CONNECTING A VFD TO A NEXUS CONTROL

August 2020

Introduction

Role of the VFD

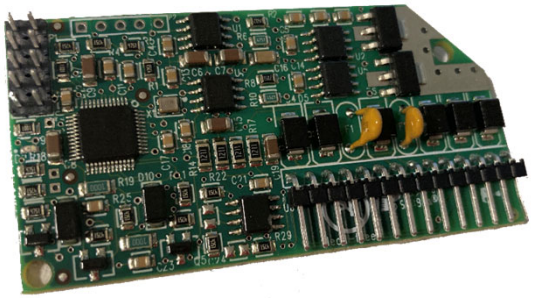
A Nexus control is defined as any one of the following: NXF4000, PPC4000, NX6100 or PPC6000. These are all fuel-air ratio control (parallel positioning) systems. These units control servos to meter the different channels of combustion accurately. Each servo has feedback to ensure precise positioning and to create a lockout any deviations are detected.

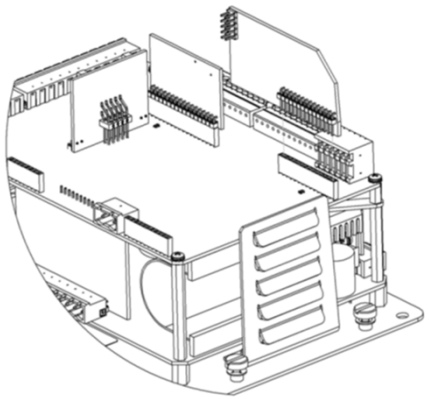
VFDs can also be incorporated as channels of control with any Nexus system. To do this, feedback must be provided to make the control closed-loop. This allows the position of the VFD to be continuously monitored. Using a VFD as a channel of control is typically done with the combustion air blower to either provide more precise control, save on electrical usage or both.

Hardware

VFD add-on card NXF4000 and PPC4000

For the NXF4000 and PPC4000, the NXCESVFD add-on card must be added to the system in order to enable the use of a VFD. To fit this card, the control must be powered down, the cover removed, and the card fitted to the top board of the control in the header provided. Once the cover is replaced, apply power and the VFD can be wired to the connections on terminal block P14 and the VFD channels can be configured for use.

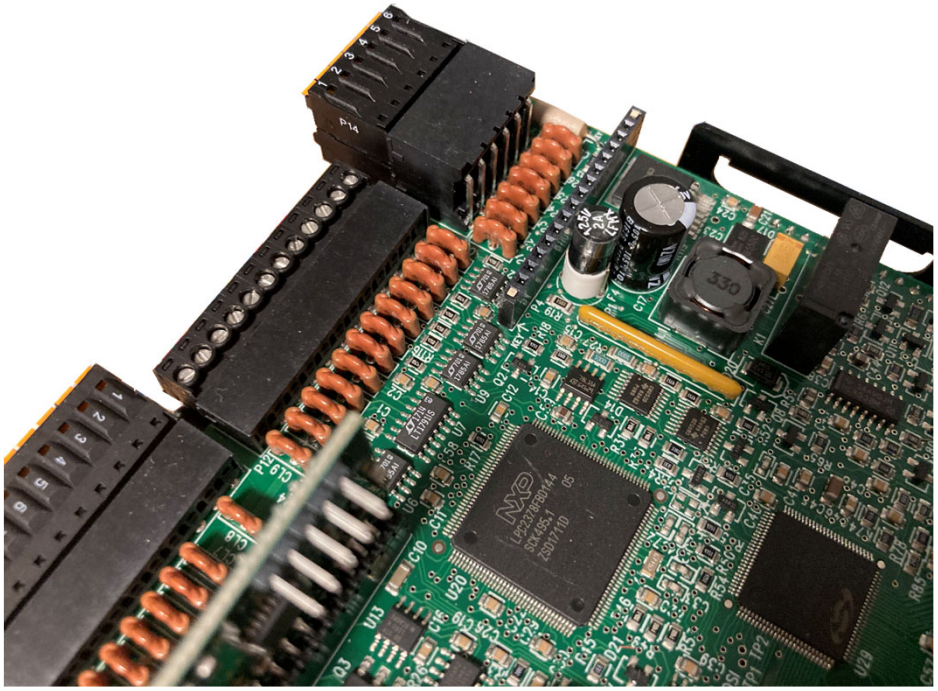




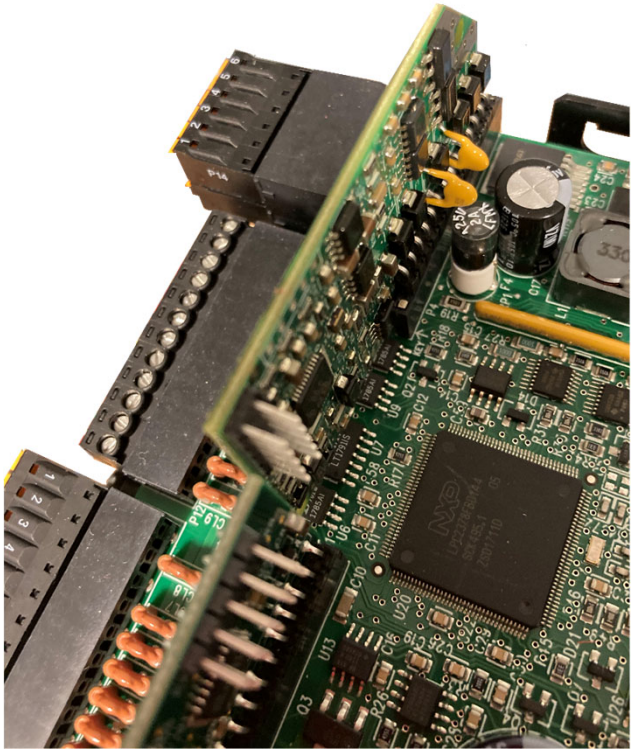
The NXCESVFD offers interfaces for up to two VFDs with either encoder feedback or with 4-20mA feedback from the VFD. The analog outputs from any unused channels can be used as user-assignable analog outputs.

