Published on *LabJack* (https://labjack.com)

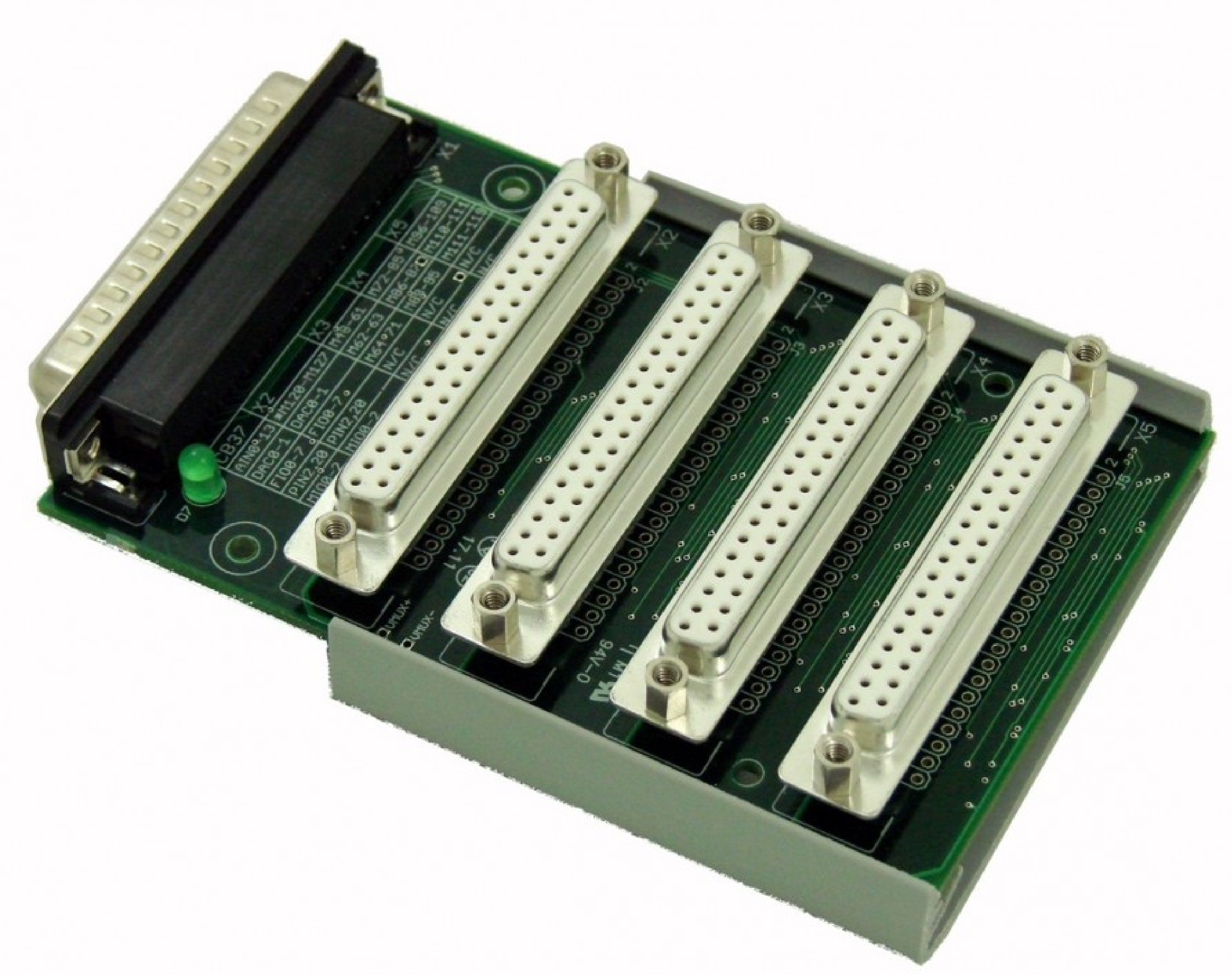
Mux80 AIN Expansion Board Datasheet

Log in or register to post comments

Mux80 AIN Expansion Board

Stock: In Stock

Price: $169.00



Click here to order!

