ACH 400

Users Manual

ACH 400 with HVAC Enhanced Electronic Bypass

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User's Manual

ACH400-US-08EEB
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EFFECTIVE: 2/25/02
SUPERSEDES: None

Safety Instructions

General Safety Instructions

Warnings in this manual appear in either of two ways:

- *Dangerous voltage warnings*, preceded by a Dangerous Voltage symbol, indicate the presence of voltages which may cause death or serious injury. These warnings describe procedures to avoid death or serious injury.
- *General warnings*, preceded by a General Warning symbol, indicate situations or conditions which may cause death or serious injury. These warnings describe procedures to avoid death or serious injury.

CAUTIONS inform you of situations or conditions which will damage machinery or cause additional motor-operation down-time if you do not take suggested steps to correct or address such situations or conditions.

Note: Notes provide you with additional and useful information. Although less urgent than cautions and warnings, notes are important and should not be ignored.

Warning Symbols

For your own safety please pay special attention to instructions containing these symbols:

This warning symbol indicates the presence of dangerous voltage. This symbol informs you of high voltage conditions, situations, and locations that may cause death or serious injury if you do not follow precautions and proper steps.

This warning symbol indicates a general warning.

This warning symbol indicates an electrostatic discharge hazard.

Warnings, Cautions, and Notes

WARNING! Your drive contains dangerous voltages when connected to the line power. Always check that the ACH 400 is safe, after disconnecting the power, by measuring the DC bus voltage and line input voltage. Failure to check voltages could cause death or serious injury. Only a qualified electrician should carry out the electrical installation.

The DC bus capacitors contain dangerous DC voltage levels (1.35 x V_{IN}). After disconnecting the supply, wait at least five minutes after the display readout on the control panel has disappeared before taking any measurements.

Dangerous external control voltages may be present on the relay outputs of the Electronic Bypass control board.

CAUTION: Electrostatic Discharge (ESD) can damage electronic circuits. Do not handle any components without following the proper ESD precautions.

Table of Contents

Chapter 1 – Introduction

This chapter explains the purpose and contents of this manual, intended audience, and conventions used in this manual.

How To Use This Manual

The purpose of this manual is to provide you with the information necessary to install and start-up your ACH 400 with Electronic Bypass. This manual also explains features and functions of the Electronic Bypass and requirements such as external drive control connections, wiring, cable sizes, and cable routing.

The ACH 400 with Electronic Bypass user documentation also includes the *ACH 400 AC Drives User's Manual* for 3 to 50 Hp drives or the *ACH 400 AC Drives User's Manual* for 60 to 400 Hp drives, depending on the model of your drive. Both this manual and the *ACH 400 User's Manual* are required to properly install and operate the ACH 400 with Electronic Bypass.

Chapter 1 – Introduction, the chapter you are reading now, introduces you to this *User's Manual for the ACH 400 with Electronic Bypass.*

Chapter 2 – Overview of the ACH 400 with Electronic Bypass explains drive identification and the available features and functions, and provides a detailed description of operation.

Chapter 3 – Installation Instructions covers Electronic Bypass pre-installation planning, initial inspection, mounting and electrical wiring.

Chapter 4 – Start-up Procedure includes safety precautions, configuration settings, installation inspection and initial start-up tests.

Intended Audience

The audience for this manual has:

- Minimal knowledge of ABB product names and terminology.
- No experience or training in installing, operating, or servicing the ACH 400 with Electronic Bypass.
- Basic knowledge of standard electrical wiring practices, electronic components, and electrical schematic symbols.

The audience for this manual will install and start-up the ACH 400 with Electronic Bypass. If you do not possess the skills listed above, please refer the installation to a qualified installer.

Terminal Block Nomenclature

This manual expresses specific terminal blocks and connections as a letter, a number, a colon (:), and another number. The letter and number to the left of the colon identify the terminal block, for example X1. The number to the right of the colon identifies the terminal number, for example 9. In this manual, a terminal connection numbered 9, located on a terminal block named X1, is identified as X1:9.

Warranty and Liability Information

The warranty for your ABB Electronic Bypass covers manufacturing defects. The manufacturer carries no responsibility for damage due to transport or unpacking.

In no event and under no circumstances shall the manufacturer be liable for damages and failures due to misuse, abuse, improper installation, or abnormal conditions of temperature, dust, or corrosives, or failures due to operation above rated capacities. Nor shall the manufacturer ever be liable for consequential and incidental damages.

The period of manufacturer's warranty is 12 months after installation, and not more than 18 months from the date of delivery.

Extended warranty may be available with certified start-up. Contact your local distributor for details.

Your local ABB Drives company or distributor may have a different warranty period, which is specified in their sales terms, conditions, and warranty terms.

If you have any questions concerning your ACH 400 with Electronic Bypass, contact your local distributor or ABB Drives office.

The technical data and specifications are valid at the time of printing. ABB reserves the right to subsequent alterations without notice.

Chapter 2 – Overview of ACH 400 with Electronic Bypass

This chapter explains the numbers and letters on the control nameplate, describes the Electronic Bypass features and provides a detailed description of operation. It also describes the Electronic Bypass hardware components and input/output connections.

General Information About the ACH 400

Control Identification

The ACH 400 with Electronic Bypass is a packaging arrangement that provides space for mounting factory installed options as designated by the type code characters following a plus sign (+) after the ACH 400 base unit type code. Locate the Control Nameplate on the Electronic Bypass and use Figure 2-1 to verify the model number.

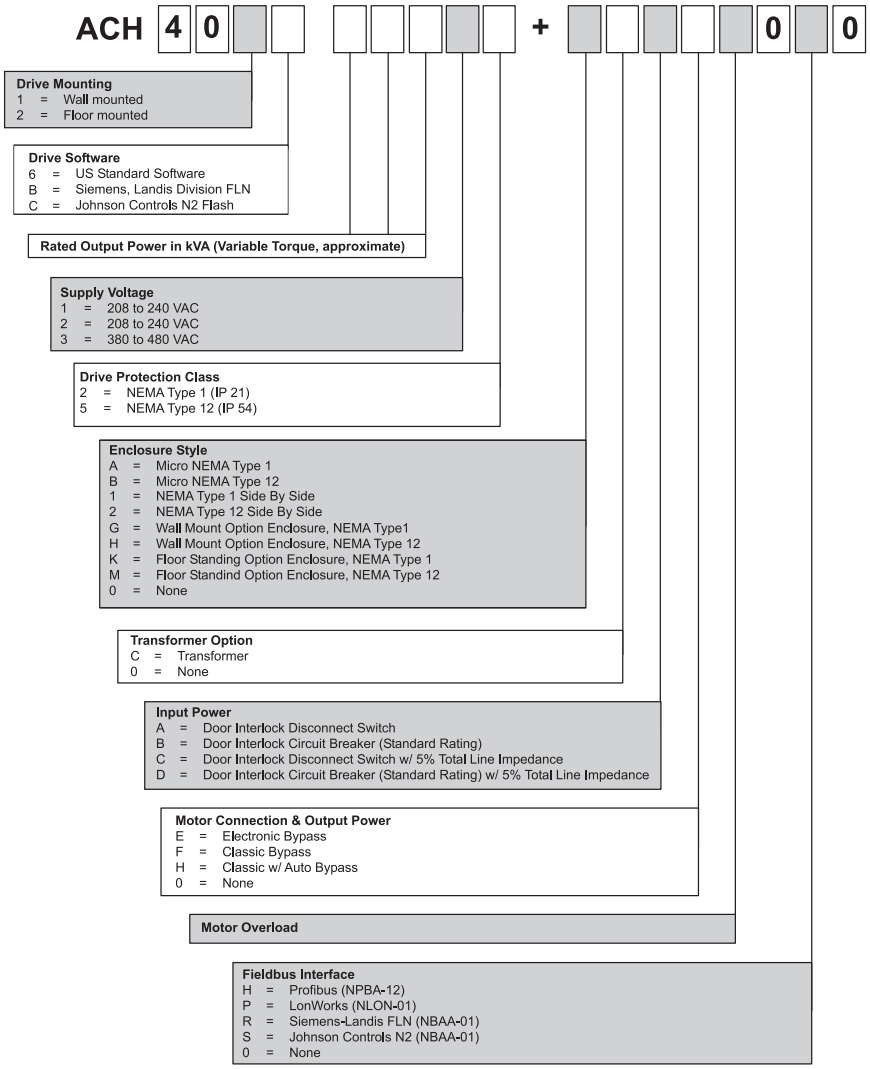


Figure 2-1 Type Code Description for the ACH 400 Electronic Bypass

Electronic Bypass Features and Functions

The ACH 400 with Electronic Bypass is an ACH 400 AC adjustable frequency drive in an integrated NEMA Type 1 or NEMA Type 12 package with a bypass motor starter. The ACH 400 with Electronic Bypass provides a disconnect switch or circuit breaker with door mounted operator (padlockable in the OFF position), a bypass starter, motor overload protection, a local operator keypad with indicating lights, and provisions for external control connections. Side by Side and NEMA Type 12 configurations also provide a drive service switch as standard.

Figure 2-2 shows the front view of the ACH 400 Electronic Bypass, and identifies the major components.

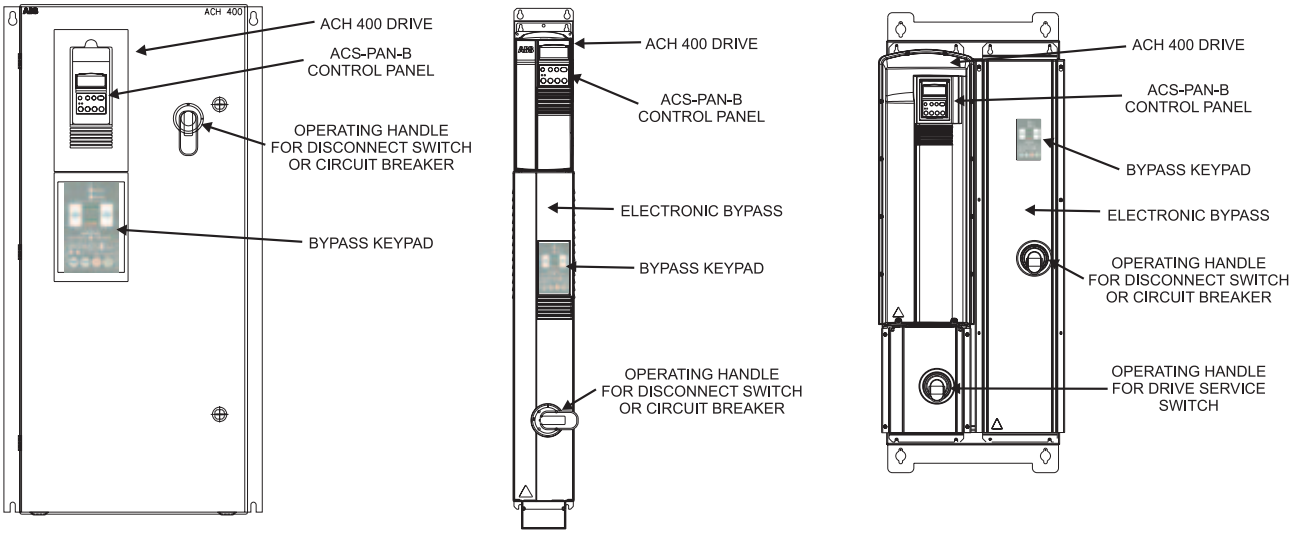


Figure 2-2 Electronic Bypass Exterior View

Input Power

Input power is connected to the ACH 400 with Electronic Bypass through a door interlocked disconnect switch or circuit breaker.

Door Interlocked Disconnect Switch

The door interlocked disconnect switch is not fused. The branch circuit that provides power to the ACH 400 with Electronic Bypass must include appropriate motor branch circuit protective devices to provide short circuit and ground fault protection for the motor in the bypass mode.

Door Interlocked Circuit Breaker

The door interlocked circuit breaker is an optional alternative to the door interlocked disconnect switch. The circuit breaker provides short circuit and ground fault protection for the motor in the bypass mode.

Drive Input Fuses

Drive input fuses are provided to disconnect the drive from power in the event that a component fails in the drive's power circuitry. Since fast-acting fuses are provided, the branch circuit protection will not clear when the drive input fuses blow. If the drive input fuses blow, the motor can be switched to Bypass without replacing fuses or resetting a circuit breaker. The drive's electronic protection circuitry is designed to clear drive output short circuits and ground faults without blowing the drive input fuses. Drive input fuse specifications are listed in Table 2-1.

Table 2-1 Drive Input Fuse Rating

240 Volt Models		480 Volt Models		Frame	Drive Input Fuse Ratings (Semiconductor Protection)	
Type Codes	HP	Type Codes	HP		Amps (660 V)	Bussmann Type
		ACH401x0043x	3	R1	10	KTK-R-10
		ACH401x0053x	5		15	KTK-R-15
ACH401x0042x	3				15	KTK-R-15
		ACH401x0063x	7.5		15	KTK-R-15
ACH401x0052x	5				25	KTK-R-25
		ACH401x0093x	10	R2	20	KTK-R-20
ACH401x0062x	7.5				30	KTK-R-30
		ACH401x0113x	15		30	KTK-R-30
		ACH401x0163x	20	R3	40	JJS-40
		ACH401x0203x	25		50	JJS-50
ACH401x0112x	10/15				60	JJS-60
ACH401x0162x	20				80	JJS-80
ACH401x0202x	25			R4	100	JJS-100
		ACH401x0253x	30		60	JJS-60
		ACH401x0303x	40		80	JJS-80
		ACH401x0413x	50		100	JJS-100
ACH401x0302x	30				110	JJS-110
ACH401x0412x	40				150	JJS-150
		ACH40160603x	60	R5	125	170M1368
		ACH40160703x	75	R6	160	170M1369
ACH40160601x	50				400	170M2621
		ACH40161003x	100		200	170M1370
ACH40160701x	60				400	170M2621
		ACH40x61203x	125	R7	400	170M3169
		ACH40x61403x	150		400	170M3169
		ACH40262103x	200	R8	550	170M5161
		ACH40262603x	250		700	170M5013
		ACH40263203x	300	R9	700	170M5013
		ACH40264003x	400		800	170M6012

Note: Fuses listed are similar in function to fuses listed in the *ACH 400 User's Manual*, physical characteristics may differ. Fuses from other manufacturers can be used if they meet the ratings given in the table. The fuses recommended in the table are UL recognized.

Line Reactor

The ACH 400 Electronic Bypass may contain optional line reactors to provide an additional 2% input impedance to limit the harmonics back to the power line. This impedance is in addition to the approximately 3% input impedance provided by internal reactors that are standard in the drive.

Bypass Contactors

The bypass circuit available with the ACH 400 Electronic Bypass includes two contactors. One contactor is the bypass contactor (2M) that can be used to manually connect the motor directly to the incoming power line in the event that the ACH 400 is out of service. The other contactor is the ACH 400 output contactor (1M for R1 through R4 and 3M for R5 through R9) that disconnects the ACH 400 from the motor when the motor is operating in the Bypass mode. The drive output contactor and the bypass contactor are interlocked to prevent "back feeding," applying line voltage to the ACH 400 output terminals.

Motor Overload Protection

In the *Drive* mode, motor overload protection is provided by the ACH 400.

In the *Bypass* mode, motor overload protection is provided by the bypass control board.

WARNING: If power is applied and the switches and contacts in the control circuit are commanding the motor to run, the motor will start as soon as the overload protection is reset.

Use caution when resetting the overload protection to make sure it is safe to start the motor.

Operator Control

The ACS-PAN-B Control Panel is a keypad with an LCD unit that provides status indication and operator control for the ACH 400 drive. In normal operation with the Electronic Bypass, the ACH 400 should be placed in the *Auto* mode of operation by pressing the *Auto* key on the ACS-PAN-B Control Panel. Refer to the *ACH 400 User's Manual* for additional information on the ACS-PAN-B Control Panel and other aspects of ACH 400 operation.

The Electronic Bypass has a separate keypad that is used for selecting the *Drive* or *Bypass* mode of operation and manually starting and stopping the motor in the *Bypass* mode. The bypass keypad has LED indicating lights that indicate the status of both the bypass and the drive. The bypass keypad is described in detail in the *Detailed Description of Operation.*

Electronic Bypass Options

In addition to the line reactor and circuit breaker options described above, the Electronic Bypass has space for installing an ABB fieldbus adapter module.

Detailed Description of Operation

The following paragraphs provide a detailed description of the various features and functions of the Electronic Bypass. Circuit diagrams for this product are shipped with the unit.

