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Title: **SVX Troubleshooting guide**   Owner: Lamp, Shawn

Troubleshooting: This is meant for a drive that has been running successfully on the application in the past.

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 means 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, see motor tests at the bottom of this document. 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). 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 (other than PM 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 775VDC 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 with the issue. 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 are harmonics on the line. These harmonics are higher order frequencies that are not easily detected with a normal DMM. The drive is affected more greatly by this if it is not active or running. The most likely place to look for this is in any passive filters on the front end, normally a 5th harmonic filter. If there is a filter on the front end deactivate this filter and see if the problem goes away. If there are no filters you are looking for voltage harmonics. The way you can normally tell that you have a harmonic issue is with the output of the drive disconnected measure the input voltage to the drive and compare this to the measured DC bus. DC bus should be close to AC input x 1.414. If it is higher than that you have some type of harmonic issue.

Ground fault (F3):
The ground fault is a software function that monitors the sum of all of the output currents. By default, the drive is looking for this to be less than 50% of the CT current rating of the drive. In later versions of software this value is settable by P1.7.25 earth fault current. Insure that this setting is not too low, commonly this should be set somewhere between 10-20%. 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. You may need to turn the ground fault to warning or no action for troubleshooting.

Charging switch fault (F5):
This fault is a feedback from the charging relay. The charging relay is basically the relay the switches from precharge to having the rectifiers turned on. On the FR4 & 5 drive this is a relay on the positive DC bus side that when turned on shorts across the precharge resistors. On all larger drives this is a feedback from the

relays that switch from the precharge resistors and diodes from being connected to positive DC bus to being connected to the gates of the SCRs on the positive rectification. On the FR6 drive this is done on the power board. On all larger drives there will be a rectifier board for each set of rectifiers there is. If the drive is a FR12 in the fault history under module it should be you if the problem is in the master or slave side. As a note this fault will normally only show up on FR8 and below drives. Once you go to FR9 drive and above this will normally show up as a F8 S7 fault. On a FR7 and FR8 drive the rectifier board would be the first thing to replace. On the FR6 and below drive this would be the power board and may not be worth repairing.

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 FR4-8 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 at the end of this document. 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 numbers 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: For FR9 and below units
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 check the fiber optic connections and order.

S1: For FR10 and above units
1. Static check the IGBTs. This will include doing gate resistance checks on the gates. There are 3 pins associated with each gate check the resistance on the outside 2 pins. As an example, if the gate is on pins 1, 2 & 3 you would check the resistance on pin 1 to 3. The easiest place to read gate resistance is on the gate driver board. The resistance will vary depending on the size of the unit, generally you are looking for them to be all the same. If you find one that is different it probably means that the gate in the IGBT is bad. This would mean that you would need to change the power module and the gate drive associated with it (the driver may be OK, but it is better to not take a chance). If static checks are OK move to the next step.
2. Power the drive up. If you get this fault when you power the drive up without starting the drive, there is a good chance the issue is in the ASIC board. Replace the ASIC board to see if the issue will go away. If you don't have the fault when you power up without starting the drive move to the next step.
3. With the motor disconnected go through the balance checks on the drive. If you have a phase that is not passing the balance checks it is advisable to isolate the IGBTs on the phase the does not pass from

each other. Insure that any loose leads can't move and touch something else. Go through the balance checks on the phase that didn't pass checking the individual IGBTs. If all the IGBTs are doing the same thing the issue is likely in the common point which would be the gate driver. If the IGBTs are doing different things the issue is in the individual IGBTs. This would mean that you would need to replace the power module (the safe thing to do would be to replace the gate driver also).

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 (S00451) and the ASIC board (S00457). 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 either the ASIC board or rectifier board is not working correctly. On the ASIC pins 21&23 are the external contacts for the charging circuit, this is a dry normally open contact. Putting a jumper from pin 21 to 25 and 23 to 26 (putting a jumper directly from 25 to 26 should also accomplish the same thing) if you have an ASIC board should bypass this fault. If you have a CPX drive disable the external rectifier before doing this troubleshooting. You do not want to have this rectifier turn on if the internal rectifiers are not turning on. It would skew your troubleshooting data. If it doesn't work replace the ASIC board. If it does get rid of the fault it probably means you are not getting the feedback from the rectifier board.