Mux80 Overview

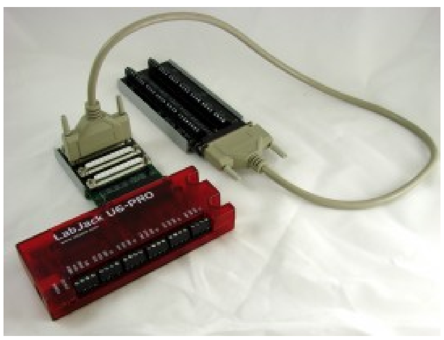
The Mux80 AIN Expansion Board serves to provide an additional 80 analog inputs to any compatible LabJack. It uses 10 multiplexer chips connected to AIN4-AIN13 and splits each channel into 8 additional channels. When a specific extended analog input channel is read on a U6, UE9, or T7, the digital output MIO lines are automatically set and the correct analog channel is read. The Mux80 has a built-in DC-DC converter which provides the upper and lower rail voltages necessary for powering the multiplexer chips.

Three vertical DB37 connectors provide an easy interface to connect 24 AIN channels each. The remaining connector brings out unused connections (FIO, DAC, etc) from the LabJack, along with the last 8 AIN channels. There are a total of 84 available analog inputs when used in conjunction with a U6, UE9, or T7.

For screw-terminal access, connect a CB37 Terminal Board and reference the chart printed at the top of the Mux80 for connections.

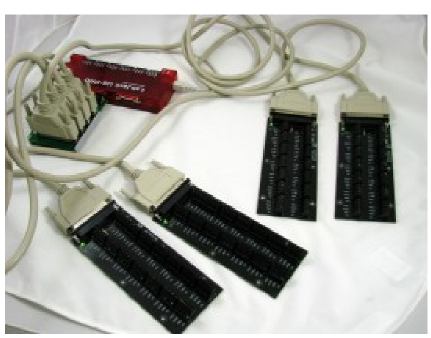
Features

- 80 Multiplexed Channels (or 40 Differential Pairs)
- Built-In DC-DC Converter
- OEM Capability
- Easy-To-Use High Density Connectors
- Snaptrack/DIN-rail compatible, with TE Connectivity P/N TKAD



Connection Options

The Mux80 can be connected several ways. The images below demonstrate use with theCB37 Terminal Board, and several 3ft DB37 Cables.



When connected to a CB37, there is a quick way to determine which screw terminals can be used as analog inputs;

reference the chart printed on the top of the Mux80, also shown below for reference.

Table 1. CB37 to MUX80 connection chart

CB37 Labels	X2	X3	X4	X5
AIN0-13	AIN0-3, AIN120-127	AIN48-61	AIN72-85	AIN96-109
DAC0-1	DAC0-1	AIN62-63	AIN86-87	AIN110-111
FIO0-7	FIO0-7	AIN64-71	AIN88-95	AIN112-119
PIN2,20	PIN2,20	N/C	N/C	N/C
MIO0-2	MIO0-2	N/C	N/C	N/C

The above table defines the pinouts of X2-X5 in terms of a CB37. If not using a CB37 see the CB37 Datasheet to translate the CB37 terminals to DB37 pin numbers.

Connector X2 is essentially a duplicate of the DB37 connector on the main device, except AIN4-AIN11 are instead AIN120-AIN127, and AIN12-AIN13 are not connected to anything. On connector X2, AIN0-AIN3 are duplicates of the main device, as well as FIO, DAC, etc.

AIN0-AIN3 are available on the built-in terminals of the T7 and also on AIN0-AIN3 of a CB37 connected to X2.

AIN120-AIN127 are available on X2, along with the DACs and DIO.

AIN48-AIN71 appear on the AIN0 through FIO7 terminals of a CB37 connected to X3. Note that terminals labeled DACx and FIOx on the CB37 are used as analog inputs.