Bypass Control Keypad

Figure 2-3 shows the bypass control keypad and identifies the keys and LED indicating lights. The functions of the various keys and LEDs are described in the following paragraphs.

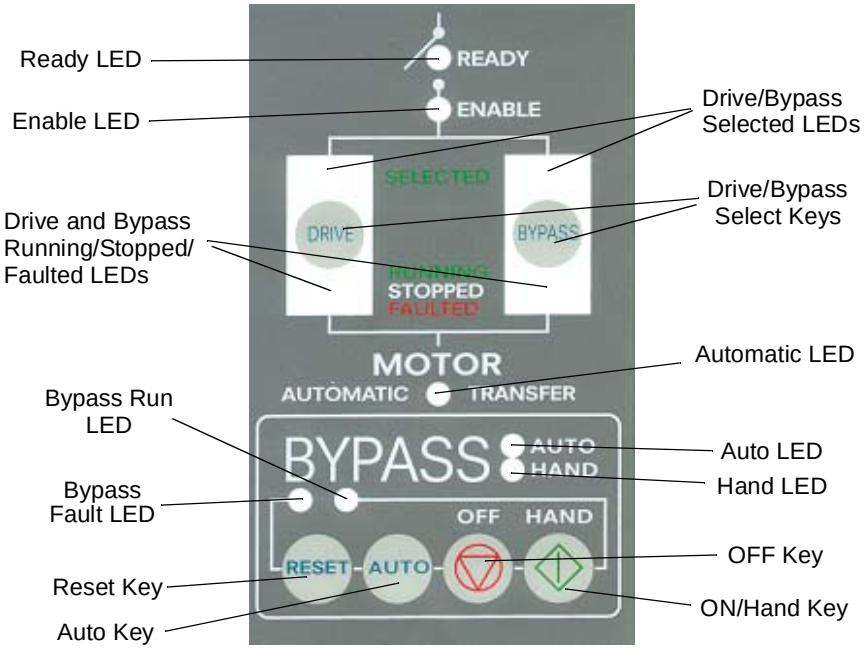


Figure 2-3 Bypass Control Keypad

Ready LED The *Ready* LED is illuminated when the disconnect switch or circuit breaker is closed and power is applied to the ACH 400 and bypass.

Enable LED The *Enable* LED is illuminated under the following conditions
1) Both the Safety Interlock and Run Enable contacts are closed.
2) The Safety Interlock contact is closed with no Start command present.
The *Enable* LED flashes when the Safety Interlock contact is closed and a Start command is present, if the Run Enable contact is open.
The *Enable* LED is not illuminated when the Safety Interlock contact is open.

Bypass Fault LED The *Bypass Fault* LED indicates the status of the bypass overload/underload protection. The LED is red when the bypass has tripped on an overload/ underload or the bypass control board has faulted.

Drive Run LED The *Drive Run* LED is illuminated green when the ACH 400 drive is running.

Drive Fault LED The *Drive Fault* LED is illuminated red when the motor or drive protection functions have shut down the ACH 400.

Drive Selected LED The *Drive Selected* LED is illuminated green when the ACH 400 drive has been selected as the power source for the motor.

Bypass Selected LED	The *Bypass Selected* LED is illuminated green when the Electronic Bypass has been selected as the power source for the motor.
Bypass Run LED	The *Bypass Run* LED is illuminated green when the motor is running in bypass.
Hand LED	The *Hand* LED is illuminated green when the motor has been started manually in the bypass mode.
Auto LED	The *Auto* LED is illuminated green when the *Auto Start* contact has been selected as the means for starting and stopping the motor in the bypass mode.
Automatic Transfer LED	The *Automatic Transfer* LED is illuminated green to indicate the system has automatically transferred to Bypass after a Drive fault. The *Automatic Transfer* LED flashes green to indicate the system has been placed in an Override condition.
Auto Key	The *Auto* key selects the *Auto Start* contact as the means for starting and stopping the motor in the bypass mode.
Reset Key	The *Reset* key resets the bypass fault. It may take several minutes before the bypass can be reset after an overload trip.
Drive Select Key	The *Drive Select* key selects the ACH 400 drive as the power source for the motor.
Bypass Select Key	The *Bypass Select* key selects the bypass as the power source for the motor.
Hand Key	The *Hand* key can be used to manually start the motor when the bypass has been selected as the power source for the motor.
OFF Key	The *OFF* key can be used to manually stop the motor if the motor has been running on bypass power.

Operating Modes

Drive mode	Under normal conditions the system is in the *Drive* mode. The ACH 400 drive provides power to the motor and controls its speed. The source of the drive's start/stop and speed commands is determined by the *Auto* or *Hand* mode selection of the drive's keypad. Commands come from the control terminals when the *Auto* mode has been selected or from the drive keypad when the *Hand* mode has been selected. The user can normally switch to the *Drive* mode by pressing the *Drive* key on the bypass keypad.
Bypass mode	In the *Bypass* mode, the motor is powered by AC line power through the bypass contactor. The source of the bypass'start/stop commands is determined by the *Auto* or *Hand* mode selection of the bypass' keypad. Commands come from the control terminals when the *Auto* mode has been selected or from the bypass keypad when the *Hand* mode has been selected. The user can normally switch to the *Bypass* mode by pressing the *Bypass* key on the bypass keypad. Alternative methods of bypass control called *Overrides* are also available. Refer to the following descriptions of the *Override* modes.

Fireman's Override mode

In the *Fireman's Override (Override 1)* mode, the motor is powered by AC line power through the bypass contactor. The source of the start command is internal and unaffected by external stop commands.The user can switch to the *Fireman's Override* mode by closing the *Fireman's Override* input contact. When the *Fireman's Override* input contact is closed, the system is forced to bypass and runs the motor. The Automatic Transfer LED flashes green when the system is in override. While in *Fireman's Override* the system does not respond to any other inputs including overloads, faults, safeties and enables. *Fireman's Override* is designed for "**Run to Destruction**" operation. Normally when the *Fireman's Override* input contact is switched from closed to open, the system returns to the operating mode that existed prior to entering *Override* and can be controlled using the *Drive* and *Bypass* keys. The exception to this is when the *Bypass Override (Override 2)* input contact is closed, in which case the system switches to *Bypass Override* operation.

Bypass Override mode

In the *Bypass Override (Override 2)* mode, the motor is powered by AC line power through the bypass contactor. The source of the start command is internal and unaffected by external stop commands.The user can switch to the *Bypass Override* mode by closing the *Bypass Override* input contact. When the *Bypass Override* input contact is closed, the system is forced to bypass and does not respond to the *Drive* and *Bypass* keys. The Automatic Transfer LED flashes green when the system is in override. While in *Bypass Override* the system responds to bypass overloads, faults, safeties and enables. Normally when the *Bypass Override* input contact is switched from closed to open, the system switches to the *Drive* mode and can be controlled using the *Drive* and *Bypass* keys.The exception to this is when the *Fireman's Override (Override 1)* input contact is closed, in which case the system remains in *Fireman's Override* operation.

Hand mode

When the system is in the *Bypass* mode, the operator can manually start the motor by pressing the *Hand* key. The motor will run and the *Hand* LED will be illuminated green. In order to run the motor, the *Safety Interlock* and *Run Enable* contacts must be closed (green *Enable* LED) and any bypass fault must be reset.

Auto mode

In the *Auto* mode the bypass start/stop command comes from the *Start/Stop* input terminal on the bypass control board. The *Auto* mode is selected by pressing the *Auto* key on the bypass keypad. The *Auto* LED is illuminated green when the bypass is in the *Auto* mode. If the system is in the *Bypass* mode, the motor will run across the line if the *Auto* mode is selected, the *Start/Stop, Safety Interlock* and *Run Enable* contacts are closed and any bypass fault is reset.

Off Mode

If the motor is running in the *Bypass* mode, the operator can manually stop the motor by pressing the *OFF* key. The *Hand* or *Auto* LED will go out. The motor can be restarted by pressing the *Hand* key or the bypass can be returned to the *Auto* mode by pressing the *Auto* key. If the system is in the *Drive* mode, pressing the *OFF* key will take the bypass out of the *Auto* mode, but will not affect motor operation from the drive. If the system is switched to the *Bypass* mode, a motor that is running will stop.

Bypass/Drive mode transfers

If the ACH 400 is in the *Auto* mode and the motor is running in the *Drive* mode, the motor will transfer to bypass operation and continue running if the system is switched to the *Bypass* mode and the bypass is in the *Auto* mode with the *Start/Stop Input* contact closed.

If the motor is running in the *Bypass* mode, the motor will transfer to drive operation and continue running if the system is switched to the *Drive* mode and the drive is in the *Auto* mode with the *Start/Stop Input* contact closed.

Starting the Motor on Application of Power

If the *Safety Interlock and Run Enable Input* contacts are closed and the system is in the *Bypass* mode and in either the *Hand* or *Auto* mode, the motor will start across the line as soon as power is applied. If the system is in the *Drive* mode with the drive in the *Auto* mode, the motor will start on the drive as soon as power is applied.

Automatic Transfer option

When the *Automatic Transfer* option is selected, the motor is automatically transferred to line power if the drive trips out on a protective trip. If automatic restart has been enabled in the drive, the drive will attempt to automatically restart before the motor is transferred to line power. The *Automatic Transfer* option is selected by setting a configuration switch on the bypass control board. See *Electronic Bypass Jumper, Switch and Pot Settings* in Chapter 4 on page 4-2. The *Automatic Transfer* LED is illuminated green once the system has automatically transferred to bypass operation.

Output Contactor Control

In the unlikely event of failure in the bypass control electronics, the user can engage the drive output contactor without the control electronics by using a configuration jumper on the bypass control board. See *Output Contactor Control* on page 4-3.

Bypass Control Board Inputs and Outputs

Electronic Bypass control board has five relay contact (digital) inputs, six relay outputs and one digital output that are available for connection to external control circuits. The internal 24VDC supply is normally used in conjunction with the relay contact inputs. Use of an external 110VAC power supply requires re-configuring Jumper J3. Care should be taken when using external supply voltages so as not to damage the drive and bypass electronics. The input and output functions are described below. Refer to *Chapter 3 – Installation Instructions* for additional information and connection instructions.

Relay Contact Inputs

Start/Stop

The *Start/Stop* input is connected to a normally open contact that starts and stops the system. When the Electronic Bypass is in the *Drive* mode and the ACH 400 is in the *Auto* mode, the *Start/Stop* input contact controls the motor by starting and stopping the ACH 400 drive. When the Electronic Bypass is in the *Bypass* mode and the *Auto* LED is illuminated green, the Start/Stop input contact controls the motor by controlling the bypass contactor.

Run Enable

The *Run Enable* input is connected to the series combination of any external normally closed permissive contacts, such as damper end switches, that must be closed to allow the motor to run. If any of these external contacts are open while a *Start* command is present, the *Enable* LED will flash and the motor is prevented from running.

Safety Interlock

The *Safety Interlock* input is connected to the series combination of any external normally closed interlock contacts, such as Firestat, Freezestat, and high static pressure switches, that must be closed to allow the motor to run. If any of these external contacts are open, the *Enable* LED is not illuminated, the drive output contactor, bypass contactor, and *System Started* relay are deenergized and the motor is prevented from running.

Fireman's Override (Override 1)

The *Fireman's Override (Override 1)* input can be connected to an external contact that is closed to select the *Fireman's Override* mode. In the *Fireman's Override* mode, the motor is powered by AC line power through the bypass contactor. The source of the start command is internal and unaffected by external stop commands. In the *Fireman's Override* mode, the system is forced to bypass and runs the motor. While in *Fireman's Override*, the system does not respond to any other inputs including overloads, faults, safeties and enables. *Fireman's Override* is designed for "**Run to Destruction**" operation. Normally when the *Fireman's Override* input contact is switched from closed to open, the system returns to the operating mode that existed prior to entering *Override* and can be controlled using the *Drive* and *Bypass* keys. The exception to this is when the *Bypass Override (Override 2)* input contact is closed, in which case the system switches to *Bypass Override* mode.

Bypass Override (Override 2)

The *Bypass Override (Override 2)* input can be connected to an external contact that is closed to select the *Bypass Override* mode. In the *Bypass Override* mode the motor is powered by AC line power through the bypass contactor. The source of the start command is internal and unaffected by external stop commands. In the *Bypass Override* mode, the system is forced to bypass and does not respond to the *Drive* and *Bypass* keys. While in *Bypass Override*, the system responds to bypass overloads, faults, safeties and enables. Normally when the *Bypass Override* input contact is switched from closed to open, the system switches to the *Drive* mode and can be controlled using the *Drive* and *Bypass* keys.The exception to this is when the *Fireman's Override (Override 1)* input contact is closed, in which case the system remains in *Fireman's Override* mode.

Relay Contact Outputs

Drive Fault — The *Drive Fault* relay is energized during normal operation. The *Drive Fault* relay is de-energized when an ACH 400 drive fault has occured.

System Run — The *System Run* relay is energized when the Electronic Bypass System is running. The *System Run* relay provides an output when the motor is running whether powered by the ACH 400 drive or the bypass.
Separate *Drive Run* and *Bypass Run* contacts can be created by using the common (C) contact of the *System Run* relay and connecting the the normally open (NO) contact of the *System Run* relay to the common (C) contact of the *Mode / Override* relay. To do this the *Mode / Override* relay must be configured for *Mode* relay operation. See *Electronic Bypass Jumper, Switch and Pot Settings* in Chapter 4 on page 4-2. The normally closed (NC) contact of the *Mode* relay becomes the *Drive Run* contact and the normally open (NO) contact of the *Mode* relay becomes the *Bypass Run* contact This configuration provides outputs that are closed when the motor is running. See *Typical Applications and Configurations* at the end of this Chapter.

System Started — The *System Started* relay is energized when the Electronic Bypass system is started. Three conditions must be met in order for the relay to energize. 1) a *Start* command must be present, 2) the *Safety Interlock* input contact must be closed and 3) there can be no fault present in the system. The *Start* command can come from the bypass control board terminal block, the ACH 400 keypad, the bypass keypad, or serial communications depending on the operational mode selected. The *System Started* relay is ideal for use in damper actuator circuits, opening the dampers only under those conditions where the system is preparing to run the motor. Closing the dampers if the safeties open, the system faults, or when a *Stop* command is issued.

Mode/Override — The *Mode / Override* relay is a configurable relay. The function of the relay is selectable between *Mode* and *Override* operation. If the *Mode / Override* relay is configured for *Mode* operation (Default), the relay is energized when the *Bypass* mode is selected and de-energized when the *Drive* mode is selected. If the *Mode / Override* relay is configured for *Override* operation, the relay is energized when the *Override* mode is selected and de-energized in all other modes. See *Electronic Bypass Jumper, Switch and Pot Settings* in Chapter 4 on page 4-2.

Bypass Fault — The *Bypass Fault* relay is energized during normal operation. The *Bypass Fault* relay is de-energized when a bypass fault has occured or when the bypass motor overload/underload protection has tripped.

Hand/Off/Auto — The *Hand/Off/Auto* relay is energized when the bypass is in the *Auto* mode and de-energized in the *Hand* mode and when the bypass is *Off*. In the Auto mode the bypass start/stop command comes from the *Start/Stop* input terminal on the bypass control board.

Digital Output

Safety Interlock

The *Safety Interlock* output is active when the *Safety Interlock Input* contact is closed. The *Safety Interlock* output is available for customer connection and routing through the ACH 400 drive. User's can select from a variety of optional communication protocols to monitor the *Safety Interlock* status through the ACH 400 digital inputs. Refer to the *ACH 400 User's Manual* and the appropriate communications manual for additional information about monitoring ACH 400 digital inputs.

ACH 400 Drive Inputs and Outputs

Some of the ACH 400 inputs and outputs are pre-wired to the bypass control board and not available for external use. The inputs and outputs that are not pre-wired are available for external use by connecting directly to the terminals in the ACH 400. The pre-wired and available inputs and outputs are described below. Refer to the *ACH 400 User's Manual* for additional information about the inputs and outputs. See also *Chapter 3 – Installation Instructions* for additional information and connection instructions.

The ACH 400 has two relay outputs that are pre-wired to the bypass control board and used to provide the *System (Drive) Started* and *Drive Fault* outputs that are described above.

