copley controls

RUGGEDIZED DIGITAL
SERVO DRIVE FOR
BRUSHLESS/BRUSH MOTORS

AFS *Advanced Feature Set*
• BiSS-C Unidirectional encoder, SSI (Consult factory)
• 32-bit floating point filters
• Multiple advanced filters
• Frequency analysis tools

CONTROL MODES
• Indexer, Point-to-Point, PVT
• Camming, Gearing, Position, Velocity, Torque

COMMAND INTERFACE
• Stepper commands
  Single-ended or Differential selectable
• CANopen
• ASCII and discrete I/O
• ±10V position/velocity/torque command
• PWM position/velocity/torque command
• Master encoder (Gearing/Camming)

COMMUNICATIONS
• CANopen
• RS-232
• RS-422 (Optional)

FEEDBACK
• Digital quad A/B encoder
• Aux encoder / emulated encoder out
• Analog Sin/Cos encoder (-S versions)
• Digital Halls

I/O - DIGITAL
• 12 inputs, 3 outputs

DIMENSIONS: mm [in]
• 168 x 99 x 31 [6.6 x 3.9 x 1.2]

CANopen®

Model	Ip	Ic	Vdc
R20-055-18	18	6	55
R20-090-09	9	3	90
R20-090-18	18	6	90
R20-090-36	36	12	90
R20-180-09	9	3	180
R20-180-18	18	6	180
R20-180-30	30	15	180

Add -S to part numbers above for Sin/Cos feedback

DESCRIPTION

REV 01 below the model number on the label indicates Accelnet R20 with the advanced feature set. R20 is a ruggedized high-performance, DC powered drive for position, velocity (using encoder, Halls, or BEMF), and torque control of brushless and brush motors. It operates as a distributed drive using the CANopen protocol, or as a stand-alone drive accepting analog or digital commands from an external motion controller. In stand-alone mode, current and velocity modes accept digital 50% PWM or PWM/polarity inputs as well as ±10V analog. In position mode inputs can be incremental position commands from step-motor controllers, analog ±10V, or A/B quadrature commands from a master-encoder. Pulse to position ratio is programmable for electronic gearing.

Accelnet R20 models operate as Motion Control Devices under the DSP-402 protocol of the CANopen DS-301 V4.01 (EN 50325-4) application layer.

DSP-402 modes supported include: Profile Position, Profile Velocity, Profile Torque, Interpolated Position Mode (PVT), and Homing. The two CAN ports are optically isolated from drive circuits.

There are twelve digital inputs eleven of which have programmable functions. These include CAN address, motion-abort, limit & home switches, stepper/encoder pulse inputs, reset, digital torque or velocity reference, and motor over-temperature. Input [IN1] is dedicated for the drive Enable. There are three programmable logic outputs for reporting an drive fault, motor brake control, or other status indications.

Drive power is transformer-isolated DC from regulated or unregulated power supplies. An AuxHV input powers control circuits for "keep-alive" operation permitting the drive power stage to be completely powered down without losing position information, or communications with the control system.

RUGGEDIZED STANDARDS CONFORMANCE

Ambient Temperature	Non-Operating	-50ºC to 85ºC
	Operating	-40ºC to 70ºC
Thermal Shock	Operating	-40ºC to 70ºC in 1 minute
Relative Humidity	Non-Operating	95% non-condensing at 60ºC
	Operating	95% non-condensing at 60ºC
Vibration	Operating	5 Hz to 500 Hz, up to 3.85 *g*rms
Altitude	Non-Operating	-400 m to 12,200 m
	Operating	-400 m to 5,000 m
Shock	Crash Safety	75 *g* peak acceleration
	Operating	40 *g* peak acceleration
MIL-STD specifications	MIL-STD-	461, 704, 810, 1275, 1399
IEC specifications	IEC-	60068, 60079

GENERAL SPECIFICATIONS

Test conditions: Load = Wye connected load: 2 mH + 2 Ω line-line. Ambient temperature = 25°C, +HV = HV_{max}

MODEL	R20-055-18	R20-090-09	R20-090-18	R20-090-36	R20-180-09	R20-180-18	R20-180-30	
OUTPUT POWER								
Peak Current	18 (12.7)	9 (6.4)	18 (12.7)	36 (25.5)	9 (6.4)	18 (12.7)	30 (21.2)	Adc (Arms), ±5%
Peak time	1	1	1	1	1	1	1	Sec
Continuous current	6 (4.2)	3 (2.1)	6 (4.2)	12 (8.5)	3 (2.1)	6 (4.2)	15 (10.6)	Adc (Arms) per phase
Peak Output Power	0.92	0.79	1.55	2.95	1.59	3.15	5.4	kW
Continuous " "	0.32	0.27	0.53	1.06	0.53	1.06	2.7	kW
Output resistance	0.075	0.075	0.075	0.036	0.075	0.075	0.075	Rout (Ω)
Maximum Output Voltage	Vout = HV*0.97 - Rout*Iout							
INPUT POWER								
HVmin~HVmax	+20 to +55	+20 to +90	+20 to +90	+20 to +90	+20 to +180	+20 to +180	+20 to +180	Vdc, transformer-isolated
Ipeak	20	10	20	40	10	20	33	Adc (1 sec) peak
Icont	6.7	3.3	6.7	13.3	3.3	6.7	16.7	Adc continuous
Aux HV	+20 to +HV Vdc @ 500 mAdc maximum							

PWM OUTPUTS

Type	3-phase MOSFET inverter, 15 kHz center-weighted PWM, space-vector modulation
PWM ripple frequency	30 kHz

DIGITAL CONTROL

Digital Control Loops	Current, velocity, position. 100% digital loop control
Sampling rate (time)	Current loop: 15 kHz (66.7 µs) Velocity, position loops: 3 kHz (333 µs)
Commutation	Sinusoidal, field-oriented control for brushless motors
Modulation	Center-weighted PWM with space-vector modulation
Bandwidths	Current loop: 2.5 kHz typical, bandwidth will vary with tuning & load inductance
HV Compensation	Changes in bus voltage do not affect bandwidth
Minimum load inductance	200 µH line-line

COMMAND INPUTS

CANopen communications	Profile Position, Profile Velocity, & Profile Torque, Interpolated Position (PVT), Homing	
Digital position reference	Step/Direction, CW/CCW	Stepper commands (2 MHz maximum rate)
	Quad A/B Encoder	2 M lines/sec, 8 M count/sec (after quadrature)
Digital position/velocity/torque reference	PWM , Polarity	PWM = 0~100%, Polarity = 1/0
	PWM	PWM = 50% +/-50%, no polarity signal required
	PWM frequency range	1 kHz minimum, 100 kHz maximum
	PWM minimum pulse width	220 ns
Analog torque, velocity, position	±10 Vdc	Differential, 5 kΩ impedance

DIGITAL INPUTS

Number	12
Inputs [IN1~5,11,12]	74HC14 Schmitt trigger, 330 µs RC filter, Vin-LO < 1.35 Vdc, Vin-HI >3.65 Vdc, +24 Vdc max
	[IN1] dedicated to drive enable function, other inputs are programmable
Input [IN6]	74HC14 Schmitt trigger, 100 ns RC filter, Vin-LO < 1.35 Vdc, Vin-HI >3.65 Vdc, +12 Vdc max
Inputs [IN7~10]	Single-ended: Comparator with 2.5 Vdc reference, 100 ns RC filter, Vin-LO <2.3 Vdc, Vin-HI > 2.45 Vdc
	Differential: RS-485 line receiver on input pairs [IN9-7], and [IN10-8], 100 ns RC filters, +12 Vdc max
All inputs	10 kΩ pull-up to +5 Vdc or pull-down to ground, selectable in groups, active level programmable

DIGITAL OUTPUTS

Number	3
[OUT1], [OUT2], [OUT3]	Current-sinking MOSFET with 1 kΩ pullup to +5 Vdc through diode
Current rating	1 Adc max, +30 Vdc max. Functions programmable
	External flyback diode required if driving inductive loads

MULTI-MODE ENCODER PORT

Operation	Programmable as input for secondary (dual) digital encoder or as buffered outputs in quad A/B/X format for digital motor feedback encoder, or emulated encoder outputs from analog Sin/Cos motor feedback encoder
Signals	Quad A/B Encoder: A, /A, B, /B, X, /X
Frequency	As input for digital encoder: 5M lines/sec, 20 M count/sec (after quadrature)
	As buffered outputs for digital motor encoder: 5 M lines/sec, 20 M count/sec (after quadrature)
	As emulated encoder outputs for Sin/Cos analog motor encoder: 4.5 M lines/sec, 18 M count/sec (after quadrature)
Input/output	26C32 differential line receiver, or 26C31 differential line driver

RS-232 PORT

Signals	RxD, TxD, Gnd in 6-position, 4-contact RJ-11 style modular connector
Mode	Full-duplex, DTE serial communication port for drive setup and control, 9,600 to 115,200 baud
Protocol	Binary and ASCII formats

RS-422 PORT (Optional)

Signals	XMT-A, XMT-B, RCV-A, RCV-B, in a 6-position, 6-contact RJ-11 style modular connector
Mode	Full-duplex, RS-422 slave, 9,600 to 115,200 baud
Protocol	Binary and ASCII formats

CAN PORT

Signals	CANH, CANL, Gnd in dual 8-position RJ-45 style modular connectors, wired as per CAN Cia DR-303-1, V1.1
	CAN interface circuit and +5 Vdc supply are optically isolated from drive circuits
Format	CAN V2.0b physical layer for high-speed connections compliant
Data	CANopen Device Profile DSP-402
Address selection	16 position rotary switch on front panel with 3 additional address bits available as digital inputs or programmable to flash memory

FEEDBACK

DIGITAL QUAD A/B ENCODER

Type	Quadrature, differential line driver outputs
Signals	A, /A, B, /B, (X, /X, index signals optional)
Frequency	5 MHz line frequency, 20 MHz quadrature count frequency

ANALOG ENCODER (-S OPTION)

Type	Sin/Cos, differential line driver outputs, 0.5 Vpeak-peak (1.0 Vpeak-peak differential) centered about 2.5 Vdc typical. Common-mode voltage 0.25 to 3.75 Vdc
Signals	Sin(+), Sin(-), Cos(+), Cos(-)
Frequency	230 kHz maximum line (cycle) frequency
Interpolation	10 bits/cycle (1024 counts/cycle)

ENCODER EMULATION

Resolution	Programmable to 16,384 counts/rev (4096 line encoder equivalent)
Buffered encoder outputs	26C31 differential line driver

DIGITAL HALLS

Type	Digital, single-ended, 120° electrical phase difference
Signals	U, V, W
Frequency	Consult factory for speeds >10,000 RPM
Connection	Typically to J2-3,6,9

ENCODER POWER SUPPLY

Power Supply	+5 Vdc @ 400 mA to power encoders & Halls
Protection	Current-limited to 750 mA @ 1 Vdc if overloaded
	Encoder power developed from +24 Vdc so position information is not lost when AC mains power is removed