AIN72-AIN95 appear on the AIN0 through FIO7 terminals of a CB37 connected to X4. Note that terminals labeled DACx and FIOx on the CB37 are used as analog inputs.

AIN96-AIN119 appear on the AIN0 through FIO7 terminals of a CB37 connected to X5. Note that terminals labeled DACx and FIOx on the CB37 are used as analog inputs.

Example: A signal is connected to FIO6 on a CB37. The CB37 is connected to X4 on the Mux80, so on the chart, under X4 and FIO0-7, locate AIN88-95. So the signal is connected to AIN94. To read AIN94 simply perform a standard AIN read for analog input number 94.

Using Differential Analog Inputs with the MUX80

Built-in

The built-in analog inputs AIN0 through AIN3 can be used normally when using the Mux80 (but AIN4 through AIN13 are not available). This allows:

- Positive channel = AIN0 paired with negative channel = AIN1
- Positive channel = AIN2 paired with negative channel = AIN3

See 14.0 AIN of the T-Series Datasheet for more details on built-in AIN.

Extended range

For extended channels, the positive channel can be any channel (even or odd) listed under the “P Channel” heading in the chart below. The negative channel number is the positive channel number plus 8 (listed under the “N Channel” heading in the chart below).

Example 1: The positive channel is connected to AIN102 (AIN6 on the CB37 connected to X5). The corresponding negative channel is AIN110 (DAC0 on the CB37 connected to X5).

Example 2: The positive channel is connected to AIN64 (FIO0 on the CB37 connected to X3). The corresponding negative channel is AIN72 (AIN0 on the CB37 connected to X4).

Note that for some differential pairs, the positive and negative are located on different connectors.

Table 2. Channel numbers for analog inputs based on block and connector

Differential Blocks	P Channel	N Channel	Connector
Block 1	AIN48-55	AIN56-63	X3
Block 2	AIN64-71	AIN72-79	X3 & X4
Block 3	AIN80-87	AIN88-95	X4
Block 4	AIN96-103	AIN104-111	X5
Block 5	AIN112-119	AIN120-127	X5 & X2

See 14.2 Extended Channels of the T-Series Datasheet for more details on extended ranges.

Specifications

Parameter	Conditions	Min	Typical	Max	Units
Typical Current Draw	No Active Readings	4.5	5.5	10	mA
V_{MUX+}		12.8	13.8	16	V
V_{MUX-}		-12.8	-13.8	-16	V
Crosstalk @ 100 Hz	DG408DVZ		-125		dB
	LabJack U6		-104		dB
	Mux80		-100		dB

Ground Offsets

A single-ended analog input measurement is the voltage difference between the analog input and ground at the A/D chip on the main device (e.g. U6 or T7). If the voltage provided by a given signal is different than the voltage at the A/D chip, that results in error.

Suppose, for example, a thermocouple is connected to AIN0 and the adjacent GND terminal on a CB37, that is connected to X3 on a Mux80 via a 3 foot cable, and that is connected to a T7. Suppose the remote end of thermocouple is at a temperature such that it is creating a voltage difference of 1600 µV between the AIN0 and GND terminals on the CB37. Typically, the voltage at the CB37-AIN0 terminal will be the same voltage presented to the A/D chip, but the voltage at the CB37-GND terminal might be 280 µV higher than ground at the A/D chip due to other currents flowing on ground. That means the A/D chip will see 1880 µV rather than 1600 µV, which is an error of roughly 7 degrees C.

Voltage drop on the AIN connection is not a concern as the only current on the AIN connection is the bias current. The typical AIN bias current of the U6 or T7 is 20 nA, so even if the path from terminal to A/D chip had a high resistance of 10 ohms that would only be 200 nV of error.

Voltage drop on the ground connection can sometimes be a concern and is called ground offset error. Just the normal power supply current of the Mux80 and CB37 can cause GND terminals on the CB37 to be 100s of microvolts higher than ground back at the A/D chip. Any current sunk to GND by user connections will increase this difference.