Hardware

Fitting NXCESVFD



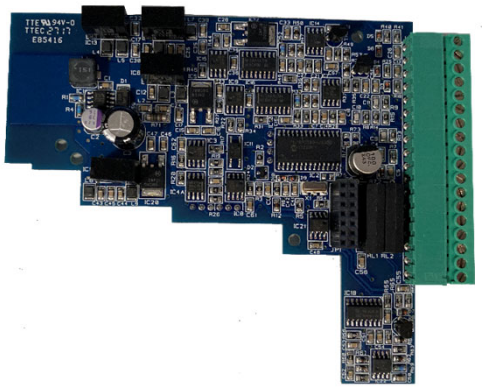
Without NXCESVFD fitted



With NXCESVFD fitted

Hardware

VFD add-on card NX6100 and PPC6000



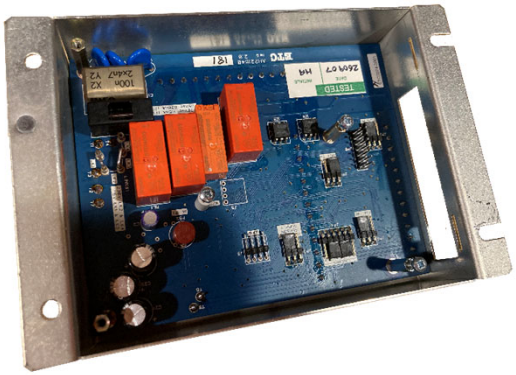
For the NX6100 and PPC6000, the NXDBVSD add-on card must be added to the system in order to enable the use of a VFD. To fit this card, the control must be powered down, the rear cover removed, the protective sticker removed from the side and the card fitted into the bottom of the control in the header provided. The terminal blocks are part of the card and will be exposed for external connections. Once the rear cover is replaced, apply power and the VFD can be wired to the connections on the terminal block and the VFD channels can be configured for use.

The NXDBVSD offers interfaces for up to two VFDs with either encoder feedback or with 4-20mA feedback from the VFD. The analog inputs or outputs from any unused channels can be used as programmable analog inputs or user-assignable analog outputs. Using this card also enables the Modbus RTU connection for BMS use.

Hardware

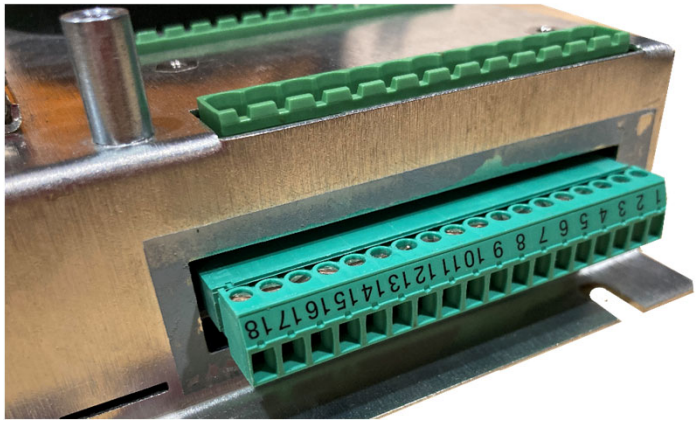
Fitting NXDBVSD

Remove screws from cover



Remove bottom cover

Fit card to header



Replace cover and screws

System design

Minimum servos

The NXF4000 and PPC4000 can have up to ten servos connected with up to four in use with any profile. Additionally, one or two VFDs may be added per profile. The minimum configuration supported is two servos, or one servo with one VFD. It is not possible to configure the control to only use one or two VFDs if there are not any servos, or to just use one servo alone without at least one VFD.

The NX6100 and PPC6000 can have up to ten servos connected and all ten can be used with any profile. One or two VFDs may be added per profile but that reduces the number of servos that can be used accordingly (ten total channels of control). The minimum configuration supported is one servo or VFD.

VFD requirements

Types of drives

It is recommended that a constant torque (vector control) drive is used. This is due to the resolution provided in the control of the motor, which allows for a quicker response to a change in commands.

If a variable torque (volt/hertz control, or HVAC) drive is used there can be a lag in the response that is large enough to cause lockouts due to improper feedback. Lengthening the acceleration and deceleration times may allow the response to match what is expected but this will result in noticeably diminished performance in the burner response to the process.

Fireye VFD options

ABB ACS550

Fireye offers for sale ACS550 drives from 5HP to 200HP in 230VAC, 460VAC or 600VAC form. The drives are packaged in NEMA 12 enclosures with fused disconnects, motor overload relay and an LCD keypad. A contactor bypass package with a Hand-Off-Auto switch is also offered.

These VFDs are programmed at the factory with all of the settings needed to work properly with the Nexus controls. The only thing to do in the field is to properly wire between the devices. If the installation is a retrofit, it may be necessary to properly commission the VFD as well (check motor insulation and enter motor nameplate data).

If your VFD needs fall outside the scope described above, let us know and we may be able to quote a drive to fit your project.

Fireye VFD options

ABB ACS550 parameter list

A listing of parameters that are pre-configured by Fireye are available for verification.

Fireye Preset Parameters

August 19, 2016

These parameters have been changed prior to shipment		
Parameter Number	Parameter Name	Parameter Value
9901	LANGUAGE	ENGLISH (AM)
1001	EXT1 COMMANDS	DI1
1003	DIRECTION	FORWARD
1201	CONST SPEED SEL	NOT SEL
1301	MINIMUM AI1	20%
1504	MINIMUM AO1	4 mA
1510	MINIMUM AO2	4 mA
1601	RUN ENABLE	DI3
2101	START FUNCTION	DC MAGN
2201	ACC/DEC 1/2 SEL	NOT SEL
2202	ACCELER TIME 1	30.0
2203	DECELER TIME 1	30.0
3002	PANEL COMM ERR	LAST SPEED
3401	SIGNAL 1 PARAM	AI1
3402	SIGNAL 1 MIN	20%
3404	OUTPUT 1 DSP FORM	+0.0
3405	OUTPUT 1 LIMIT	mA
3406	OUTPUT 1 MIN	4 mA
3407	OUTPUT 1 MAX	20 mA
3408	SIGNAL 2 PARAM	POWER
3411	OUTPUT 2 DSP FORM	+/- 0.0
3412	OUTPUT 2 UNIT	HP
3415	SIGNAL 3 PARAM	OUTPUT FREQ

See Note Below

These parameters must be set during commissioning by the customer		
Parameter Number	Parameter Name	Parameter Value
9905	MOTOR NOM VOLT	*
9906	MOTOR NOM CURR	*
9907	MOTOR NOM FREQ	*
9908	MOTOR NOM SPEED	*
9909	MOTOR NOM POWER	*
3413	OUTPUT 2 MIN	Param 34.09 x 1.34 **
3414	OUTPUT 2 MAX	Param 34.10 x 1.34 **
* - From Motor Data Nameplate		
** - Multiply the value in parameter 34.xx by 1.34 and enter the the result		

Set this parameter after commissioning is completend the parameters have been saved with the "Upload to Panel" function		
Parameter Number	Parameter Name	Parameter Value
1606	LOCAL LOCK	ON

Feedback

Safety requirement

In a parallel positioning system, all channels of control must be closed-loop. This means that feedback is checked to ensure that the commanded signals are being carried out properly. With the servos, this is done internally by an encoder and is part of the secure transmission between the servo and the control. Both the commands and feedback are carried out over the same bus connection. The VFD is treated the same as a servo in that feedback is required. Since the VFD is an external device, the connections between the Nexus control and the VFD are hard-wired. This allows for a couple of different options to be used to supply the feedback.