MOTOR CONNECTIONS

Phase U, V, W	PWM outputs to 3-phase ungrounded Wye or delta connected brushless motors, or DC brush motors
Hall U, V, W	Digital Hall signals, single-ended
Digital Encoder	Quadrature encoder signals, A, /A, B, /B, X, /X), differential (X or Index signal not required) 5 MHz maximum line frequency (20 M counts/sec) 26LS32 differential line receiver with 121 Ω terminating resistor between complementary inputs
Analog Encoder	Sin/Cos, differential line driver outputs, 0.5 Vpeak-peak (1.0 Vpeak-peak differential) centered about 2.5 Vdc typical. Common-mode voltage 0.25 to 3.75 Vdc
Signals	Sin(+), Sin(-), Cos(+), Cos(-)
Frequency	230 kHz maximum line (cycle) frequency
Interpolation	Programmable: 10 bits/cycle (1024 counts/cycle)
Hall & encoder power	+5 Vdc ±2% @ 250 mAdc max, current limited to 750 mAdc @ +1 Vdc if output overloaded
Motemp [IN5]	Motor overtemperature sensor input. Active level programmable Programmable to disable drive when motor over-temperature condition occurs Same input circuit as GP digital inputs (Digital Inputs above)
Brake	[OUT1,2,3] programmable for motor brake function, external flyback diode required

STATUS INDICATORS

Amp Status	Bicolor LED, drive status indicated by color, and blinking or non-blinking condition
CAN Status	Bicolor LED, status of CAN bus indicated by color and blink codes to CAN Indicator Specification 303-3

PROTECTIONS

HV Overvoltage	$+HV > HV_{max}$	Drive outputs turn off until $+HV < HV_{max}$ (See Input Power for HV_{max})
HV Undervoltage	$+HV < +20$ Vdc	Drive outputs turn off until $+HV > +20$ Vdc
Drive over temperature	Heat plate > 80ºC ±3 ºC	Drive outputs turn off
Short circuits	Output to output, output to ground, internal PWM bridge faults	
I²T Current limiting	Programmable: continuous current, peak current, peak time	
Motor over temperature	Digital inputs programmable to detect motor temperature switch	

MECHANICAL & ENVIRONMENTAL

Size	6.58 in (167 mm) X 3.89 in (98.8 mm) X 1.17 in (29.7 mm)
Weight	0.94 lb (0.43 kg)
Ambient temperature	-40ºC to +70ºC operating, -50ºC to +85ºC storage
Humidity	0 to 95%, non-condensing
Contaminants	Pollution degree 2
Environment	IEC 68-2
Cooling	Heat sink and/or forced air cooling required for continuous power output

Notes: 1. Digital input & output functions are programmable.

REV 01 indicates Accelnet R20 with Advanced Feature Set.
Datasheets for Accelnet R20 models without REV 01 on their labels can be found in the Legacy section of the website: www.copleycontrols.com.

copley controls
Assembled in U.S.A.

Model Number: R20-180-30
REV 01
Serial Number: 36189999

Volts	INPUT	Amps		Volts	OUTPUT		Amps
20-180 ⎓		15 ⎓ pk		180 ⎓ max.	15 ⎓ cont.		30 ⎓ pk.

AGENCY STANDARDS CONFORMANCE

Standards and Directives

In accordance with EC Directive 2014/30/EU (EMC Directive)

EN 55011

EN 61000-6-1

IEC 61800-3(Pending)

Product Safety

Directive 2014/35/EU (Low Voltage)

IEC 61800-5-1(Pending)
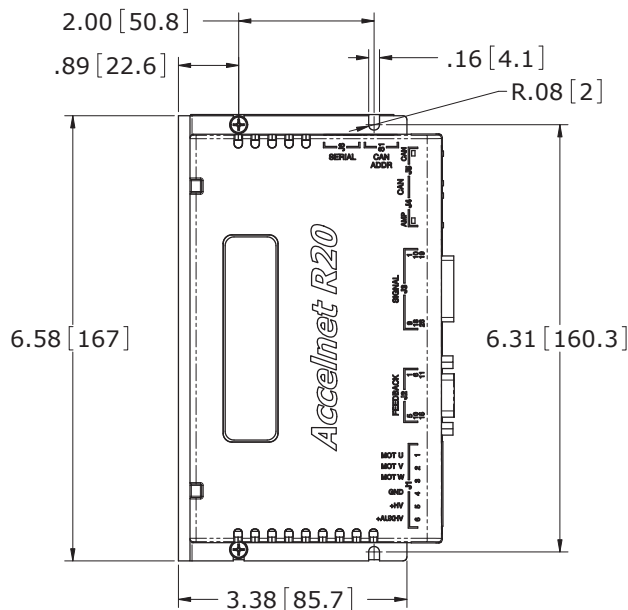
UL 61010-1, 3rd Ed.

Approvals

UL 61010-1, 3rd Ed.

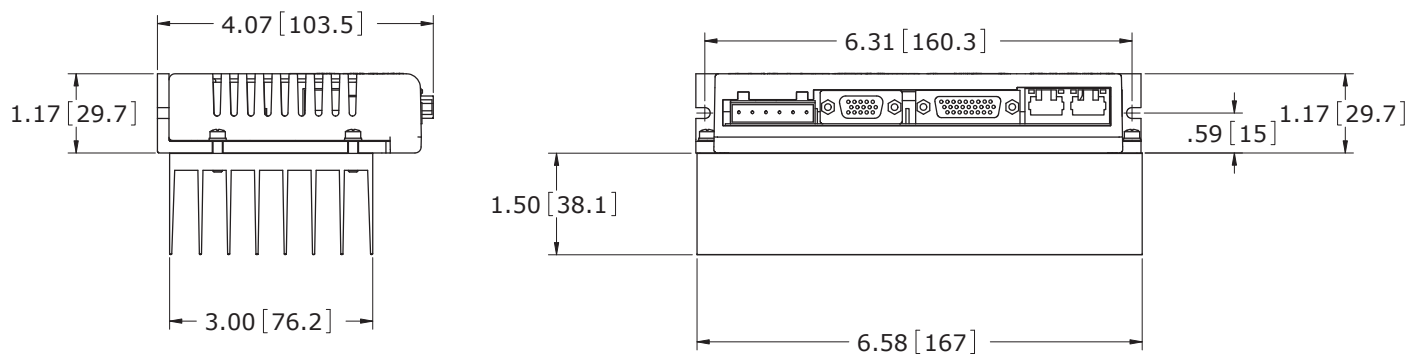IEC 61800-5-1(Pending)

FIRMWARE

File name: ARM_x.xx.cff

The latest version of the firmware can be downloaded from www.copleycontrols.com.

DIMENSIONS

NOTES

1. Dimensions shown in inches [mm].
2. Heatsink is mounted with four screws. Two of these are not shown to show dimensions of slots in the heatplate.

Weights:
Drive: 0.94 lb (0.43 kg)
Heatsink: 1.0 lb (0.45 kg)

COMMUNICATIONS

CME SOFTWARE

Drive setup is fast and easy using CME software communicating via RS-232 or over the CAN bus. All of the operations needed to configure the drive are accessible through this powerful and intuitive program. Auto-phasing of brushless motor Hall sensors and phase wires eliminates "wire and try". Connections are made once and CME does the rest thereafter. Encoder wire swapping to establish the direction of positive motion is eliminated.

Motor data can be saved as .ccm files. Drive data is saved as .ccx files that contain all drive settings plus motor data. This eases system management as files can be cross-referenced to drives. Once a drive configuration has been completed systems can be replicated easily with the same setup and performance. When operating as a stand-alone drive that takes command inputs from an external controller, *CME* is used for configuration. When operated as a CAN node, *CME* can be used for programming before and after installation in a CAN network. *Accelnet* can also be controlled via *CME* while it is in place as a CAN node. During this process, drive operation as a CAN node is suspended. When adjustments are complete, *CME* relinquishes control of the drive and returns it to the CAN node state.

RS-232 COMMUNICATION

Accelnet operates as a DTE device from a three-wire, full-duplex RS-232 port at 9,600 to 115,200 Baud. COM port settings must be "N81" (No parity, 8 data-bits, 1 stop-bit). The SER-CK Serial Cable Kit provides an adapter that connects to the COM port of a PC (a 9 position, male D-Sub connector) and accepts a modular cable with RJ-11 connectors for connection to the Accelnet RS-232 port (J6).

PC COM PORT SIGNALS

Dsub-9F to RJ11 Adapter

D-Sub 9F

RJ-11 cable 6P6C Straight-wired 7 ft (2.13 m)

RJ-11 on Servo Drive

J6 SIGNALS

RxD 2 ← 5 TxD

TxD 3 → 2 RxD

Gnd 5 → 3 Gnd
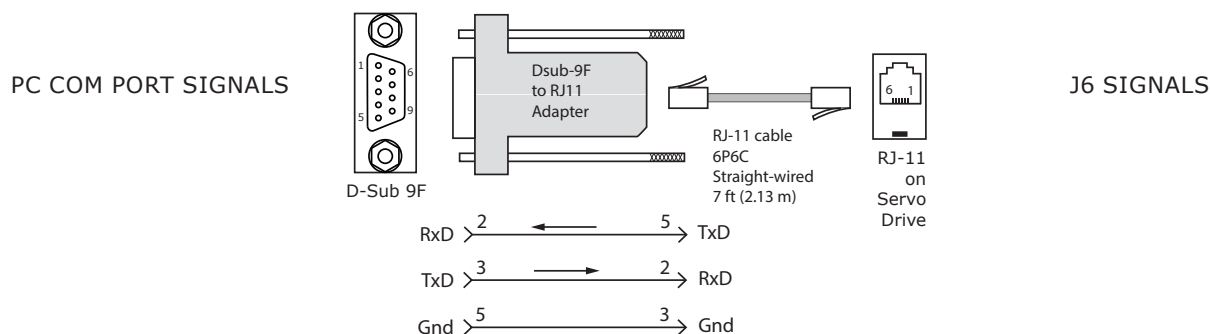
SER-CK SERIAL CABLE KIT ADAPTER CONNECTIONS

RS-232 "MULTI-DROP"

The RS-232 specification makes no allowance for more than two devices on a serial link. But, multiple Accelnet drives can communicate over a single RS-232 port by daisy-chaining a master drive to other drives using CAN cables. In the CAN protocol, address 0 is reserved for the CAN master and thereafter all other nodes on a CAN network must have unique, non-zero addresses. When the Accelnet CAN address is set to 0, it acts as a CAN master, converting the RS-232 data into CAN messages and passing it along to the other drives which act as CAN nodes.