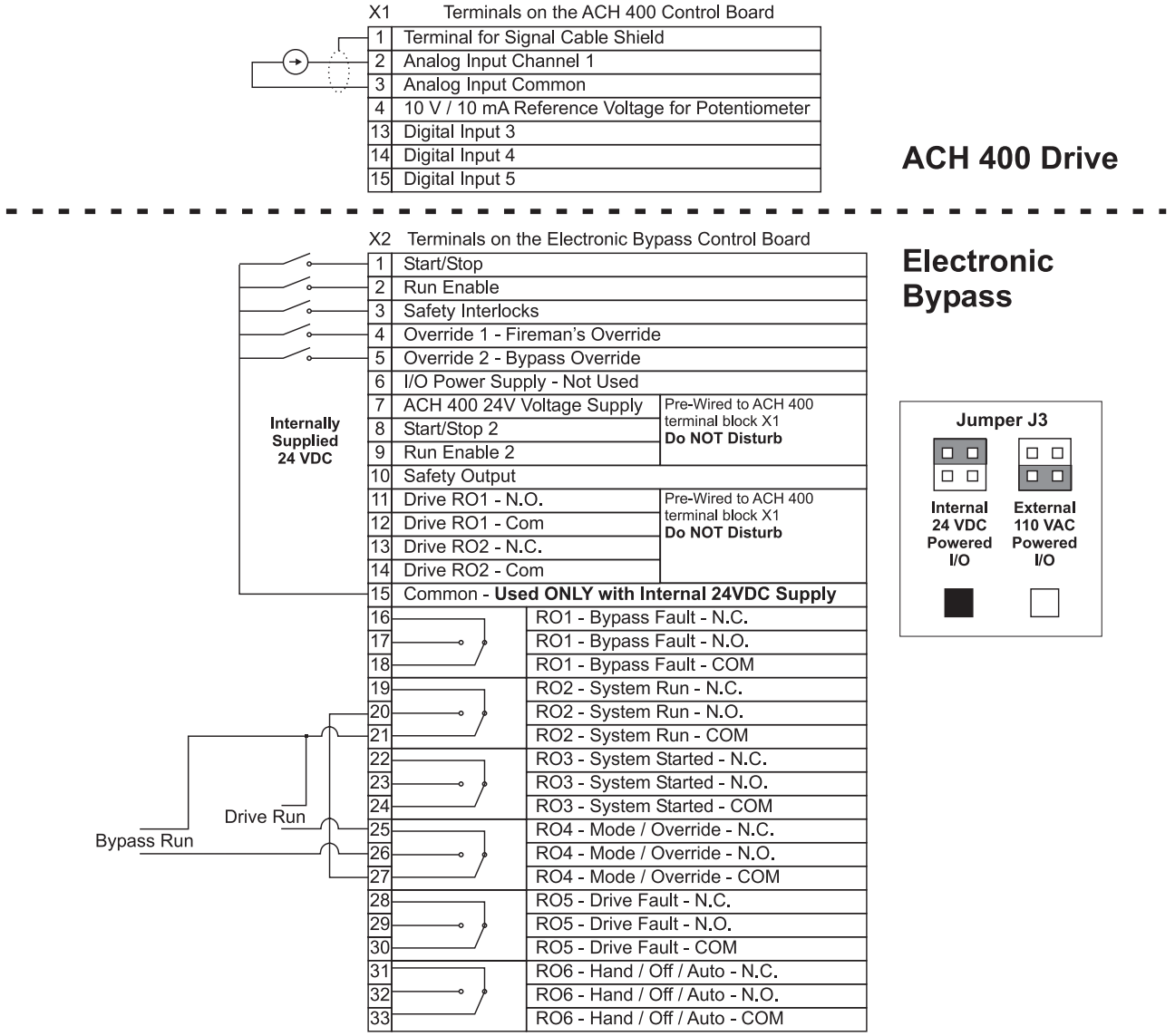
Two of the ACH 400's digital inputs, the *Auto Mode Start/Stop* input and the *Run Enable* input are also pre-wired to the bypass control board and coordinated with the *Start/Stop* and *Run Enable* inputs that control the motor in both the Drive and Bypass modes of operation.

Caution: The Electronic Bypass will not work properly if the Drive relay outputs RO1 and RO2 or the Drive digital inputs DI1 and DI2 are reassigned by changing ACH 400 configuration settings. The only macros that provide the proper configuration settings are the HVAC, HVAC Floating Point and the HVAC PID Control macros. When using the above macros, Parameter 1402 (RO2) must be changed from "RUN" to "STARTED" or portions of the Electronic Bypass will not function properly. Refer to the *ACH 400 User's Manual* for additional information.

Three of the digital inputs of the ACH 400 are available for routing Electronic Bypass outputs (digital and relay) through the ACH 400 drive. Users can select from a variety of communication protocols to monitor the Electronic Bypass status through the ACH 400 digital inputs. The digital inputs of the ACH 400 are also available for selecting constant speeds or providing *Speed Increase* and *Speed Decrease* inputs. The functions of these inputs is determined by the ACH 400 macro selection. Refer to the *ACH 400 User's Manual* for additional information.

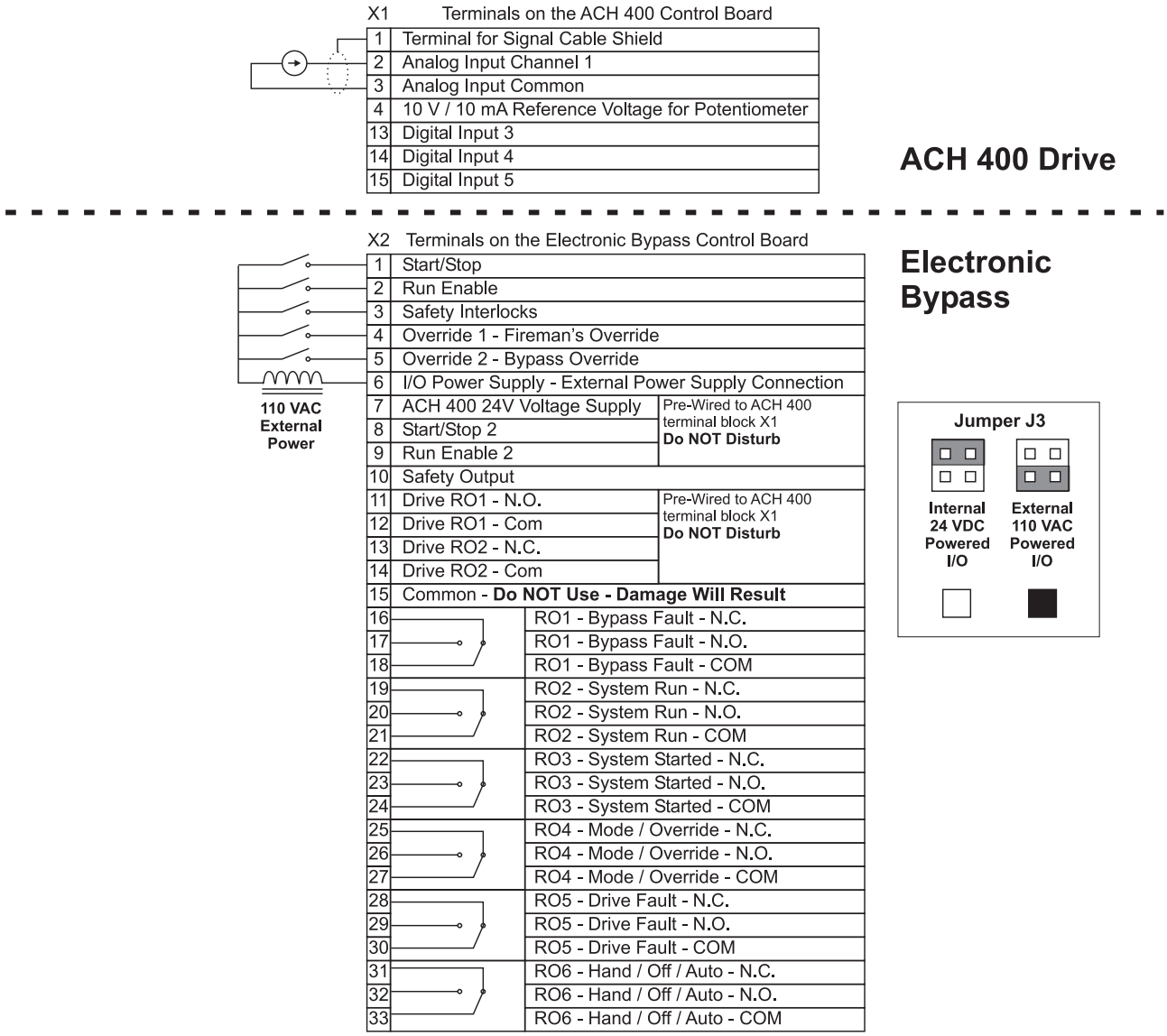
The ACH 400 *Auto Mode External Reference* input is an analog input that sets the operating speed when the ACH 400 *HVAC* macro is selected and the drive is in the *Auto* mode. When the HVAC PID Control macro is selected, analog inputs are used for setting the PID reference and receiving the transducer feedback "actual" signal. Refer to the *ACH 400 User's Manual* for additional information.

The *Output Frequency* analog output of the ACH 400 provides a 4 to 20 mA signal proportional to the drive output frequency or motor speed.



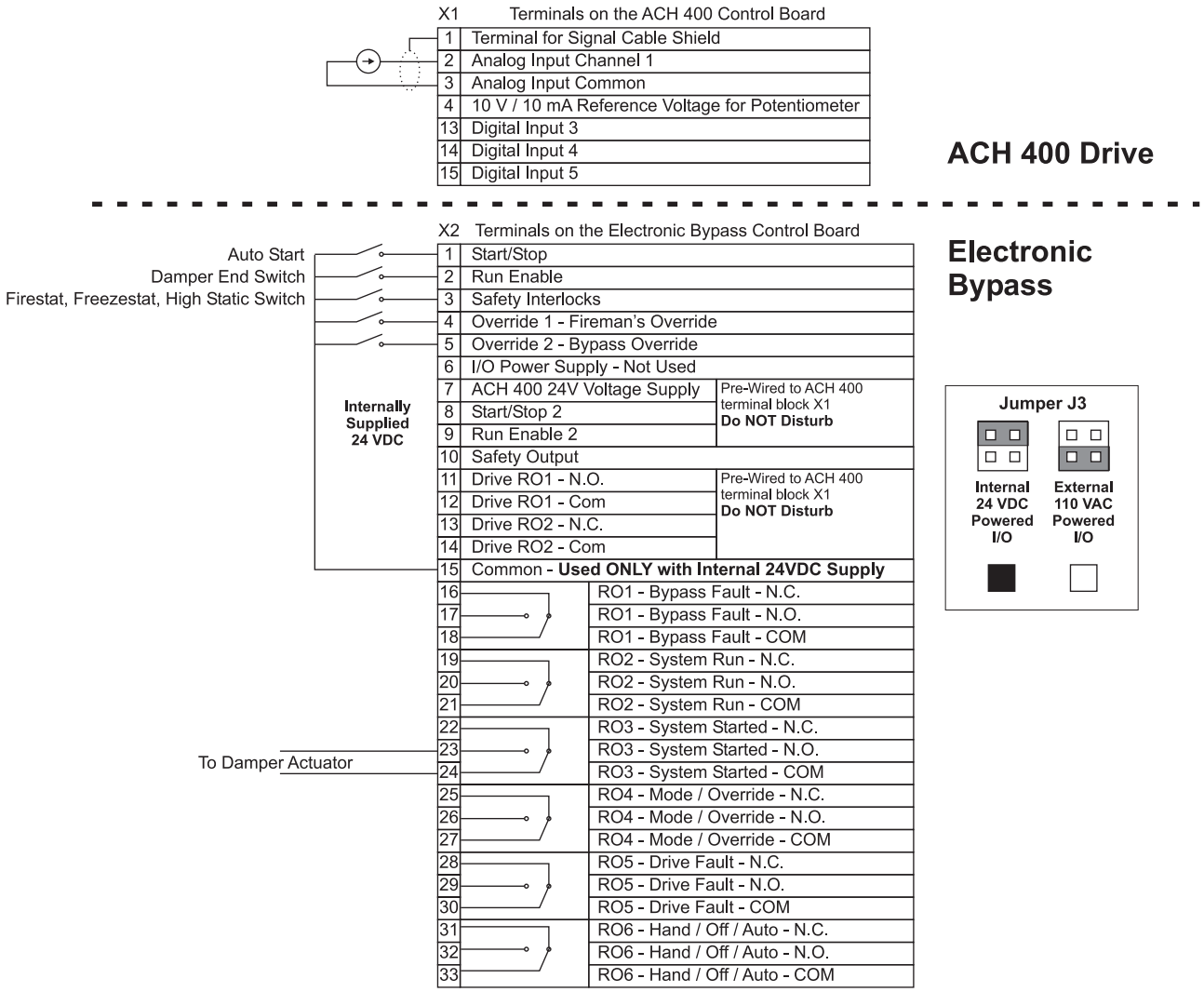
Parameter Number	Description	Setting
1402	RELAY OUTPUT 2	31 (STARTED)

Figure 2-4 Basic Control Connections for Separate Drive Run & Bypass Run Commands



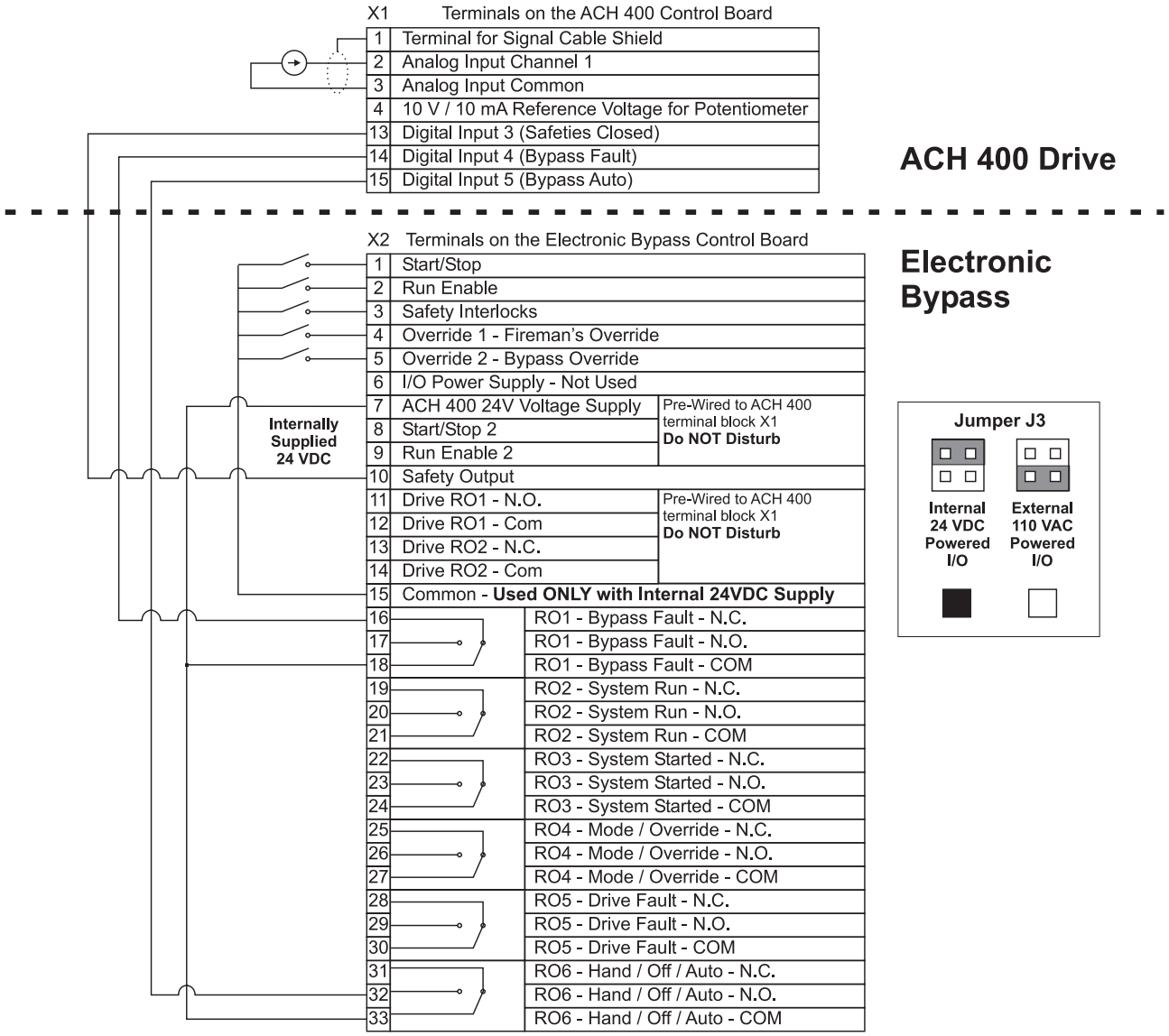
Parameter Number	Description	Setting
1402	RELAY OUTPUT 2	31 (STARTED)