Feedback

4-20mA feedback from the VFD

The command signal to the VFD is an analog 4-20mA signal. The feedback can be provided by the VFD, also using a 4-20mA signal. The requirement for this to work is that the function of the 4-20mA output is properly assigned to indicate the running frequency of the VFD, in the same scale as the commanded frequency (typically 50Hz or 60Hz). Safety is provided with this method since the VFD is analyzing the electrical connection to the motor to determine if the motor is running as it should be. The VFD would have an internal fault if the motor was not running properly based upon the voltage and frequency being supplied.

If there was a situation where the motor was running but there was not any connection to the combustion air fan, the Nexus control would lockout based upon an airflow interlock safety fault.

Feedback

Encoder feedback

If required for the installation, an external encoder can be mounted to the motor shaft to provide the feedback to the Nexus control. If this option is used, the 4-20mA signal from the Nexus still goes to the VFD, but the 4-20mA output from the VFD is not connected and instead the signal from the encoder provides feedback to the Nexus control.

Feedback

Encoder selection

The encoder selected must have an **open-collector** output type. The NXF4000 and PPC4000 controls have an internal pull-up resistor to work with this signal, while the NX6100 and PPC6000 require either an encoder with a built-in pull-up resistor or an external pull-up resistor can be used. The NXF4000 and PPC4000 use 24VDC power to the encoder, while the NX6100 and PPC6000 use 12VDC.

The encoder can be either a single-channel or a quadrature-type. If the encoder is a quadrature-type it may have many outputs such as A, A', B, B', Z and Z', but only one output (A or B) is connected to the Nexus control.

Note that the output from an open-collector encoder should be limited to 30 feet or less and should be protected from noise as much as possible. Do not install in the same conduit as high-voltage wiring and use shielded cable.

Feedback

Encoder selection

The encoder output counts pulses as the motor shaft rotates. It is important to select an encoder with the correct number of counts per revolution (CPR). This can be determined using the following formula to determine the scale value to enter into the Nexus control: **(Motor RPM x CPR) / 60**. The NXF4000 and PPC4000 can have the encoder scale values set from 300 to 5000 and the NX6100 and PPC6000 can have the encoder scale values set from 255 to 999.

The table below shows the CPR range that can be used for different motor RPMs based on the formula above:

Motor RPM	NXF4000/PPC4000 Usable CPR Range	NX6100/PPC6000 Usable CPR Range
1750	11 to 171	9 to 34
3500	6 to 85	5 to 17

Feedback

Encoder mounting options

There are a couple of different options for mounting and using encoders. First, the encoder can be ordered as an integrated part of the motor. If this is an option, make sure that the encoder type and CPR is compatible with what is needed. If it is not, converter modules can be used to change the output type (from line driver to open-collector, for example) or to reduce the CPR by dividing the pulses. It is common for many integrated encoders to have 1024 CPR, so converter modules that divide the pulses by a factor of 64 are often used in this application. Using an integrated encoder is the easiest option to choose if available.

An external encoder can also be used. There are two choices for this method. First, a slim or low-profile encoder can be fitted to the main shaft and the blower wheel then fitted onto the main shaft after that. This method would require that the shaft is long enough as well as the design supports this and leaves clearance for the electrical connections to be secured. Lastly, a motor with a tail shaft can be used and the encoder then fitted to the tail shaft directly.

Feedback

Encoders

Here are some examples of encoders from EPC (Encoder Products Company, www.encoders.com):

Model 775 low-profile (1.375”)

Model 25T

Model 702 motor mounted

Wiring

NXF4000 and PPC4000

With an NXF4000, the command to start the VFD is wired to the blower relay output (terminals P4.3 and P4.4). If a PPC4000 is used, a line voltage relay must be connected to the fan output of the flame safeguard to switch the VFD on. Either relay switches the VFD internal power supply to a digital input assigned to start the VFD. If a bypass model ACS550 is used the start signal uses line voltage.

The analog wiring is all connected to and from from the P14 terminal block and can be done with a single three-conductor shielded cable.

It is also required to wire the run and fault contacts into the safety limit string (NXF4000 terminal P5.10, or to the flame safeguard) so that there is a lockout if the VFD doesn't start within the allotted time for the airflow switch to prove, or if there is a VFD fault. Most VFDs have at least two relays that are assigned to these functions by default. The logic for the fault contact is to wire to the normally closed pole and the relay is normally powered when there is no fault present. This is so that the fault contact will indicate a fault if the VFD is not powered at all.

Wiring

NXF4000 and PPC4000 connections to ACS550

Digital wiring:

Description	NXF4000/PPC4000	ACS550 Non-Bypass	ACS550 Bypass
Start common	NXF4000: **P4.3** PPC4000: *N/A*	**X1.10 (+24V)**	**<line voltage>**
ACS550 jumper for digital input power supply	*N/A*	**X1.11 (GND) to X1.12 (DCOM)**	*PRE-WIRED*
Start command	NXF4000: **P4.4** PPC4000: *N/A*	**X1.13 (DI1)**	**1TB.3 (CR1)**
Other safety limits	NXF4000: **<SL input*>** PPC4000: *<to FSG>*	**X1.22 (RO2 C)**	**1TB.7 (run)**
ACS550 jumper from run contact to fault contact	*N/A*	**X1.24 (RO2 NO) to X1.25 (RO3 C)**	**1TB.8 (run) to X1.25 (RO3 C)**
Safety limits complete	NXF4000: **P15.10** PPC4000: *<to FSG>*	**X1.26 (RO3 NC)**	**X1.26 (RO3 NC)**