RS-232

CANopen

CANopen

CAN Addr 0
CAN Master

CAN Addr 1
CAN Node

CAN Addr n
CAN Node
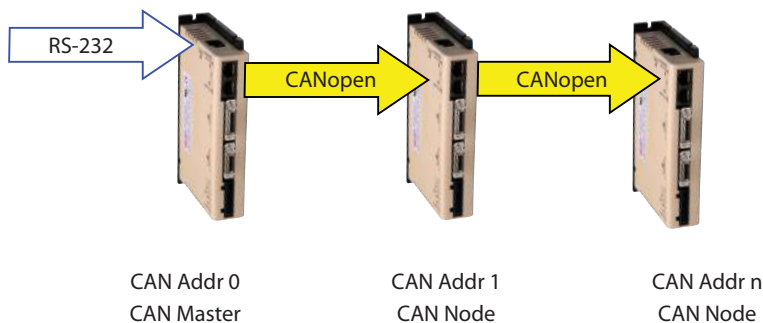
ASCII COMMUNICATIONS

The Copley ASCII Interface is a set of ASCII format commands that can be used to operate and monitor Copley Controls Accelnet, Stepnet, and Xenus series amplifiers over an RS-232 serial connection. For instance, after basic amplifier configuration values have been programmed using CME 2, a control program can use the ASCII Interface to:
• Enable the amplifier in Programmed Position mode.
• Home the axis.
• Issue a series of move commands while monitoring position, velocity, and other run-time variables.
Additional information can be found in the ASCII Programmers Guide on the Copley website.

COMMUNICATIONS (CONTINUED)

CANOPEN

Based on the CAN V2.0b physical layer, a robust, two-wire communication bus originally designed for automotive use where low-cost and noise-immunity are essential, CANopen adds support for motion-control devices and command synchronization. The result is a highly effective combination of data-rate and low cost for multi-axis motion control systems. Device synchronization enables multiple axes to coordinate moves as if they were driven from a single control card.

CANOPEN COMMUNICATION

Accelnet uses the CAN physical layer signals CANH, CANL, and GND for connection, and CANopen protocol for communication.

Before installing the drive in a CAN system, it must be assigned a CAN address. A maximum of 127 CAN nodes are allowed on a single CAN bus. The rotary switch on the front panel controls the four lower bits of the seven-bit CAN address. When the number of nodes on a bus is less than sixteen, the CAN address can be set using only the switch.

For installations with sixteen or more CAN nodes on a network CME 2 can be used to configure Accelnet to use the rotary switch, or combinations of digital inputs and programmed offset in flash memory to configure the drive with a higher CAN node address. For more information on CANopen communications, download the CANopen Manual from the Copley website.

CANOPEN CONNECTORS

Dual RJ-45 connectors that accept standard Ethernet cables are provided for CAN bus connectivity. Pins are wired-through so that drives can be daisy-chained and controlled with a single connection to the user's CAN interface. A CAN terminator should be placed in the last drive in the chain. The ADP-NK connector kit provides a D-Sub adapter that plugs into a CAN controller and has an RJ-45 socket that accepts the Ethernet cable.
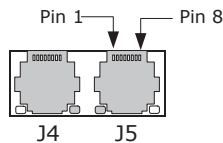
J4,5 CAN CONNECTIONS

R20-NK CAN CONNECTOR KIT

The kit contains the ADP-CV adapter that converts the CAN interface D-Sub 9M connector to an RJ-45 Ethernet cable socket, plus a 10 ft (3 m) cable and terminator. Both connector pin-outs conform to the CiA DR-303-1 specification.
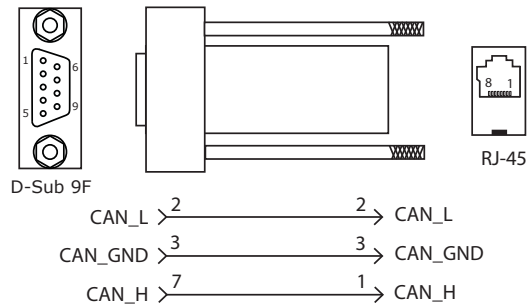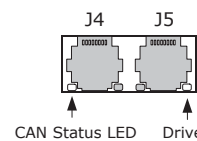

CAN S STATUS LED

DRIVE STATE	LED ON-OFF CONDITION
Pre-operational	
Operational	
Stopped	
Warning Limit Reached	
Error Control Event	
Sync Error	
Bus-off	
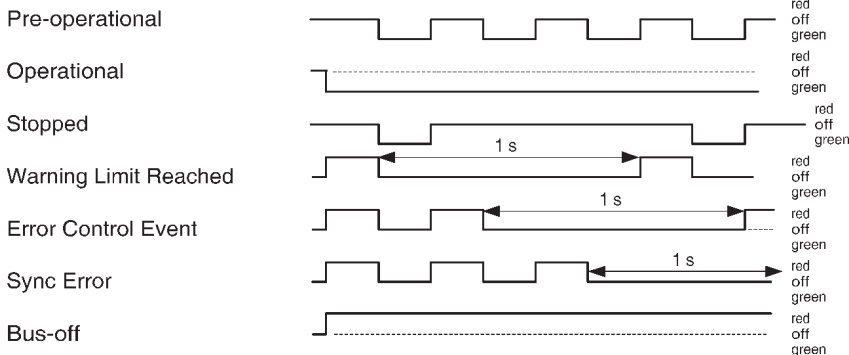
Note: Red & green led on-times do not overlap.
LED color may be red, green, off, or flashing of either color.

COMMUNICATIONS (CONTINUED)

DRIVE STATUS LED

A single bi-color LED gives the state of the drive by changing color, and either blinking or remaining solid.
The possible color and blink combinations are:

- *Green/Solid:*   Drive OK and enabled. Will run in response to reference inputs or CANopen commands.
- *Green/Slow-Blinking:* Drive OK but NOT-enabled. Will run when enabled.
- *Green/Fast-Blinking:* Positive or Negative limit switch active. Drive will only move in direction not inhibited by limit switch.
- *Red/Solid:*   Transient fault condition. Drive will resume operation when fault is removed.
- *Red/Blinking:*   Latching fault. Operation will not resume until drive is Reset.

Drive Fault conditions:
- Over or under-voltage
- Motor over-temperature
- Encoder +5 Vdc fault
- Short-circuits from output to output
- Short-circuits from output to ground
- Internal short circuits
- Drive over-temperature

Faults are programmable to be either transient or latching

RS-422 (OPTIONAL)

The drive is configured for full-duplex operation as a RS-422 slave. Because RS-422 allows only one driver per signal-pair, it is possible to have other RS-422 receive-only nodes connected to the cable from the Master's transmit port. The data protocol is the same as that of the RS-232 port. The diagram below shows connections using a wiring adapter from QVS, model CC436 to convert the modular cable for the drive to a Dsub-9M connector. The RS-422 signals are shown sourced from an RS-232 to RS-422 converter from B&B Electronics.

RS-422 CONNECTIONS
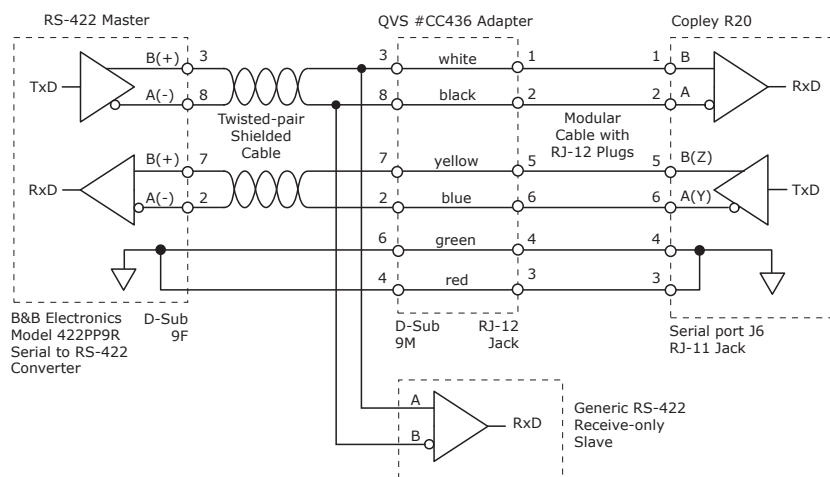
J6 SIGNALS
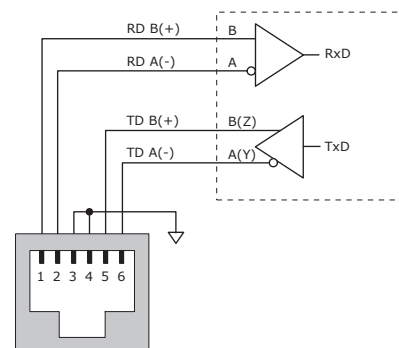
RS-422 ADAPTER (USER SUPPLIED)

This shows the connections to make using a QVS CC436 adapter. This comes with the connections to the RJ-12 already made and the pins for the D-sub uncommitted. Insert these into the D-sub as shown.
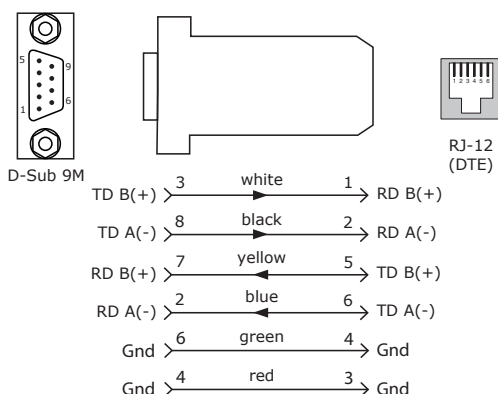
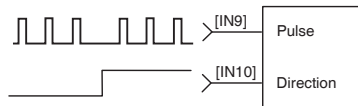## COMMAND INPUTS

ANALOG REFERENCE INPUT

A single ±10 Vdc differential input takes inputs from controllers that use PID or similar compensators, and outputs a current command to the drive. Drive output current or velocity vs. reference input voltage is programmable.
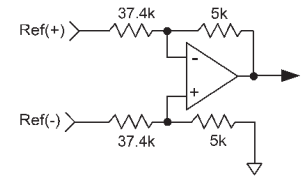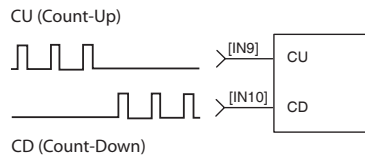

DIGITAL POSITION

Digital position commands can be in either single-ended or differential format. Single-ended signals should be sourced from devices with active pull-up and pull-down to take advantage of the high-speed inputs. Differential inputs have 121 Ω line-terminators.