Figure 2-5 Basic Control Connections for Externally Supplied 115 VAC Power



Parameter Number	Description	Setting
1402	RELAY OUTPUT 2	31 (STARTED)

Figure 2-6 Basic Control Connections for Damper Actuator Control



Parameter Number	Description	Setting
1201	CONST SPEED SEL	0 (NOT SEL)
1402	RELAY OUTPUT 2	31 (STARTED)

Figure 2-7 Basic Control Connections for Routing Outputs Through the ACH 400

X1 Terminals on the ACH 400 Control Board

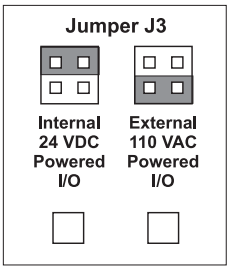
1	Terminal for Signal Cable Shield
2	Analog Input Channel 1
3	Analog Input Common
4	10 V / 10 mA Reference Voltage for Potentiometer
13	Digital Input 3
14	Digital Input 4
15	Digital Input 5

ACH 400 Drive

X2 Terminals on the Electronic Bypass Control Board

1	Start/Stop	
2	Run Enable	
3	Safety Interlocks	
4	Override 1 - Fireman's Override	
5	Override 2 - Bypass Override	
6	I/O Power Supply - Not Used	
7	ACH 400 24V Voltage Supply	Pre-Wired to ACH 400 terminal block X1 **Do NOT Disturb**
8	Start/Stop 2	
9	Run Enable 2	
10	Safety Output	
11	Drive RO1 - N.O.	Pre-Wired to ACH 400 terminal block X1 **Do NOT Disturb**
12	Drive RO1 - Com	
13	Drive RO2 - N.C.	
14	Drive RO2 - Com	
15	Common - **Used ONLY with Internal 24VDC Supply**	
16	RO1 - Bypass Fault - N.C.	
17	RO1 - Bypass Fault - N.O.	
18	RO1 - Bypass Fault - COM	
19	RO2 - System Run - N.C.	
20	RO2 - System Run - N.O.	
21	RO2 - System Run - COM	
22	RO3 - System Started - N.C.	
23	RO3 - System Started - N.O.	
24	RO3 - System Started - COM	
25	RO4 - Mode / Override - N.C.	
26	RO4 - Mode / Override - N.O.	
27	RO4 - Mode / Override - COM	
28	RO5 - Drive Fault - N.C.	
29	RO5 - Drive Fault - N.O.	
30	RO5 - Drive Fault - COM	
31	RO6 - Hand / Off / Auto - N.C.	
32	RO6 - Hand / Off / Auto - N.O.	
33	RO6 - Hand / Off / Auto - COM	

Electronic Bypass



Parameter Number	Description	Setting
1402	RELAY OUTPUT 2	31 (STARTED)

Figure 2-8 Customer Control Connection Worksheet

Chapter 3 – Installation Instructions

This chapter explains how to install the ACH 400 with Electronic Bypass and connect all power, motor, and control wiring. It also explains the initial inspection procedures.

Pre-Installation Planning

Before beginning installation, review the installation instructions in this chapter and make sure that the installation requirements can be met. The following topics should be considered in pre-installation planning:

- Environment
- Heat Dissipation Requirements
- Mounting Area
- Wiring Requirements

Environment

The ACH 400 with Electronic Bypass must be installed in a heated, indoor controlled environment that is relatively free of moisture and conductive contaminants such as condensation, carbon dust, and the like.

The maximum ambient temperature allowed is 104°F (40°C) for an ACH 400 in the Electronic Bypass enclosure. The rating is based on a variable torque load with the load current lower than or equal to the continuous maximum load current.

Heat Dissipation Requirements

ACH 400 drives are self-cooled. The cooling air entering the drive must be clean and free from corrosive materials. The tables below give the heat dissipated into the hot air exhausted from the drives. If the drives are installed in a confined space, the heat must be removed from the area by ventilation or air conditioning equipment.

Table 3-1 Heat Dissipation for ACH 400 Electronic Bypass Units

240 Volt Models		480 Volt Models		Heat Dissipation			
				Drive Only		Drive with Line Reactors	
Type Codes	HP	Type Codes	HP	Watts	BTU/Hr	Watts	BTU/Hr
ACH40160042x	3			80		95	
		ACH401x0043x	3	100	340	115	390
ACH40160052x	5			120		140	
		ACH401x0053x	5	130	440	145	490
ACH40160062x	7.5	ACH401x0063x	7.5	180	610	195	670
		ACH401x0093x	10	240	820	260	700
		ACH401x0113x	15	340	1160	360	1230
ACH40160112x	10/15			340		390	
		ACH401x0163x	20	460	1570	490	1670
ACH40160162x	20			460		520	
		ACH401x0203x	25	570	1950	620	2120
ACH40160202x	25			610		680	
		ACH401x0253x	30	670	2290	730	2490
ACH40160302x	30			750		840	
		ACH401x0303x	40	910	3110	970	3310
ACH40160412x	40			910		1010	
		ACH401x0413x	50	1110	3790	1180	4030
		ACH40160603x	60	1800	6150	1910	6520
		ACH40160703x	75	2100	7170	2200	7510
ACH40160601x	50			2185	7500	2300	7850
ACH40160701x	60			2950	10100	3080	10500
		ACH40161003x	100	3000	10200	3120	10650
		ACH40x61203x	125	3600	12300		
		ACH40x61403x	150	4200	14300		
		ACH40262103x	200	6300	21500		
		ACH40262603x	250	7800	26600		
		ACH40263203x	300	9600	32800		
		ACH40264003x	400	12000	40900		

If the cooling air contains dust, clean the cooling surfaces of the unit regularly using compressed air and a brush. If the ACH 400 is in a NEMA 1 enclosure, cover the vents during cleaning to prevent the dust from entering the unit.

If the heatsink is not cleaned and is not able to dissipate the expended heat, the ACH 400's thermal protection will activate, causing a fault indication which stops the drive. The ACH 400 can be started again when the temperature of the heatsink has fallen below the trip level.

Mounting Location

When mounting the unit take the following precautions.

- DO NOT mount in direct sunlight.
- DO NOT mount on surfaces with temperatures above 104°F (40°C).
- DO NOT allow the ambient temperature around the ACH 400 to exceed the ambient temperature as stated in *Environment* above.
- Mount the Electronic Bypass enclosure vertically with the ACH 400 control panel and Bypass control panel visible and the disconnect accessible.
- Enclosure dimension drawings are presented in this chapter.
- For proper cooling, each unit must have two inches (50 mm) of clear space on each side. If units are to be mounted next to each other, there must be a total of four inches (100 mm) from unit to unit.
- The units cannot be mounted one above the other.

Wiring Requirements

The ACH 400 with Electronic Bypass is designed for use on a three-phase system. Four wires (three phase wires plus a ground wire) are required for the input wiring. Input and output conductors, and branch circuit protection must be sized to local codes. All field power wiring shall be copper, rated for 60°C if rated for less than 100 amps or 75°C if rated 100 amps or more. At least three separate conduits are required, one for input power, one for output power to the motor and one for control signals. The External Speed Reference signal must be wired using a shielded twisted pair cable. Refer to *Electrical Installation* on page 3-13 for detailed wiring information.

Initial Inspection Procedure

As you unpack the ACH 400 with Electronic Bypass, check for any signs of damage and verify that the delivery is complete by examining the contents for items such as the user's manual, keypad, etc. In the event of damage, please contact the shipping company or the supplier. Locate the drive nameplate and confirm that the Electronic Bypass is configured to the order specifications. Refer to *Chapter 2 – Overview of ACH 400 with Electronic Bypass* in this manual.

If the Electronic Bypass is stored before start-up, verify that the environmental conditions in the storage room meet the following conditions:

- Temperature between -40°F and +158°F (-40°C and +70°C),
- Relative humidity is less than 95 percent
- No condensation.

The warranty covers defects in manufacturing. The manufacturer carries no responsibility for damage incurred during transport or unpacking.

If any questions arise concerning the ACH 400 with Electronic Bypass, please contact your Distributor or local ABB Drives Office.

Mechanical Installation

Securely mount the ACH 400 with Electronic Bypass on a wall in a vertical position. Use the four mounting notches at the top and bottom of the unit. Before mounting the unit, verify that the environmental conditions conform to the specifications listed in *Pre-Installation Planning* in this chapter.

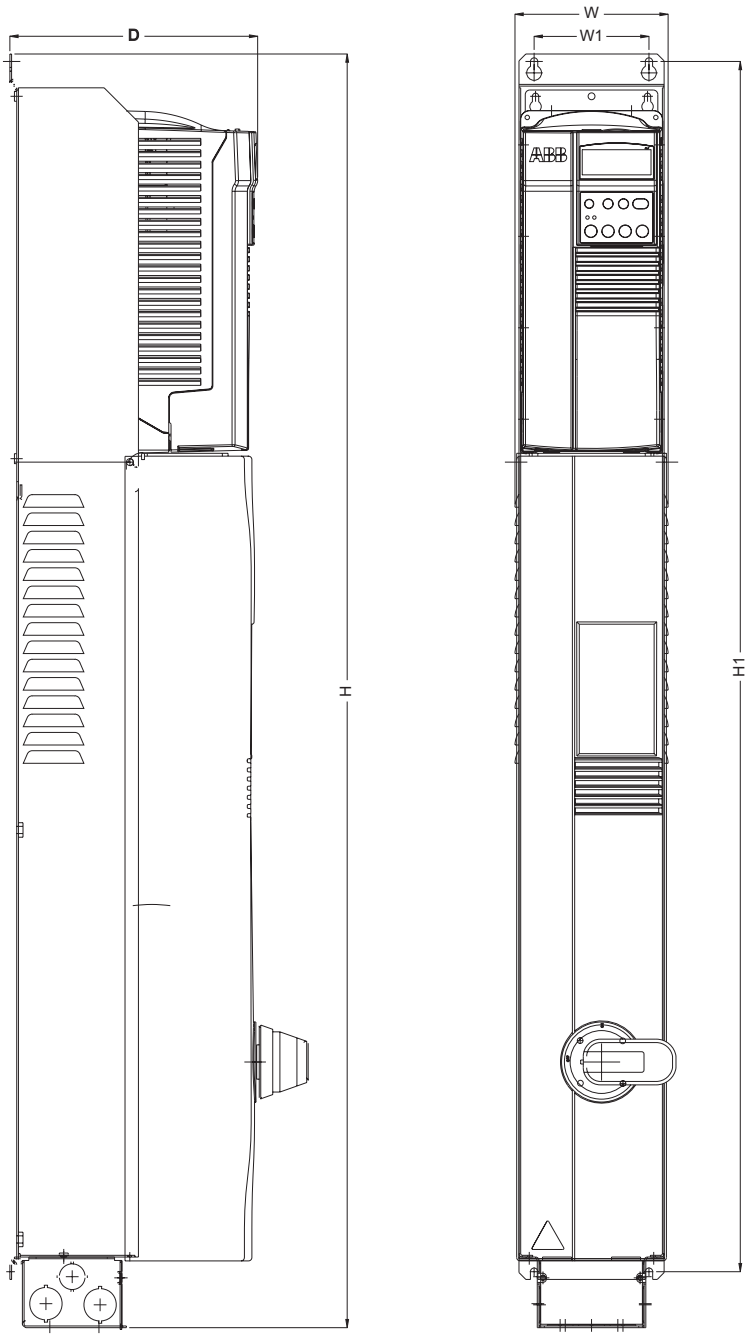
To ensure safe installation, check that the surface of the mounting location is flat.

Attach the Electronic Bypass enclosure at the mounting notches and tighten the bolts.

Dimensions and Weights

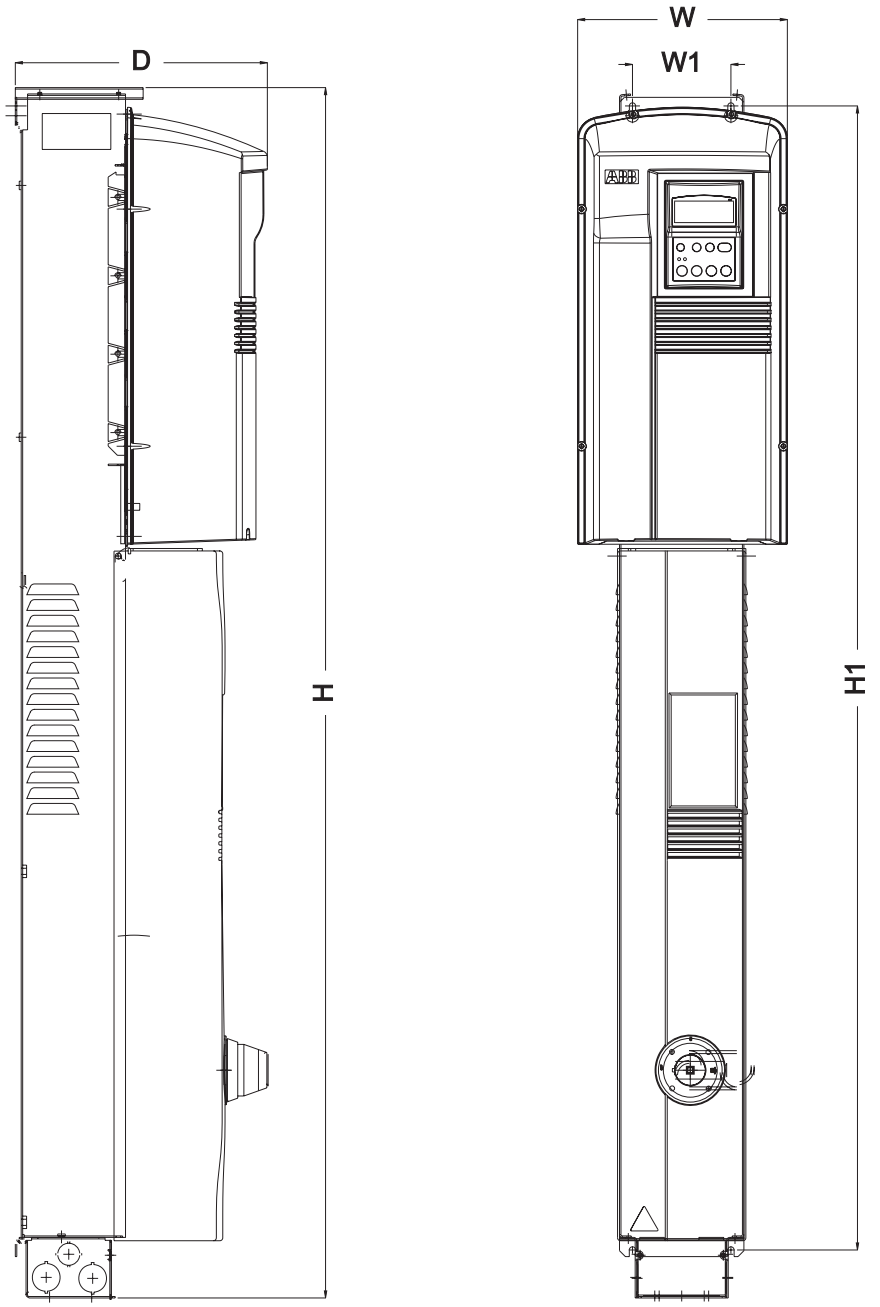
The dimensions and weights of the ACH 400 Electronic Bypass units are given in the following illustrations.