One solution is to use the AGND terminal on the CB37. AGND has its own dedicated path back to the main device, so as long as the user does not sink any current into AGND it will be at the same voltage as ground at the A/D chip.

To measure how much offset exists from a particular GND terminal to ground at the A/D chip, simply jumper the GND terminal in question to an unused AIN terminal and measure the single-ended voltage from that AIN channel.

Suggestions & Solutions:

A. Use differential analog inputs. Differential readings take the difference between 2 AIN lines and thus are not affected by ground offset. For example with a thermocouple, connect thermocouple+ to a positive channel (AIN48 for example) and connect thermocouple- to a negative channel (AIN56 for example). A resistor (100k would be typical e.g. CF14JT100K) from the negative channel to GND is also required, as the thermocouple cannot be totally floating (see the Differential Readings App Note). Now configure and read AIN48 as differential.

B. Use AGND for all passive sensors such as thermocouples. Make sure not to connect anything to AGND that will sink/source any substantial current to AGND or offset will be created from AGND versus A/D chip ground.

C. Use an extra AIN channel on the CB37 in question and jumper it to GND on the CB37 to measure the GND offset so it can be accounted for in software.

D. Get rid of or at least reduce GND offset by minimizing connections (minimizing resistance) between the signal terminals and A/D chip, avoiding sourcing/sinking current to GND on the CB37, and adding a big fat wire from CB37-GND to U6-GND or T7-GND.

E. Use a star ground, and have a single solid connection from that star ground toU6-GND or T7-GND. For example, connect the negative leads of all signals to an external grounding post or grounding bar, and run a big fat wire from there to a GND on the main LabJack.

Troubleshooting - U6 or UE9 Only

It is possible to check Mux80 functionality inLJControlPanel by performing the following steps:

1. Open LJControlPanel
2. Select UD device and click `Test`
3. On test pane, locate `MIO 00` , `MIO 01` , `MIO 02` checkboxes for both `Digital Direction` and `Digital State`
4. Check the boxes for all 3 MIO lines under `Digital Direction`
5. Check desired boxes under `Digital State` according to the following table. Find the extended channel number to investigate, then trace across the row to the Digital State of MIO0, MIO1, and MIO2. Set the output state to high (checked) for 1 and low (un-checked) for 0.
6. Trace the column up to AIN#, this is the analog input that your analog signal will appear on.

Table 3. Channel selection based on mux input

Output State				**Expected Channel in LJControlPanel**									
MIO0	MIO1	MIO2		AIN4	AIN5	AIN6	AIN7	AIN8	AIN9	AIN10	AIN11	AIN12	AIN13
0	0	0		48	56	64	72	80	88	96	104	112	120
1	0	0		49	57	65	73	81	89	97	105	113	121
0	1	0		50	58	66	74	82	90	98	106	114	122
1	1	0		51	59	67	75	83	91	99	107	115	123
0	0	1		52	60	68	76	84	92	100	108	116	124
1	0	1		53	61	69	77	85	93	101	109	117	125
0	1	1		54	62	70	78	86	94	102	110	118	126
1	1	1		55	63	71	79	87	95	103	111	119	127

For example: I have connected an analog signal to AIN65. If I am using a CB37 Terminal Board, this will mean that the CB37 is connected to X3 on the Mux80, and the signal is wired to FIO1 on the CB37. Looking at the above chart I note that

65 shares a row with MIO Output States of 1,0,0. I then set MIO0 checked, MIO1 unchecked, and MIO2 unchecked. Next I follow the column for 65 up to AIN6, so that is the analog input where I will see my analog signal with this MIO configuration.

If there seem to be problems with incorrect readings, also check that V_{MUX+} and V_{MUX-} are within specified limits by measuring the test points with respect to GND. The Mux80 does not use VM+/VM- from the main device at all, but rather has its own power supply circuit to convert 5V (VS) to ±13V (V_{MUX+} and V_{MUX-}) for the mux chips. Note that with a CB37 connected to any of X2-X5, the screw terminals labeled VM+/VM- are actually connected to V_{MUX+} and V_{MUX-}, so this is a another way to measure besides the test points on the PCB.