SINGLE-ENDED PULSE & DIRECTION

DIFFERENTIAL PULSE & DIRECTION
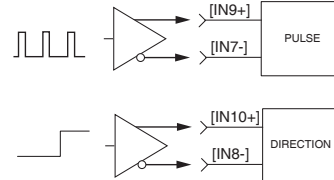
SINGLE-ENDED CU/CD

DIFFERENTIAL CU/CD

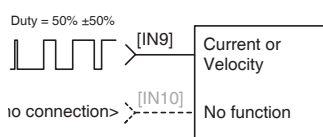### QUAD A/B ENCODER SINGLE-ENDED
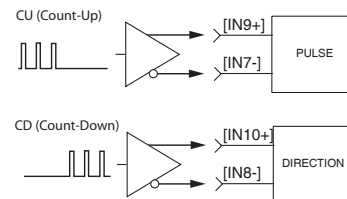
QUAD A/B ENCODER DIFFERENTIAL
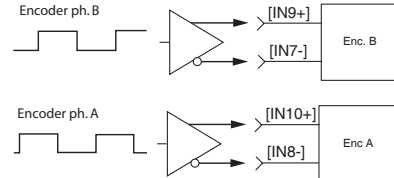
DIGITAL POSITION/VELOCITY/TORQUE

Digital position/velocity/torque PWM commands can be in either single-ended or differential format. Single-ended signals must be sourced from devices with active pull-up and pull-down to take advantage of the high-speed inputs.
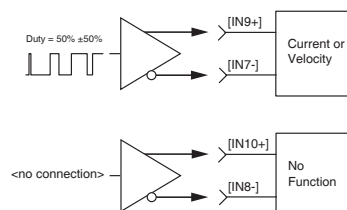
SINGLE-ENDED PWM & DIRECTION

DIFFERENTIAL PWM & DIRECTION

SINGLE-ENDED 50% PWM
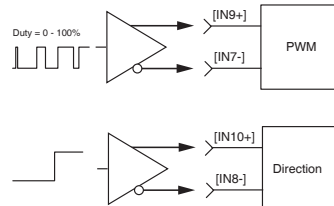
DIFFERENTIAL 50% PWM

COMMAND INPUTS (CONTINUED)

DIGITAL INPUTS

Accelnet has twelve digital inputs, eleven of which have programmable functions. Input [IN1] is dedicated to the drive Enable function. This is done to prevent accidental programming of the input in such a way that the controller could not shut it down.

Two types of RC filters are used: GP (general purpose) and HS (high speed). Input functions such as Pulse/Dir, CW/CCW, Quad A/B are wired to inputs having the HS filters, and inputs with the GP filters are used for general purpose logic functions, limit switches, and the motor temperature sensor. Programmable functions of the digital inputs include:

- Positive Limit switch
- Negative Limit switch
- Home switch
- Drive Reset
- PWM current or velocity commands
- CAN address bits

- Step & Direction, or CU/CD step motor position commands
- Quad A/B master encoder position commands
- Motor over-temperature
- Motion Profile Abort

PULL-UP/PULL-DOWN CONTROL

In addition to the active level and function for each programmable input, the input resistors are programmable in four groups to either pull up to +5 Vdc, or down to ground. Grounded inputs with HI active levels interface to PLC's that have PNP outputs that source current from +24 Vdc sources. Inputs pulled up to +5 Vdc work with open-collector, or NPN drivers that sink current to ground. The table below shows the PU/PD groups and the inputs they control.`
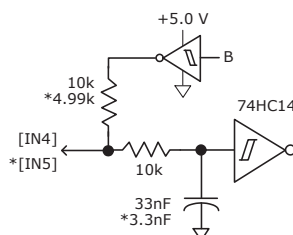
DIGITAL INPUT CIRCUITS
24VDC MAX

24VDC MAX

| Group	Inputs
A	1,2,3
B	4,5
C	6,7,8
D	9,10,11,12
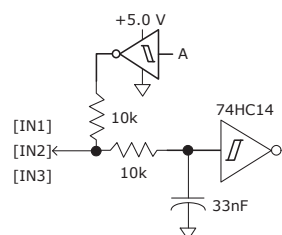
HS (HIGH SPEED) DIGITAL INPUTS

These inputs have all the programmable functions of the GP inputs plus these additional functions on [IN8] & [IN9] which can be configured as single-ended or differential:

- PWM 50%, PWM & Direction for Velocity or Current modes
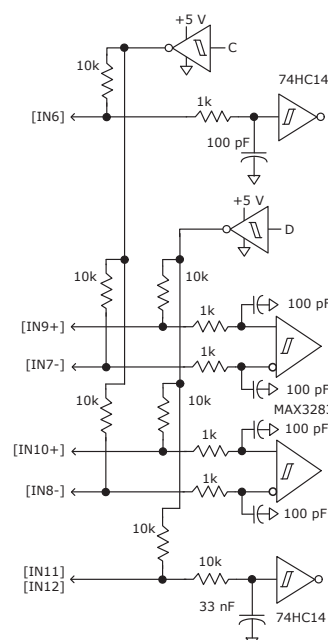- Pulse/Direction, CU/CD, or A/B Quad encoder inputs for Position or Camming modes

SINGLE-ENDED
12 VDC MAX
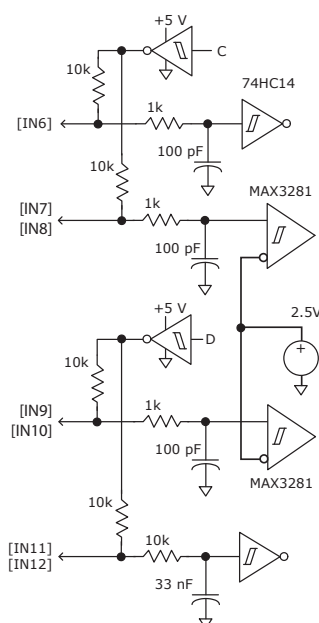
DIFFERENTIAL
12 VDC MAX

OUTPUTS

DIGITAL OUTPUTS
The digital outputs are open-drain MOSFETs with 1 kΩ pull-up resistors in series with a diode to +5 Vdc. They can sink up to 1 Adc from external loads operating from power supplies to +30 Vdc. The output functions are programmable. The active state of the outputs is programmable to be on or off.

When driving inductive loads such as a relay, an external fly-back diode is required. The internal diode in the output is for driving PLC inputs that are opto-isolated and connected to +24 Vdc. The diode prevents conduction from +24 Vdc through the 1 kΩ resistor to +5 Vdc in the drive. This could turn the PLC input on, giving a false indication of the drive output state.
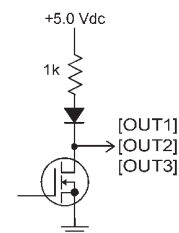
MOTOR CONNECTIONS
Motor connections are of three types: phase, feedback, and thermal sensor. The phase connections carry the drive output currents that drive the motor to produce motion. A thermal sensor that indicates motor overtemperature is used to shut down the drive to protect the motor. Feedback can be digital quad A/B encoder, analog Sin/Cos encoder or digital Halls, depending on the version of the drive.

MOTOR PHASE CONNECTIONS
The drive output is a three-phase PWM inverter that converts the DC buss voltage (+HV) into three sinusoidal voltage waveforms that drive the motor phase-coils. Cable should be sized for the continuous current rating of the motor. Motor cabling should use twisted, shielded conductors for CE compliance, and to minimize PWM noise coupling into other circuits. The motor cable shield should connect to motor frame and the drive frame ground terminal (J2-1) for best results.
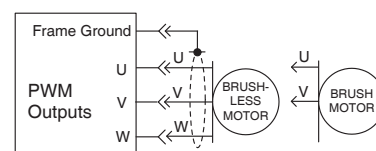
DIGITAL HALL SIGNALS
Hall signals are single-ended signals that provide absolute feedback within one electrical cycle of the motor. There are three of them (U, V, & W) and they may be sourced by magnetic sensors in the motor, or by encoders that have Hall tracks as part of the encoder disc. They typically operate at much lower frequencies than the motor encoder signals, and are used for commutation-initialization after startup, and for checking the motor phasing after the amplifer has switched to sinusoidal commutation. See page 16 for connections.
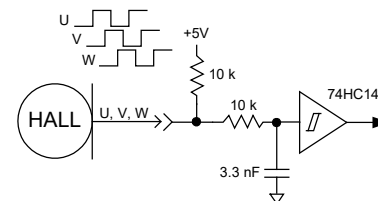
DIGITAL ENCODERS
The quad A/B encoder interface is a differential line-receiver with R-C filtering on the inputs. Encoders with differential outputs are required because they are less susceptible to noise that can degrade single-ended outputs. Encoder cables should use twisted-pairs for each signal pair: A & /A, B & /B, X & /X. An overall shield should be used, and for longer cables, shields for individual pairs may be necessary to guarantee signal integrity.
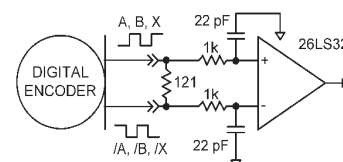
ANALOG ENCODER (-S MODELS)
Accelnet supports analog encoder signals for position feedback. The Sin and Cos inputs are differential with 121 Ω terminating resistors and accept 1.0 Vp-p signals in the A/B format used by encoders with analog outputs such as Heidenhain, Stegman, and Renishaw. When Copley's ServoTube motors are used the analog encoder supplies both commutation and incremental position feedback.
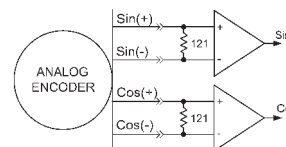
MOTOR TEMPERATURE SENSOR
Digital input [IN5] is for use with a motor overtemperature switch. The input should be programmed as a pull-up to +5 Vdc if the motor switch is grounded when cold, and open or high-impedance when over-heating.
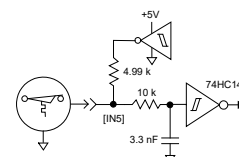
ANALOG HALLS (-S MODELS) + DIGITAL ENCODER

For position feedback with higher resolution than is possible by interpolating analog Halls, a digital incremental encoder is connected to the multi-mode port. The Halls are then used for commutation and the multi-mode port is programmed as a differential input for the Secondary Incremental motor encoder.

Position feedback for
position/velocity control

Hall feedback for
brushless motor commutation
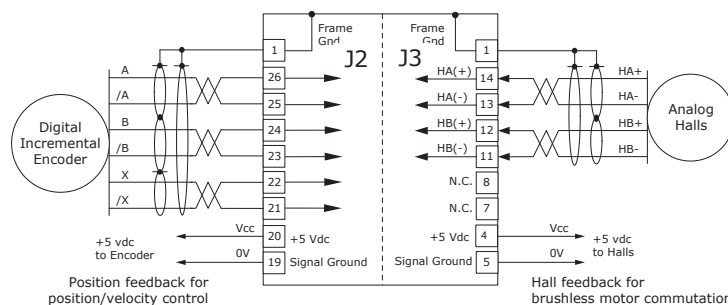
MULTI-MODE ENCODER PORT

This port consists of three differential input/output channels that take their functions from the Basic Setup of the drive.
On drives with quad A/B encoder feedback, the port works as an output buffering the signals from the encoder. With Sin/Cos encoder versions, the feedback is converted to quad A/B signals with programmable resolution. These signals can then be fed back to an external motion controller that closes the position or velocity loops. As an input, the port can take quad A/B signals to produce a dual-loop position control system or use the signals as master-encoder feedback in camming mode. In addition, the port can take stepper command signals (CU/CD or Pulse/Direction) in differential format.

