EyeRobot 3.0 Control System

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24th April 2020

Hardware Specifications

ER 2.0 control system: block diagram

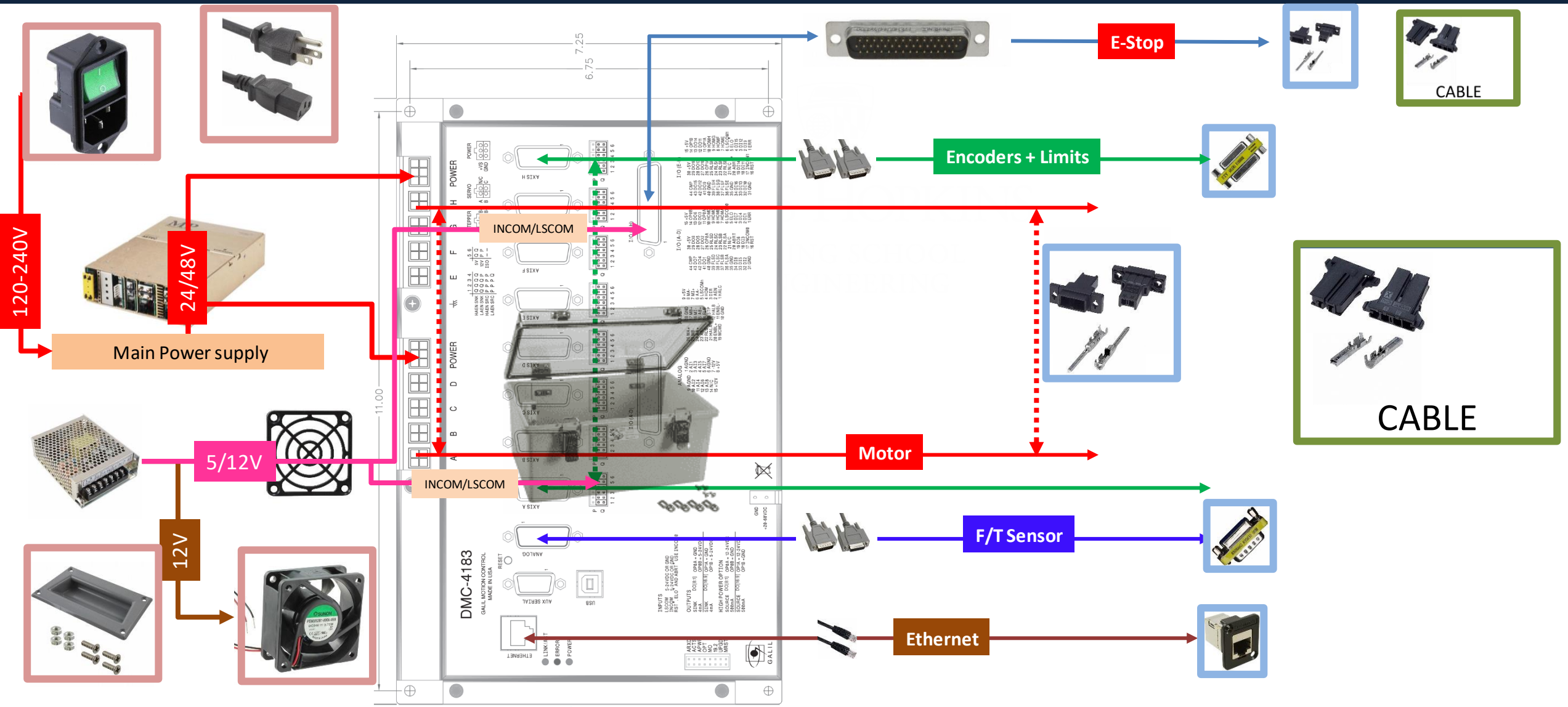


Figure 2.4: DMC-41x3-BOX4 Dimensions[1] (in inches) where x= 5, 6, 7, and 8-axis

Power	Components on the controller box	Components on the interface panel	Components on the cables