To ensure that there are no blown rectifiers or precharge resistors go through the rectifier static checks. Values for these readings are at the end of this document.

To see if the internal rectifiers are turning on the first thing to do is see if the drive is bypassing the precharge resistors. You do this by the DC bus level. If the drive is bypassing the precharge resistors you should see a normal DC bus. Normal DC bus is V_{in} x 1.414 (CPX drives will be higher than this due to the phase shifting transformer). If the drive is not going past precharge DC bus will be somewhere between 10-20% low. If the drive is not going through precharge the most likely cause of this is the rectifier board although the ASIC can cause this also.

If you have a drive with 2 rectifiers in it (all FR11 drives and all FR10 CPX drives except drives sync) you have to deal with this slightly differently. There will be 2 rectifier boards. These boards are the same except the first rectifier board has the X50 jumper cut off of it. The first rectifier board is the board on the right side of the drive. You could potentially have one rectifier turn on without the other turning on. This would indicate that the ASIC is working put one of the rectifier boards is not. You will not be able to tell this by the DC bus level. You will need to check current draw for this.

To check current draw, you will need to run the drive at a low power level. You don't want to get too high of a power level because you don't know at this point how many rectifiers are working. I would try to keep the

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power level to no more than 25%. It is best to check current with something that gives you a visual display, but you can use a normal clamp on ammeter. If a rectifier doesn't turn on it does not eliminate all current on that phase. If stops the positive current on that phase. This will take some of the current away from the other 2 phases, so they don't look so unbalanced. In a normal 3 phase system what it does is takes 50% of the current away from the phase that is not working but will take 25% of the current away from the other 2 phases. Therefore, it is best to use a meter with a visual display because it is easy to see the phase that is missing all of the positive current. If you are missing the positive current on any rectifier double check your static checks on the rectifiers. If the static checks are good, replace the rectifier board.

If all of the current draw is good, it probably means that you are getting a false trip from the rectifier board. You can run the drive this way, but it is advisable to get the drive fixed as soon as possible. The potential for failure running this way is if the rectifier doesn't turn on you could draw current through the precharge resistors. The likely result of this is that the precharge resistor would open up. This will normally not cause any other damage than that so is limited in what could happen.

If you had disabled the external rectifier on a CPX drive, enable the rectifier.

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: This is a safe disable fault. There are 2 inputs into this card, and this is telling us that they are different. Check the inputs and see which one is off.

S31: This is a short circuit on the thermistor input on the safe disable card. Check what is connect to the thermistor input. Whether this is monitored or not is set by the X10 jumper on the board. If short circuit

detection is on you are limited to about 250M of cable. If you aren't using short circuit detection you can go out to 1500M of cable. Turn the short circuit monitoring off and see if you can reset the fault.

S32: This is saying that the safe disable board has been removed without going to the system menu under security and removing the safe disable card.

S33: This is an EEprom checksum error on the safe disable card. Try cycling power to the drive. If this does not clear the fault or the fault comes back after a period of time replace the safe disable card.

S34-36: A hardware supply voltage problem has been detected on the safe disable card. Try disconnecting all inputs into the card to see if this will go away. If it does not replace the card.

S37-40: A hardware problem detected in the safe disable card. This could be the control card or the safe disable card. Replace one at a time to see which one it is.

S41-43: A hardware problem detected for the thermistor input into the safe disable card. Disconnect the thermistor input to see if you can clear this fault. If this does not work replace the card.

S44-46:   A hardware problem detected for the thermistor input or safe disable input into the safe disable card. Disconnect the inputs to see if you can clear this fault. If this does not work replace the card.

S47: Safe disable card installed in a control board not equipped for a safe disable card. The card needs to be a VB00561H or newer card.

S48: The programming for the thermistor fault does not match the hardware setting. X12 jumper is what determines how the drive reacts to this. With the jumper in the drive will always shut down no mater what you have the action set to. If you do not want the drive to stop when this exceeds temp you will need to cut the X12 jumper.

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. In the fault history look to see what the sub-code is for the fault.

Sub-code S-1:   This problem predominately is a loss of input power while 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 one another you may have a monitoring problem in the drive. Normally this fault is an external loss of input voltage to the unit.