AS BUFFERED OUTPUTS FROM A DIGITAL QUADRATURE FEEDBACK ENCODER

When using a digital quadrature feedback encoder, the A/B/X signals drive the multi-mode port output buffers directly. This is useful in systems that use external controllers that also need the motor feedback encoder signals because these now come from J7, the Control connector. In addition to eliminating "Y" cabling where the motor feedback cable has to split to connect to both controller and motor, the buffered outputs reduce loading on the feedback cable that could occur if the motor encoder had to drive two differential inputs in parallel, each with it's own 121 ohm terminating resistor.
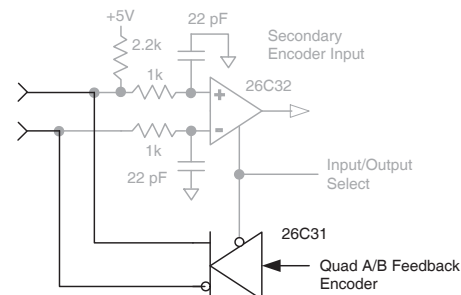
AS EMULATED QUAD A/B/X ENCODER OUTPUTS FROM AN ANALOG SIN/COS FEEDBACK ENCODER

Analog Sin/Cos signals are interpolated in the drive with programmable resolution. The incremental position data is then converted back into digital quadrature format which drives the multi-mode port output buffers. Some analog encoders also produce a digital index pulse which is connected directly to the port's output buffer. The result is digital quadrature A/B/X signals that can be used as feedback to an external control system.
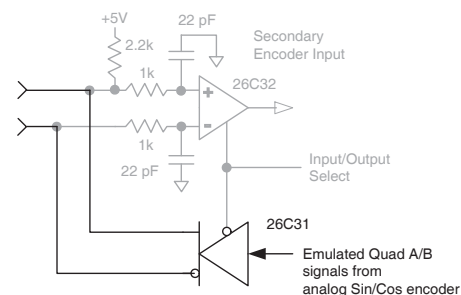
AS A MASTER OR CAMMING ENCODER INPUT FROM A DIGITAL QUADRATURE ENCODER

When operating in position mode the multi-mode port can accept digital command signals from external encoders. These can be used to drive cam tables, or as master-encoder signals when operating in a master/slave configuration.

AS DIGITAL COMMAND INPUTS IN PULSE/DIRECTION, PULSE-UP/PULSE-DOWN, OR DIGITAL QUADRATURE ENCODER FORMAT

The multi-mode port can also be used when digital command signals are in a differential format. These are the signals that typically go to [IN9] and [IN10] when they are single-ended. But, at higher frequencies these are likely to be differential signals in which case the multi-mode port can be used.
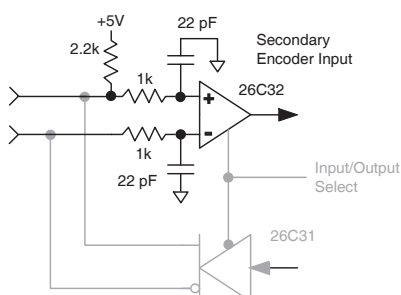
DRIVE CONNECTIONS
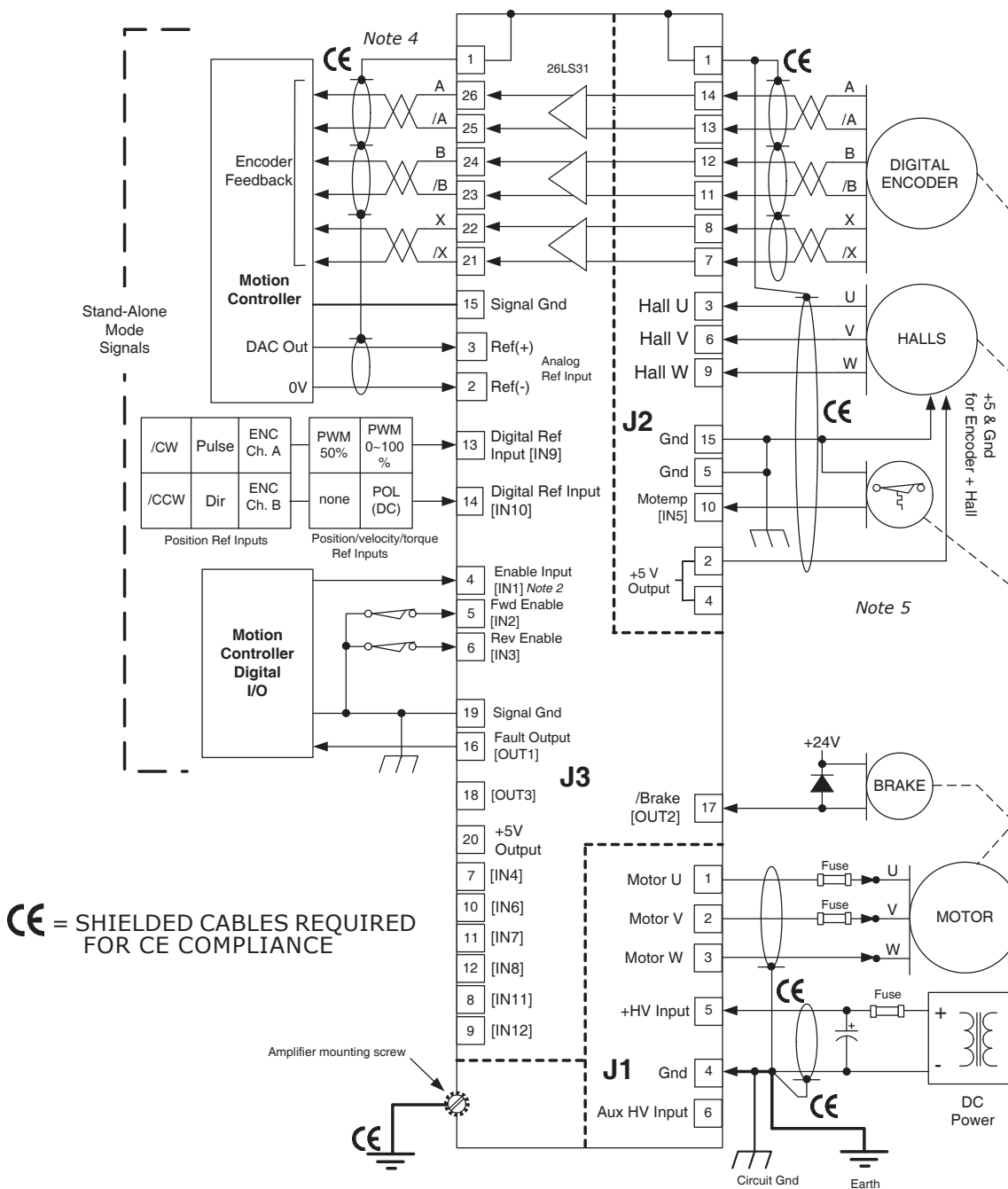
NOTES

1. The functions of input signals on J2-10, and J3-5,6,7,8,9,10,11,12,13, and 14 are programmable. Default functions are shown.
2. The function of [IN1] on J3-4 is always Drive Enable and is not programmable
3. Pins J3-20, J2-2, and J2-4 all connect to the same +5 Vdc @ 250 mAdc power source. Total current drawn from both pins cannot exceed 250 mAdc.
4. Multi-mode encoder port (J3-21~26) is shown configured for buffered-output of a digital primary motor encoder.

J6 RS-232

PIN	SIGNAL
1	No Connection
2	RxD
3	Signal Ground
4	Signal Ground
5	TxD
6	No Connection

J6 CABLE CONNECTOR
RJ-11 style, male, 6 position
Cable: 6-conductor modular type

J4-J5 CAN BUS

PIN	SIGNAL
1	CAN_H
2	CAN_L
3	CAN_GND
4	No Connection
5	Reserved
6	(CAN_SHLD) [1]
7	CAN_GND
8	(CAN_V+) [1]

J4, J5 CABLE CONNECTOR:
RJ-45 style, male, 8 position
Cable: 8-conductor, modular type

J3 CONTROL SIGNALS

PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
1	Frame Gnd	10	[IN6] HS	19	Signal Gnd
2	Ref(-)	11	[IN7] HS	20	+5 Vdc (Note 1)
3	Ref(+)	12	[IN8] HS	21	Multi Encoder /X
4	[IN1] Enable	13	[IN9] HS	22	Multi Encoder X
5	[IN2] GP	14	[IN10] HS	23	Multi Encoder /B
6	[IN3] GP	15	Signal Gnd	24	Multi Encoder B
7	[IN4] GP	16	[OUT1]	25	Multi Encoder /A
8	[IN11] GP	17	[OUT2]	26	Multi Encoder A
9	[IN12] GP	18	[OUT3]		

J3 CABLE CONNECTOR:
High-Density D-Sub
26 Position, Male
#4-40 locking screws

J2 MOTOR FEEDBACK

PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
1	Frame Gnd	6	Hall V	11	Encoder /B
2	+5 Vdc (Note 1)	7	Encoder /X	12	Encoder B
3	Hall U	8	Encoder X	13	Encoder /A
4	+5 Vdc (Note 1)	9	Hall W	14	Encoder A
5	Signal Gnd	10	[IN5] Motemp	15	Signal Gnd

J2 CABLE CONNECTOR:
High-Density D-Sub
15 Position, Male
#4-40 locking screws

J1: MOTOR & POWER

PIN	SIGNAL
1	Motor U Output
2	Motor V Output
3	Motor W Output
4	Ground (HV, Signal)
5	+HV Input
6	Aux HV Input

J1 CABLE CONNECTOR:
Terminal block,6 position, 5.08 mm, black
  UL rated 300V, 15A:
  Amphenol PCD: ELFP06210
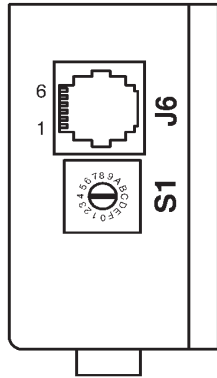 Molex: 39530-0006
  TE Connectivity: 796635-6