* This connection is from the end of the safety limit string that would have connected to P15.10

Wiring

NXF4000 and PPC4000 connections to ACS550

Analog three-conductor shielded:

Description	NXF4000/PPC4000	ACS550 Non-Bypass	ACS550 Bypass
4-20mA to VFD	VFD1: **P14.1** VFD2: **P14.2**	**X1.2 (AI1)**	**X1.2 (AI1)**
4-20mA from VFD	VFD1: **P14.3** VFD2: **P14.4**	**X1.7 (AO1)**	**X1.7 (AO7)**
Analog common	**P14.12**	**X1.3 (AGND)**	**X1.3 (AGND)**
Shield	*N/A*	**X1.1 (SCR)**	**X1.1 (SCR)**

Note that a three-conductor cable can be used since the analog input and output on the NXF4000 and PPC4000 have the same power supply (reference). All of the terminals from P14.7 to P14.12 have continuity at 0V. Additionally, the analog inputs and outputs on the ACS550 also have the same reference. Any terminal marked AGND has common continuity.

If the drive used does not have a common analog reference, simply connect the analog input common and analog output common together at the VFD – they would be connected together at the NXF4000 or PPC4000 anyway if a four-conductor cable were to be used.

Wiring

NXF4000 and PPC4000 connections to encoder

Analog three-conductor shielded or encoder wire lead:

Description	NXF4000/PPC4000	Encoder
Power supply 24VDC	**P2.1, P2.2, P2.3, P11.2 or P11.3**	**+VDC**
Signal from encoder	VFD1: **P14.5** VFD2: **P14.6**	**A or B**
Power supply common	VFD1: **P14.8** VFD2: **P14.7**	**COM**
Shield	**<to earth ground>**	*N/A*

Note that the encoder terminals have generic names – these will vary by manufacturer, but each should have a terminal to cover the function.

Multiple terminal options are listed for 24VDC power and common on the NXF4000 and PPC4000. Any available terminal can be used.

The shield should only be connected at one end of the cable.

Wiring

NX6100 and PPC6000

With an NX6100, the command to start the VFD is wired to the blower relay output (terminals PD1 and PD2). If a PPC6000 is used, a line voltage relay must be connected to the fan output of the flame safeguard to switch the VFD on. Either relay switches the VFD internal power supply to a digital input assigned to start the VFD. If a bypass model ACS550 is used the start signal uses line voltage.

The analog wiring is all connected to and from from the PZ terminal block on the NXDBVSD and can be done with a single four-conductor shielded cable.

It is also required to wire the run and fault contacts into the safety limit string (NX6100 assignable digital input, or to the flame safeguard) as with the NXF4000 and PPC4000. Since the digital inputs for this are assigned, dedicated digital inputs can be used for different safety limits if desired.

Wiring

NX6100 and PPC6000 connections to ACS550

Digital wiring:

Description	NX6100/PPC6000	ACS550 Non-Bypass	ACS550 Bypass
Start common	NX6100: **PD1** PPC6000: *N/A*	**X1.10 (+24V)**	**<line voltage>**
ACS550 jumper for digital input power supply	*N/A*	**X1.11 (GND) to X1.12 (DCOM)**	*PRE-WIRED*
Start command	NX6100: **PD2** PPC6000: *N/A*	**X1.13 (DI1)**	**1TB.3 (CR1)**
Other safety limits	NX6100: **<SL input*>** PPC6000: *<to FSG>*	**X1.22 (RO2 C)**	**1TB.7 (run)**
ACS550 jumper from run contact to fault contact	*N/A*	**X1.24 (RO2 NO) to X1.25 (RO3 C)**	**1TB.8 (run) to X1.25 (RO3 C)**
Safety limits complete	NX6100: **<DI assigned>** PPC6000: *<to FSG>*	**X1.26 (RO3 NC)**	**X1.26 (RO3 NC)**

* This connection is from the end of the safety limit string that would have connected to the assigned digital input

Wiring

NX6100 and PPC6000 connections to ACS550

Analog four-conductor shielded:

Description	NX6100/PPC6000	ACS550 Non-Bypass	ACS550 Bypass
4-20mA to VFD (+)	VFD1: **PZ2** VFD2: **PZ4**	**X1.2 (AI1)**	**X1.2 (AI1)**
4-20mA to VFD (-)	VFD1: **PZ1** VFD2: **PZ3**	**X1.3 (AGND)**	**X1.2 (AGND)**
4-20mA from VFD (+)	VFD1: **PZ13** VFD2: **PZ14**	**X1.7 (AO1)**	**X1.7 (AO7)**
4-20mA from VFD (-)	VFD1: **PZ12** VFD2: **PZ13**	**X1.6 (AGND)**	**X1.6 (AGND)**
Shield	**<screen clamp provided>**	**X1.1 (SCR)**	**X1.1 (SCR)**

Note that PZ13 is used for both VFD1 feedback (+) and VFD2 feedback (-). This is a design feature and not an error.

Unlike with the NXF4000 and PPC4000, it is recommended that the shield wire is connected at both ends with the NX6100 and PPC6000.

Wiring

NX6100 and PPC6000 analog wiring cable

Special instructions must be followed when wiring analog signals to the NX6100 or PPC6000. Consider using one of the following recommended cables:

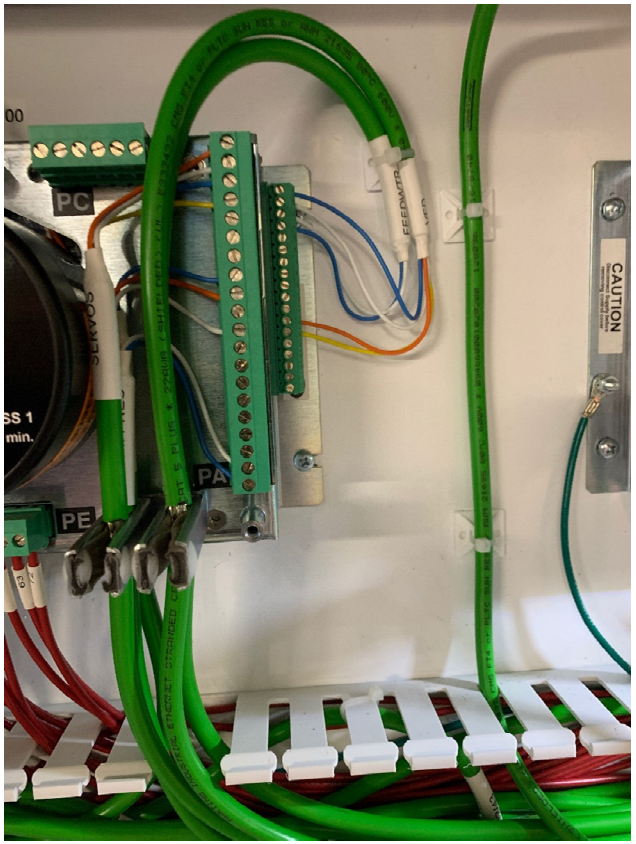
Voltage Rating	Alpha	Carol	Belden	Harting
300V	4-conductor: **25164** 2-conductor: **25524**	4-conductor: **C2688** 2-conductor: **---**	4-conductor: **9940** 2-conductor: **7895A**	4-conductor: **---** 2-conductor: **---**
600V	4-conductor: **25162** 2-conductor: **25522**	4-conductor: **---** 2-conductor: **---**	4-conductor: **---** 2-conductor: **---**	4-conductor: **094560001020200** 2-conductor: **---**

