause is that the fuses are blown. The fuses for this are 8A (6A in early versions of the drive) fast acting fuse and like fuses should be used when replacing these. Remove power from the drive and locate the fuses. If you follow the wires back from X2 on the fan driver this should lead you to the fuses. Remove fuses and ohm check. If you have a blown fuse before you replace it, do a diode check on the X2 connector. Forward bias you should get .8-1.6V depending on the board and reverse bias you should get an overload. If you see a short on this the fan driver will have to be replaced, this is likely as something took out the fuse and it is likely to be the fan driver.

- Checking the output of the fan driver board:

Insure that power is removed from the drive and then disconnect the blue and black wires going out of the fan driver board. These are the only 2 spade connections made to this board. Connect a DMM to the spade connections on the board, you will be reading 230VAC at 50 Hz when the board is running. Power up drive and insure that the green LED is flashing, you should have roughly 230VAC on the DMM. If you don't have 230VAC here replace the board. If you have 230VAC here power down and reconnect the wires that were originally connected to these terminals.

- Checking the output of the fan isolation transformer:

The easiest place to check the fan isolation transformer is at the fan plug. On FR9 and above units this is at the bottom of the drive where the fans are and is a 4 pin quick disconnect. On FR8 drives this is located where the output leads enter the drive at the bottom of the unit, these are spade connectors. Disconnect the fan. Power up the drive and insure there is a flashing green LED on the fan driver board. With a DMM between the blue and black connection you should read 230VAC and between the blue and brown connection you should read the same. If you do not read 230VAC between blue and black replace the isolation transformer if you read it between blue and black and not blue and brown replace the starting cap.

- Checking the fan and starting capacitor:

Remove power from the drive and check the fan windings and starting capacitance per the table below. Normally if you are going to see something wrong with the windings they will be open. If the capacitor is less than 50% of its value it probably is not going to get the fan spinning at full speed. The fan may run with the cap at a low value but it will probably not get up to speed as it depends on this cap to give the motor a rotating magnetic field. If the capacitor is less than 75% of its value it is a good idea to change it as this indicates that the capacitor is starting to go bad.

Fan part number	**PP01123 (FR8)**	**PP01080 (FR9 and above)**
Fan wires	Resistance in ohms	Resistance in ohms
Black – brown	110	60
Brown – blue	50	35
Blue - black	60	25
Fan starting capacitor	5uF	7uF

Try to spin the fan by hand to see if there is something mechanical stopping it from working. If the fan does not spin freely remove whatever is obstructing movement or replace the fan. The most likely thing that would stop a fan from spinning is the bearings. If the bearings are bad they can be replaced. The bearings in the PP01080 fan are one each of a 608 and 6000 bearing. The PP01123 will have a couple 608 bearings. These bearings are skate board bearings so can be purchased from someplace that deals in this type of bearing. The recommended bearings to put back in the fan are the ceramic coated bearings. If the bearings are bad this is a symptom of the problem, more than likely you will have to also replace the starting capacitor as this is what normally causes this. If the fan spins freely hook the fan back up and power up the drive. The fan should start as soon as the green LED starts flashing on the driver board. If the fan doesn't start when the driver board has a green flashing LED recheck the starting capacitor, if that checks out replace the fan.

By following the above steps this should lead you to successfully troubleshooting the problem but there are a few problems these will not find but all of the basic signals are explained. There can still be problems in the ASICs and control board for FR10 and above and problems in the power board and control board for the FR8 & 9. You should be able to tell this by the signals into and out of the fan driver board.