DRIVE CONNECTIONS
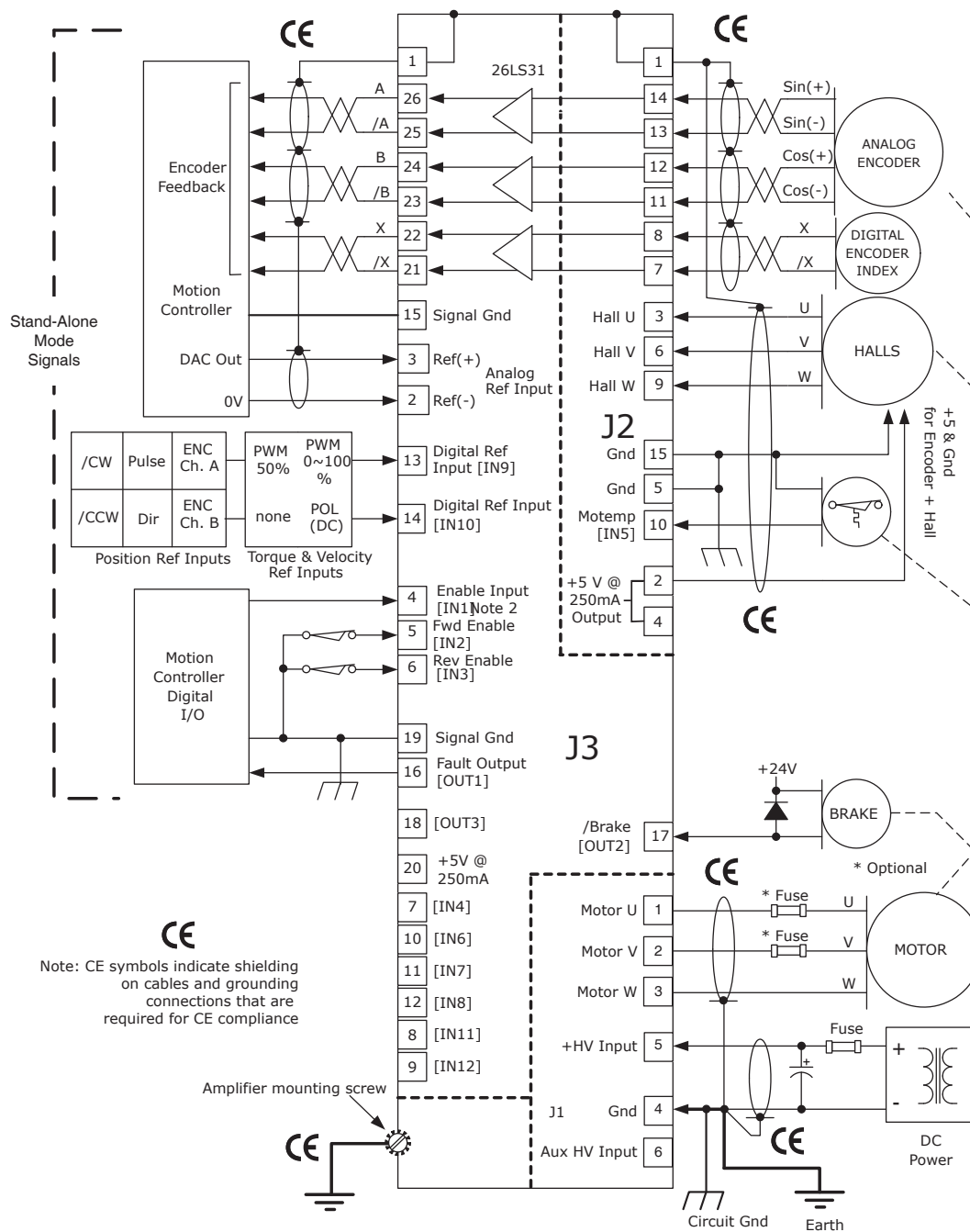
NOTEVS

1. The functions of input signals on J2-10, and J3-5,6,7,8,9,10,11,12,13, and 14 are programmable. Default functions are shown.

2. The function of [IN1] on J3-4 is always Drive Enable and is not programmable

3. Pins J3-20, J2-2, and J2-4 all connect to the same +5 Vdc @ 250 mAdc power source. Total current drawn from both pins cannot exceed 250 mAdc.

4. Multi-mode encoder port (J3-21~26) is shown configured for buffered-output of a digital primary motor encoder. Page 11 shows connections for analog Hall commutation with digital incremental position feedback.

J6 RS-232

PIN	SIGNAL
1	No Connection
2	RxD
3	Signal Ground
4	Signal Ground
5	TxD
6	No Connection

J6 CABLE CONNECTOR
RJ-11 style, male, 6 position
Cable: 6-conductor modular type

J4-J5 CAN BUS

PIN	SIGNAL
1	CAN_H
2	CAN_L
3	CAN_GND
4	No Connection
5	Reserved
6	(CAN_SHLD) [1]
7	CAN_GND
8	(CAN_V+) [1]

J4, J5 CABLE CONNECTOR:
RJ-45 style, male, 8 position
Cable: 8-conductor, modular type

J3 CONTROL SIGNALS

PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
1	Frame Gnd	10	[IN6] HS	19	Signal Gnd
2	Ref(-)	11	[IN7] HS	20	+5 Vdc (Note 1)
3	Ref(+)	12	[IN8] HS	21	Multi Encoder /X
4	[IN1] Enable	13	[IN9] HS	22	Multi Encoder X
5	[IN2] GP	14	[IN10] HS	23	Multi Encoder /B
6	[IN3] GP	15	Signal Gnd	24	Multi Encoder B
7	[IN4] GP	16	[OUT1]	25	Multi Encoder /A
8	[IN11] GP	17	[OUT2]	26	Multi Encoder A
9	[IN12] GP	18	[OUT3]		

J3 CABLE CONNECTOR:
High-Density D-Sub 26 Position, Male

J2 MOTOR FEEDBACK

PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
1	Frame Gnd	6	Hall V	11	Encoder Cos(-)
2	+5 Vdc (Note 1)	7	Encoder /X	12	Encoder Cos(+)
3	Hall U	8	Encoder X	13	Encoder Sin(-)
4	+5 Vdc (Note 1)	9	Hall W	14	Encoder Sin(+)
5	Signal Gnd	10	[IN5] Motemp	15	Signal Gnd

J2 CABLE CONNECTOR:
High-Density D-Sub 15 Position, Male

J1: MOTOR & POWER

PIN	SIGNAL
1	Motor U Output
2	Motor V Output
3	Motor W Output
4	Ground (HV, Signal)
5	+HV Input
6	Aux HV Input

J1 CABLE CONNECTOR:
Terminal block, 6 position, 5.08 mm, black
  UL rated 300V, 15A:
  Amphenol PCD: ELFP06210
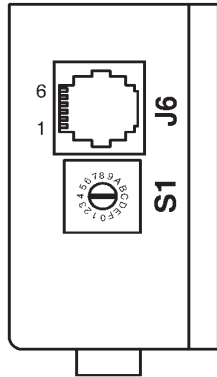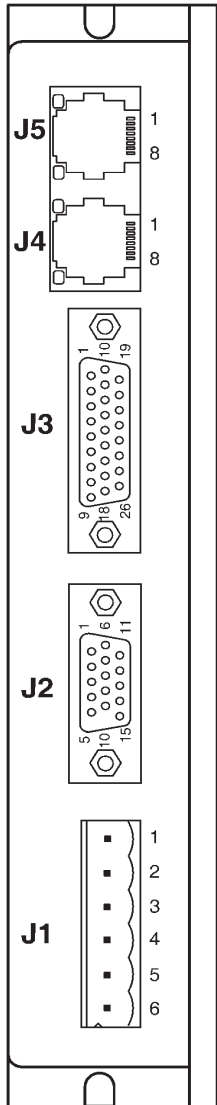 Molex: 39530-0006
  TE Connectivity: 796635-6

GROUNDING CONSIDERATIONS

Power and control circuits in *Accelnet R20* share a common circuit-ground (Gnd on J1-4, and Signal Ground on J2-2, 10 ,15 ,20, and J3-2, 23). Input logic circuits are referenced to Signal Ground, as are analog Reference inputs, digital outputs, encoder and Hall signals. For this reason, drive Gnd terminals should connect to the users' common ground system so that signals between drive and controller are at the same common potential, and to minimize noise. The system ground should, in turn, connect to an earthing conductor at some point so that the whole system is referenced to "earth". The CAN ports are optically isolated from the drive circuits.

Because current flow through conductors produces voltage-drops across them, it is best to connect the drive HV Return to system earth, or circuit-common through the shortest path, and to leave the power-supply floating. In this way, the power supply (-) terminal connects to ground at the drive HV Return terminals, but the voltage drops across the cables will not appear at the drive ground, but at the power supply negative terminal where they will have less effect.

Motor phase currents are balanced, but currents can flow between the PWM outputs, and the motor cable shield. To minimize the effects of these currents on nearby circuits, the cable shield should connect to Gnd (J1-4).

The drive case does not connect to any drive circuits. Connections to the case are provided on connectors J2-1, and J3-1. Cables to these connectors should be shielded for CE compliance, and the shields should connect to these terminals. When installed, the drive case should connect to the system chassis. This maximizes the shielding effect of the case, and provides a path to ground for noise currents that may occur in the cable shields.

Signals from controller to drive are referenced to +5 Vdc, and other power supplies in user equipment. These power supplies should also connect to system ground and earth at some point so that they are at same potential as the drive circuits.

The final configuration should embody three current-carrying loops. First, the power supply currents flowing into and out of the drive at the +HV and Gnd pins on J1. Second the drive outputs driving currents into and out of the motor phases, and motor shield currents circulating between the U, V, and W outputs and Gnd. And, lastly, logic and signal currents connected to the drive control inputs and outputs.

For CE compliance and operator safety, the drive should be earthed by using external tooth lockwashers under the mounting screws. These will make contact with the aluminum chassis through the anodized finish to connect the chassis to the equipment frame ground.
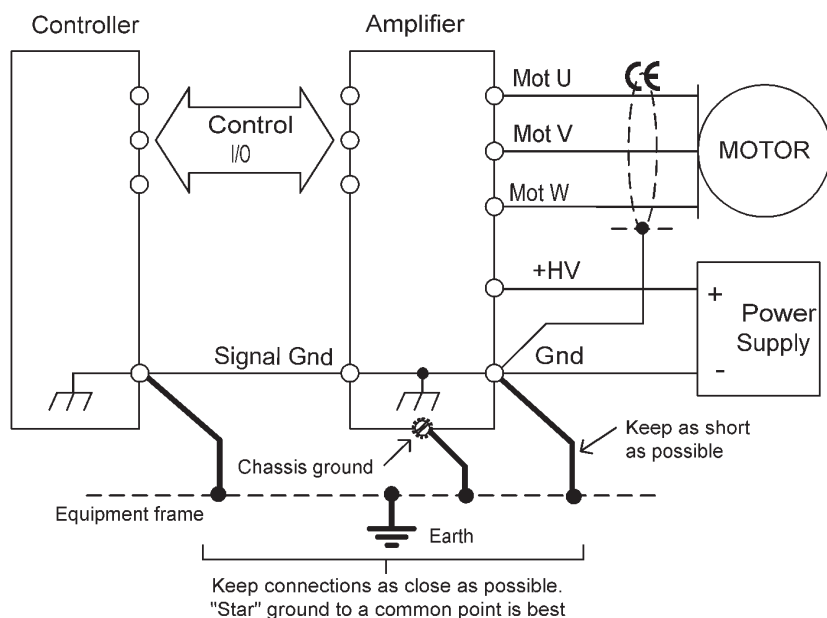

CE = SHIELDED CABLES REQUIRED FOR CE COMPLIANCE

POWER SUPPLIES

Accelnet R20 operates typically from transformer-isolated, unregulated DC power supplies. These should be sized such that the maximum output voltage under high-line and no-load conditions does not exceed the drives maximum voltage rating. Power supply rating depends on the power delivered to the load by the drive. In many cases, the continuous power output of the drive is considerably higher than the actual power required by an incremental motion application.