Sub-code S-2: This is a loss of communication of the DC bus level between the power and control sections. This is likely to be in the power section. On units that are fiber optically coupled this problem could be in the ASIC, bus/star coupler or the fiber optics although it is not likely to be the fiber optics. The most likely cause would be the ASIC.

Input phase fault (F10):
S1: 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.

S2: This is the input phase fault on AFE drives. Troubleshoot the same as above.

S3: This is an input phase fault on an AFE that is on a microgrid. Things to look for is the frequency of the grid, is it too or too high. Phase rotation of the input.

Output phase fault (F11):
Sub code S1: 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.

Sub code S2: This sub code you get in closed loop applications. This means that there is no current flowing in one or more of the output phases. Best to change to open loop and troubleshoot in open loop.

Sub code S3: This code of for open loop DC brake control. Check the resistors connections. Static check the brake IGBT.

Sub code S4: This code is for a PM motor, start angle identification.

For S1 and S2 sub codes:
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, hook the drive back up to the original motor. Before hooking the motor back up do an inductance check (if you do not have an inductance meter do an ohm check on the windings). You should not see an open on the windings and if you are checking inductance, they should all have about even reading normally in the range of about 300uH to about 3mH. If the drive trips right away, you will need to change the trip setting (1.7.6) in the drive to a warning or no action. Then you can start the drive and compare the measured output current to the monitored output current. You can see all 3 output phase currents in the system menu under power monitor. If you have all of the measured current but you are missing a monitored current, there is an issue in the drive. If you are missing a measured current stop running the drive as soon as possible as the motor will be single phasing. If your voltage checks on the output of the drive were good and you did not see any open windings in the motor to differentiate between the motor and the drive switch where the output leads are connected to the drive. If you need to maintain the same rotation for this test you will need to move all 3 output leads over one connection. If the direction does not matter for the test swap the lead that did not have current on it with one that did. Restart the drive and check the current again. If the problem stayed with the same phase on the drive the issue is in the drive. If the problem moved with the motor lead the issue is somewhere in the motor or output run.

Brake chopper supervision (F12):
This fault comes up when the drive is either trying to brake or testing the brake and does not see the right voltage across the brake transistor. The first thing to check is the resistor. Check the resistor for the proper resistance value. The value of the resistor should be on the enclosure for the resistor. If the resistor is OK static check the IGBT for the brake. On FR6 and below drives the brake chopper is standard on the drive and is part of the normal power structure. If there is an internal problem with the brake you probably will need to replace the drive. On FR10 and above drives the brake feeds through the ASIC to the separate brake driver board. The issue could be in either of these. On FR9 drive this feed through the power board to the rectifier board. On FR7 & 8 drives the brake is driven from the power board.

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 more recent versions of software there is a cold weather group which will let you put settings in the drive where it will use the switching losses and I2R losses from magnetizing current to try to warm the drive up. If the drive succeeds in raising the temp up above -10C in the allotted time it will then start normal operation. If it does not it will fault out and you will need to use other means to raise the temp.

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.

S1: 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.

S2: This trip comes from the power board. On FR7 & 8 drives this is a temp switch, so you only see the fault. On FR9 and above drives this is an analog temp being fed back from the power board (on FR10 and above this is the ASIC). This indicates that either the temp that the power board is in is too high or the fan cooling the power board is not working.

S3: This trip is for liquid cooled drives. This indicates that the liquid flow is low. Check liquid flow and detection devices.

S4: The module code should tell you what power module this fault is coming from if this is a master/ slave drive. The submodule codes are board, U, V, W. This is overheating of the FET on either the ASIC or the gate driver. The only place we have seen this come from at this point is the ASIC board. Check to make sure that the fan for the ASIC is working. Check the temp of the ASIC in the power monitor in the system menu. This tends to be a hardware trip so the temp of the board might not be high. The first thing I would try is the ASIC board. If that doesn't work and the submodule is U, V or W replace the gate driver associated with the code.

Motor stall (F15):
Motor stall is set up in the protections group. There are 4 parameters that are set for the motor stall. First you set what you are going to do with the stall. The default for SVX software is to no action. You can set it as a warning, fault or fault/coast to stop. The next thing that is set is the stall current. This is the value of current the drive has to exceed for the drive to look for a stall. Normally you would set this a little below the current limit of the drive. The next thing that is set is the time. This is the amount of time the drive needs to exceed the stall current for the trip to activate. The last thing is the frequency. This is the frequency at which the drive stops looking for the stall. If you get a stall it means that you have exceeded your stall current for longer than the stall time below the stall freq. This normally indicated a locked rotor situation, or it is an application that is hard to start.