Notes:

- Ensure your device has the latest firmware. There is a known U6 firmware issue concerning MIO lines in v1.26 and older. See revision history for more info. U6 firmware v1.40 and newer is able to stream differential channel pairs with the Mux80.
- On the U6 and U6-Pro, the digital lines CIO0-2 and MIO0-2 are shared. This means that changing the state of MIO0-2 will also change the state of CIO0-2. Therefore, anyone using a Mux80 with a U6 needs to be aware that digital lines CIO0-2 are not usable.

Appendix A - OEM Pinout Info

Log in or register to post comments

OEM Pin-out Info

J1-J5 are OEM pin-header locations, and appear immediately next to the DB37 connectors. A 40 pin (2x20) 0.1" spacing header fits the location. OEM pin-header designators are shown in red.

X1 is the Male DB37 connector which interfaces with the LabJack.

X2-X5 provide access to the 80 Mux channels, along with the FIO, DAC, VM+, VM-, and MIO lines. Please reference the spreadsheets below for exact pin locations for each J connector and X connector.

Table A1.1 OEM Pin-out for J type connector (2x20 Header .1 in) J1

1	GND		2	GND		3	PIN20 (10µA)
4	PIN2 (200µA)		5	FIO7		6	FIO6
7	FIO5		8	FIO4		9	FIO3
10	FIO2		11	FIO1		12	FIO0
13	MIO0/CIO0		14	MIO1/CIO1		15	MIO2/CIO2
16	GND		17	Vs		18	Vm-
19	Vm+		20	GND		21	DAC1
22	DAC0		23	AGND		24	AIN13
25	AIN12		26	AIN11		27	AIN10
28	AIN9		29	AIN8		30	AIN7
31	AIN6		32	AIN5		33	AIN4
34	AIN3		35	AIN2		36	AIN1
37	AIN0		38	GND		39	GND
40	GND						

Table A1.2 OEM Pin-out for J type connector (2x20 Header .1 in) J2

1	GND		2	GND		3	PIN20 (10µA)
4	PIN2 (200µA)		5	FIO7		6	FIO6
7	FIO5		8	FIO4		9	FIO3
10	FIO2		11	FIO1		12	FIO0
13	MIO0/CIO0		14	MIO1/CIO1		15	MIO2/CIO2
16	GND		17	Vs		18	Vmux-
19	Vmux+		20	GND		21	DAC1
22	DAC0		23	AGND		24	N/C
25	N/C		26	AIN127		27	AIN126
28	AIN125		29	AIN124		30	AIN123
31	AIN122		32	AIN121		33	AIN120
34	AIN3		35	AIN2		36	AIN1
37	AIN0		38	GND		39	GND
40	GND						

Table A1.3 OEM Pin-out for J type connector (2x20 Header .1 in) J3

1	GND		2	GND		3	N/C
4	N/C		5	AIN71		6	AIN70
7	AIN69		8	AIN68		9	AIN67
10	AIN66		11	AIN65		12	AIN64
13	N/C		14	N/C		15	N/C
16	GND		17	Vs		18	Vmux-
19	Vmux+		20	GND		21	AIN63
22	AIN62		23	AGND		24	AIN61
25	AIN60		26	AIN59		27	AIN58
28	AIN57		29	AIN56		30	AIN55
31	AIN54		32	AIN53		33	AIN52
34	AIN51		35	AIN50		36	AIN49
37	AIN48		38	GND		39	GND
40	GND						

Table A1.4 OEM Pin-out for J type connector (2x20 Header .1 in) J4

1	GND		2	GND		3	N/C
4	N/C		5	AIN95		6	AIN94
7	AIN93		8	AIN92		9	AIN91
10	AIN90		11	AIN89		12	AIN88
13	N/C		14	N/C		15	N/C
16	GND		17	Vs		18	Vmux-
19	Vmux+		20	GND		21	AIN87
22	AIN86		23	AGND		24	AIN85
25	AIN84		26	AIN83		27	AIN82
28	AIN81		29	AIN80		30	AIN79
31	AIN78		32	AIN77		33	AIN76
34	AIN75		35	AIN74		36	AIN73
37	AIN72		38	GND		39	GND
40	GND						