Choose a cable that has at least as many conductors as needed. Unused conductors can be taped off and secured.

Wiring

NX6100 and PPC6000 analog wiring methods

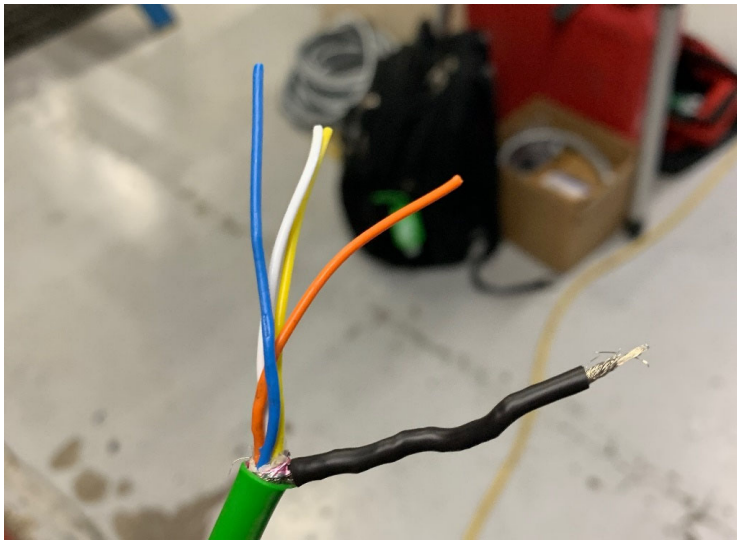
The cable shield must be grounded at each end. At the NX6100 or PPC6000, strip back enough insulation to expose the braided shield and insert into the screen clamp as shown.



Wiring

NX6100 and PPC6000 analog wiring methods

On the VFD side, wrap the braid and shield wire into a single strand and cover with shrink tubing or insulating tape.



Wiring

NX6100 and PPC6000 connections to encoder

Analog three-conductor shielded or encoder wire lead:

Description	NX6100/PPC6000	Encoder
Power supply 12VDC	VFD1: **PZ8** VFD2: **PZ10**	**+VDC**
Signal from encoder	VFD1: **PZ7** VFD2: **PZ9**	**A or B**
Power supply common	**PZ12**	**COM**
Shield	**<to earth ground>**	**<to earth ground>**

Note that the encoder terminals have generic names – these will vary by manufacturer but each should have a terminal to cover the function.

Additionally, a 2.4k 1/4W pull-up resistor needs to be added between terminals PZ8 and PZ7 (or PZ10 and PZ9 for VFD2) if the encoder does not have one built-in.

Wiring diagrams

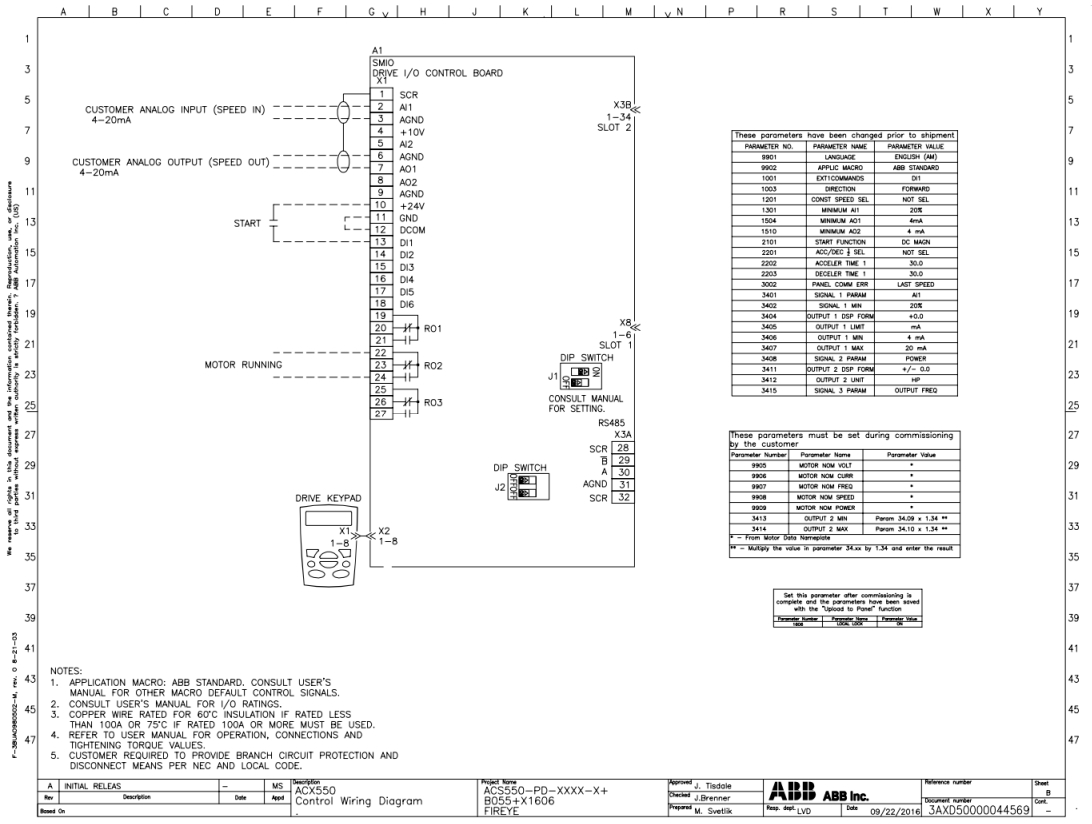
www.fireye.com

The Fireye website contains many application wiring diagrams. The *Service Guide* section of each Nexus control contains many links to wiring diagrams and other helpful documents.