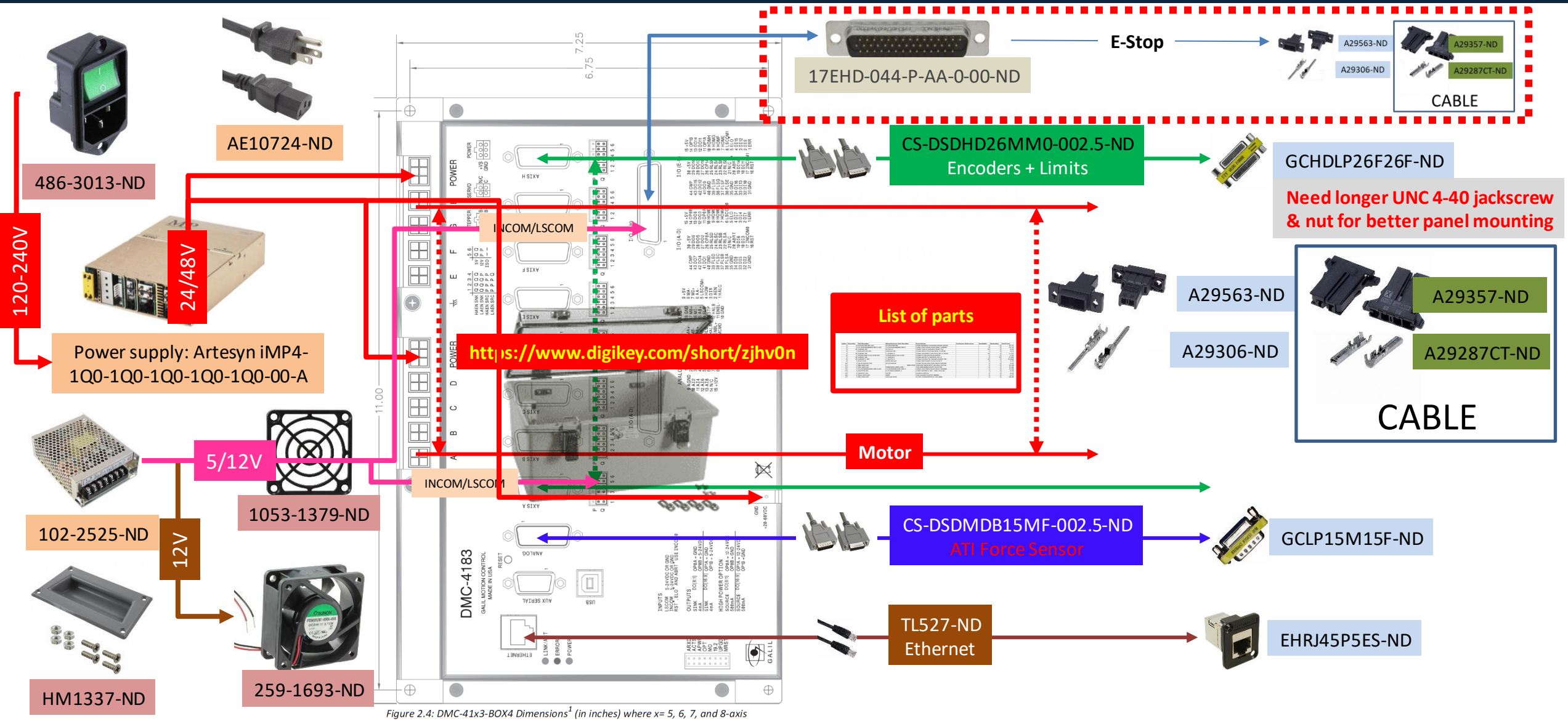
List of components: ER 2.0

- Controller enclosure
  - BUD Industries NBA-10172 Style A Plastic Indoor Box with Clear Door, 19-43/64" Length x 15-3/4" Width x 7-55/64" Height, Light Gray Finish
- Galil 4183 embedded motion controller
  - DMC-4163-BOX8(16BIT,MO)-ABCD(HSRC)-EFGH(SSI,HSRC)-D3040-D3020
  - http://galil.com/order/part-number-generator/dmc-41x3#DMC-4163-BOX8(16BIT,MO)-ABCD(HSRC)-EFGH(SSI,HSRC)-D3040-D3020
- Power supplies
  - Astec 24V, 5 channel, 7A per channel power supply
  - Obsolete product number: Astec MP4-1Q-1Q-1Q-1Q-1Q-00: **Most probably this one should confirm by looking to the controller box**
  - 24-5V power supply : http://www.digikey.com/short/j4q53z
- Foot-pedal interface
  - https://www.phidgets.com/?tier=3&catid=2&pcid=1&prodid=4
  - I think one which was connected to Analog 1 should be connected to 1 on USB IO board too and the other one with analog 2.
- For each axis
  - 26 pin D-sub Cable
  - 2 pin motor cable
- Cable for force sensor 15 pin + panel interface
- 41 pin connector : Digikey part number 17EHD-044-P-AA-0-00-ND
- Digikey order
  - http://www.digikey.com/short/jprbnd
  - http://www.digikey.com/short/jzfw3t
- Extra cart links- not required, delete later
  - http://www.digikey.com/short/jprrj1
  - http://www.digikey.com/short/jzw5cr
- Liquid electrical tape:
  - https://www.walmart.com/ip/Performix-Liquid-Electrical-Tape/16888975?wmlspartner=wlpa&selectedSellerId=0&adid=22222222280096169 75&wl0=&wl1=g&wl2=m&wl3=42529846112&wl4=pla-81187513952&wl5=9060100&wl6=&wl7=&wl8=&wl9=pla&wl10=8175035&wl11=online&wl12=16888975&wl13=&veh=sem

ER 3.0 control system

- Galil 4183
  - Incremental encoders: HEDM-55xx/560x & HEDS-55xx/56xx
  - Absolute encoder (SSI/BiSS): Renishaw RESOLUTE/EVOLUTE based on our requirements
  - Motors: Maxon, faulharber
  - ATI Force sensor: Nano 17
  - Foot pedal: may be we could find USB foot switch instead of using the Phidget one
  - Power supply
    - Galil controller and drivers: Artesyn 5 output, each output: 7 Amp, 24/48V
    - Fan and limit switches: 5/12 V power supply
- Interface panel with connections for
  - 8 Encoders
  - 8 Motors
  - 1 F/T sensor
  - 1 emergency switch
  - May be 3 breaks for linear actuators (if they are back drivable)
  - 1 Ethernet port for communication to Galil 4183
- Controller enclosure
- Controller base-plate for mounting all the components

Block diagram with Digikey part numbers



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- Controller enclosure
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  - https://www.digikey.com/products/en/boxes-enclosures-racks/boxes/594?fid=615062
- Galil 4183 embedded motion controller
  - DMC-4183-BOX8(16BIT,MO,ISCNTL)-ABCD(SER,LSNK)-EFGH(SER,LSNK)-D3040-D3040
  - http://galil.com/order/part-number-generator/dmc-41x3#DMC-4183-BOX8(16BIT,MO,ISCNTL)-ABCD(SER,LSNK)-EFGH(SER,LSNK)-D3040-D3040
  - Ask for **SSI** and **BiSS** encoder interfaces and may be 400mA outputs
- Power supplies
  - Astec 24V, 5 channel, 7A per channel power supply

    - https://www.artesyn.com/documents/518/
    - https://www.artesyn.com/assets/imp_ds_04may2015_7d448d5004.pdf
    - https://www.digikey.com/en/product-highlight/a/artesyn-embedded-tech/configurable-power-supplies#iMP-Series
    - https://www.digikey.com/products/en/power-supplies-external-internal-off-board/ac-dc-configurable-power-supplies-factory-assembled/955?k=iMP4
    - Obsolete product number: Astec MP4-1Q-1Q-1Q-1Q-1Q-00
  - 24-5V power supply : http://www.digikey.com/short/j4q53z
- Foot-pedal interface
  - https://www.phidgets.com/?tier=3&catid=2&pcid=1&prodid=4
  - I think one which was connected to Analog 1 should be connected to 1 on USB IO board too and the other one with analog 2.
- For each axis
  - 26 pin D-sub Cable
  - 2 pin motor cable
- Cable for force sensor 15 pin + panel interface
- 41 pin connector : Digikey part number 17EHD-044-P-AA-0-00-ND
- Digikey cart
  - https://www.digikey.com/short/zjhv0n
- **BRAKES??**