Operation from regulated switching power supplies is possible if a diode is placed between the power supply and drive to prevent regenerative energy from reaching the output of the supply. If this is done, there must be external capacitance between the diode and drive.
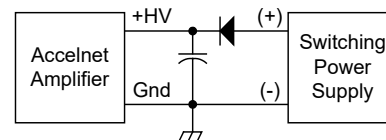
AUXILIARY HV POWER

Accelnet R20 has an input for AUX- HV. This is a voltage that can keep the drive communications and feedback circuits active when the PWM output stage has been disabled by removing the main +HV supply. This can occur during EMO (Emergency Off) conditions where the +HV supply must be removed from the drive and powered-down to ensure operator safety. The AUX HV input operates from any DC voltage that is within the operating voltage range of the drive and powers the DC/DC converter that supplies operating voltages to the drive DSP and control circuits.

When the drive +HV voltage is greater than the AUX-HV voltage it will power the DC/DC converter. Under these conditions the AUX-HV input will draw no current.

MOUNTING & COOLING

Accelnet R20 has slots for mounting to panels at 0° or 90°. Cooling is by conduction from drive heatplate to mounting surface, or by convection to ambient.

A heatsink (optional) is required for the drive to deliver the rated continuous output current. Depending on the drive mounting and cooling means this may not be required.

GROUNDING & SHIELDING FOR CE

Grounding and shielding are the means of controlling the emission of radio frequency energy from the drive so that it does not interfere with other electronic equipment.
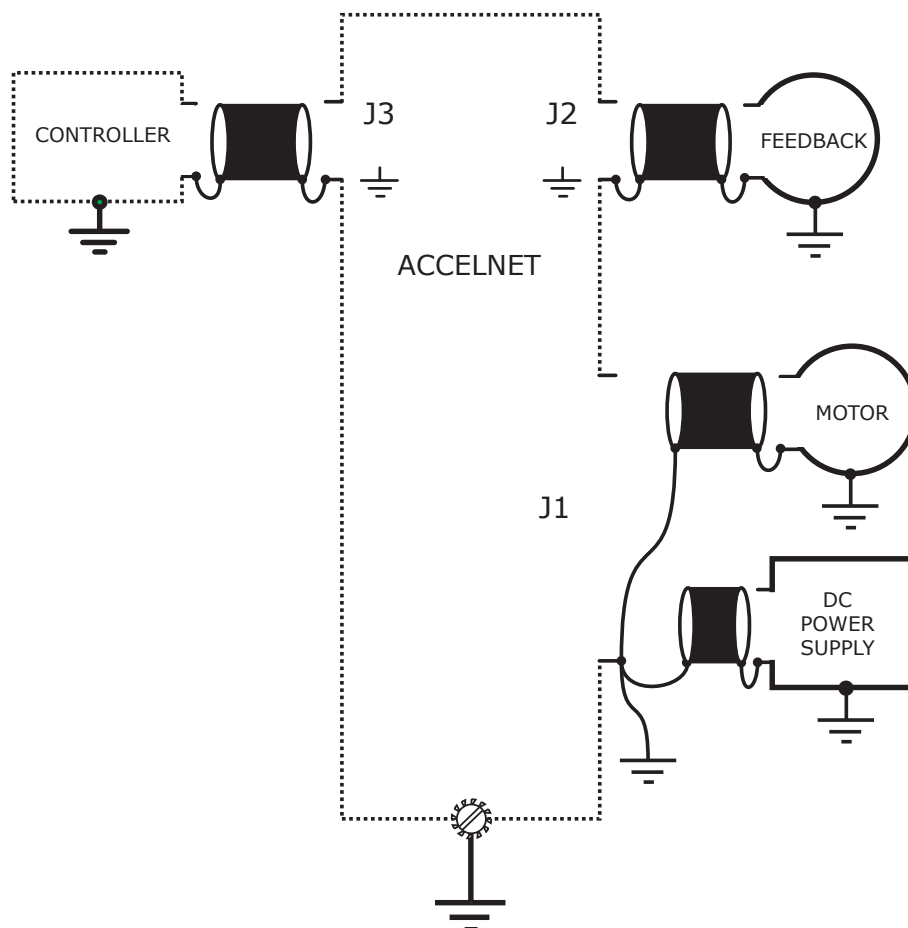
The use of shielded cables to connect the drive to motors and feedback devices is a way of extending the chassis of the drive out to these devices so that the conductors carrying noise generated by the drive are completely enclosed by a conductive shield.

The process begins at the connector J1 of the drive. When possible, it is best to ground the (-) HV terminal to the equipment earth ground with as short a connection as possible. The drives' PWM outputs produce current pulses in the wires between drive and power supply. By grounding the power supply at the drive end of the cables, this noise will not appear between earth ground and drive circuit ground. And, using shielded cable between drive and power supply will provide a return path for noise produced in the cables that might otherwise radiate to adjacent equipment.

The shield of the motor cable should also connect to either J1-4, or to a nearby star ground at the chassis where the power-supply (-) terminal connects. Connecting the shields of the motor cable to the motor frame completes the return path for noise that is capacitively coupled to the motor frame.

Next, ground the motor heatplate using an external-tooth locking washer. This will penetrate the anodized finish of the heatplate (which is an electrical insulator) and make good electrical contact with the aluminum plate. Grounding the heatplate in this way shortens the path from drive to earth ground and further reduces emissions.
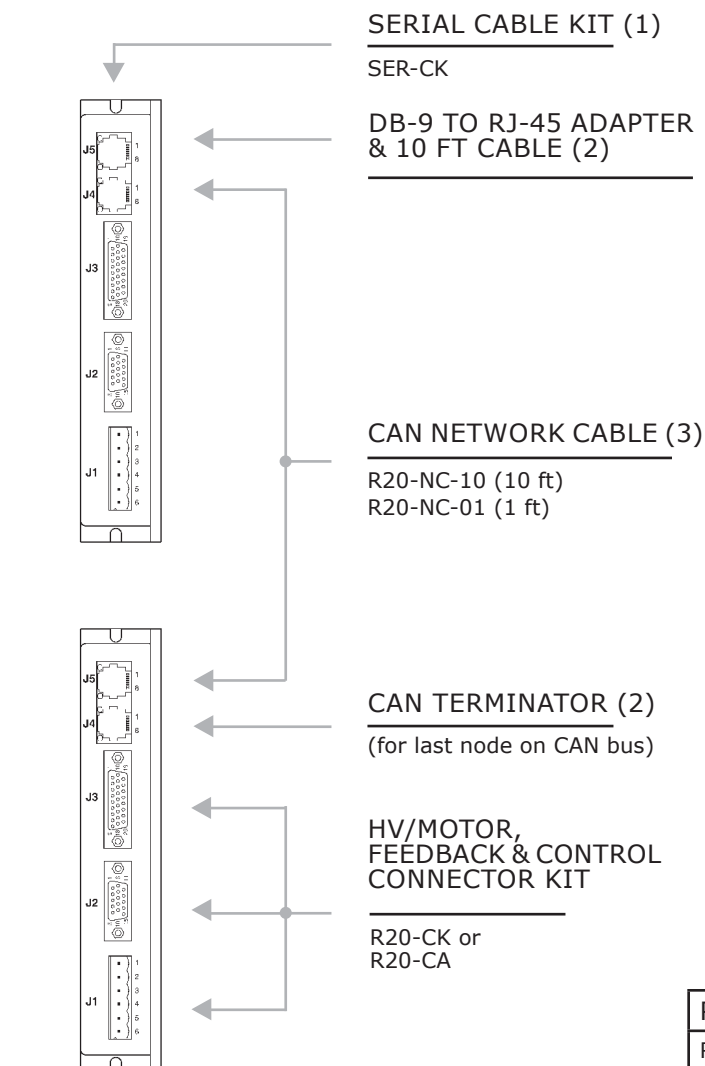
Shield should also be added to the cables from the motion controller or control system, and from the feedback device on the motor.

Notes:
1) Shielded cables required for CE are shown in the diagram above.

copley controls

CANOPEN CONFIGURATION

SERIAL CABLE KIT (1)

SER-CK

DB-9 TO RJ-45 ADAPTER
& 10 FT CABLE (2)

CAN NETWORK CABLE (3)

R20-NC-10 (10 ft)
R20-NC-01 (1 ft)

CAN TERMINATOR (2)

(for last node on CAN bus)

HV/MOTOR,
FEEDBACK & CONTROL
CONNECTOR KIT

R20-CK or
R20-CA

Multiple drives are connected as nodes on a CAN bus

Individual drives are configured using an RS-232 connection and CME 2™ software

Notes:

1. Only one SER-CK is needed per installation
2. Included in CANopen Network Kit R20-NK
3. Order one cable (1 or 10 ft) for each additional drive

+HV

POWER SUPPLY
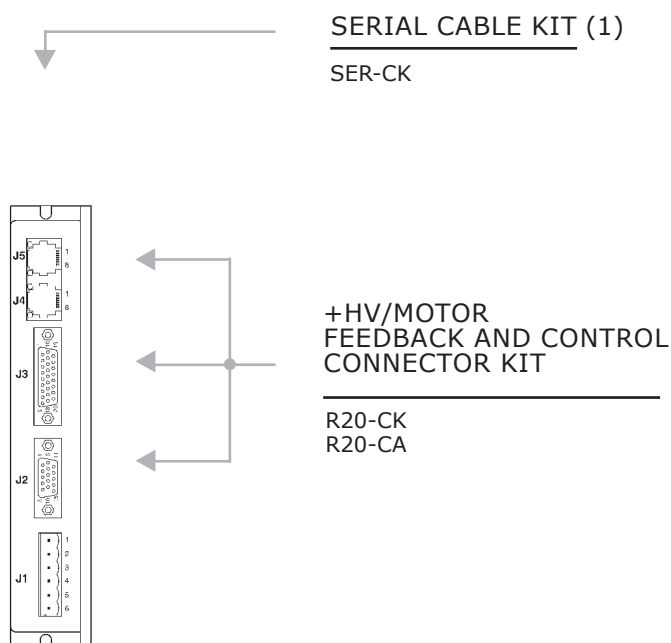
Mains-isolated DC
Required for all systems
User-supplied

R20-HK

HEATSINK

(Optional)

PART NUMBER	DESCRIPTION
R20-055-18	Accelnet R20 Servo drive, 55 Vdc, 6/18 A
R20-090-09	Accelnet R20 Servo drive, 90 Vdc 3/9 A
R20-090-18	Accelnet R20 Servo drive, 90 Vdc, 6/18 A
R20-090-36	Accelnet R20 Servo drive, 90 Vdc, 12/36 A
R20-180-09	Accelnet R20 Servo drive, 180 Vdc, 3/9 A
R20-180-18	Accelnet R20 Servo drive, 180 Vdc, 6/18 A
R20-CK	Connector Kit for Accelnet R20 (P1 plug, and plugs with soldercups & backshells for P2 & P3)
R20-NK	CAN Network Kit (Sub-D 9F to RJ-45 adapter, 10 ft. modular cable, and CAN terminator)
R20-NC-10	CAN network cable, 10 ft (3 m)
R20-NC-01	CAN network cable, 1 ft (0.3 m)
SER-CK	RS-232 Cable Kit
R20-HK	Heatsink (optional)

Add -S to part numbers above for Sin/Cos feedback

STAND-ALONE CONFIGURATION

SERIAL CABLE KIT (1)

SER-CK

+HV/MOTOR
FEEDBACK AND CONTROL
CONNECTOR KIT

R20-CK
R20-CA

Current or Velocity Mode Signals:
    PWM & Polarity
    PWM 50%
    ±10V Analog

Position-mode Signals:
    Step/Direction
    CW/CCW
    ±10V Analog

Electronic Gearing Signals:
    A/B Quadrature encoder

CME 2™ is used for setup and
configuration.