Full application wiring diagrams for the NXF4000 and PPC4000 are available in these sections, and NX6100 and PPC6000 versions of these diagrams are in process. Searching for “ABB” in the search bar will display all of the ACS550 documentation from wiring diagrams to required parameter settings.

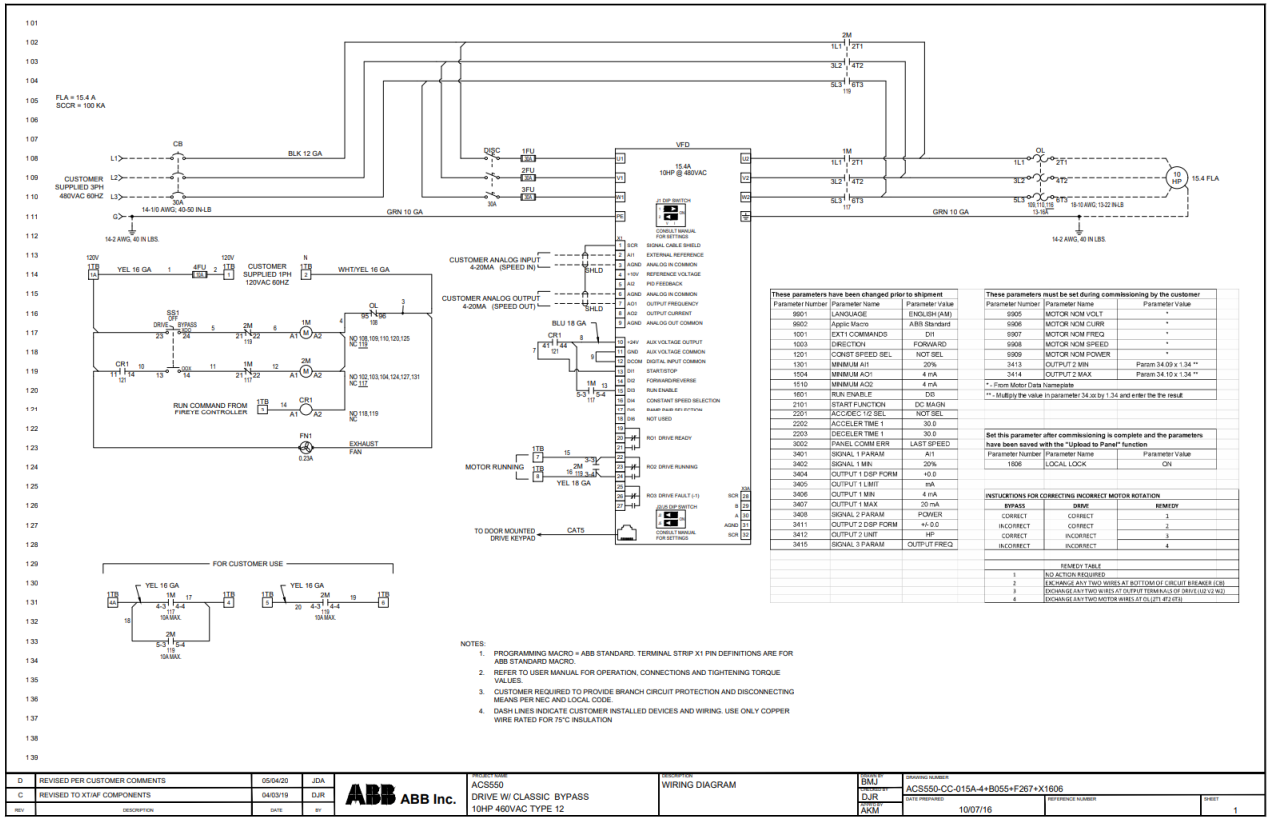
Wiring diagrams

ACS550 Non-bypass



Wiring diagrams

ACS550 Bypass



These parameters have been changed prior to shipment		
Parameter Number	Parameter Name	Parameter Value
9901	LANGUAGE	ENGLISH (AM)
9902	Applic Macro	ABB Standard
1001	EXT1 COMMANDS	DI1
1003	DIRECTION	FORWARD
1201	CONST SPEED SEL	NOT SEL
1301	MINIMUM AI1	20%
1504	MINIMUM AO1	4 mA
1510	MINIMUM AO2	4 mA
1601	RUN ENABLE	D6
2101	START FUNCTION	DC MAGN
2201	ACC/DEC 1/2 SEL	NOT SEL
2202	ACCELER TIME 1	30.0
2203	DECELER TIME 1	30.0
3002	PANEL COMM ERR	LAST SPEED
3401	SIGNAL 1 PARAM	AI1
3402	SIGNAL 1 MIN	20%
3404	OUTPUT 1 DSP FORM	+0.0
3405	OUTPUT 1 LIMIT	mA
3406	OUTPUT 1 MIN	4 mA
3407	OUTPUT 1 MAX	20 mA
3408	SIGNAL 2 PARAM	POWER
3411	OUTPUT 2 DSP FORM	+/-.0.0
3412	OUTPUT 2 UNIT	HP
3415	SIGNAL 3 PARAM	OUTPUT FREQ

These parameters must be set during commissioning by the customer		
Parameter Number	Parameter Name	Parameter Value
9905	MOTOR NOM VOLT	*
9906	MOTOR NOM CURR	*
9907	MOTOR NOM FREQ	*
9908	MOTOR NOM SPEED	*
9909	MOTOR NOM POWER	*
3413	OUTPUT 2 MIN	Param 34.09 x 1.34 **
3414	OUTPUT 2 MAX	Param 34.10 x 1.34 **

* - From Motor Data Nameplate
** - Multiply the value in parameter 34.xx by 1.34 and enter the the result

Set this parameter after commissioning is complete and the parameters have been saved with the "Upload to Panel" function	
Parameter Number	Parameter Name	Parameter Value
1606	LOCAL LOCK	ON

INSTUCKTIONS FOR CORRECTING INCORRECT MOTOR ROTATION		
BYPASS	DRIVE	REMEDY
CORRECT	CORRECT	1
INCORRECT	CORRECT	2
CORRECT	INCORRECT	3
INCORRECT	INCORRECT	4