ELO/DIO/LSwitch Power connection diagram

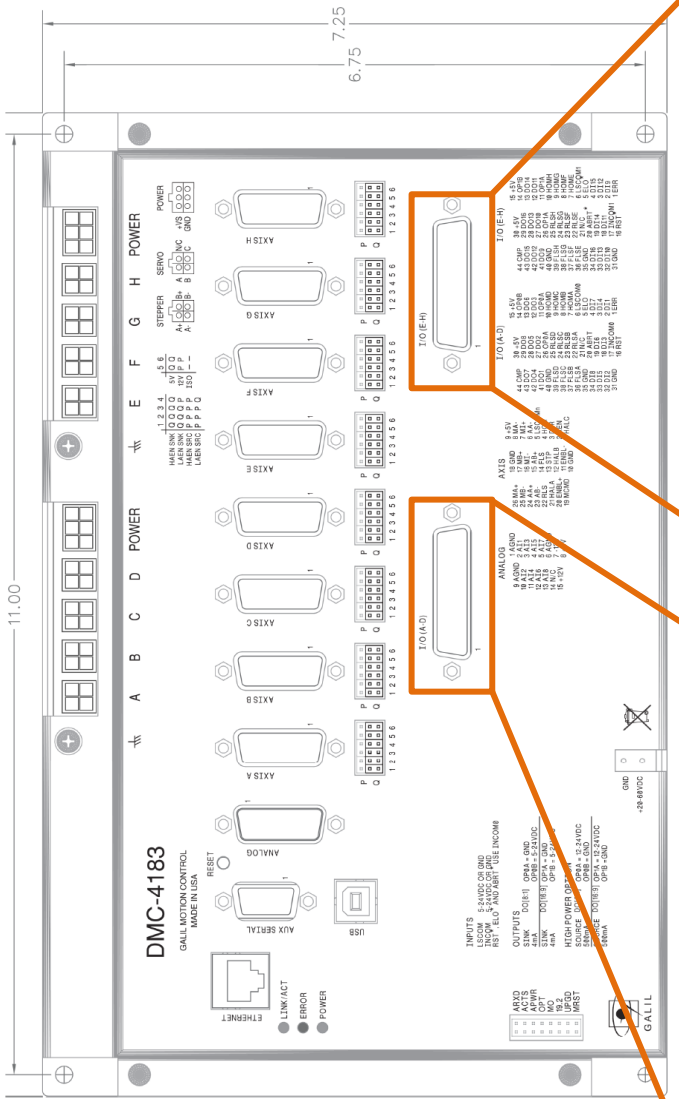
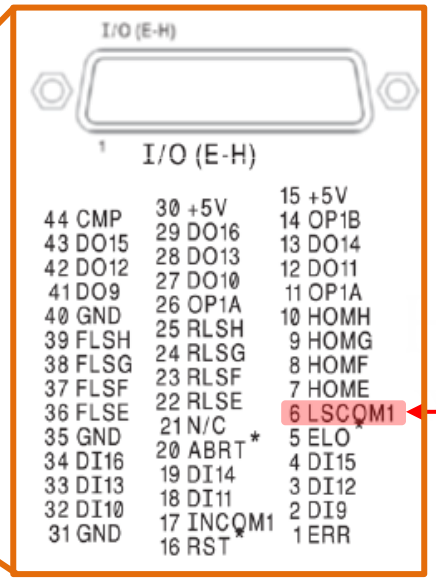
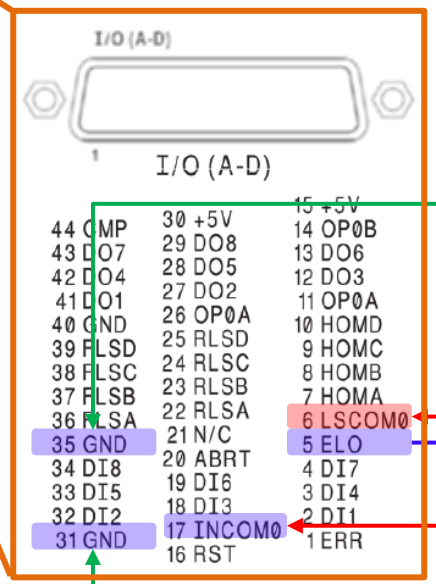


Figure 2.4: DMC-41x3-BOX4 Dimensions[1] (in inches) where x= 5, 6, 7, and 8-axis





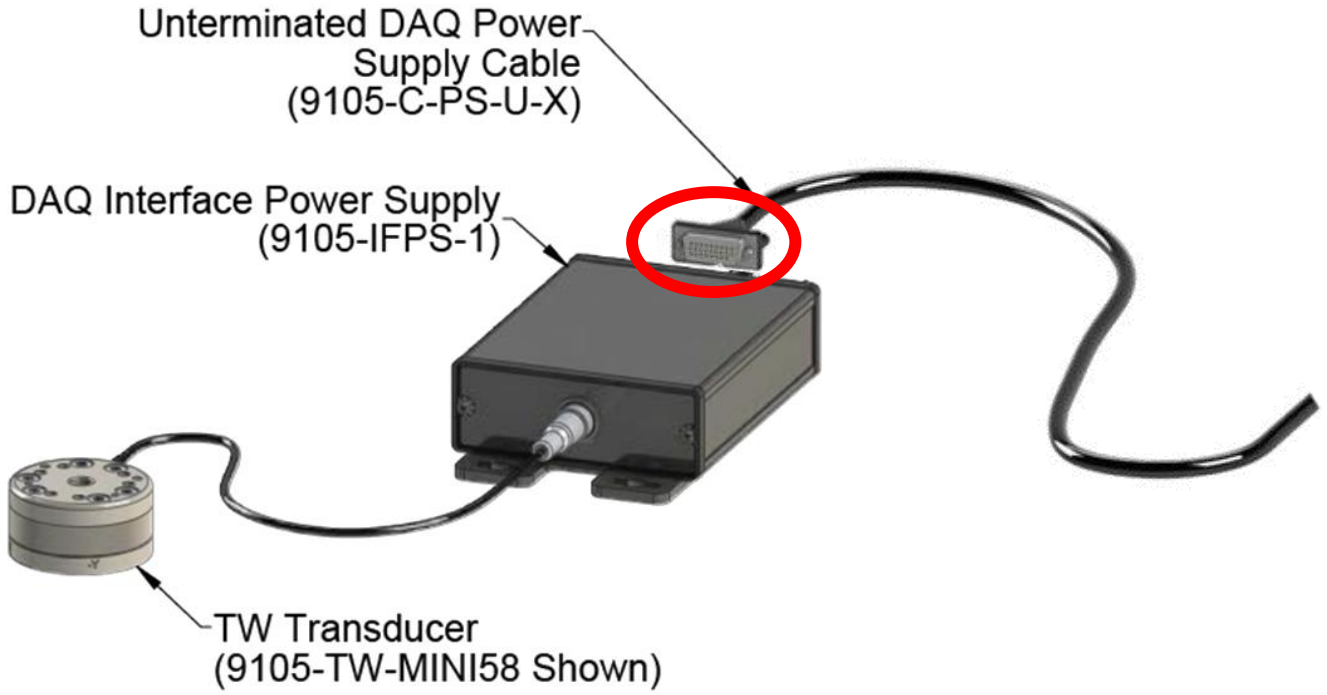
V depends on requirement for the limit switches and Digital IO