Table A1.5 OEM Pin-out for J type connector (2x20 Header .1 in) J5

1	GND		2	GND		3	N/C
4	N/C		5	AIN119		6	AIN118
7	AIN117		8	AIN116		9	AIN115
10	AIN114		11	AIN113		12	AIN112
13	N/C		14	N/C		15	N/C
16	GND		17	Vs		18	Vmux-
19	Vmux+		20	GND		21	AIN111
22	AIN110		23	AGND		24	AIN109
25	AIN108		26	AIN107		27	AIN106
28	AIN105		29	AIN104		30	AIN103
31	AIN102		32	AIN101		33	AIN100
34	AIN99		35	AIN98		36	AIN97
37	AIN96		38	GND		39	GND
40	GND						

Table A2.1 OEM Pin-out for X type connectors (Dsub 37 Female) X1

1	GND		14	AIN9		27	Vs
2	PIN2 (200µA)		15	AIN7		28	Vm+
3	FIO6		16	AIN5		29	DAC1
4	FIO4		17	AIN3		30	AGND
5	FIO2		18	AIN1		31	AIN12
6	FIO0		19	GND		32	AIN10
7	MIO1/CIO1		20	PIN20 (10µA)		33	AIN8
8	GND		21	FIO7		34	AIN6
9	Vm-		22	FIO5		35	AIN4
10	GND		23	FIO3		36	AIN2
11	DAC0		24	FIO1		37	AIN0
12	AIN13		25	MIO0/CIO0			
13	AIN1		26	MIO2/CIO2			

Table A2.2 OEM Pin-out for X type connectors (Dsub 37 Female) X2 (Same as CB37)

1	GND		14	AIN125		27	Vs
2	PIN2 (200µA)		15	AIN123		28	Vmux+
3	FIO6		16	AIN121		29	DAC1
4	FIO4		17	AIN3		30	AGND
5	FIO2		18	AIN1		31	N/C
6	FIO0		19	GND		32	AIN126
7	MIO1/CIO1		20	PIN20 (10µA)		33	AIN124
8	GND		21	FIO7		34	AIN122
9	Vm-		22	FIO5		35	AIN120
10	GND		23	FIO3		36	AIN2
11	DAC0		24	FIO1		37	AIN0
12	N/C		25	MIO0/CIO0			
13	AIN127		26	MIO2/CIO2			

Table A2.3 OEM Pin-out for X type connectors (Dsub 37 Female) X3

1	GND		14	AIN57		27	Vs
2	N/C		15	AIN55		28	Vm+
3	AIN70		16	AIN53		29	AIN63
4	AIN68		17	AIN51		30	AGND
5	AIN66		18	AIN49		31	AIN60
6	AIN64		19	GND		32	AIN58
7	N/C		20	N/C		33	AIN56
8	GND		21	AIN71		34	AIN54
9	Vmux-		22	AIN69		35	AIN52
10	GND		23	AIN67		36	AIN50
11	AIN62		24	AIN65		37	AIN48
12	AIN61		25	N/C			
13	AIN59		26	N/C			

Table A2.4 OEM Pin-out for X type connectors (Dsub 37 Female) X4

1	GND		14	AIN81		27	Vs
2	N/C		15	AIN79		28	Vmux+
3	AIN94		16	AIN77		29	AIN87
4	AIN92		17	AIN75		30	AGND
5	AIN90		18	AIN73		31	AIN84
6	AIN88		19	GND		32	AIN82
7	N/C		20	N/C		33	AIN80
8	GND		21	AIN95		34	AIN78
9	Vmux-		22	AIN93		35	AIN76
10	GND		23	AIN91		36	AIN74
11	AIN86		24	AIN89		37	AIN72
12	AIN85		25	N/C			
13	AIN83		26	N/C			