NEMA Type 1, Size R1 - R4



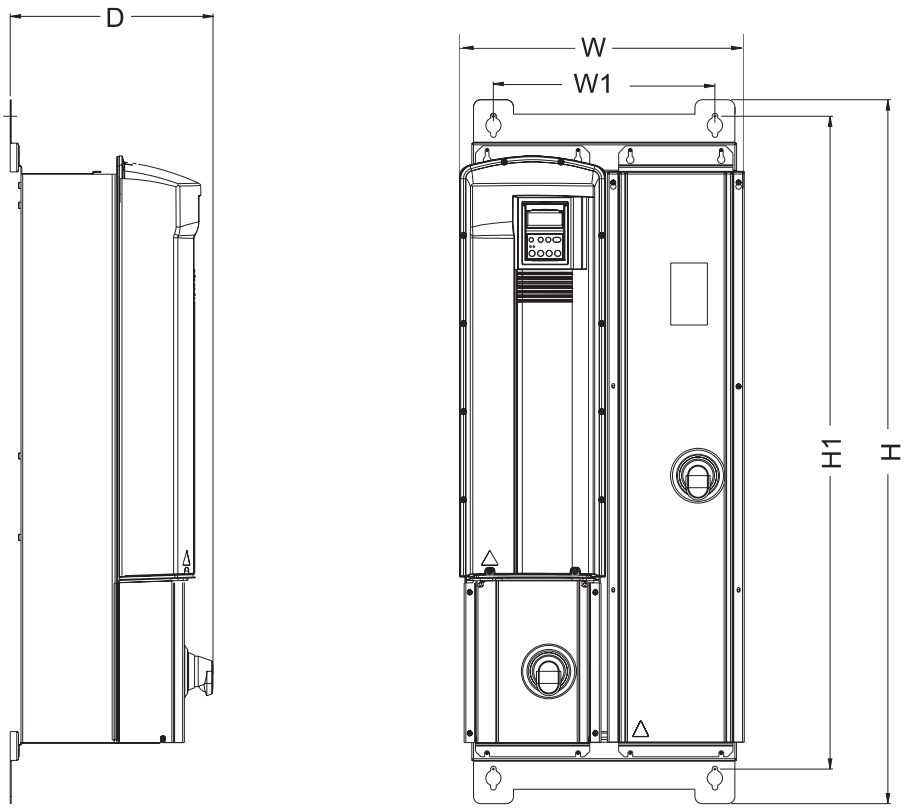
Dimensions Reference (in/mm)	Frame Size, IP21/NEMA 1			
	R1	R2	R3	R4
W	5.28/134	5.28/134	8.66/220	8.66/220
W1	3.96/101	3.96/101	6.34/161	6.34/161
H	43.67/1114	47.80/1214	54.93/1395	58.47/1485
H1	41.68/1059	45.62/1159	52.47/1133	56.01/1423
D	10.28/261	10.20/259	1176/299	11.76/299
Mass (lb/kg)	34/16	41/19	108/49	127/58

NEMA Type 12, Size R1 - R4



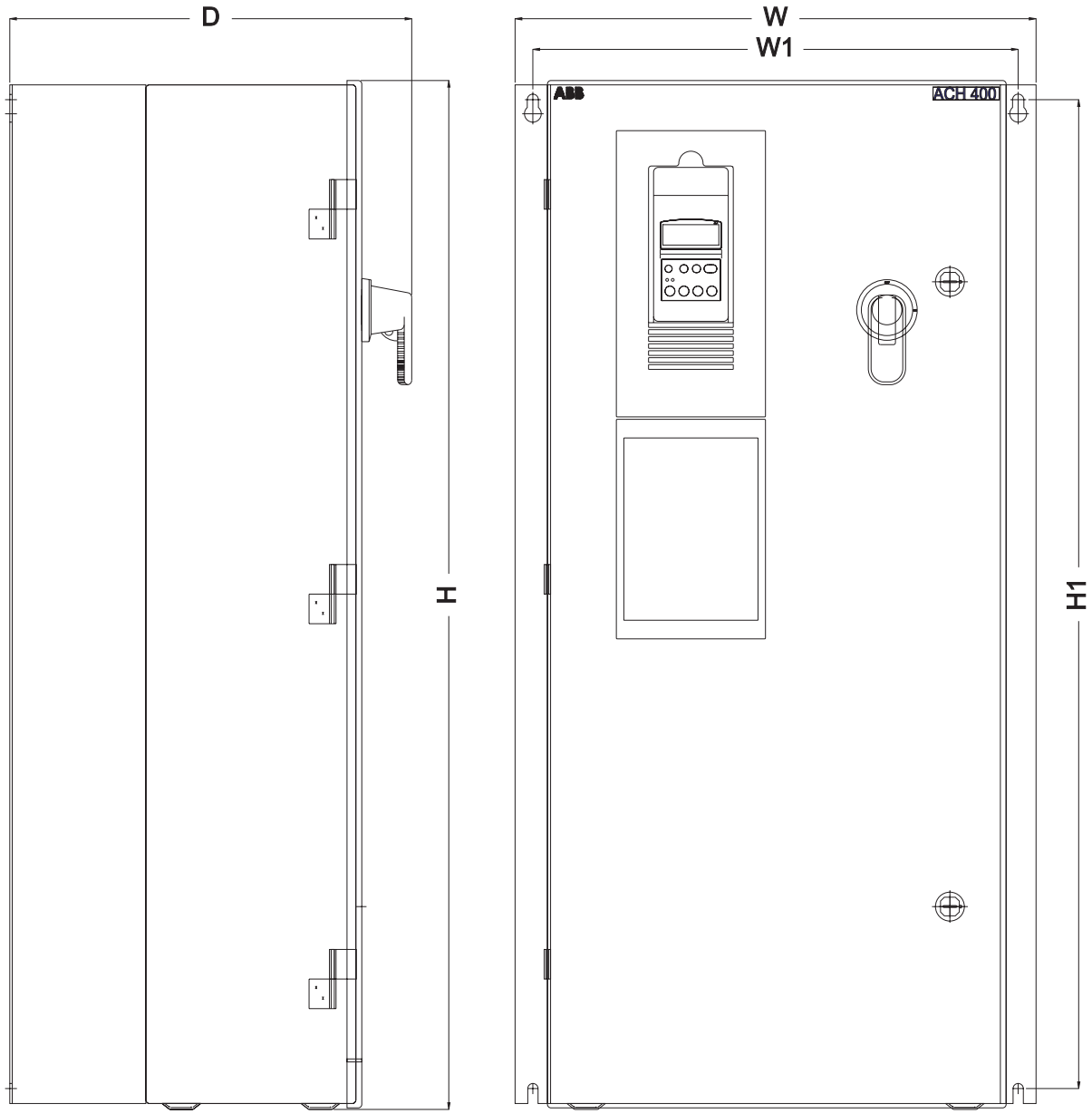
Dimensions Reference (in/mm)	Frame Size, IP54/NEMA 12			
	R1	R2	R3	R4
W	8.43/214	8.43/214	10.09/256	10.09/256
W1	3.96/101	3.96/101	6.34/161	6.34/161
H	48.63/1235	52.51/1334	59.71/1517	63.65/1617
H1	45.97/1168	50.37/1279	57.29/1455	61.19/1554
D	10.20/259	10.20/259	11.76/299	12.45/316
Mass (lb/kg)	36/17	44/20	112/51	131/60

ACH 400 Side By Side NEMA Type 1/12, Size R1 - R4



Dimensions Reference (in/mm)	Frame Size, IP21/IP54, NEMA 1/12			
	R1	R2	R3	R4
W	15.45/392	15.45/392	19.71/501	19.71/501
W1	9.68/246	9.68/246	15.35/390	15.35/390
H	33.87/860	33.87/860	48.75/1238	48.75/1238
H1	31.43/798	31.43/798	45.21/1148	45.21/1148
D	12.59/320	12.59/320	14.04/357	14.04/357
Mass (lb/kg)	55/25	63/29	131/60	150/68

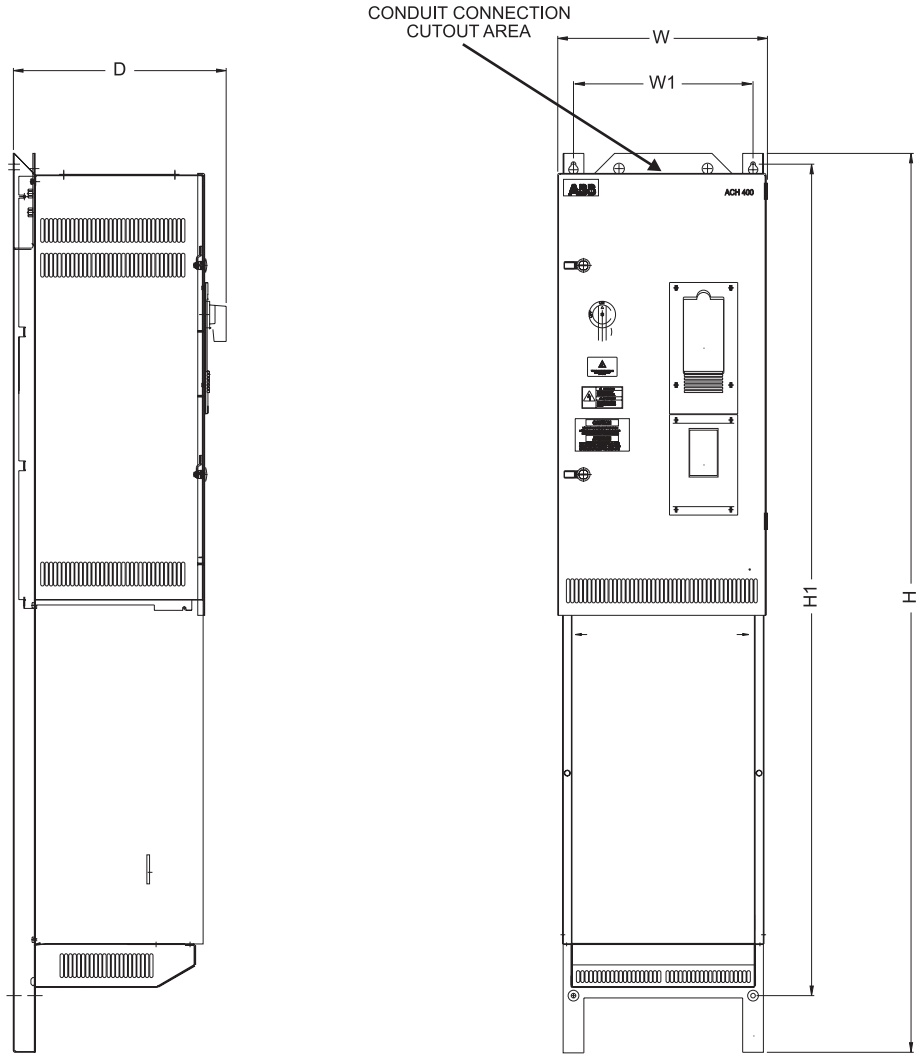
NEMA Type 1/12, Size R5 - R6



Dimensions Reference (in/mm)	Frame Size, IP21/IP54, NEMA 1/12		
	R4*	R5	R6
W	30/762	30/762	30/762
W1	28/711	28/711	28/711
H	59.44/1510	59.44/1510	59.44/1510
H1	57.75/1467	57.75/1467	57.75/1467
D	22.87/581	22.87/581	22.87/581
Mass (lb/kg)	251/114	269/122	302/137

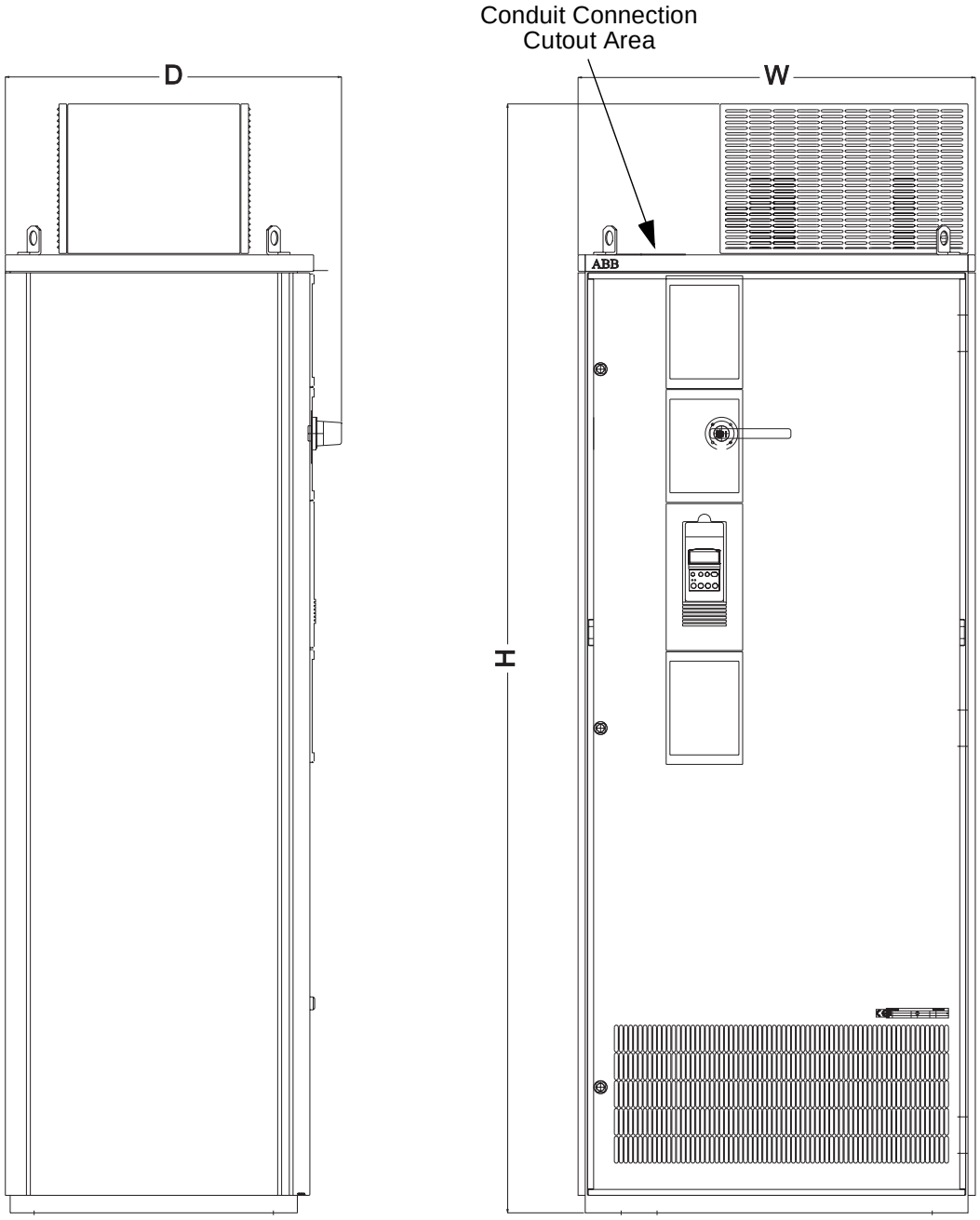
* R4, 30 and 40 HP 230V Models ONLY.