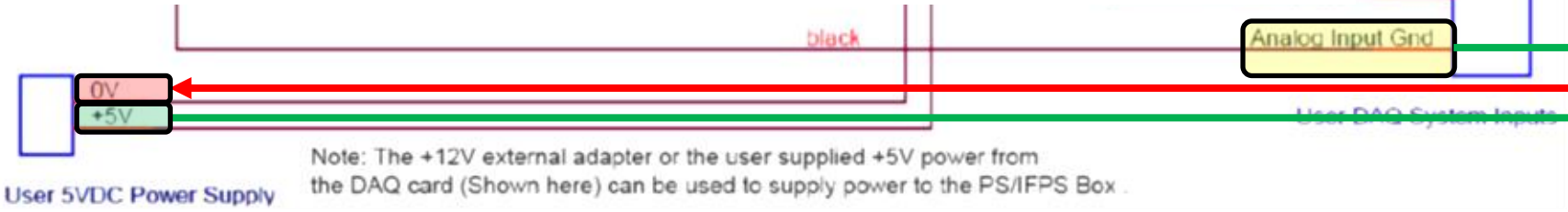
5/12 V

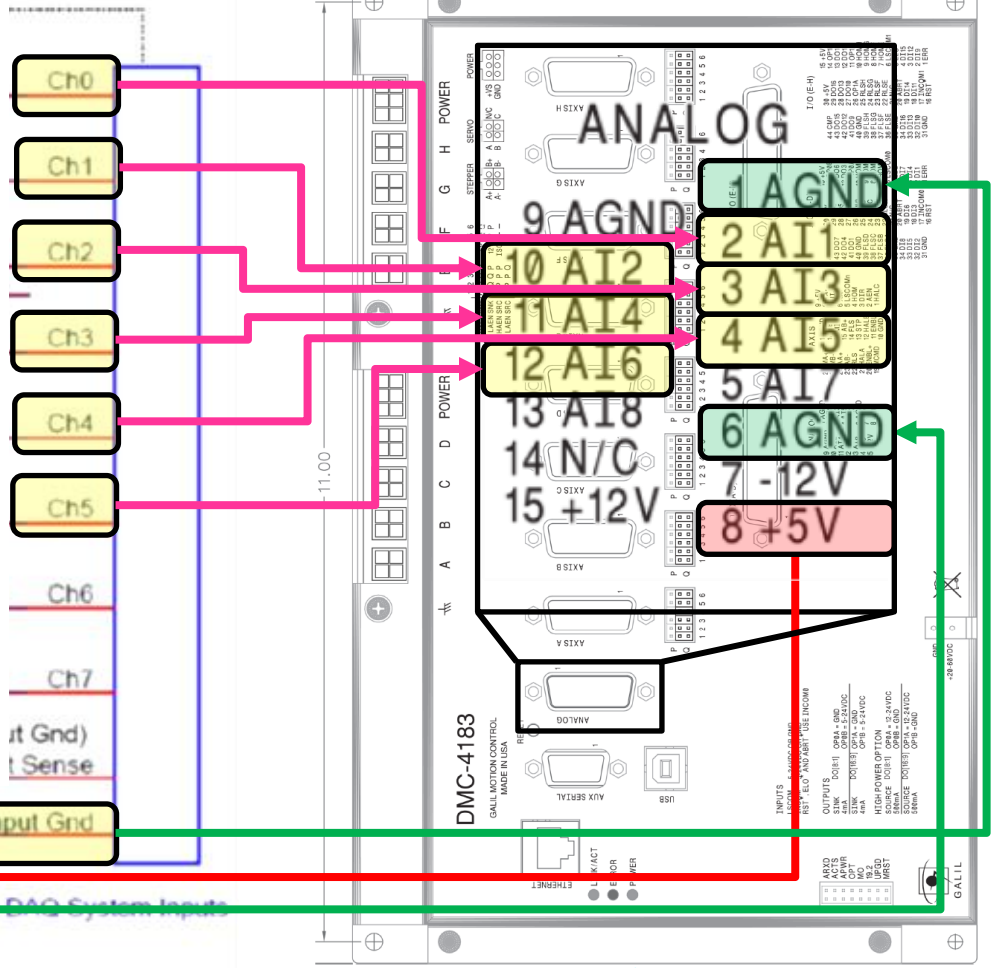
GND

Ensures optisolation

F/T Sensor connection diagram