A locked motor normally means that there is something mechanical that is stopping the motor from turning. In pumps this is likely to be something caught in the pump or the pump is frozen. There is the possibility of bearings being frozen also. If it is a start-up or the first time you are running the drive and the application has anti-backspin you may be rotating in the wrong direction.

An application that may be hard to start would include a conveyor, positive displacement pump or possibly a fan. If the application is hard to start the best thing to do is an ID with run on the motor. To do this you will need to uncouple the motor but by doing this the drive will identify the motor and know exactly what it takes to start it. You can also set the auto torque boost in the drive. What this does is give a little more voltage at start up to give you more starting torque. Depending on how many poles the motor is you could current trip the drive by using this setting. As a rule of thumb, I would be cautious of using this on any 8 pole or higher motor.

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If you can't find anything in the application that is causing this fault the next thing to try would be to disconnect the motor and run the drive. The drive should read close to zero current with nothing connected to the output. If you are reading significant current, there may be a current measurement issue in the drive. If you see no issues at this point reconnect the motor and uncouple the application. When you start the motor, you should see the magnetizing current of the motor. Depending on the motor and the number of poles this could be anywhere between 20-70% of the FLA of the motor. A 4-pole motor should have somewhere around 25% whereas an 8-pole motor will draw somewhere around 50% magnetizing current. If the drive goes into current limit either there is something wrong with the motor or the drive is reading the wrong current. More than likely you will not be able to read this with a clamp on meter as it is happening at such a low frequency.   The best thing to do at this point is try a different motor on the drive and see if the current is right. If you don't see any problems up to this point the problem more than likely is in the application somewhere.

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?

Motor underload (F17):
Motor underload is somewhat the opposite of stall protection. There are 4 parameters associated with this.

- Underload protection: This is what the drive will do to an underload
- UP fnom torque: This is the top of the curve. This sets under what torque at motor nameplate freq the drive will start counting towards a fault.
- UP f0 torque: This is the bottom of the curve. This sets the toque the drive needs to be above at zero freq or it start counting towards a fault.
- Up time limit: This is the amount of time that the drive needs to be continuously below the curve set above to fault out.

This fault is normally an indication that somehow the application is not connected to the drive. The easiest way to troubleshoot this fault is to turn the fault off so you can run the drive. The first thing to confirm is that the drive is drawing current on the output. If it is not you need to look at output contactors or disconnect switches. If the drive is drawing current but no power look to see if the application is connected. If the coupler sheered? Are the belts off? Etc. If you are drawing current and torque did something change in the application that you are not drawing enough torque? Are the settings correct in the drive for the application?

Unbalance fault (F18):
The unbalance fault is for master/slave drives so this would be on FR12 and FR14 drives.

S1: This is an unbalance of current between the 2 sides. You will need to confirm if this is a real unbalance or a measurement problem. As you bring the drive up keep it under the point where it trips. Measure the current on both sides and they should be close to each other. Then take a look in the power monitor in the system menu and compare the measured values to each other. Again, they should be close to each other. One of the best things for balancing current between 2 inverters is output reactors. Normally a 1.5% or so reactor on the output of each inverter does a pretty good job of balancing. The other thing to look for here is whether or not the DC bus in the same on both sides. If the DC buses are not connected together the buses could be different. If they are different you will need to investigate why they are not.

S2: This is an unbalance of the DC bus between the 2 sides. First thing to do is to confirm that there is a true difference or a measurement difference. In the power monitors in the system menu you can see the monitored values on the 2 sides. Compare that to the actual measured values. If there is a measurement problem the DC bus is actually measured in the ASIC board. You can swap the ASIC boards between the 2 sides and see if the problem goes with the board. If it does it is the ASIC. If it doesn't, I would try the star coupler board. If the DC buses are actually different you will need to look at the rectification for both sides. Check the AC input to both halves to make sure there isn't an issue with the reactors. If you can run the drive at a certain power level check the current into both halves.

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.

Counter fault (F24):

This is an operating clock or energy counter checksum error. Reset this fault and check the drive for grounding. If the fault comes back replace the control module.