ACH 401 NEMA Type 1, Size R7



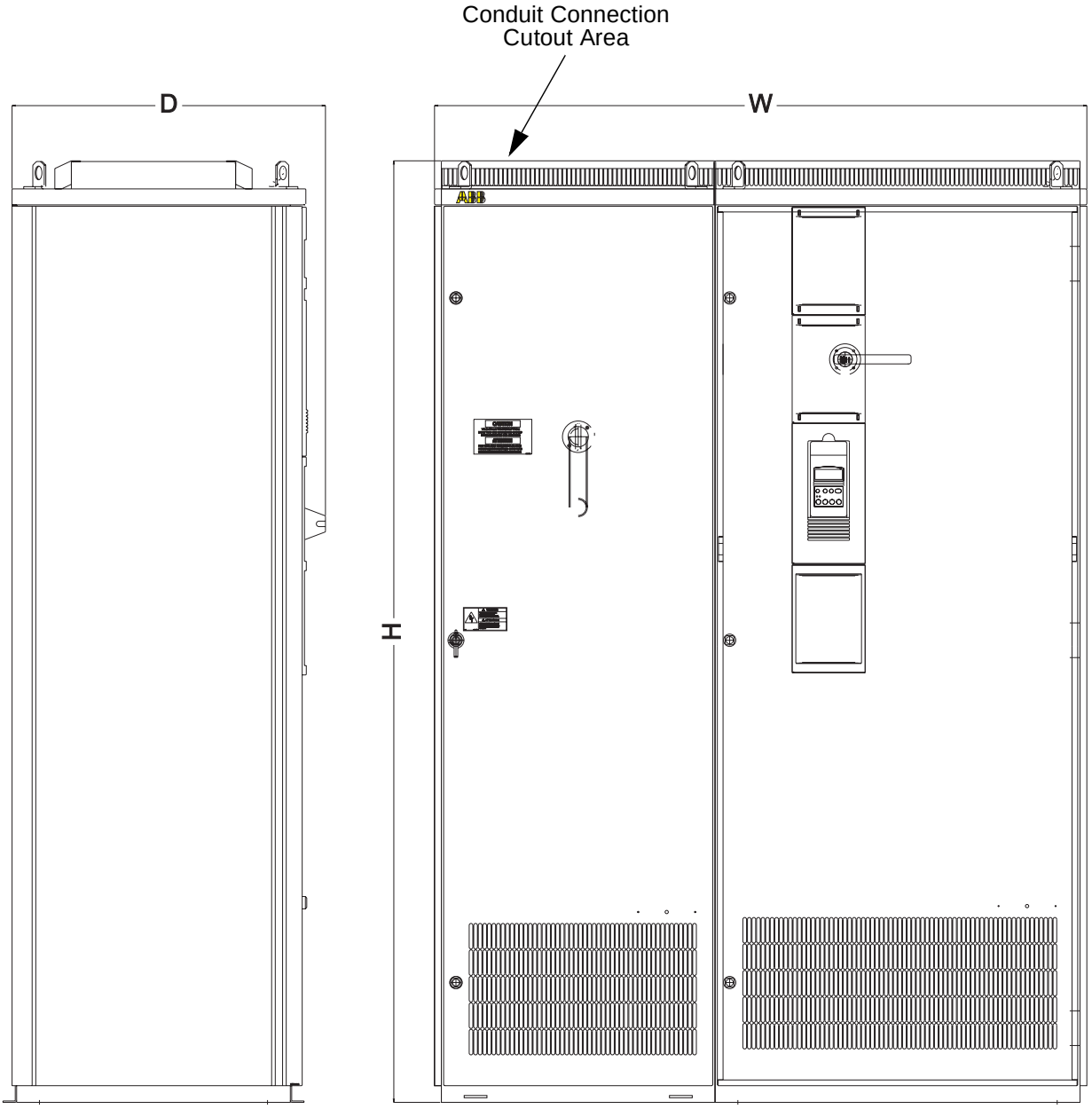
Dimensions Reference (in/mm)	NEMA 1 R7
W	19.26/491.8
W1	16.59/421.3
H	83/2108.2
H1	76.78/1950.1
D	19.64/498.9
Mass (lb/kg)	182/400

ACH 402 NEMA Type 12, Size R7



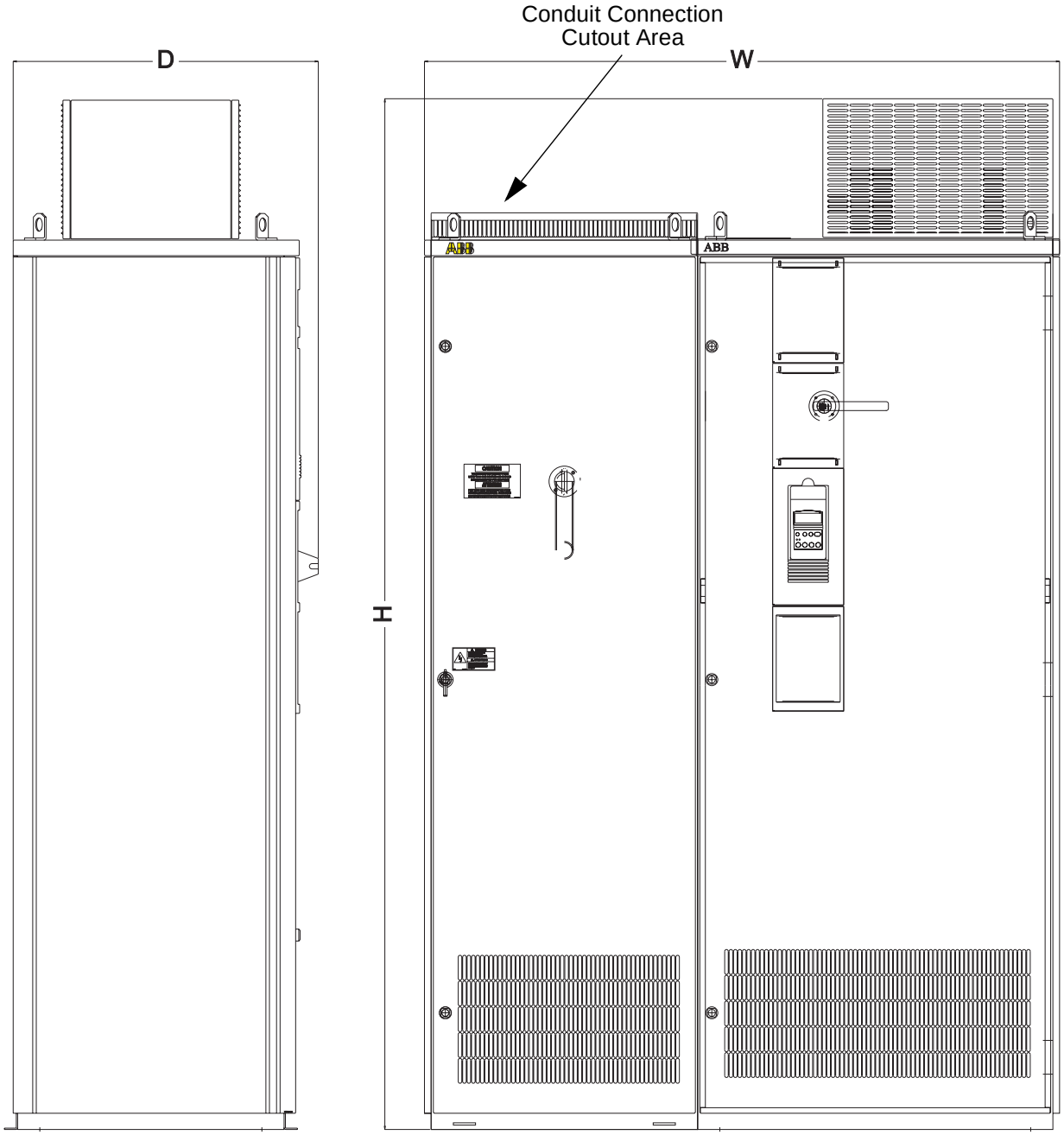
Dimensions Reference (in/mm)	Frame Size, IP54/NEMA 12 R7 W/BYP
W	32.68/830
H	91.20/2317
D	27.64/702
Mass (lb/kg)	650/290

ACH 402 NEMA Type 1, Size R8 - R9



Dimensions Reference (in/mm)	Frame Size, IP21/NEMA 1	
	R8	R9
W	56.30/1430	56.30/1430
H	81.14/2061	81.14/2061
D	27.05/687	27.05/687
Mass (lb/kg)	660/300	1130/515

ACH 402 NEMA Type 12, Size R8 - R9



Dimensions Reference (in/mm)	Frame Size, IP54/NEMA 12	
	R8	R9
W	56.30/1430	56.30/1430
H	91.33/2320	91.33/2320
D	27.05/687	27.05/687
Mass (lb/kg)	660/300	1130/515

Electrical Installation

Cable Entries

Most ACH 400 Electronic Bypass drives are configured for wiring access from the bottom only. Types ACH 401612032 and ACH 401614032 are configured for wiring access from the top only. At least three separate conduits are required, one for input power, one for output power to the motor and one for control signals.

Terminal Sizes

Power and motor cable terminal sizes are shown in the Table 3-2 for connections to an input circuit breaker or disconnect switch, a motor terminal block and ground lugs. The table also lists torque that should be applied when tightening the terminals.

Table 3-2 Wire Size Capacities and Tightening Torques for Power Terminals

<table>
<tr><th colspan="4">ACH 400 Type Code and Nominal Hp</th><th colspan="4">Wire Size Range(AWG) and Tightening Torque (in/lbs.)</th></tr>
<tr><th colspan="2">240 V Units</th><th colspan="2">480 V Units</th><th rowspan="2">Input Circuit Breaker</th><th rowspan="2">Input Disconnect Switch</th><th rowspan="2">Motor Terminal Block</th><th rowspan="2">Ground Lug</th></tr>
<tr><th>Hp</th><th>Type Code ACH 40x-</th><th>Hp</th><th>Type Code ACH 40x-</th></tr>
<tr><td></td><td></td><td>3</td><td>x0043</td><td rowspan="10">#14 - #8:
22 in/lbs.
#6 - #3:
4 in/lbs.</td><td rowspan="4">#18 - #8:
7 in/lbs.</td><td rowspan="4">#20 - #6:
11 - 13 in/lbs.</td><td rowspan="4">#14 - #10:
35 in/lbs.
#8:
40 in/lbs.
#6 - #4:
45 in/lbs.
#2:
50 in/lbs.</td></tr>
<tr><td></td><td></td><td>5</td><td>x0053</td></tr>
<tr><td>3</td><td>x0042</td><td>7.5</td><td>x0063</td></tr>
<tr><td>5</td><td>x0052</td><td>10</td><td>x0093</td></tr>
<tr><td>7.5</td><td>x0062</td><td>15</td><td>x0113</td><td rowspan="4">#14 - #4:
18 in/lbs.</td><td rowspan="4">#14 - #10:
35 in/lbs.
#8:
40 in/lbs.
#6 - #2/0:
120 in/lbs.</td><td rowspan="9">AWG
#14 - #10:
35 in/lbs.
#8:
40 in/lbs.
#6 - #4:
45 in/lbs.
#2 - #1/0:
50 in/lbs.</td></tr>
<tr><td>10</td><td>x0112</td><td>20</td><td>x0163</td></tr>
<tr><td>15</td><td>x0112</td><td>25</td><td>x0203</td></tr>
<tr><td></td><td></td><td>30</td><td>x0253</td></tr>
<tr><td>20</td><td>x0162</td><td>40</td><td>x0303</td></tr>
<tr><td>25</td><td>x0202</td><td>50</td><td>x0413</td><td rowspan="2">#8 - #1/0:
55 in/lbs.</td></tr>
<tr><td></td><td></td><td>60</td><td>60603x</td><td rowspan="3">#2 - #4/0:
120 in/lbs.</td><td rowspan="4">#14 - #1/0:
35 in/lbs.</td></tr>
<tr><td>30</td><td>x0302x</td><td>75</td><td>60703x</td><td rowspan="3">#2 - 300MCM:
375 in/lbs.</td></tr>
<tr><td>40</td><td>x0412x</td><td>100</td><td>61003x</td></tr>
<tr><td>50</td><td>60601x</td><td></td><td></td><td rowspan="2">25 kAIC CB:
#4 to 300 MCM:
275 in/lbs.
65 kAIC CB:
#6 to 350 MCM:
275 in/lbs.</td></tr>
<tr><td>60</td><td>60701x</td><td></td><td></td></tr>
<tr><td></td><td></td><td>125</td><td>612032</td><td rowspan="2">#6 - 350MCM,
275 in/lbs.</td><td rowspan="2">#6 - 300MCM,
275 in/lbs.</td><td>#6 - 350MCM,
275 in/lbs.</td><td rowspan="2">300MCM 3BRL
375 in/lbs.</td></tr>
<tr><td></td><td></td><td>150</td><td>614032</td><td>#4 - 400MCM,
375 in/lbs.</td></tr>
<tr><td></td><td></td><td>125</td><td>612035</td><td rowspan="3">25 kAIC CB:
#4 to 300 MCM:
275 in/lbs.
65 kAIC CB:
#6 to 350 MCM:
275 in/lbs.</td><td rowspan="5">Not Applicable</td><td rowspan="5">Bus bar connection:
Two holes, 10mm (3/8”) diameter, 1” spacing

NEMA two hole lugs can be used.
350 in/lbs.</td><td rowspan="5">Bus bar connection
See description at left</td></tr>
<tr><td></td><td></td><td>150</td><td>614035</td></tr>
<tr><td></td><td></td><td>200</td><td>62103x</td><td>Qty (2) 3/0 to 250 MCM:
275 in/lbs.</td></tr>
<tr><td></td><td></td><td>250</td><td>62603x</td><td rowspan="3">Qty (2) 250 MCM to 500 MCM:
275 in/lbs.</td></tr>
<tr><td></td><td></td><td>300</td><td>63203x</td></tr>
<tr><td></td><td></td><td>400</td><td>64003x</td></tr>
</table>

Connection Points

Figure 3-1 shows the Electronic Bypass wiring connection points for R1 - R4 frame sizes. Other frames sizes are addressed in the section *Connection Points* on page 3-16. Refer to the *ACH 400 User's Manual* for control connections to the drive.

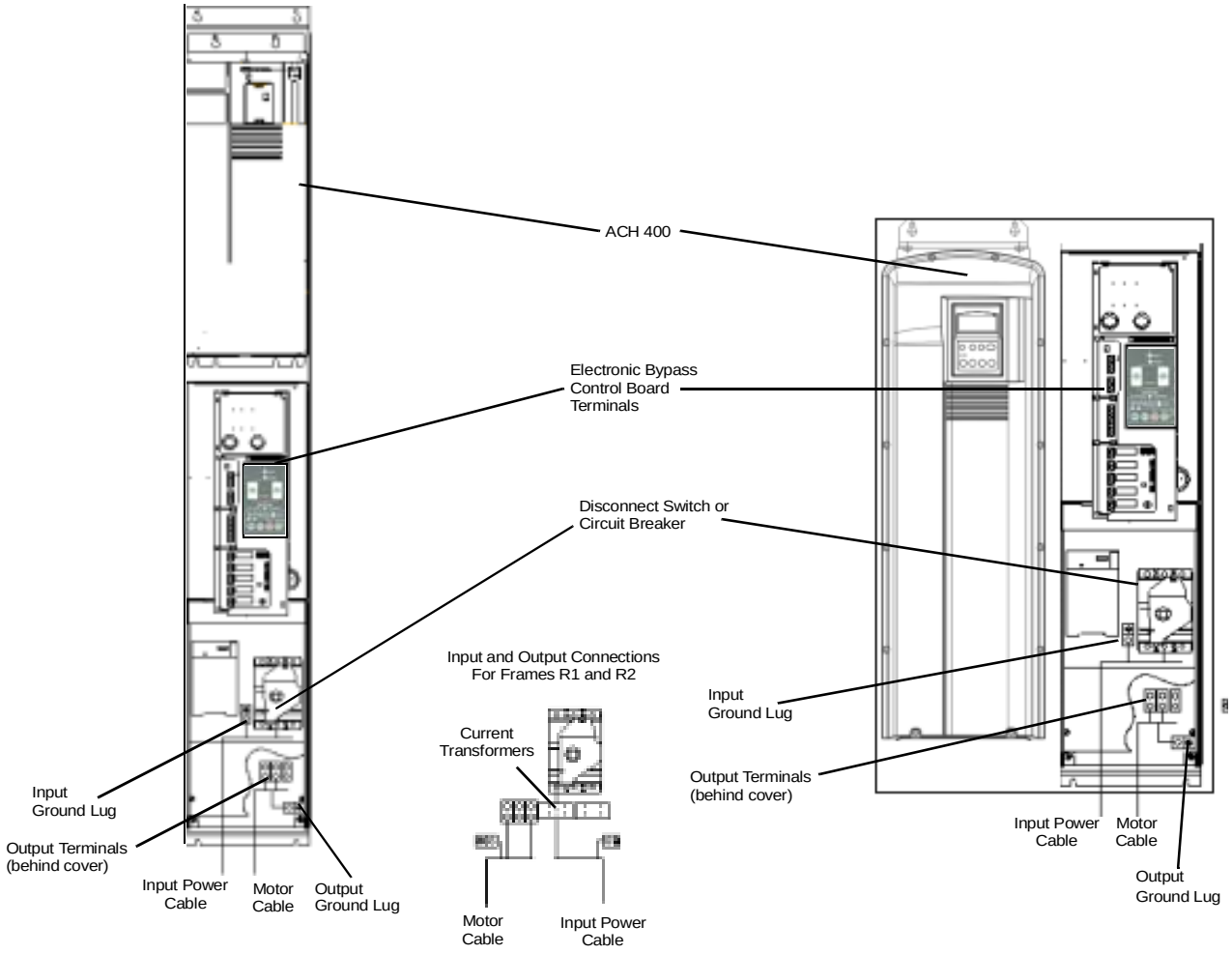


Figure 3-1 Wiring Connection Points

Input Wiring

The ACH 400 with Electronic Bypass is designed for use on a three-phase system. Four wires (three phase wires plus a ground wire) are required for the input wiring.

All field power wiring shall be copper, rated for 60°C if rated for less than 100 amps or 75°C if rated 100 amps or more.