	FR8/230V	**FR8/480V**	**FR8/690V**	**FR9/230V**	**FR9/480V**	**FR9/690V**
Fan driver	VB00599	VB00799	VB00699	VB00899	VB00399	VB00299
Iso xmfr	PP08026	PP08026	PP08026	PP09056	PP09055	PP09055
Fan	PP01123	PP01123	PP01123	PP01080	PP01080	PP01080
Starting cap	PP00061	PP00061	PP00061	S00465	S00465	S00465
Fan fuses	PP20202	PP20202	PP20202	PP20202	PP20202	PP20202

	FR10/12	**FR11**	**FR13/14**
Fan driver	VB00299	VB00299	VB00299

Iso xmfr	FR10844 (Left) FR10845(Right)	FR10845	
Fan driver assembly includes both parts above	FR10846 (Left) FR10847(Right)	FR10847	FI13301
Fan	PP01080	PP01080	PP01080
Starting cap	S00528	S00530	S00520
Fan fuses	PP20202	PP20202	PP20202

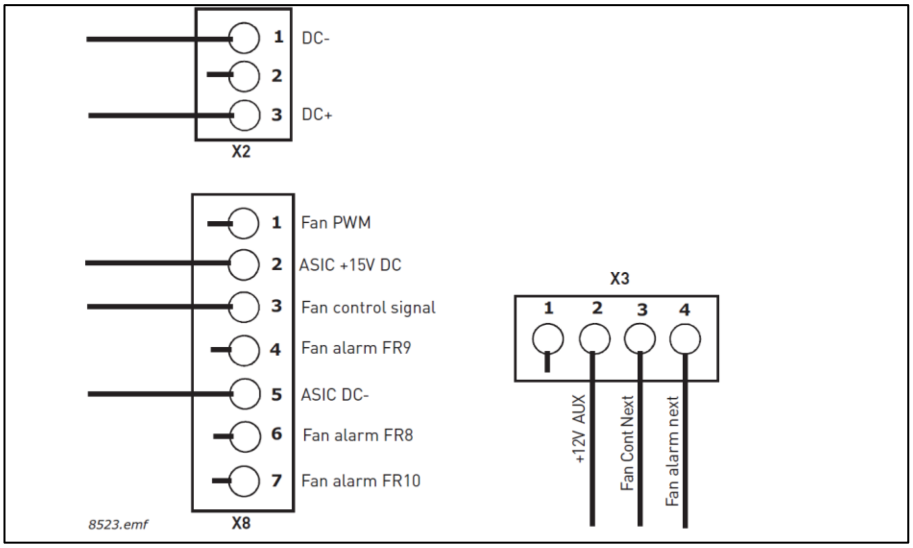
DC fan F32 fault:

The DC fans operate with about the same signals as the AC fans which make them interchangeable from a control standpoint as the connectors going to the fan drivers are the same. One of the main differences between the DC fans and the AC fans is that the DC fans have an encoder in them so we monitor the fan for speed which means with the DC fans it is not only the fan driver that is monitored by this fault but the fan also. This also means that if you disconnect the fan as soon as the drive asks for the fan to run you are going to get an F32 fault whereas with the AC fan the drive did not know if the fan was connected only that the fan drivers were working.

- X2 pins 1 & 2 are DC bus. This comes from the DC bus of the drive through a pair of fast acting 8A fuses.
- X3 pins 2 & 4 are for the alarm coming from the next board in the series. The last board in the series will have a jumper between these two pins. Most FR8 & 9 drives have a board that does not have this connector although if the FR9 drive has a board with an X3 connector there has to be a jumper installed or you will constantly get a F32 fault.
- X8 pin 2 is +15VDC control voltage. Pin 3 is the control signal, this will be –DC bus. When there is a 15VDC potential between pins 2 & 3 the fan driver turns on (-DC bus is applied to pin 3 to turn on and removed to turn off). Pins 4, 6 & 7 are the different alarm signal. 15VDC referenced to –DC bus is OK, 0V is alarmed.