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.

Startup prevented (F26):
S1: A start has been prevented due to the DC bus level. DC is too high

S2: A start has been prevented after a safe disable reset. Start command is leading edge so start needs to be removed and reapplied.

S30: A start has been prevented after an update to software. Start command needs to be removed and reapplied.

Thermistor fault (F29):
Thermistor input is greater than 4k ohms on the OPTAF card. Check thermistor. Check motor temp.

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: (Please note that the AC fan system is obsolete and parts are not normally available. It is advised that you update the system with a DC fan kit. These kits are listed in the DC fan troubleshooting section.)
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.
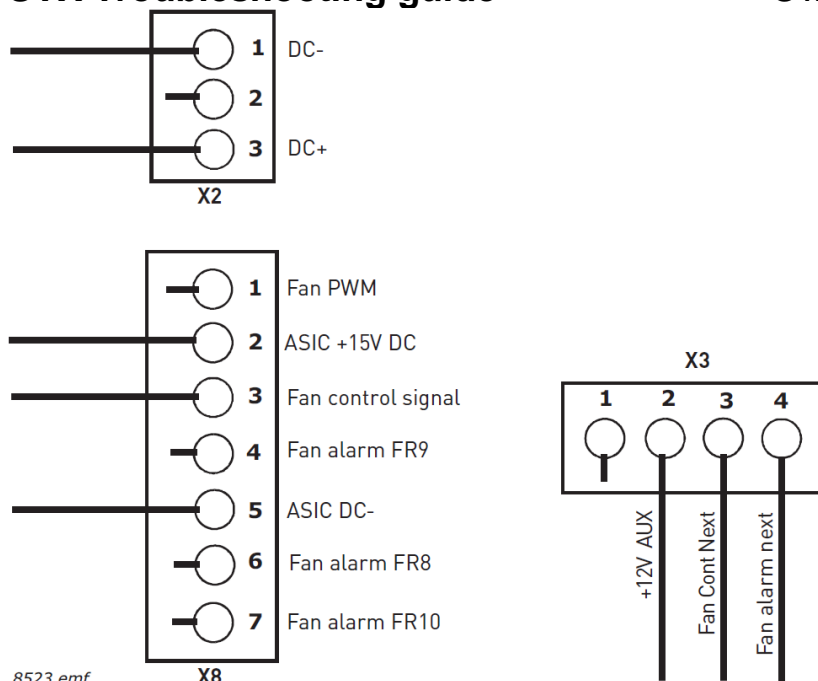
Fan Control Signals

- X2 pins 1 & 3 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, 0VDC is alarmed on FR9 and above. FR8 is alarmed with 15VDC and OK at 0VDC. 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

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DC fan F32 fault:
The DC fans were installed on FR8 drives starting with serial number 13068696 and FR9 and above drives starting with serial number 13100567.

On FR8 and larger drives the F32 fan fault is active. On drives with the AC fan which would be drives with serial numbers smaller than above the F32 fault is monitoring the fan driver board only. On drives with DC fans the F32 fault is expanded to include a temperature sensor on the driver board and an encoder feedback from the fan.

When troubleshooting the F32 fault on drives with a DC fan it is important to know what fan control you are set up for on the drive. The fan control is P5.7.2. This is located in the system menu under hardware settings. There are 4 different fan settings that you can use.

Continuous: when in this mode the fan will run continuously. We only really want to use this mode for testing and troubleshooting purposes.

Temperature: when in this mode the fan will run for about 30 seconds when powered on and then will turn off. The fan will restart when the drive goes to run and will continue to run until the drive turns off. When the drive turns off the fan will run for another 30 sec and then turn off until the next time the drive starts up. This mode is not the preferred method of running the fan as it may run the fan when it is not needed although it is more preferred than continuous or first start.

First start: when in this mode the fan will remain off until the first time the drive is started. When the drive is started it will run the fan continuously until the drive is powered down and repowered at which point it will again leave the fan off until the drive is started. This mode is preferred over continuous but not as preferred as temperature or calculated temperature.

Calculated temperature: when in this mode the fan will not start until the drive temperature reaches 40C. At 40C the fan will start and run until the drive cools down to 30C. This is the preferred setting for the fan as it will only run the fan when the drive needs cooling.