When connected to a 480 VAC power source, the ACH 400 with Electronic Bypass with the circuit breaker option is suitable for use on a circuit capable of delivering not more than 20,000 RMS symmetrical amperes (14,000 RMS symmetrical amperes for the 3 and 5 Hp models). When connected to a 240 VAC power source, the ACH 400 with Electronic Bypass with the circuit breaker option is suitable for use on a circuit capable of delivering not more than 50,000 RMS symmetrical amperes.

WARNING!

- Do not connect or disconnect input or output power wiring, or control wires, when power is applied.
- Never connect line voltage to drive output Terminals T1, T2, and T3.
- Do not make any voltage tolerance tests (Hi Pot or Megger) on any part of the unit. Disconnect motor wires before taking any measurements in the motor or motor wires.
- Make sure that power factor correction capacitors are not connected between the drive and the motor.

Connection Points

For Frames R1 through R4

Connect the input power to the terminals at the bottom of the disconnect switch or circuit breaker as shown in Figure 3-1. Connect the equipment grounding conductor to the ground lug near the input power connection point.

Caution: For frames R1 and R2, note that two of the input power wires must be passed through the windows of two current transformers located just below the terminals of the disconnect switch or circuit breaker. If these wires do not pass through the current transformers, the bypass will not provide motor overload/underload protection.

For Frames R5 through R9

Connect input power to the terminals of the disconnect switch or circuit breaker. Connect the equipment grounding conductor to the ground lug at the bottom of the enclosure. Figure 3-2 shows the connection points for frames R5 through R6. For frames R7 through R9, refer to the appropriate detailed drawings at the beginning of this chapter for conduit entry locations.

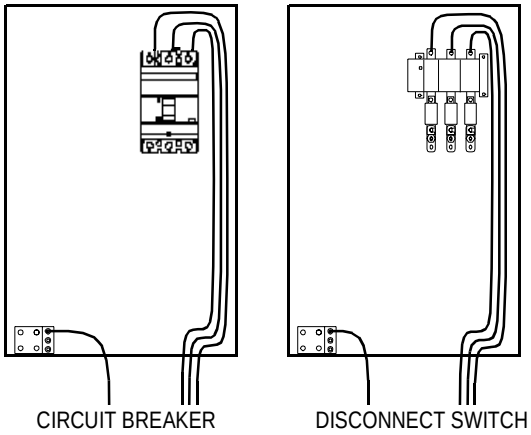


Figure 3-2 Input Power Connection Points

Output Wiring

Install the motor wiring away from other wire routes. Avoid long parallel runs with other wires. A dedicated conduit should be provided from the drive to the motor for the output wiring.

WARNING! Check the motor and motor wiring insulation before connecting the ACH 400 to line power. Follow the procedure provided below. Before proceeding with the insulation resistance measurements, check that the ACH 400 is disconnected from incoming line power. Failure to disconnect line power could result in death or serious injury.

Connection Points

For frames R1 through R4

Connect the output power to the terminals at the bottom of the bypass section as shown in Figure 3-1. Connect the equipment grounding conductor to the ground lug near the motor cable terminal block connection point.

For frames R5 through R9

Connect the motor cables to the output terminal block. The motor grounding conductor can be connected to the ground lug. Figure 3-3 shows the connection points for frames R5 through R6. For frames R7 through R9, refer to the detail drawings at the beginning of this chapter for conduit entry locations.

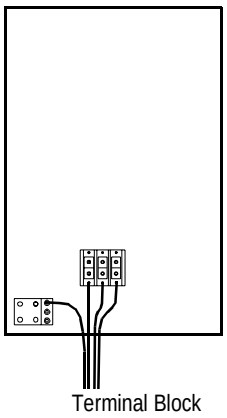


Figure 3-3 Output Power Connection Points

Checking Motor Wiring and Motor Insulation

1. Check that the motor wires are disconnected from the Electronic Bypass output on Terminals T1, T2, and T3.
2. Check that the motor wires are disconnected from the motor and remove bridging connections at the motor.
3. Measure the insulation resistances of the motor. The voltage range of the insulation resistance meter must be at least equal to the line voltage, but not exceeding 1000 V. The insulation resistance must be greater than 1 MΩ.
4. Measure the insulation resistance of the motor wiring between the phases and between each phase and ground. The insulation resistance must be greater than 1 MΩ.

Connection Points

Connect the motor cables to the output terminal block as shown in Figures 3-1 and 3-3. The motor grounding conductor can be connected to the ground lug near the terminal block.

Note: Do not connect the motor wires before proceeding with the Keypad Control Test, Motor Disconnected. Refer to Keypad Control Tests, Chapter 4 – Start-up Procedure, in this manual.

Motor Cable Length

The rapid rate of voltage changes causes capacitive coupling between motor wiring and the grounded metallic conduit. This phenomenon can cause substantially higher measured current than actual motor current, which may result in nuisance overcurrent trips or ground faults. Table 3-3 lists the maximum motor cable length based on capacitive coupling. It may also be necessary to consider motor insulation requirements related to drive output dv/dt.

Table 3-3 Maximum Recommended Motor Wire Lengths

Frame Size	Maximum Cable Length	
	Feet	Meters
R1	330	100
R2, R3 & R4	660	200
R5, R6, R7, R8 & R9	990	300

Control Wiring

The control wiring includes connections to an analog speed command signal and a start/stop relay contact for controlling the motor in the AUTO mode. There may also be connections to external run enable interlock contacts and a connection from the Motor Run contact to an external status indicating circuit. For a detailed description of the control circuit functions, refer to the section entitled *Detailed Description of Operation* on page 2-5.

Connection Points

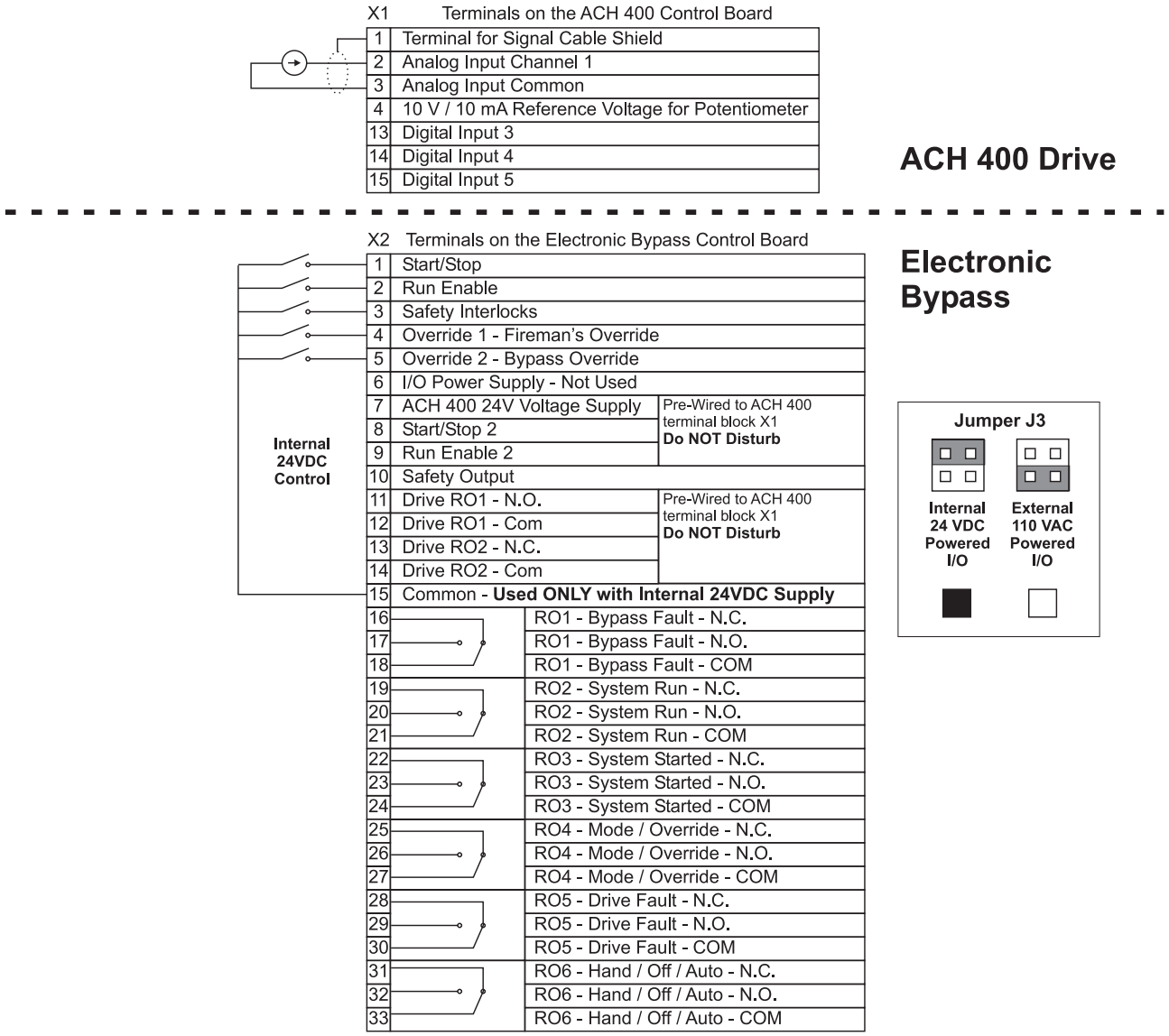
Control wiring is connected to terminal block X1 on the ACH 400 control board and to terminal block X2 on the Electronic Bypass control board. Figure 3-1 shows the location of X2. Refer to the *ACH 400 User's Manual* for the location of X1. X1 accepts one wire per terminal in wire sizes ranging from 22 AWG to 16 AWG and X2 accepts one wire per terminal in wire sizes ranging from 26 AWG to 14 AWG. Up to three wires per terminal can be connected with a proportional reduction in maximum wire size. The control terminals should be tightened to 13 inch - lbs. of torque.

Basic Connections

Figure 3-4 shows the basic control connections for use with the HVAC macro. These connections are described in the following paragraphs.

Additional Connections

Analog inputs and outputs and additional digital input connections are available on Terminal Block X1 inside the ACH 400. Note that the Electronic Bypass control circuitry uses inputs and outputs DI1, DI2, RO1 and RO2. These inputs and outputs are not available for any other purpose and must not be reconfigured. AI1, AI2, AO1, DI 3, DI4 and DI5 are available for use. Refer to the *ACH 400 User's Manual* for information about control connections on Terminal Block X1. When making connections to Terminal Block X1, be careful not to disturb the factory installed wiring between ACH 400 terminal block X1 and Electronic Bypass control board terminal X2.



Parameter Number	Description	Setting
1402	RELAY OUTPUT 2	31 (STARTED)

Figure 3-4 Basic Control Connections for HVAC Hand-Auto Macro

Analog Input

The one analog input is usually used with the HVAC macro. The customer's external *Auto Speed Reference* is connected to ACH 400 terminals X1:2(+) and X1:3(-).

The analog inputs can accept a voltage signal (0 – 10 VDC) or a current signal (0 – 20 mA). Switch J1, located on the ACH 400 control board (J1 is used for both AI1 and AI2), determines the signal type. J1 can be set in either the voltage or current position according to the type of external signal that will be connected. Place the switches in the appropriate positions for voltage or current. Figure 3-5 shows switch positions.

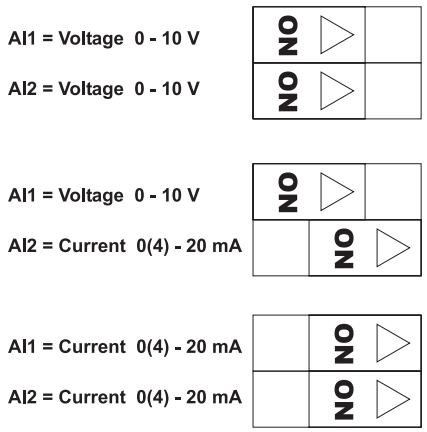


Figure 3-5 ACH 400 J1 Position Examples

Caution: There are pre-wired connections on bypass terminals X2:7 through X2:9 and X2:11 through X2:14. Do not disturb these connections when adding external wiring connections.

Bypass Control Board Connections

Relay Contact Inputs

Start/Stop Input Contact

To start the ACH 400 by dry contact (maintained), connect the contact between bypass terminals X2:1 and X2:15. Closing this contact will start the system when the drive or bypass is in the *Auto* mode provided the *Safety Interlock* input is closed.

Run Enable Input Contacts

Run Enable permissives, such as damper end switches are normally closed dry contacts connected in series between bypass terminals X2:2 and X2:15. When any of these contacts opens, the motor will stop and the *System Run* relay will de-energize, whether in DRIVE or BYPASS.

Safety Interlock Input Contacts

*Safety Interlock*s, such as Freeze, Fire, and Smoke protection are normally closed dry contacts connected in series between bypass terminals X2:3 and X2:15. When any of these contacts opens, the motor will stop and the *System Started & System Run* relays will de-energize, whether in DRIVE or BYPASS.

Fireman's Override (Override 1) Contact

Fireman's Override is designed for "**Run to Destruction**" operation. If the *Fireman's Override (Override 1)* input contact is closed, the system is forced to the *Bypass* mode and runs the motor. The system does not respond to any other inputs including overloads, faults, safeties and enables. Normally, when the *Fireman's Override* input contact is switched from closed to open, the system returns to the operating mode that existed prior to entering *Override* and can be controlled using the *Drive* and *Bypass* keys.

Connect the *Fireman's Override* contact between bypass terminals X2:4 and X2:15.

Bypass Override (Override 2) Contact

If the *Bypass Override (Override 2)* input contact is closed, the system is forced to the *Bypass* mode, runs the motor and does not respond to the *Drive* and *Bypass* keys. Normally, when the *Bypass Override* input contact is switched from closed to open, the system switches to the *Drive* mode and can be controlled using the *Drive* and *Bypass* keys.

Connect the *Bypass Override* contact between bypass terminals X2:5 and X2:15.

Caution: There are pre-wired connections on bypass terminals X2:7 through X2:9 and X2:11 through X2:14. Do not disturb these connections when adding external wiring connections.

Relay Contact Outputs

Drive Fault

Form C contacts of a *Drive Fault* relay are provided at bypass terminals X2:16(NC), X2:17(NO) and X2:18(COM). The drive fault relay is energized when the drive is energized and not faulted.

System Run

Form C contacts of a *System Run* relay are provided at bypass terminals X2:19(NC), X2:20(NO) and X2:21(COM). The *System Run* relay is energized when the Electronic Bypass System is running. The *System Run* relay provides an output when the motor is running whether powered by the ACH 400 drive or the bypass.

Separate normally open *Drive Run* and *Bypass Run* contacts can be created by using the *System Run* relay with the *Mode / Override* relay. This is done by using X2:21(COM) and connecting X2:20(NO) to X2:27(COM). X2:25(NC) becomes the *Drive Run* contact and X2:26(NO) becomes the *Bypass Run* contact. This configuration provides outputs that are closed when the motor is running. To do this the *Mode / Override* relay must be configured for *Mode* relay operation. See *Electronic Bypass Jumper, Switch and Pot Settings* in Chapter 4 on page 4-2.

System Started

Form C contacts of a *System Started* relay are provided at bypass terminals X2:22(NC), X2:23(NO) and X2:24(COM). Three conditions must be met in order for the relay to engergize. 1) a *Start* command must be present, 2) the *Safety Interlock* input contact must be closed and 3) there can be no fault present in the system. The *System Started* relay is ideal for use in damper actuator circuits.

Mode/Override

Form C contacts of a *Mode / Override* relay are provided at bypass terminals X2:25(NC), X2:26(NO) and X2:27(COM). The *Mode / Override* relay is a configurable relay. The function of the relay is selectable between *Mode* and *Override* operation. If the *Mode / Override* relay is configured for *Mode* operation (Default), the relay is energized when the *Bypass* mode is selected and de-energized when the *Drive* mode is selected. If the *Mode / Override* relay is configured for *Override* operation, the relay is energized when the *Override* mode is selected and de-energized in all other modes. See *Electronic Bypass Jumper, Switch and Pot Settings* in Chapter 4 on page 4-2.

Bypass Fault

Form C contacts of a *Bypass Fault* relay are provided at bypass terminals X2:28(NC), X2:29(NO) and X2:30(COM). The *Bypass Fault* relay is energized when the bypass is energized and not faulted and the underload/ overload protection is reset.