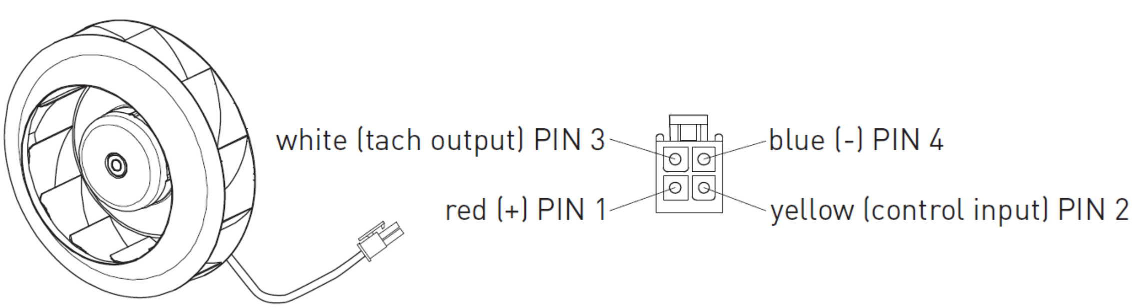
DC Fan Parts			
Frame size	**Fan part #**	**Fan driver part #**	**Fan upgrade kit***
FR8 480/575V	PP00071	S01016	S00965
FR8 230V	PP00071		S01053
FR9 480/575V	PP00072	S01017	S00966
FR9 230V	PP00072		S01054
FR10	PP00072	S01017	S00967
FR11	PP00072	S01017	S00971
FR12	PP00072	S01017	S00970
FR13	PP00072	S01017	S00979
FR14	PP00072	S01017	S00982
FI9	PP00072	S01017	S00968
FI10	PP00072	S01017	S00969
FI12	PP00072	S01017	S00972
FI13	PP00072	S01017	S00973
FI14	PP00072	S01017	S00974

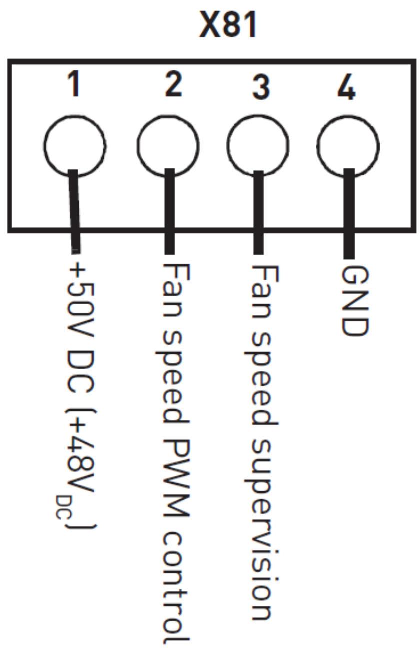
*The upgrade kits include all extra wiring and hardware needed along with the fans and fan drivers to complete the whole drive. When switching from AC to DC fans it is recommended to do this with a kit to insure that you have all of the wiring and hardware needed to complete the upgrade.



Fan Control Signals

1. The first thing to look for are the LED lights on the fan driver. There are 3 LEDs on the driver: green = power on, yellow = fan start command given and red = fault. If there are LEDs lit skip the checking fuses step.
2. If when the drive is powered up there are no LEDs lit on the fan driver board the most likely cause is that the fuses are blown. The fuses for this are 8A (6A in early versions of the drive) fast acting fuse and like fuses should be used when replacing these. Remove power from the drive and locate the fuses. If you follow the wires back from X2 on the fan driver this should lead you to the fuses. Remove fuses and ohm check. If you have a blown fuse before you replace it, do a diode check on the X2 connector. Forward bias you should get .8-1.6V depending on the board and reverse bias you should get an overload. If you see a short on this the fan driver will have to be replaced, this is likely as something took out the fuse and it is likely to be the fan driver.
3. If the green and yellow LEDs are lit and you have an F32 fault check the output out of the fan driver back to the control or ASIC unit. The outputs are described above so you should see 15VDC referenced to –DC bus on the appropriate pin. If you do not see this signal replace the fan driver. If you do have the right signal going out of the fan driver but still have a fan fault replace the ASIC board (on the FR9 this would be the power module and on the FR8 it would be the power board).
4. If you have a red LED on that means that the driver is faulted. If this is in a FR10 or higher drive try switching the fans or the drivers whichever is easier and see which one the problem follows. Replace the component that the problem follows.
5. If you have a FR8 or FR9 drive and you do not have any spare parts to try you can try to read the DC output out of the fan driver. This output should be right around 50VDC (these connections are not easy to get at so this may not be feasible). If you have spare parts the first thing to try is a different fan. If this does not work try a different fan driver.