The first thing we are trying to determine is whether this is a software or hardware problem. What we have been experiencing is that over time and with different environmental conditions the DC fans are a little slower to ramp up to speed. In the software of the drive there is a 5 second delay between the time the drive asks the fan to run to the time that the drive looks for the feedback telling it that the fan is running. If this is a problem depending on the fan setting will depend on when this fault is occurring.

Continuous: the fault will occur when the drive is powered up. If you can reset the fault and everything works OK until the next time the drive powers down and power back again it is likely to be software.

Temperature: the fault could occur when the drive powers up or when the drive starts. The fault may not occur every time but normally in the fault history you will see the faults occur pretty close to room temperature.

First start: the fault would occur the first time the drive is started. Once reset the fault should not occur again until the drive is power down and back up again. Then you have the potential the fault will occur again the first time the drive is started.

Calculated temperature: the fault would occur when the drive is at 40C as that is when the drive is starting the fan.

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If any of the above circumstances are true it is probably software that is the issue and not hardware. SVX00031V029 or SPX00032V024 or higher version number (version number is in red) has the extended fan fault delay of 10 seconds in it. This version of SVX software can only be loaded to the SVX2 control board which has a part number of VB00752. If you have an SVX1 control module (VB00252) the software you will need to load to the drive is SVX00031V022. If software can't be loaded to the drive right away the best way to combat this problem is to change the fan control to continuous. On continuous you should just need to reset the fault right away and then it will not come back until power is cycled to the unit.

When loading new software remember to first save the parameter file to your laptop first. It is likely that trying to load parameters back from the keypad will not work as the applications are different. You will be able to reload parameters from your laptop using 9000xdrive. The new application will have a few new parameters in it. One that you should set is P1.7.25 earth fault current. This is defaulted to 50% in some versions so you should probably set this somewhere between 15-20%. Also set the fan control back to calculated temperature if you had changed it from this for troubleshooting.

If it is not software that is the issue, follow the troubleshooting procedure below:

Caution: unlike the AC fan the DC fan always has the 48VDC power applied to the fan when the fan driver is powered up. Only unplug and plug in the fan with power removed.
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 the fan 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. See the fan control signals diagram in the AC fan section for the pin out for the DC fan driver.

- X2 pins 1 & 3 are DC bus. This comes from the DC bus of the drive through a pair of fast acting 4A or 8A fuses, depending on how many fans there are. The FR9 fan will probably have 4A fuses but 8A fuses can be used in any drive.
- 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. FR8 drives have a board that does not have this connector. The FR9 drive has the same board as the FR10 and above drives. On the FR9 drive there will not be anything connected to the X3 connector because it uses a different fan alarm feedback.
- 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, 0VDC is alarmed on FR9 and above. FR8 is alarmed with a 15VDC signal and OK with a 0VDC signal.
- The encoder feedback is on the white wire coming back from the fan referenced to the blue wire. The feedback is about 3 PPR. Without the fan spinning this feedback is about 15VDC. When the fan starts to spin the voltage drops down to 5VDC and is a pulse train coming back from the fan. The driver board is not looking for a speed but rather is looking for the voltage feedback to drop below about 10VDC telling the board that the fan is spinning (anything from about an 18k-47k resistor referenced to the – connection will simulate this) so really any speed will satisfy the board.
- The fan always has the 48VDC applied to it when the fan driver is powered up.   The fan speed is varied by varying the voltage into the PWM or control pin. The input into this is 0-10VDC referenced to the – pin. The fan driver board does not vary the input into this, it puts out about 12VDC to run the fan at its maximum speed (about 1700RPM).

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 ensure that you have all of the wiring and hardware needed to complete the upgrade.