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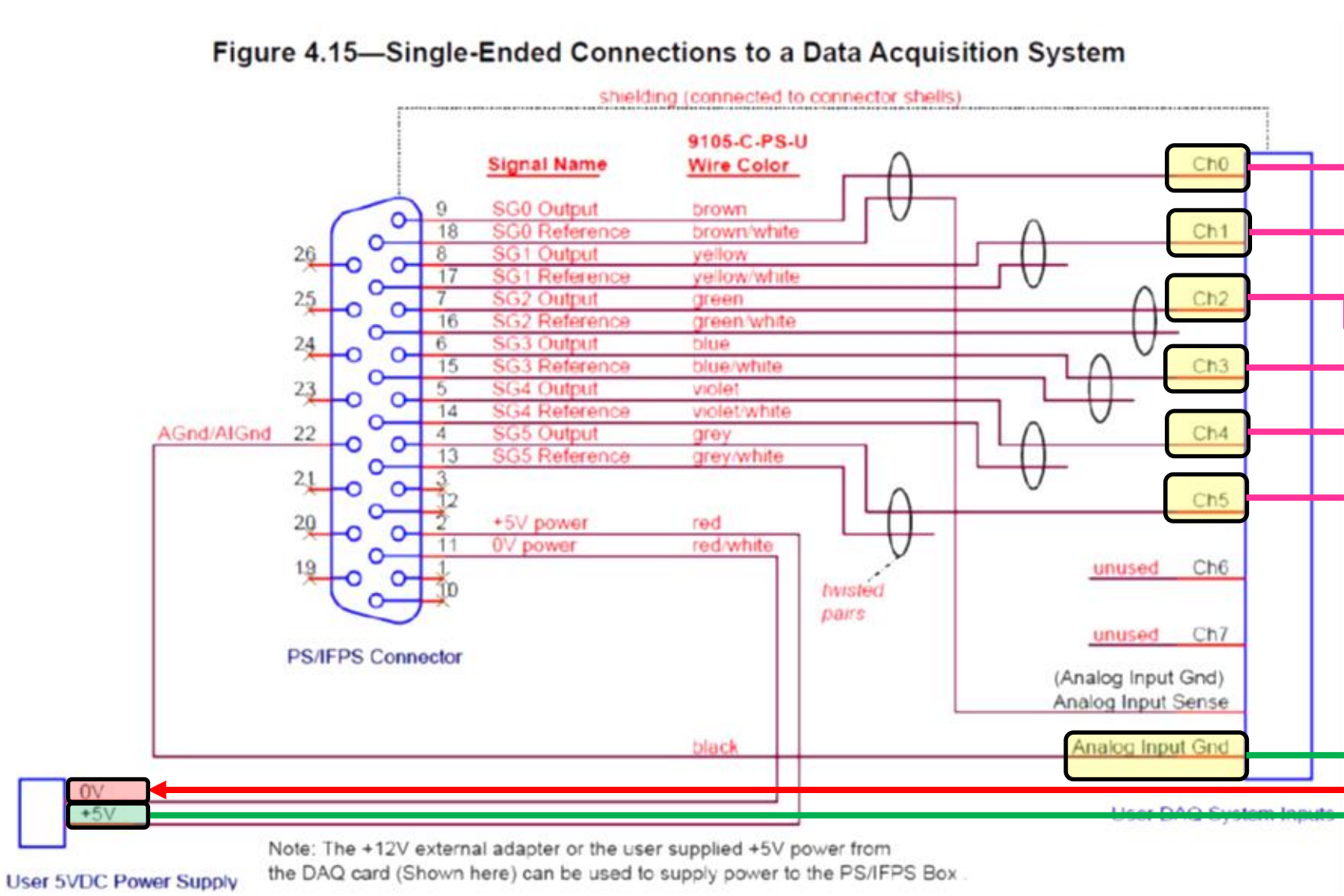
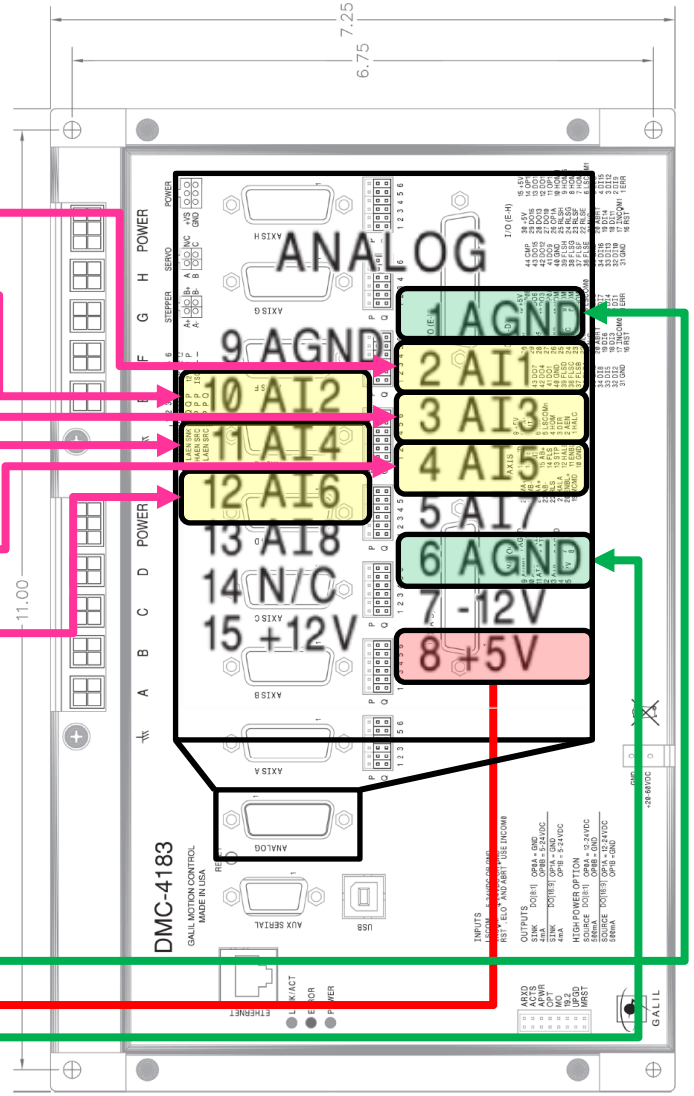
F/T Sensor connection diagram