Fan Pin Out

Application fault (F35):

This fault occurs if the application has gotten overloaded for some reason. The first thing to do is reset the fault and see if it will reoccur. If the fault does reoccur you should reload the system and application software. If this does not fix the problem please contact Eaton for further instructions.

Device unknown fault (F40):

A device unknown fault predominately happens when replacing boards in a drive. What this fault is looking for is valid data in the EEPROM on the circuit boards. This fault usually comes from the power board but the fault history should tell you what module and sub-module that is not valid. If this fault comes up without any work being done to the unit it means that some data has been lost by the board in question. You may be able to reprogram the board and get it to work but the board should probably be replaced at the earliest convenience as it is likely to happen again. If this happens after a board has been replaced it is likely that the correct data has not been loaded to the board. On drives that have multiple ASIC boards all the extra data needs to match from one unit to another. Of some note is that a star coupler board has to have a serial number programmed in it to make it work.

IGBT over temp (F41):

This fault is the software I2T trip. It works a little different than the hardware trip and is active on all drives. For this trip the drive calculates a simulated temperature for the IGBT and adds it to the measured temperature for the IGBT. If this temp exceeds 125C the drive will trip on a F41 fault. You troubleshoot this fault about the same way you troubleshoot the F31 fault.

Ext fault (F51):

The external fault on this drive is mainly from temperature switches. There are 3 series temp switches in the phase shifting transformer and one temp switch on the external rectifiers. On FR10 above drives this is normally all that there is so you would be looking for one of these to be tripped. If one of them is tripped you will have to investigate the reason for it. On FR9 and below you also have an interlock on the precharge contactor added into this. If the drive trips on external fault only when you try to start the drive it probably is this interlock that is causing it as there is a normally closed run contact across this so it does look for this until you try to start.

Slot communication fault (F54):

A slot communication fault occurs when the main control board cannot communicate with one of the boards that are plugged into it. In the fault history under the sub-module it should tell you what slot it is not seeing. The easiest way to troubleshoot this problem is to take the board out of this slot and install a different board. If you do not have another board to try this most boards can be put into more than one slot. Switch the board in question to another slot, if the problem moves with the board you have a bad board that will need to be changed. If the problem stays with the slot the control board is bad. To temporarily get up and running if you have an open slot that the board can be put into move the board. Sometimes this fault can't be cleared whether there is a board in the slot or not, in this case the only real option is to replace the control board.

Static checks:

The first thing that should be done is static checks on the drive. This has to be done with power removed from the drive and the motor isolated from the drive. Checks can be done with any meter that has a diode scale on it but different meters may read this differently, we recommend a Fluke 87V. Forward bias is with your + lead to –DC or your – lead to +DC.

Measure point:	Value:	Measure point:	Value:
Rectifier forward: L1/L2/L3 to B+	1,2 V	Rectifier reverse: B+ to L1/L2/L3	Infinite
Rectifier forward: B- to L1/L2/L3	0,45 V	Rectifier reverse: L1/L2/L3 to B-	Infinite
Brake diode forward: R- to B+	0,35V	Brake diode reverse: B+ to R-	Infinite
Brake chopper: R- to B-	Infinite	Brake chopper: B- to R-	0,35V
IGBT diode forward: B- to U/V/W	0,35 V	IGBT diode reverse: U/V/W to B-	Infinite
IGBT diode forward: U/V/W to B+	0,35 V	IGBT diode reverse: B+ to U/V/W	Infinite