LED status of the DC fan driver			
Green	Yellow	Red	Status
Off	Off	Off	No power applied, possible blown fuse
On	Off	On	Standby, no start command to board
On	On	Off	Normal run state
On	On	On	Faulted
Any other state than what is listed above is likely to be a failed fan driver board			

1. The first thing to identify is whether the fan is working or not. If the fan appears to be working, it is possible that the fan driver board is getting too hot. This is more likely to happen on FR8 & 9 drives which have a fan that cools this board. Look to make sure the fan that cools the board is OK. If the fan is defective replace the fan if it is OK go to step 2. On the FR9 drive if you do not have a fan to replace the one that cools the board you can remove the cover over the top of the board. This will increase the air flow around the board and should sufficiently cool the board without the fan.
2. Look for 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 (skip to step 4 below).
3. 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 (4A on the FR8 and FR9 drive) fast acting fuse and like fuses should be used when replacing these. You can use 8A fuses on any of the drives, but I would not use the 4A fuses on any drive that has multiple fans. 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.
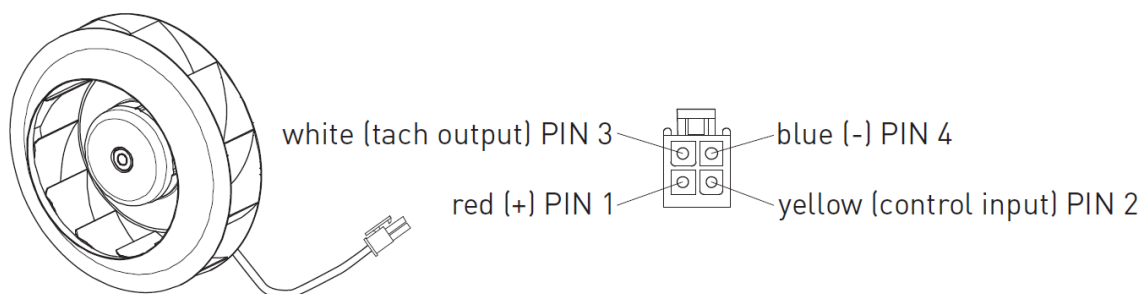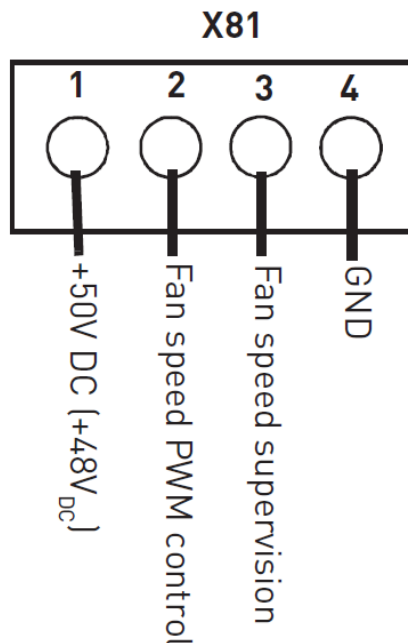
4. If the green and yellow LEDs are lit and you have an F32 fault check the output out of the fan driver back to the control or ASIC unit. The outputs are described above so you should see 15VDC referenced to –DC bus on the appropriate pin. If you do not see this signal replace the fan driver. If you 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).

5. If you have a red LED, yellow LED and green 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.

6. 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). This output should be there whether the fan is running or not so you can unplug the fan and check the output out of the fan driver board. If you do not have the 48VDC present at the output of the fan driver board replace the fan driver board. If you do have the 48VDC check for the control voltage output (this should be about 12VDC between the – pin and the control pin). The control voltage output should be there if the yellow LED is lit. If the control voltage is not there, replace the fan driver. If the control voltage and 48VDC are there replace the fan.

7. If you have any flashing lights on the board it is likely a bad fan driver board. Try disconnecting the fan from the driver board to see if the flashing lights go away. If they do go away try a different fan or induce a false feedback by installing a resistor (around 30K ohms) between the – connection and the tach feedback connection. If the board works OK at this point you have a bad fan if the board gets flashing lights again you have a bad fan driver board.

white (tach output) PIN 3 — blue (-) PIN 4
red (+) PIN 1 — yellow (control input) PIN 2

X81

| 1 | 2 | 3 | 4 |

+50V DC (+48V DC)

Fan speed PWM control

Fan speed supervision

GND

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.

Control unit fault (F36):
This is an incompatibility between the control unit and the power section. If you have access to device properties, you may need to check the data in the power section. You do need to make sure that you are not trying to use the wrong control card with the drive. An example of this would be trying to use a SVX control card on a FR12 or FR14 drive. You can try to reload software to the control card to see if that will fix the problem.