+HV

POWER SUPPLY

Mains-isolated DC
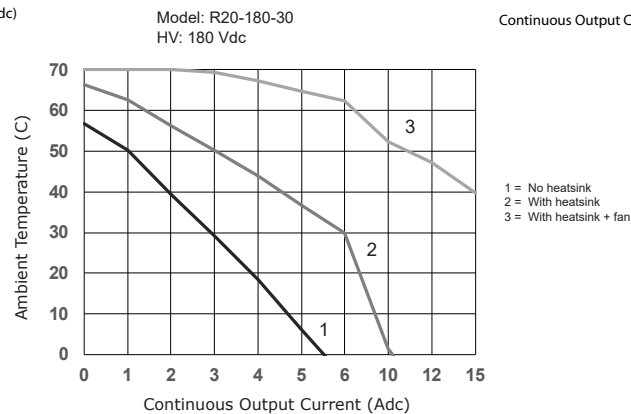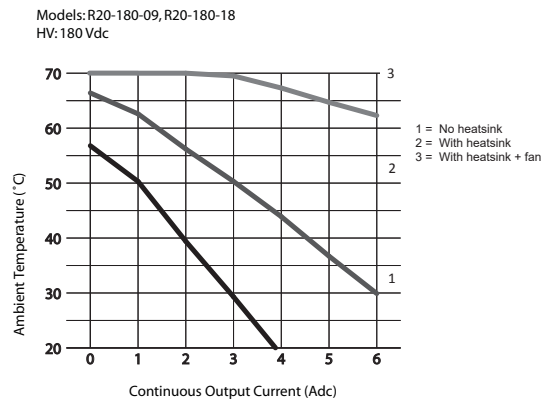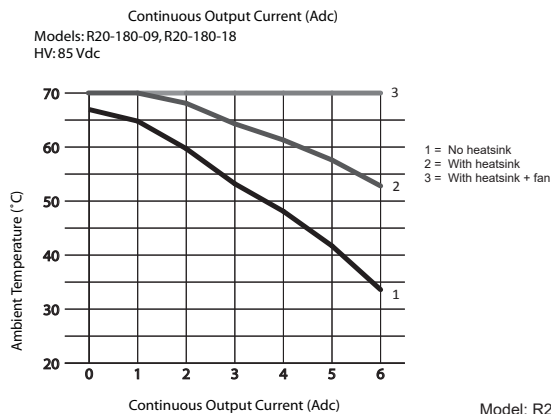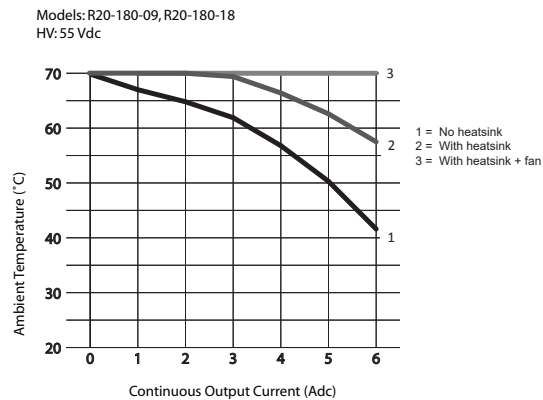Required for all systems
User-supplied

R20-HK

HEATSINK

(Optional)

PART NUMBER	DESCRIPTION
R20-055-18	Accelnet R20 Servo drive, 55 Vdc, 6/18 A
R20-090-09	Accelnet R20 Servo drive, 90 Vdc 3/9 A
R20-090-18	Accelnet R20 Servo drive, 90 Vdc, 6/18 A
R20-090-36	Accelnet R20 Servo drive, 90 Vdc, 12/36 A
R20-180-09	Accelnet R20 Servo drive, 180 Vdc, 3/9 A
R20-180-18	Accelnet R20 Servo drive, 180 Vdc, 6/18 A
R20-CK	Connector Kit for Accelnet R20 (P1 plug, and plugs with soldercups & backshells for P2 & P3)
SER-CK	RS-232 Cable Kit
R20-HK	Heatsink (optional)

Add -S to part numbers above for Sin/Cos feedback

MAXIMUM OPERATING TEMPERATURE VS HEATSINK & AIR CIRCULATION

The charts below show that maximum ambient temperature vs. continuous output current for the Accelnet R20 models. The cooling conditions are no heatsink, with heatsink, and heatsink with forced-air from a fan.

Models: R20-055-18, R20-090-09, R20-090-18, R20-090-36
HV: 25 Vdc

1 = No heatsink
2 = With heatsink
3 = With heatsink + fan

Models: R20-055-18, R20-090-09, R20-090-18, R20-090-36
HV: 55 Vdc

1 = No heatsink
2 = With heatsink
3 = With heatsink + fan

Models: R20-055-18, R20-090-09, R20-090-18, R20-090-36
HV: 90 Vdc

1 = No heatsink
2 = With heatsink
3 = With heatsink + fan

Models: R20-180-09, R20-180-18
HV: 55 Vdc

1 = No heatsink
2 = With heatsink
3 = With heatsink + fan

Models: R20-180-09, R20-180-18
HV: 85 Vdc

1 = No heatsink
2 = With heatsink
3 = With heatsink + fan

Models: R20-180-09, R20-180-18
HV: 180 Vdc

1 = No heatsink
2 = With heatsink
3 = With heatsink + fan

Model: R20-180-30
HV: 180 Vdc

1 = No heatsink
2 = With heatsink
3 = With heatsink + fan

MOUNTING

Thermal data for convection-cooling with a heatsink assumes a vertical mounting of the drive on a thermally conducting surface. Heatsink fins run parallel to the long axis of the drive. When fan-cooling is used vertical mounting is not necessary to guarantee thermal performance of the heatsink.

THERMAL RESISTANCE

Thermal resistance is a measure of the temperature rise of the drive heatplate due to power dissipation in the drive. It is expressed in units of °C/W where the degrees are the temperature rise *above ambient*.

E.g., an drive dissipating 16 W mounted with no heatsink or fan would see a temperature rise of 46 °C above ambient based on the thermal resistance of 2.9 °C/W. Using the drive maximum heatplate temperature of 70 °C and subtracting 46 °C from that would give 24 °C as the maximum ambient temperature the drive in which the ampifier could operate before going into thermal shutdown. To operate at higher ambient temperatures a heatsink or forced-air would be required.

TOP VIEW
VERTICAL MOUNTING
WITH FAN
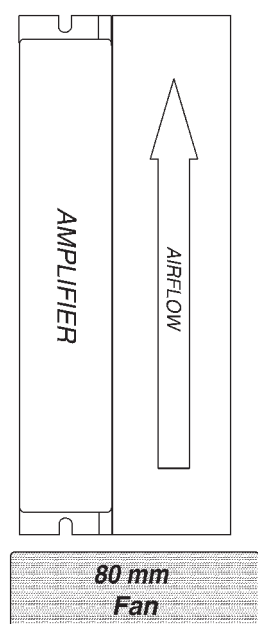
END VIEWS
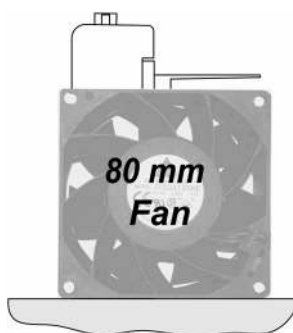VERTICAL MOUNTING

AMPLIFIER AIRFLOW 80 mm Fan

80 mm Fan
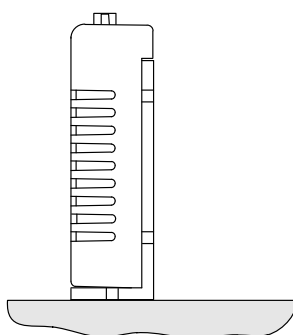
NO HEATSINK, NO FAN	°C/W
CONVECTION	2.9
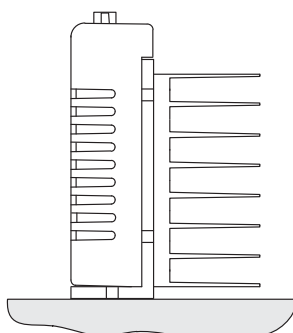
HEATSINK, NO FAN	°C/W
CONVECTION	1.7

HEATSINK + FAN	°C/W
FORCED-AIR, 300 LFM	0.6

MASTER ORDERING GUIDE

QUAD A/B MODELS	SIN/COS MODELS	DESCRIPTION
R20-055-18	R20-055-18-S	Accelnet R20 Servo drive, 55 Vdc, 6/18 A
R20-090-09	R20-090-09-S	Accelnet R20 Servo drive, 90 Vdc 3/9 A
R20-090-18	R20-090-18-S	Accelnet R20 Servo drive, 90 Vdc, 6/18 A
R20-090-36	R20-090-36-S	Accelnet R20 .Servo drive, 90 Vdc, 12/36 A
R20-180-09	R20-180-09-S	Accelnet R20 Servo drive, 180 Vdc, 3/9 A
R20-180-18	R20-180-18-S	Accelnet R20 Servo drive, 180 Vdc, 6/18 A
R20-180-30	R20-180-30-S	Accelnet R20 Servo drive, 180 Vdc, 15/30 A

Contact factory for RS-422 option

ACCESSORIES

	QTY	DESCRIPTION
CONNECTOR KIT R20-CK	4	Connector, 6 Terminal, 5.08 mm
	1	26 Pin Connector, High Density, D-Sub, Solder Cup
	1	26 Pin Connector Backshell
	1	15 Pin Connector, High Density, D-Sub, Solder Cup
	1	15 Pin Connector Backshell
CANOPEN NETWORK KIT R20-NK	1	Adapter Assy, DB9 Female to RJ45 Jack (ADP-CV)
	1	CANopen Network Cable, 10 ft. (ADP-NC-10)
	1	CANopen Network Terminator (ADP-NT)
HEATSINK KIT R20-HK	1	Heatsink, Low Profile
	1	Heatsink Thermal Material
	4	Heatsink Hardware
R20-CV		Adapter Assembly, DB9 Female to RJ45 Jack
R20-NC-10		CANopen Network Cable, 10 ft
R20-NC-01		CANopen network cable, 1 ft
R20-NT		CANopen Network Terminator
SER-CK		Serial Cable Kit

ORDERING EXAMPLE

Example: Order an R20-090-18-S servo drive with heatsink installed at factory and associated components:

Qty	Item	Remarks
1	R20-090-18-S-H	Accelnet R20 servo drive, Sin/Cos encoder, heasink installed at the factory
1	R20-CK	Connector Kit
1	SER-CK	Serial Cable Kit

16-0120045 Document Revision History

Revision	Date	Remarks
00	August 22, 2018	Initial released version

Note: Specifications subject to change without notice