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26 pin Axis connector

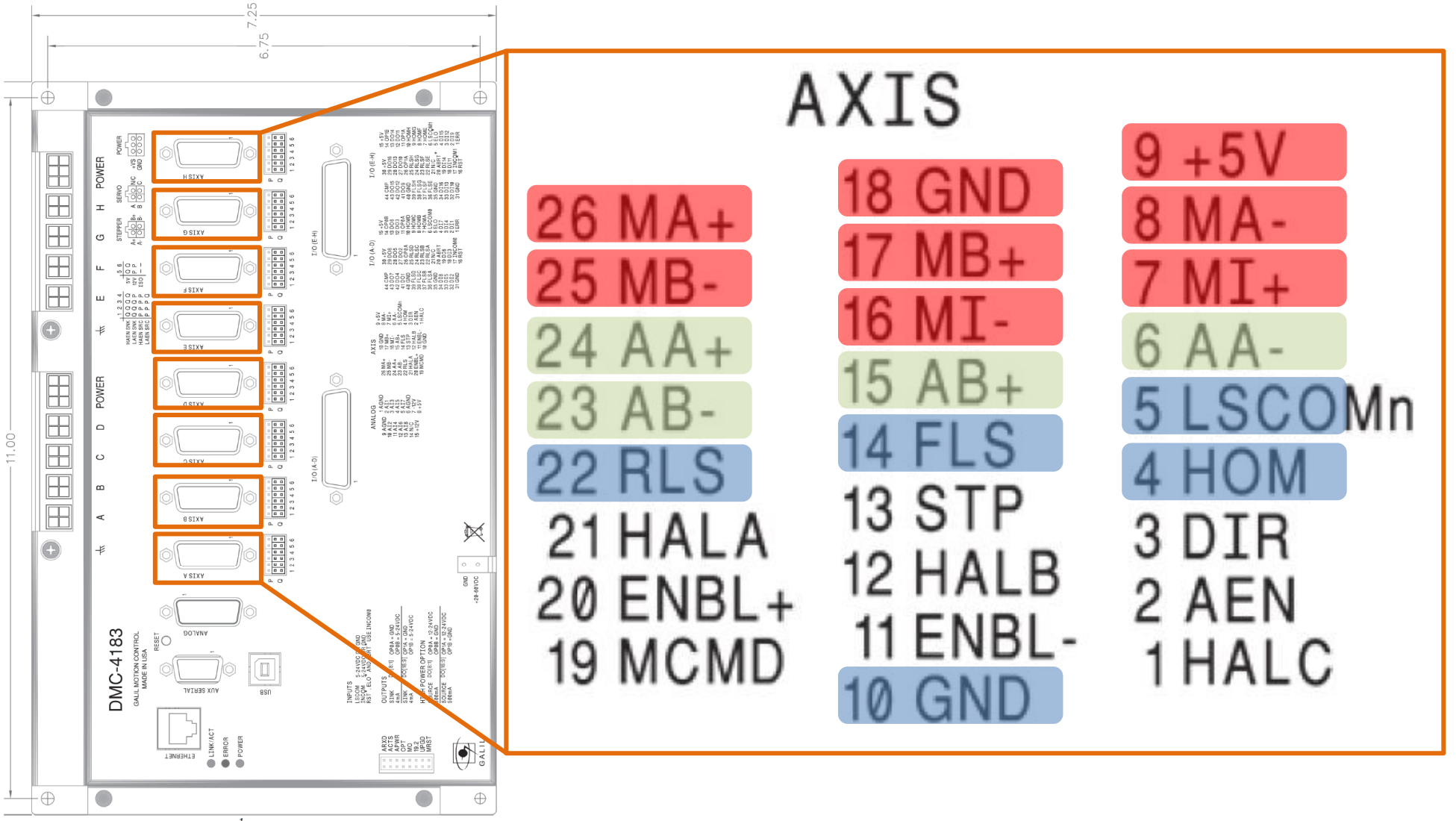


Figure 2.4: DMC-41x3-BOX4 Dimensions[1] (in inches) where x= 5, 6, 7, and 8-axis

Main Encoder - Incremental | Limit switches | Auxiliary Encoder (Incremental/Absolute)

SSI and BiSS interface pin configuration

SER – BiSS and SSI Absolute Encoder Interface

The DMC-41x3 controller can be configured to support BiSS and SSI encoders. See the SS and SI commands in the DMC-41x3 Command Reference (http://galil.com/download/comref/com41x3/index.html). Pin-out information is shown below:

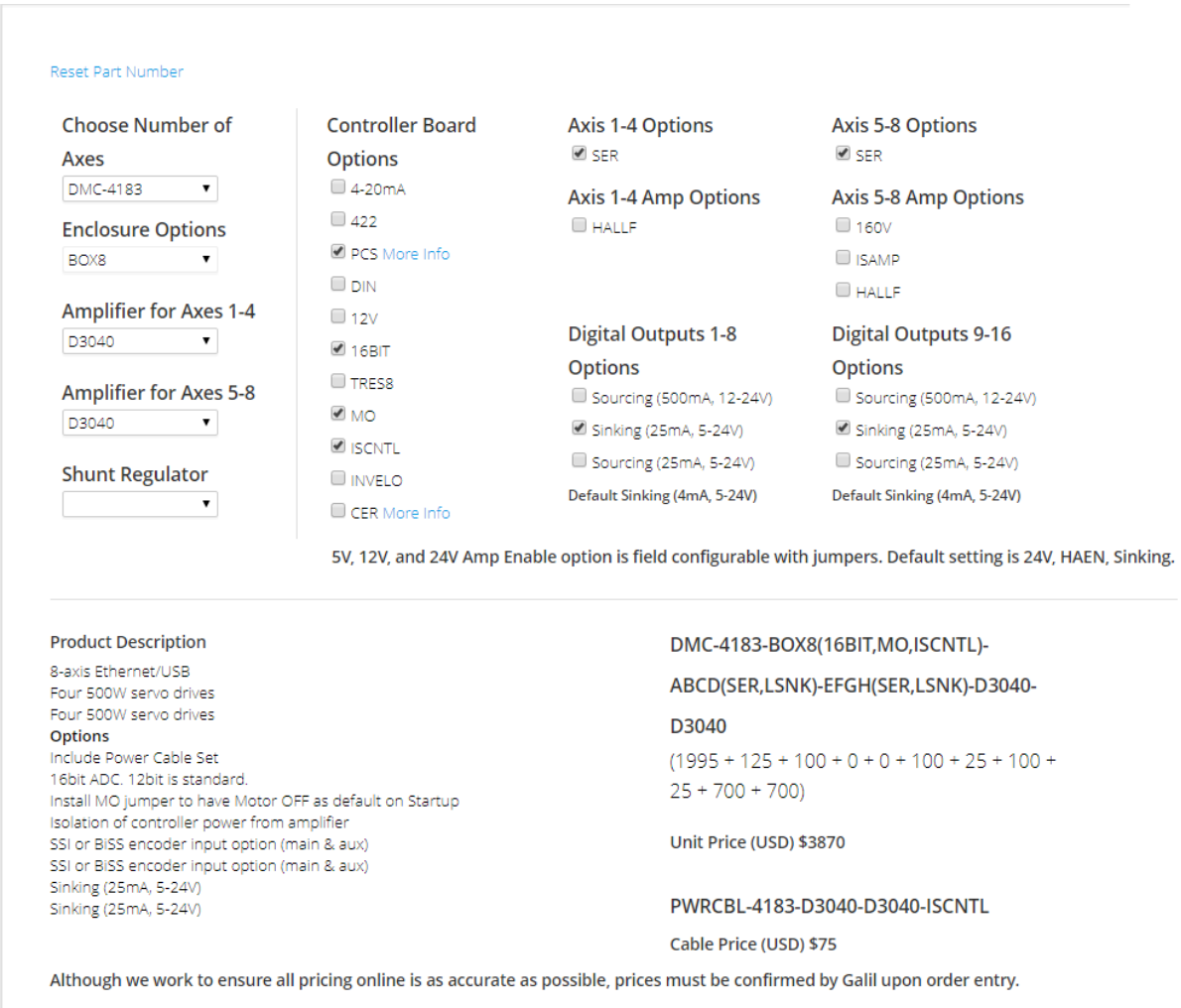
Jn1 - Encoder 26 pin HD D-Sub Connector (SER option)