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 is a digital input into the drive. This is normally some type of interlock such as a door switch, vibration switch, etc. You have to know what input the external fault is programmed for and whether it is programmed for normally open or normally closed operation. This you can find in the input signals group in parameters. Normally we are using the drives 24VDC to drive this input. You can look in the monitoring group to see what the drives thinks the input is doing. If it is programmed to external fault open it would mean that if the input is off you will get the fault, the opposite is true for external fault closed. If the fault is doing what it should you will need to troubleshoot what is feeding this fault. If you don't think the fault is right with a VM check the digital input. These inputs are referenced to certain pins. DIN1-3 is referenced to pin 11 and DIN 4-6 is reference to pin 17. Check to see if you have the proper voltage on the pin. If you have the proper voltage at the pin and it still is not working properly move the input to another digital input if one is open and reprogram the pin. See if the external fault works. You can also jump the voltage straight to the pin to see if it will activate properly. Most people use positive logic which means 24VDC activates the pin (24VDC is on pin 6 and 12). If you are using negative logic it would mean ground activates the input (ground is on pin 7 and 13). If the digital input is not working replace the board.

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:
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, does not matter what the frequency reference is set for. 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.

Motor checks:

There are a couple of simple checks that you can do on a motor to check it for failure.

- You can do a simple ohm check on the windings. This is more telling for something like an output phase fault where you are questioning if there is a closed circuit on the output. This test can be done with the motor still connected to the drive. A motor should look pretty close to a short circuit on the output.
- A more telling reading on the output is an inductance test. Different motors will read a different inductance. Generally larger motors will read a lower inductance. Typically, the inductance can be anywhere from 300uH to 3mH. Somewhat the key to these readings is that they are even. Inductance is what is needed to support the AC voltage that the drive is outputting. This is a really important reading for a startup on a system that is using multiple conductors on the output. This will confirm that leads weren't crossed so you would be shorting phase to phase in the peckerhead. This reading can also identify a direct winding to winding short. This would give you less inductance on the phases that are shorted to each other. You can do this test with the drive connected as it is a low voltage test.
- An insulation test (megger) is an important test for the motor. The level you should technically test to is: (DC bus of the drive x 2) + 1000VDC. For a typical 480V drive, DC bus would be about 680VDC so plugging these numbers in you would get (680 x 2) + 1000 = 2360VDC. If you don't have a tester that will go this high test as high as you can. Most problems you will find at a lower level. This is a test that you have to isolate that drive from the motor due to the voltage. You can connect all 3 of the motor leads together and test to ground. Apply voltage until the reading becomes stabile. Typically, this test will be above 250M ohms to ground. The drive will run on a lower reading than that but the lower the reading the more likely there is a problem. If it does not support the full voltage you are testing to, I would also consider that a problem. Once you are done test insure that you short the windings to ground as there is capacitance there and it will hold a charge. Please also note that this does not test for a winding to winding short. If there is a direct short you can pick this up with an inductance test. If you want to insulation test for a winding to winding short you have to go to the peckerhead and separate all of the windings (you can only do this if the windings are all brought out to the peckerhead, if you only have 3 leads coming out the motor is connected internally and you can't separate the windings). Once the windings are separated you can short the start and finish of each winding together and then test from one winding to another.

Revision History & Approval

Rev	Sections	Changes	Owner	Approved by	Date
1	AC fan	Changed the fan starting cap part #	Shawn Lamp	Shawn Lamp	6/22/11
2	DC fan	Added DC fan TS, added more sub codes to F8	Shawn Lamp	Shawn Lamp	10/22/13
3	DC fan	Updated DC fan TS	Shawn Lamp	Shawn Lamp	2/13/14
4	F15	Added F15 stall fault	Shawn Lamp	Shawn Lamp	5/21/14
5	DC fan	Added temp sensor to DC driver	Shawn Lamp	Shawn Lamp	5/29/14
6	UV trip, DC fan	Added sub-codes, added software troubleshooting	Shawn Lamp	Shawn Lamp	5/21/15
7	F11, F32	Added sub-codes, changed DC fan TS	Shawn Lamp	Shawn Lamp	12/9/16
8	F8, S1	Added TS for FR10 and above	Shawn Lamp	Shawn Lamp	4/3/17
9	Multiple	Added multiple faults and motor TS	Shawn Lamp	Shawn Lamp	3/10/20
10	F8,S7/ F14	Added TS steps	Shawn Lamp	Shawn Lamp	9/28/20