FR7/8 & FR10 and above

Measure point:	Value:	Measure point:	Value:
Rectifier forward: L1/L2/L3 to B+	0,45 V	Rectifier reverse: B+ to L1/L2/L3	Infinite
Rectifier forward: B- to L1/L2/L3	0,45 V	Rectifier reverse: L1/L2/L3 to B-	Infinite
Brake diode forward: R- to B+	0.4 V	Brake diode reverse: B+ to R-	Infinite
IGBT diode forward: B- to U/V/W	0,4 V	IGBT diode reverse: U/V/W to B-	Infinite
IGBT diode forward: U/V/W to B+	0,4 V	IGBT diode reverse: B+ to U/V/W	Infinite

FR4-6 & FR9

If you find a short or open where you should have a diode reading there is more than likely something wrong with at least one of the PN junctions, please contact Eaton with this information and further instructions. If everything looks good proceed to the next step.

DC balance checks:

Power the unit up and insure that the drive is not started. With your meter on DC measure from –DC bus to U, V & W. You should read somewhere between 2-50VDC. The real key that we are looking for is one that reads either 0VDC or a very high voltage. All 3 of the phases should read relatively even but I wouldn't reject it unless it is outside of the range stated above. If you do find something outside of the range, stop and contact Eaton with these readings.

If the readings pass start the drive and do the DC checks again. With the drive running you should now get an even split from + & - DC to U, V & W **(this has to be done with the drive in ramp to start and not flying start)**. If an IGBT is not firing you will likely either get 0VDC or full DC bus, if you get either of these stop and contact Eaton. If the readings are OK ramp the drive up to full speed and check AC phase to phase on the output. You should see voltage that is normally higher than the actual rating of the drive but this will depend on the meter you are using. All 3 phases should be even. You can also measure from each phase to ground but this may vary depending on what your input power is referenced to. Most people have a wye input so the output will kind of look like a wye and it is easier to see what phase is giving you a problem if you are seeing a problem but only use this as a reference. If there are problems noted here please contact Eaton with the results.

If all checks are good up to this point it is not a bad idea to connect a small test motor to the drive and run it. If the drive can smoothly spin a small motor it tells us there isn't a problem with the firing of the IGBTs in the drive. If the drive passes all of the tests up to this point it either means it takes current for the drive to fail or the motor is failing. If there is another motor close by that the drive can be run on it would be a good idea to try and run it on a known good motor. If it fails on this it is most likely the drive, if it works it is most likely the motor or grounding.

Checking the output of the drive with its output disconnected: (drive has to be set for ramp to start and not flying start) What a drive actually controls is the voltage and freq on its output. It basically controls everything else by adjusting these 2 things. Checking the output voltage on the drive will tell you within a certain amount of reason that the drive is outputting what it should. To check this, do the following steps:

1. Make sure everything is disconnected from the drives output. This includes reactors, DV/DTs, etc.
2. With the drive powered up check for DCV from –DC bus to U, V & W. This voltage should be even and will probably be in the range of about 5VDC to 50VDC. If you have a problem here you will normally see either 0VDC or full DC bus. If either of these is seen the drive will have to be repaired or replaced.

3. Start the drive at 0 Hz or close to 0 Hz. Check from both the + & - DC bus to U, V & W. The reading should all be at about 50% of the full DC bus. Again if you have a problem you will normally see either 0VDC or full DC bus. If either of these is seen the drive will have to be repaired or replaced.
4. Ramp the drive up to full speed and check U, V & W from phase to phase for ACV. The reading here may vary with the meter that you use so this measurement is more for reference, it will normally read high because of the PWM output. The readings should be even (the readings should be within a couple % of each other), if they are not repair or replace the drive.
5. If the drive is a master/slave drive with the drive running check to make sure there is little to no difference between the same phases of the master and slave drive. If there is a large voltage difference likely the two drives are not in phase with each other. This is likely to be fiber optics that are switched.
6. Ramp the drive back down and turn off.

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Additional Help

In the US or Canada: please contact the Technical Resource Center at 1-877-ETN-CARE or 1-877-326-2273 option 2, option 6.

All other supporting documentation is located on the Eaton web site at www.eaton.com/Drives

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