Hand/Off/Auto

Form C contacts of a *Hand/Off/Auto* relay are provided at bypass terminals X2:31(NC), X2:32(NO) and X2:33(COM). The *Hand/Off/Auto* relay is energized when the bypass is in the *Auto* mode and de-energized in in the *Hand* mode and when the bypass is *Off*.

Relay contact ratings:

Maximum Voltage: 30 VDC / 125 VAC

Maximum Switching Current: 8 A at 24 VDC, 0.4 A at 125 VAC

Maximum Continuous Current: 2 A rms

If the relay contacts are used to control inductive loads, such as the coils of relays or contactors, some form of noise suppression must be provided at the load. This is to reduce the electrical noise that could interfere with the electronics in the drive, as well as increase the life of the contacts in the relay.

DC coils should be suppressed with a diode, although this is not required because of the small amount of noise generated by these type of circuits. If a diode is used, it should have a voltage rating greater than or equal to the supply voltage rating.

Wiring Practices

The external control wiring to X1 and X2 must not be run in the same conduit or raceway with any high power wiring. The external speed reference signal must be wired using a twisted pair shielded cable. The shield connection must be terminated at the ground terminal provided (X1:1). The other end of the shield should be cut and taped back at the signal source.

Chapter 4 – Start-up Procedure

This chapter explains how to inspect the installation and how to start up the ACH 400 with Electronic Bypass.

Safety Precautions

Before start-up, read and follow the precautions listed below.

- After the supply voltage is disconnected from the input, the DC Bus capacitors should discharge to a safe voltage in about five minutes.
- To ensure that the voltage level is safe, measure the voltage between the DC Bus terminals, UC+ and UC- inside the ACH 400 drive unit. The testing meter must be rated for 1000 VDC.

WARNING! When the ACH 400 with Electronic Bypass is connected to the line power, the Motor Terminals T1, T2, and T3 are live even if the motor is not running. Do not make any connections when the ACH 400 with Electronic Bypass is connected to the line. Disconnect and lock out power to the drive before servicing the drive. Failure to disconnect power may cause death or serious injury.

Installation Inspection

Inspect the mechanical and electrical installation of the ACH 400 with Electronic Bypass for compliance with your local electrical installation regulations and codes.

Note: *Do not connect the motor wires before proceeding with the Keypad Control Test with Motor Disconnected. Refer to* Keypad Control Tests *in this chapter.*

After installation, inspect the following:

- ACH 400 with Electronic Bypass and motor grounding.
- Supply and motor wire size and connections.
- Control cable connections, wire shield grounding, and control cable location away from the power wires.
- Quantity and quality of cooling air for the ACH 400 with Electronic Bypass.

Connect the ACH 400 with Electronic Bypass to supply voltage. Check that the voltage between $L_1 – L_2$, $L_1 – L_3$, and $L_2 – L_3$ is $V_N \pm 10\%$.

Refer to *Chapter 3 – Installation Instructions* in this manual for detailed installation instructions and requirements.

Electronic Bypass Jumper, Switch and Pot Settings

Figure 4-1 shows the locations of the jumpers, DIP switch and potentiometers on the Electronic Bypass control board. The functions and settings of these items are explained in the following paragraphs.

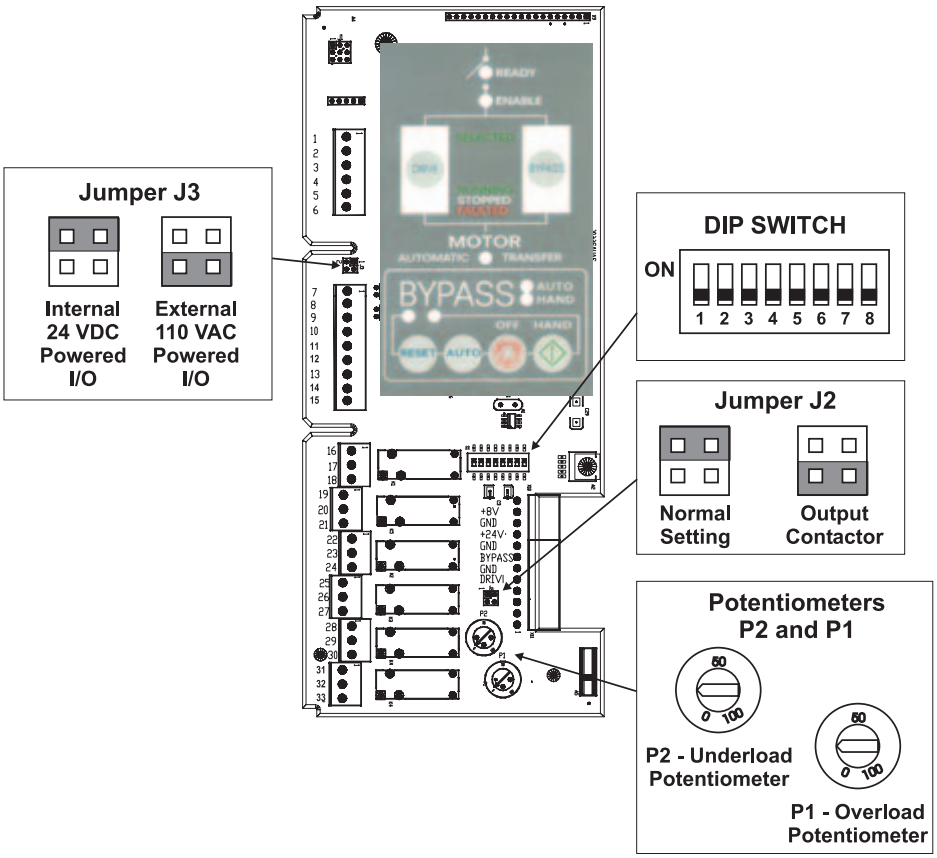


Figure 4-1 Electronic Bypass Control Board

DIP Switch Settings

The DIP switch is used to configure the bypass overload protection, select the function of the *Mode / Override* relay and enable the automatic bypass feature.

Match the DIP Switch Codes to your drive model using Table 4-3.

Table 4-1 DIP Switch Settings

Switch Position	Switch Setting Configurations							
	Switch Code							
	A	B	C	D	E	F	G	H
1	(OFF) / ON = Automatic Transfer Bypass Feature (OFF) / ON							
2	(OFF) / ON = Mode / Override Relay RO4 (Mode) / Override							
3	RESERVED (OFF)							
4	OFF / (ON) = NEMA Class 30 / (NEMA Class 20) overload trip curve							
5	RESERVED (OFF)							
6	OFF	OFF	OFF	OFF	ON	ON	ON	ON
7	OFF	OFF	ON	ON	OFF	OFF	ON	ON
8	OFF	ON	OFF	ON	OFF	ON	OFF	ON

Default settings in (parentheses).

Output Contactor Control

In the unlikely event of failure in the bypass control electronics, the user can engage the drive output contactor without the control electronics by moving jumper J2 to the position as shown in Figure 4-1. When the jumper is in the *Output Contactor* position, the *Drive* contactor is energized and the *Bypass* contactor is deenergized. The contactors, and therefore the system, are not controlled by the bypass electronics when jumper J2 is in the *Output Contactor* position. The system is incapable of Bypass or Override operation in this configuration.

Overload Trip Current Adjustment Potentiometer

The overload protection trip current must be adjusted to the motor nameplate current using the P1 adjustment potentiometer located in the lower right hand area of the bypass control board as shown in Figure 4-1. Table 4-2 shows the trip currents for the various frame sizes for potentiometer settings of 0 to 100.

Underload Trip Current Adjustment Potentiometer

The underload protection trip current must be adjusted to a percentage of the motor nameplate current using the P2 adjustment potentiometer located in the lower right hand area of the bypass control board as shown in Figure 4-1. Potentiometer settings are adjustable from 0 to 100% of the P1 (overload trip) setting. The default setting is 0% which effectively removes the underload protection trip feature from the system.

Table 4-2 Overload Trip Current Potentiometer Settings

Potentiometer Setting	Overload Trip Current (Values in Amps)							
	Switch Code							
	A	B	C	D	E	F	G	H
10	1.2	2.5	3.8	7.5	10.4	15.5	20.0	47.7
20	2.4	5.0	7.6	15.0	20.8	31.0	40.0	95.4
30	3.6	7.5	11.4	22.5	31.2	46.5	60.0	143.1
40	4.8	10.0	15.2	30.0	41.6	62.0	80.0	190.8
50	6.0	12.5	19.0	37.5	52.0	77.5	100.0	238.5
60	7.2	15.0	22.8	45.0	62.4	93.0	120.0	286.2
70	8.4	17.5	26.6	52.5	72.8	108.5	140.0	333.9
80	9.6	20.0	30.4	60.0	83.2	124.0	160.0	381.6
90	10.8	22.5	34.2	67.5	93.6	139.5	180.0	429.3
100	12.0	25	38.0	75.0	104.0	155.0	200.0	477.0

Circuit Breaker Settings

The circuit breakers on ACH 400 Electronic Bypasses with output ratings above 120 amps have adjustable switch settings for instantaneous and overload current protection. The factory default settings are practical for most applications. Refer to the *ABB SACE Instruction Sheet* supplied with your equipment for additional information on the adjustment of these settings.

Table 4-3 Overload Trip Current DIP Switch Code Selection

208 - 240 VAC	308 - 480 VAC	Switch Code
ACH401x0042x	ACH401x0043x	A
	ACH401x0053x	
	ACH401x0063x	
ACH401x0052x	ACH401x0093x	B
ACH401x0062x	ACH401x0113x	
	ACH401x0163x	C
	ACH401x0203x	
ACH401x0112x	ACH401x0253x	D
ACH401x0162x	ACH401x0303x	
ACH401x0202x	ACH401x0413x	
ACH401x0302x	ACH40160603x	E
ACH401x0412x	ACH40160703x	F
ACH40160601x	ACH40161003x	
ACH40160701x	ACH40x61203x	G
	ACH40x61403x	
	ACH40262103x	H
	ACH40262603x	
	ACH40263203x	
	ACH40264003x	

Macros and Parameter Settings

Apply power to the Electronic Bypass unit. The display should show the operating status of the drive. If the motor is a standard 208 V, 60 Hz motor connected to a 208 V drive or a 480 V, 60 Hz motor connected to a 480 V drive, the default parameter settings should be suitable for the initial tests described below. If the motor's rating is not 208 V or 480 V, 60 Hz, the MOTOR NOM VOLT and MOTOR NOM FREQ parameters will need to be properly set before proceeding. Refer to the *ACH 400 User's Manual* and set the parameters as required.

The only macros that provide the proper configuration settings are the HVAC, HVAC Floating Point and the HVAC PID Control macros. The default macro is HVAC. If the HVAC FLOATING POINT macro or the HVAC PID macro will be used, the selected macro can be set after completing the initial tests. When using the above macros, Parameter 1402 (RO2) must be changed from "RUN" to "STARTED" or portions of the Electronic Bypass will not function properly. Refer to the *ACH 400 User's Manual* for additional information.

Keypad Control Tests

Motor Disconnected from the ACH 400 with Electronic Bypass

After setting the Start-up Data parameters, test and become familiar with the operation of the ACH 400 Drive with Electronic Bypass without the motor connected as follows:

1. Disconnect and lock out power to the Electronic Bypass unit, wait at least five minutes after disconnecting power.
2. Disconnect the motor from the Electronic Bypass unit.
3. Apply power to the Electronic Bypass unit by turning on the branch circuit disconnect device and the bypass disconnect switch or circuit breaker.
4. The ACH 400 Control Panel display should be illuminated. On the bypass keypad, the *Ready* LED and *Enable* LED should be illuminated. If the *Enable* LED is not illuminated, check to see that closed contacts or jumpers connect terminal X2:2 and X2:3, on the bypass control board, to terminal X2:15.
5. Either the *Drive Selected* or *Bypass Selected* LED should be illuminated. Pressing the *Drive Select* or *Bypass Select* key should switch the bypass back and forth between the *Drive* mode and the *Bypass* mode as indicated by the LEDs above each button. Check that the bypass keypad switches the system between modes. Leave the system in the Bypass mode when proceeding to the next step.
6. Check to see that pressing the *Auto* key on the bypass keypad causes the *Auto* LED to be illuminated, pressing the Hand key causes the *Hand* LED to be illuminated and pressing the *OFF* key causes either the *Hand* or *Auto* LED to go off. Leave the *Hand* and *Auto* LEDs off when proceeding to the next step.
7. For Steps 8 through 13, set Parameter 9904 MOTOR CONTROL MODE to “SCALAR” for drive units above 50 Hp. Refer to the *ACH 400 User’s Manual* for details on setting parameters. After successful completion of Step 12, return Parameter 9904 to “DTC”.
8. Press the *Drive Select* key on the bypass keypad. The *Drive Select* LED should be illuminated.
9. Press the *HAND* key on the ACH 400 keypad. Note that the bottom line of the display indicates “HAND” and “RUN” and a Right Arrow. The *Drive Run* LED on the Bypass keypad should be illuminated.
10. Press the UP arrow. Note that the reference frequency indication in the top line of the display increases from “0.0 Hz.” The large actual output frequency indication in the center line of the display should also increase from “0.0 Hz.”
11. In the top line of the display, the output current indication should indicate “0.0 A” and the torque indication should indicate “0%.”

12. Press the DOWN arrow until the frequency indications return to “0.0 Hz”
13. Press the OFF key. Note that the bottom line of the display indicates “Off.”

If the ACH 400 Drive and Electronic Bypass operate according to these steps, disconnect and lock out power to prepare for the next test.

WARNING! Wait at least five minutes after disconnecting power from the drive before you attempt to service the drive. Bus capacitors in the intermediate DC circuit must discharge before servicing the drive. Check for zero volts at Terminals UC+ and UC-. Meter must be rated for 1000 VDC.

If the drive does not operate according to these steps, refer to the *ACH 400 User’s Manual.*

Motor Connected to the Electronic Bypass

After successfully testing the drive with the motor disconnected, continue testing the drive as follows:

1. Disconnect and lock out power to the Electronic Bypass unit.
2. Connect the motor to the output terminals.

CAUTION: If the *Fireman’s Override (Override 1)* input contact is closed the motor will start across the line as soon as power is applied.
If the *Safety Interlock and Run Enable* input contacts are closed and the *Bypass Override (Override 2)* input contact is closed the motor will start across the line as soon as power is applied.
If the *Start/Stop*, *Safety Interlock and Run Enable* input contacts are closed and the system is in the *Bypass* mode and in either *Hand* or *Auto*, the motor will start across the line as soon as power is applied.
If the *Start/Stop*, *Safety Interlock and Run Enable* input contacts are closed and the system is in the *Drive* mode with the drive in either *Hand* or *Auto* mode, the motor will start on the drive as soon as power is applied.
In order to prevent the motor from starting, the system should be in the *Drive* mode and the drive should be *OFF* when the power is disconnected at the end of the previous series of tests with the motor disconnected.

In order to prevent the motor from running without disconnecting the motor, open the *Run Enable and Safety Interlock* contacts on bypass control board terminals X2:2, X2:3 and X2:4 before applying power. Set the bypass to *Drive* mode and the drive to *OFF.*

3. Apply power to the Electronic Bypass unit.

4. Press the *Hand* key on the ACH 400 control panel.

CAUTION: Check motor rotation direction as soon as the motor begins to move. If motor does not rotate in the correct direction, shut down the drive, disconnect and lock out power to the drive and wait five minutes. Swap any two motor **output** wires (T1, T2, and T3). Incorrect motor rotation direction may cause equipment damage.

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5. Slowly increase the output frequency by pressing the UP ARROW key. Verify that motor speed varies as frequency varies.
6. Increase the speed to 60 Hz or the highest safe operating speed.
7. Measure the output current in all three phases. The current should be balanced, and should not exceed the motor or drive rating.
8. Press the *OFF* key on the ACH 400 control panel. The motor should stop.

CAUTION: Check the motor rotation direction in bypass.

Press the OFF key and then the Bypass Select key on the bypass keypad. Press the *Hand* key and then quickly press the *OFF* key to "bump" the motor. If the motor turns in the wrong direction, swap any two **input** power leads at the disconnect switch. Do not swap the motor leads.

If the drive does not operate according to these steps, refer to the *ACH 400 User's Manual*.

If the drive operates according to these steps, your ACH 400 with Electronic Bypass is ready to use with preset or modified macro settings. Refer to the *ACH 400 User's Manual* for programming instructions.

Index

ACH400-US-08EEB
3AUA 489002B6163 R0101
EFFECTIVE: 2/25/02
SUPERSEDES: None

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