Table A2.5 OEM Pin-out for X type connectors (Dsub 37 Female) X5

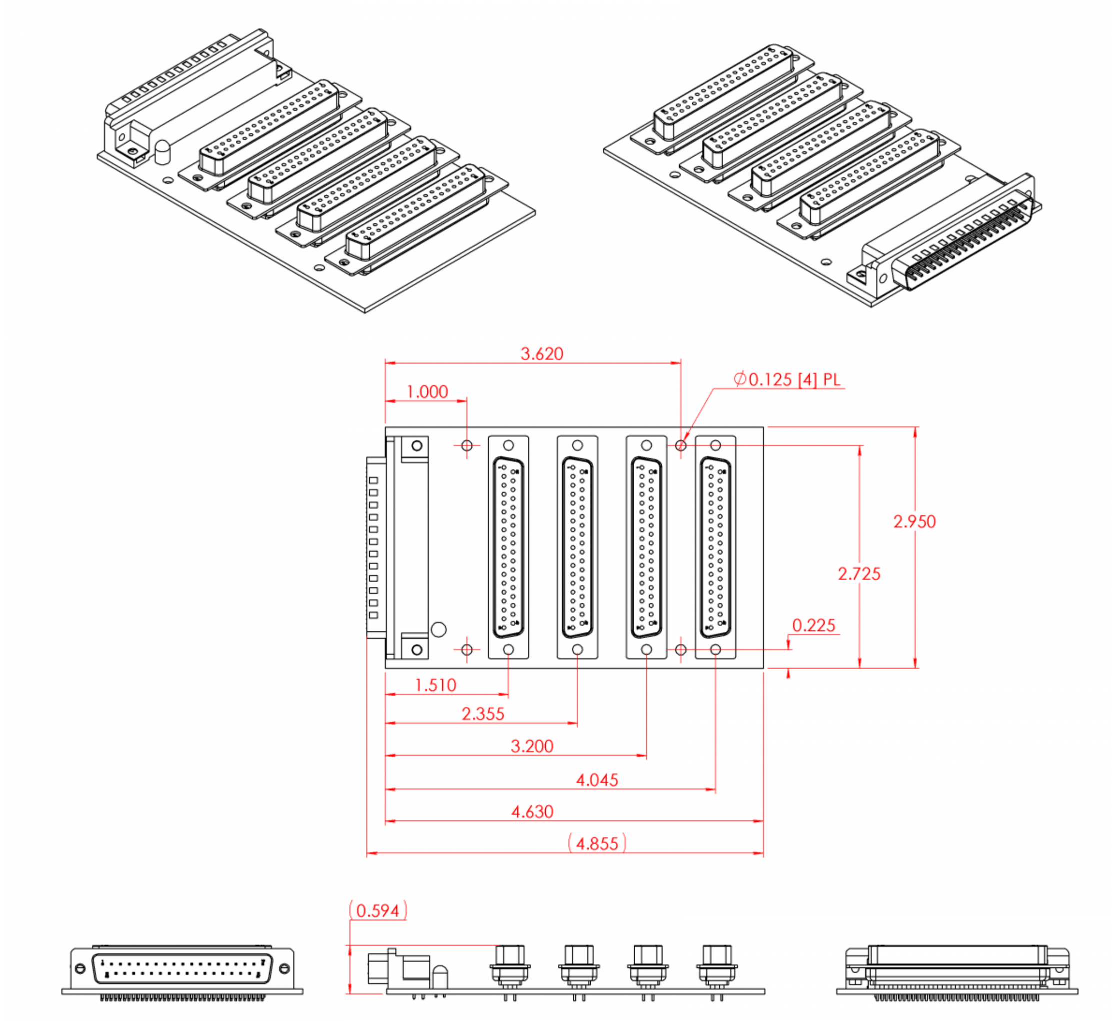
1	GND		14	AIN105		27	Vs
2	N/C		15	AIN103		28	Vmux+
3	AIN118		16	AIN101		29	AIn111