Pin #	Label	Description	Pin #	Label	Description
1	HALC	Hall C	14	FLS	Forward Limit Switch Input
2	AEN	Amplifier Enable	15	AB+	Data + (Dn+ or SLO+)
3	DIR	Direction	16	MI-	I- Index Pulse Input
4	HOM	Home	17	MB+	B+ Main Encoder Input
5	LSCOMn	Limit Switch Common [2]	**18**	**GND**	**Digital Ground** [1]
6	AA-	Clock - (Cn- or MA-)	19	MCMD	Motor Command
7	MI+	I+ Index Pulse Input	20	ENBL+	Amp Enable Power
8	MA-	A- Main Encoder Input	21	HALA	Hall A
9	+5V	+5V	22	RLS	Reverse Limit Switch Input
10	**GND**	**Digital Ground** [1]	23	AB-	Data - (Dn- or SLO-)
11	ENBL-	Amp Enable Return	24	AA+	Clock + (Cn+ or MA+)
12	HALB	Hall B	25	MB-	B- Main Encoder Input
13	STP	PWM/Step	26	MA+	A+ Main Encoder Input

[1] Only one ground pin must be connected to the encoders digital ground signal.

[2] LSCOMn on JA1, JB1, JC1 and JD1 is common to LSCOM0 on J5
LSCOMn on JE1, JF1, JG1 and JH1 is common to LSCOM1 on J8

Galil 4183 part number generator



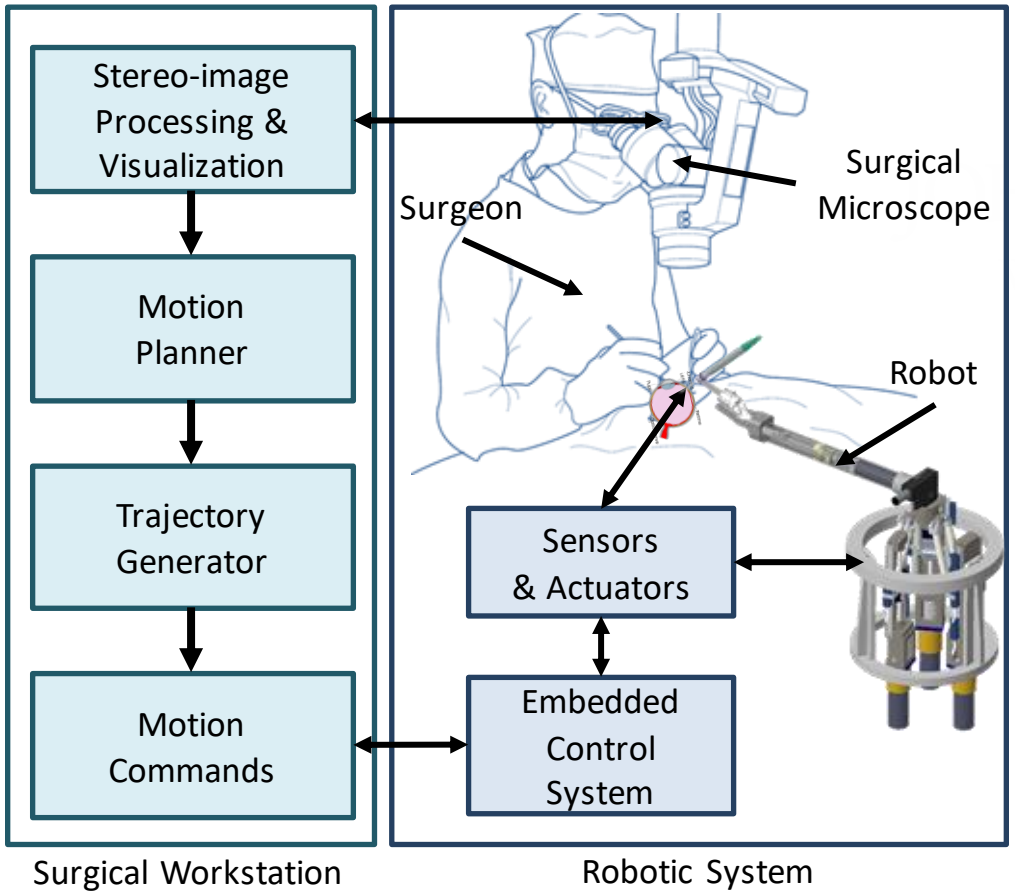
Product Description
8-axis Ethernet/USB
Four 500W servo drives
Four 500W servo drives
Options
Include Power Cable Set
16bit ADC. 12bit is standard.
Install MO jumper to have Motor OFF as default on Startup
Isolation of controller power from amplifier
SSI or BiSS encoder input option (main & aux)
SSI or BiSS encoder input option (main & aux)
Sinking (25mA, 5-24V)
Sinking (25mA, 5-24V)
DMC-4183-BOX8(16BIT,MO,ISCNTL)-ABCD(SER,LSNK)-EFGH(SER,LSNK)-D3040-D3040
(1995 + 125 + 100 + 0 + 0 + 100 + 25 + 100 + 25 + 700 + 700)
Unit Price (USD) $3870