REMEDY TABLE	
1	NO ACTION REQUIRED
2	EXCHANGE ANY TWO WIRES AT BOTTOM OF CIRCUIT BREAKER (CB)
3	EXCHANGE ANY TWO WIRES AT OUTPUT TERMINALS OF DRIVE (U2 V2 W2)
4	EXCHANGE ANY TWO MOTOR WIRES AT OL (2T1 4T2 6T3)

Wiring diagrams

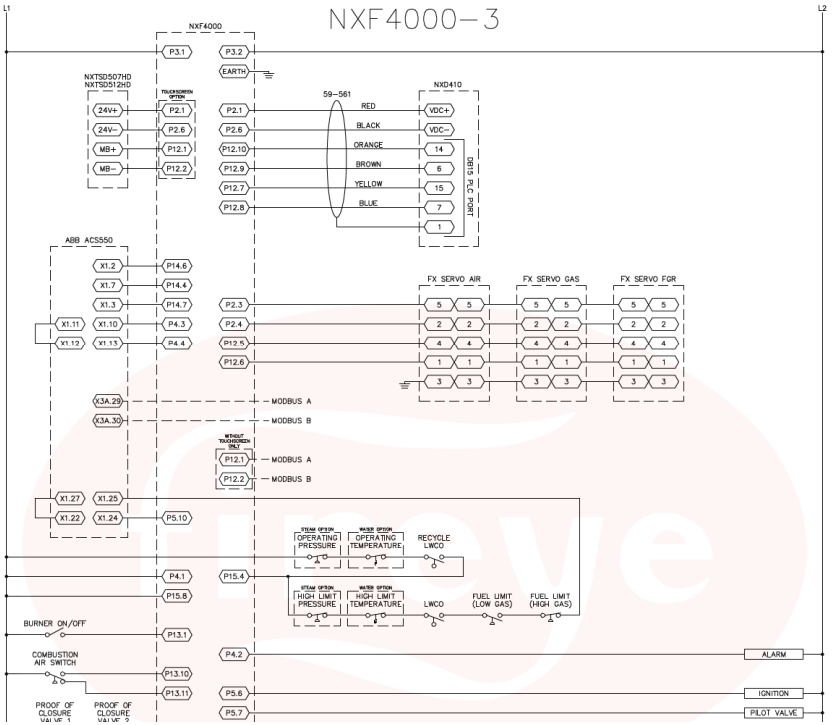
Wiring application guides

NXF4000 Wiring Application Guide

April 6, 2020

WIRING DIAGRAMS BY FEATURE

Diagram Number	User Interface	O_2	VFD	VFD Bypass	Dual Fuel
NXF4000-1	NXD410	---	---	---	---
NXF4000-2	NXD410TS	---	---	---	---
NXF4000-3	NXD410	---	ACS550	---	---
NXF4000-4	NXD410TS	---	ACS550	---	---
NXF4000-5	NXD410	---	ACS550	Yes	---
NXF4000-6	NXD410TS	---	ACS550	Yes	---
NXF4000-7	NXD410	NXCESO2	ACS550	---	Yes
NXF4000-8	NXD410	FXO2TRIM-1	ACS550	---	Yes
NXF4000-9	NXD410TS	NXCESO2	ACS550	---	Yes
NXF4000-10	NXD410TS	FXO2TRIM-1	ACS550		Yes



Profile selection

Switching between profiles

With four available profiles, it is possible to have a dual-fuel burner with each burner capable of running in VFD bypass if required. Additionally, this can be automated as the ACS550 with bypass has a dry contact output to indicate when bypass is active. This can be connected to a relay and added to the fuel changeover switching to choose from the four available profiles instead of just two. The bypass profiles are simply commissioned with the VFD channel disabled since the motor will be running at full speed (across the line).

Full diagrams for this action can be found in the wiring application guides available on the Fireye website (www.fireye.com).

Parameters

NXF4000 and PPC4000

The VFD channels can be configured from the SERVO SETUP menu. There is a menu for both VFD1 and VFD2. To enable the VFD for use, a name must be selected for the VFD. Once a name has been selected, the following setup options are presented:

- **ASSIGNMENT:** Which profiles this VFD is used with.
- **DISPLAY FORMAT:** Choose between **CNTS** (counts), **ENCOD** (encoder) or **%FS** (percent).
  - **CNTS**: Used with 4-20mA, shows the feedback as 0-1000 (ex. 30Hz = 500 for 60Hz max).
  - **ENCOD**: Used with an encoder, shows the feedback as 0-1000 as described above.
  - **%FS**: Used with 4-20mA, shows the feedback as 0-100% (ex. 30Hz = 50% for 60Hz max).
- **ENCODER COUNTS**: This is where the number calculated from the encoder scaling formula **(Motor RPM x CPR) / 60** is entered. The allowed range is 300 to 5000.

Parameters

NXF4000 and PPC4000

- **RUN MODE:** Choose between **AUTO** and **MANUAL**. The default is AUTO.
  - **AUTO:** The NXF4000 or PPC4000 controls the PID function for the VFD. The VFD is programmed to take a direct speed command. This is the recommended run mode.
  - **MANUAL:** The VFD will use the internal PID to choose a speed based upon the input signal. The NXF4000 or PPC4000 will only issue the setpoint. This is not recommended as it may lead to lockouts from failure to reach the required positions.
- **GAIN:** This is the proportional gain for the internal PID for the VFD. This can be set from 1% to 100%. This only needs to be adjusted if the VFD is reacting too fast or too slow for satisfactory operation. The default is 1%
- **INTEGRAL:** This is the integral for the internal PID for the VFD. This can be set from 0.0 (disabled) up to 100.0 in 0.1 increments. This only needs to be adjusted if the VFD is having trouble reaching the desired speed. The default is 0.0.

Parameters

NXF4000 and PPC4000

- **TOLERANCE:** Sets the allowable deviation from the target speed. This is based upon a normalized range of 0-1000 for the 0-60Hz speed range. Falling outside of this tolerance range will result in a lockout. Choose between **LOW** and **HIGH**. The default is HIGH.
  - **LOW:** The positioning error must be less than 4% (40 counts) over a period of 30 seconds.
  - **HIGH:** The positioning error must be less than 6% (60 counts) over a period of 15 seconds. Only choose this setting if it can result in safe combustion.
- **ACCEL/DECEL:** This is the time it takes to ramp from 0Hz to full speed (60Hz). Lengthening this time is normally one way to solve tolerance errors. The range can be set from 0 to 255 seconds. The default is 30 seconds.
- **STOP TIME:** This is the time that the NXF4000 or PPC4000 will wait between cycles before restarting. This gives the motor time to come to a stop and for the airflow switch to change states. The range can be set from 0 to 100 seconds. The default is 0 seconds.