4	AIN116		17	AIN99		30	AGND
5	AIN114		18	AIN97		31	AIN108
6	AIN112		19	GND		32	AIN106
7	N/C		20	N/C		33	AIN104
8	GND		21	AIN119		34	AIN102
9	Vmux-		22	AIN117		35	AIN100
10	GND		23	AIN115		36	AIN98
11	AIN110		24	AIN113		37	AIN96
12	AIN109		25	N/C			
13	AIN107		26	N/C			

Appendix B - Dimensions and CAD Models

Mux80

CAD drawings are attached to the bottom of this page. The free onlineAutodesk Viewer can be used to view these and make measurements among other things.

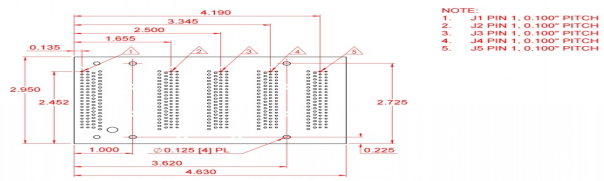


Notes:

1. Mux80 standard version depicted for clarity. See CAD files below for OEM versions.
2. 3" Snap-Track not shown.

Mux80-OEM

CAD drawings are attached to the bottom of this page. The free onlineAutodesk Viewer can be used to view these and make measurements among other things.



Common neutral format CAD models are provided below. Right-click and select the "Save link as..." option to download STEP files.

File Attachment:
- Mux80.DXF
- Mux80.IGS
- Mux80.STEP
- Mux80_OEM.DXF
- Mux80_OEM.IGS
- Mux80_OEM.STEP
- SnapTrack_3in.IGS
- SnapTrack_3in.STEP

Appendix C - AIN Registers

Log in or register to post comments

When using the Mux80 with a Modbus compatible device, such as the T7, use the following registers to read the extended analog inputs.

Mux80 AIN Registers

Name	Start Address	Type	Access
AIN#(48:127) Returns the voltage of the specified analog input.	96	FLOAT32	R
AIN#(48:127)_RANGE The range/span of each analog input. Write the highest expected input voltage.	40096	FLOAT32	R/W
AIN#(48:127)_NEGATIVE_CH Specifies the negative channel to be used for each positive channel. 199=Default=> Single-Ended.	41048	UINT16	R/W
AIN#(48:127)_RESOLUTION_INDEX The resolution index for command-response and AIN-EF readings. A larger resolution index generally results in lower noise and longer sample times.	41548	UINT16	R/W

Name	Start Address	Type	Access
AIN#(48:127)_SETTLING_US Settling time for command-response and AIN-EF readings.	42096	FLOAT32	R/W
AIN_ALL_RANGE A write to this global parameter affects all AIN. A read will return the correct setting if all channels are set the same, but otherwise will return -9999.	43900	FLOAT32	R/W
AIN_ALL_NEGATIVE_CH A write to this global parameter affects all AIN. Writing 1 will set all AINs to differential. Writing 199 will set all AINs to single-ended. A read will return 1 if all AINs are set to differential and 199 if all AINs are set to single-ended. If AIN configurations are not consistent 0xFFFF will be returned.	43902	UINT16	R/W
AIN_ALL_RESOLUTION_INDEX The resolution index for command-response and AIN-EF readings. A larger resolution index generally results in lower noise and longer sample times. A write to this global parameter affects all AIN. A read will return the correct setting if all channels are set the same, but otherwise will return 0xFFFF.	43903	UINT16	R/W
AIN_ALL_SETTLING_US Settling time for command-response and AIN-EF readings. A write to this global parameter affects all AIN. A read will return the correct setting if all channels are set the same, but otherwise will return -9999. Max is 50,000 us.	43904	FLOAT32	R/W

&print=true

For more information on multiplexing with the U6, see U6 Channel Numbers

For more information on multiplexing with the UE9, see UE9 Channel Numbers