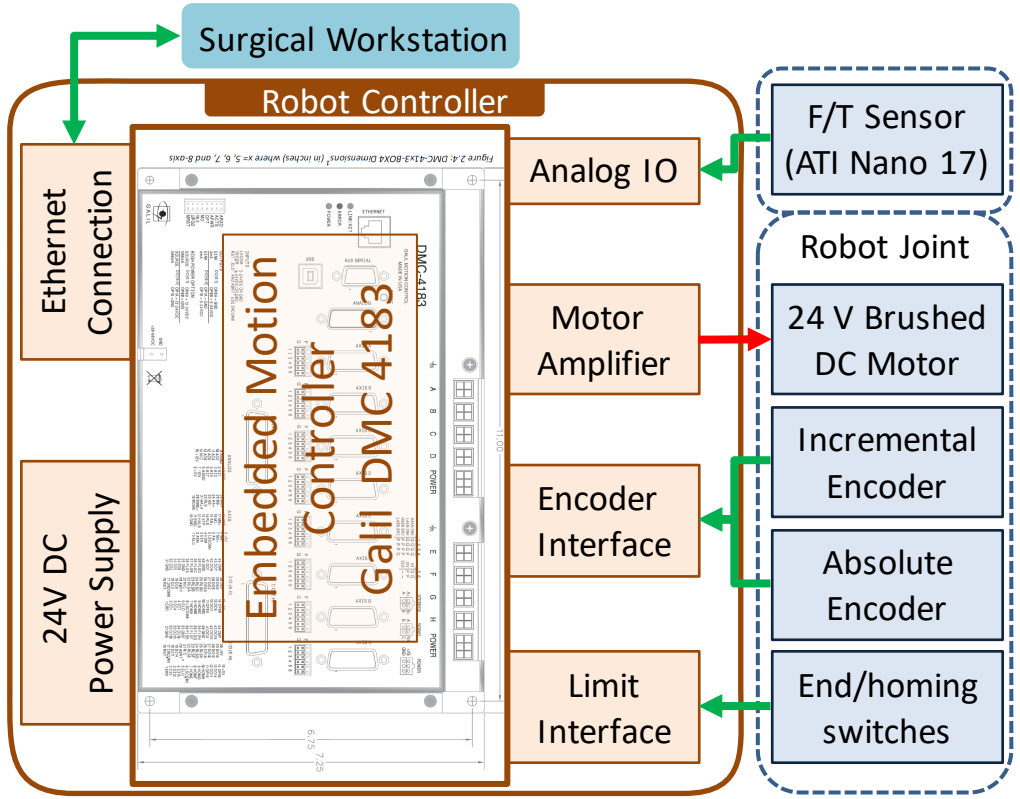
PWRCBL-4183-D3040-D3040-ISCNTL
Cable Price (USD) $75

Cable specifications

- Low voltage/current signals: **839-30-01126-30-ND**
  - Incremental encoder: 5 if single ended or 8 if differential?
    - A, B, I, VCC, GND
  - Absolute encoder: 4 conductors BiSS
    - CLK+, CLK-, DATA+, DATA-
  - Limit switches: 3 conductors per each but would be sharing VCC and GND so get 5 conductor cable and then split it near the limit switches OR carry 3 conductor cable to each limit switch?
    - Each limit switch require 3 conductors: VCC, GND, SIG
  - Specifications: 26/28/30 gauge?
- 2 conductors for motor
  - 22 gauge?

ER3.0 Block Diagrams





Software Specifications

Robot specific software components

- Controller IP address
  - Using IA and BN command burn a fixed IP address on the Galil
    - IA **192,168,1,xxx**;
    - BN
  - Do ARP for a fixed IP address on the router using Galil MAC address
    - You would have to look at the router manual OR internet is always there to help
- Galil configuration file
  - Encoder, Motor, Limit configuration
  - Dynamic parameters: velocity, inertia etc
- ATI F/T sensor calibration file
- Robot model
  - eye_robot/EyeRobot2/code:**RobotModel.cpp/RobotModel.h**

eye_robot/EyeRobot2/code/robotTask.cpp

```
void robotTask::Configure(const std::string &robotVersion)
{
    std::cerr << "Before Galil init " << Galil::libraryVersion() << std::endl;
    std::string galilIP = "";

    if( ROBOT_VERSION == "2.0"){
        galilIP = "192.168.1.101";
    }else{
        galilIP = "192.168.1.100";
    }
    if (Galil.Init(galilIP, robotVersion)) {
        CMN_LOG_CLASS_INIT_VERBOSE << "Configure: connected to Galil controller" << std::endl;
    } else {
        CMN_LOG_CLASS_INIT_ERROR << "Configure: failed to connect to galil controller" << std::endl;
        std::cin.get();
    }

    osaSleep(0.5);
}
```

eye_robot/ GalilController/code/devGalilController1886.cpp

```
bool devGalilController1886::Init(const std::string &deviceName, const std::string &robotVersion)
{
-----------------------------------------------------
//depending upon the robot version load an appropriate config file
        if (robotVersion == "2.1")
        {
           std::cout << "Loading Galil Program file from ~/catkin_ws/src/eye_robot/EyeRobot2/eyeRobot2ConfigMacro.dmc";
           galil->programDownloadFile("/home/eyebrp/catkin_ws/src/eye_robot/EyeRobot2/eyeRobot2ConfigMacro.dmc"); //this is in the source directory
        }
        else if(robotVersion == "2.0")
        {
           std::cout << "Loading Galil Program file from ~/catkin_ws/src/eye_robot/EyeRobot2/eyeRobot2-6dofConfig_05022018.dmc";
           galil->programDownloadFile("/home/eye/catkin_ws/src/eye_robot/EyeRobot2/eyeRobot2-6dofConfig_05022018.dmc"); //this is in the source
directory
        }
        //the interrupt program is linked to input 1 by the setup program
-------------------------------------------------------------
}
```

- This file contains the most important information about the robot configuration, you have to come up with correct values for each command in this file
- **Configure Encoder (CE) and Motor Type (MT)** are the most important commands as having them wrong will make the motor **runaway** and could cause damage to the robot
- Similarly the **limit switch** configuration is important
- Also start with **smaller values for acceleration, velocity etc** so that during tests none of the motors run at higher speed

eye_robot/Example/main.cpp

```
if( ROBOT_VERSION == "2.1" )
  {
    ATIFTTask->Configure("/home/eyebrp/catkin_ws/src/eye_robot/FTSensorATI/calibrations/FT11560.cal");  //FT11560 --2.1
    std::cout << " I AM 2.1" << std::endl;
  }
  else if( ROBOT_VERSION == "2.0" )
  {
    ATIFTTask->Configure("/home/eye/catkin_ws/src/eye_robot/FTSensorATI/calibrations/FT24829.cal");  //FT24829 --2.0
    std::cout << " I AM 2.0" << std::endl;
  }
  else {
    CMN_LOG_RUN_ERROR<<"No matched robot version "<<ROBOT_VERSION<<std::endl;
  }
```

- We have got this **.cal** file for the new F/T sensor from ATI
- Always check the **sensor part number FT***** and make sure you are using corresponding **.cal** file here.

Thank You!

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http://amiro.lcsr.jhu.edu

https://www.patelnirav.com