Note that if the VFD is set up and there is not an NXCESVFD card inserted, there will be a lockout. The terminal block will likely still be present even if the NXCESVFD card is not fitted as the terminal block is part of the chassis, not directly mounted to the card.

Parameters

NX6100 and PPC6000

The VFD channels can be configured by choosing the appropriate option from one of the DRIVE SERIAL NUMBER parameters (OPTION 03.x). This is where you can choose from **VSD(1)(2):mA** for 4-20mA feedback or **VSD(1)(2):Hz** for encoder feedback. The NXDBVSD card must be fitted for these options to be present.

Other options to set, note that these apply to both VSD1 and VSD2 unless noted:

- **INVERTER CONTROL ACCURACY (OPTION 9.0):** Choose between **0** and **1**. The default is 0.
  - **0:** This selects the low accuracy setting. The accuracy will be ±9 counts (full speed range normalized to 1000 counts). This equates to ±0.54Hz for a 60Hz system (60/1000). Only choose this setting if it can result in safe combustion.
  - **1:** This selects the high accuracy setting. The accuracy will be ±3 counts.This equates to ±0.18Hz for a 60Hz system.

Parameters

NX6100 and PPC6000

- **INVERTER ERROR TOLERANCE (OPTION 9.1):** Choose between **0** and **1**. The default is 0. Falling outside of this tolerance range will result in a lockout.
  - **0:** This selects the low tolerance setting. The positioning error must be less than 30 counts for 15 seconds or 55 counts for 3 seconds.
  - **1:** This selects the high tolerance setting. The positioning error must be less than 55 counts for 3 seconds. Only choose this setting if it can result in safe combustion.
- **INVERTER CLOSED LOOP GAIN (OPTION 9.2):** The NX6100 or PPC6000 controls the PID function for the VFD. The VFD is programmed to take a direct speed command. This can be set from 15% to 125% with a default of 100%.
- **INVERTER STOP TIME (OPTION 9.3):** This is the time that the NX6100 or PPC6000 will wait between cycles before restarting. This gives the motor time to come to a stop and for the airflow switch to change states. The range can be set from 0 to 100 seconds. The default is 0 seconds.

Parameters

NX6100 and PPC6000

- **INVERTER ACCELERATION TIME (OPTION 9.4):** This is the time it takes to ramp from 0Hz to full speed (60Hz). Lengthening this time is normally one way to solve tolerance errors. The range can be set from 0 to 100 seconds. The default is 30 seconds.
- **VSD1 SPEED ENCODER SCALING (OPTION 9.5):** This is where the number calculated from the encoder scaling formula **(Motor RPM x CPR) / 60** is entered. The allowed range is from 255 to 999. Set to 0 if 4-20mA feedback is used.
- **VSD2 SPEED ENCODER SCALING (OPTION 9.6):** Same as above, except for VSD2.

Troubleshooting

No response with 4-20mA feedback

Once commissioning mode is entered, the positions of the servos and VFD are set. The VFD isn't set until P1, which is the purge position. Once a desired position is entered the control will not allow progressing to the next position until that previous position has been reached. If there is an issue with the wiring between the VFD and the control, or with the VFD configuration, this can lead to an inability to commission since either the command or the feedback is not being sent or received properly.

To confirm that there is an issue in the VFD wiring or configuration, jumper the 4-20mA output to the 4-20mA input on the control. With the NXF4000 or PPC4000, this simply means jumping P14.1 to P14.3 (or P14.2 to P14.4 for VFD2) since the analog signals internally share a common reference. For the NX6100 and PPC6000, jumper PZ2 to PZ13 and PZ1 to PZ14 (or PZ4 to PZ14 and PZ3 to PZ13 for VSD2). If the purge position can be set properly with these jumpers in place, start by checking the VFD configuration. If the configuration is correct, connect only the output to the VFD and see if it is running at the proper speed. Finally check that the feedback signal matches that speed and then reconnect. If the signals match the VFD should be able to be commissioned.

Troubleshooting

No encoder feedback

If there is no encoder feedback, first check to make sure that all of the necessary wires are connected properly. The encoder needs a power source and a common connection to be able to create the pulsed output. If the connections are properly made and the encoder has multiple outputs, try connecting the other output (if A is connected, connect B). Make sure all unused connections from the multi-wire cable are secured and not touching anything.

If there is still no signal, a pull-up resistor may need to be added. This only applies to the NX6100 and PPC6000 as the NXF4000 and PPC4000 have an internal resistor. Connect a 2.4k 1/4W resistor between terminals PZ7 and PZ8 (or PZ9 and PZ10 for VSD2).

Finally, make sure the encoder is the correct type. An open-collector output is required. If an encoder with a line driver output is installed, an external converter can be used to convert the signal to the proper format.

Troubleshooting

Incorrect encoder feedback

Check to see if the incorrect encoder feedback varies with the VFD speed. If it does, check that the encoder scaling is correct for the model of encoder used. If it is close, the scaling number can be adjusted slightly if needed. For the NX6100 and PPC6000, run the VFD at full speed and check the value at Engineer's Key 69 (70 for VSD2). Add 2% to 5% to this value and enter in Option 9.5 (9.6 for VSD2). Follow up by checking that the feedback is linear at various other positions.

If the encoder has too many pulses to work correctly with the control, an external divider can be added to convert the signal to a compatible number of pulses. For the NX6100 and PPC6000, this will read as "High" in red instead of as a value (maximum value shown is 999).

Conclusion

Improve efficiency

With the amount of electrical energy saving that is possible, a VFD should be added whenever possible. The additional channel of control is also useful for combustion setup as well. The ability to use four profiles allows bypass VFDs to be used with dual-fuel applications which can be a requirement for certain installations where they need that level of backup.

With a full lineup of bypass and non-bypass VFDs for all 230V/460V/600V three-phase motors from 5HP to 200HP, Fireye is equipped to make using a VFD as easy as possible. Application guides, wiring diagrams and technical support are available to help you choose a VFD and Nexus control for your next application.

THANK YOU