SAE HVAC Vehicle Operation Guide

Version 3
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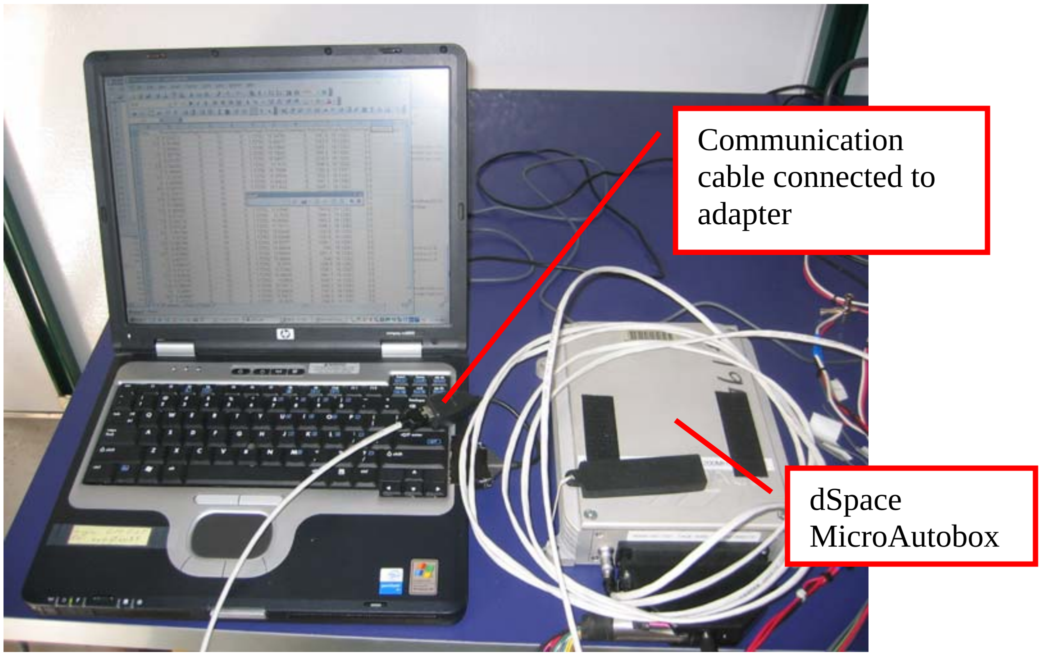
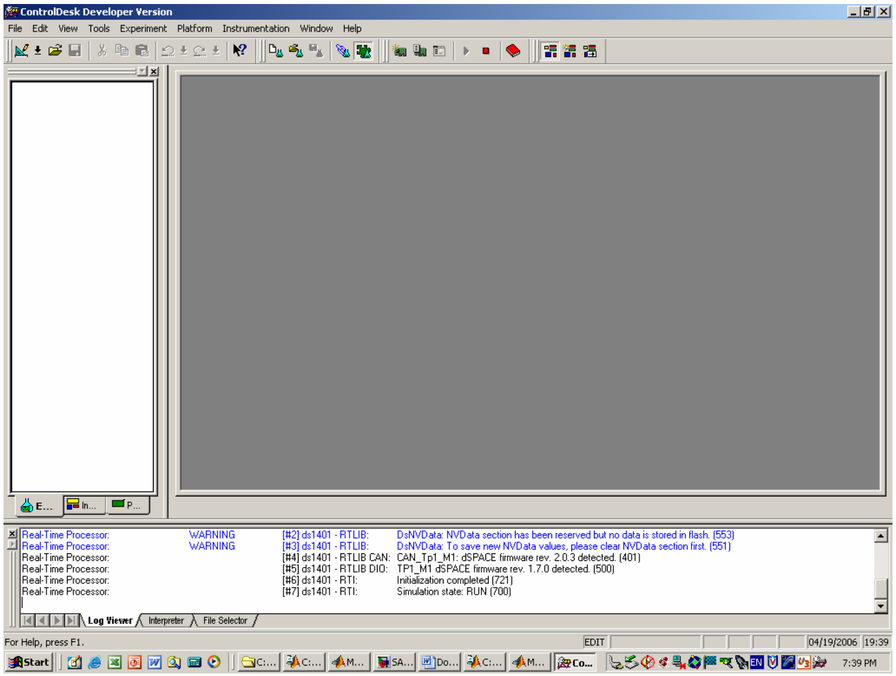
Topics

1. Loading and running dSpace ControlDesk

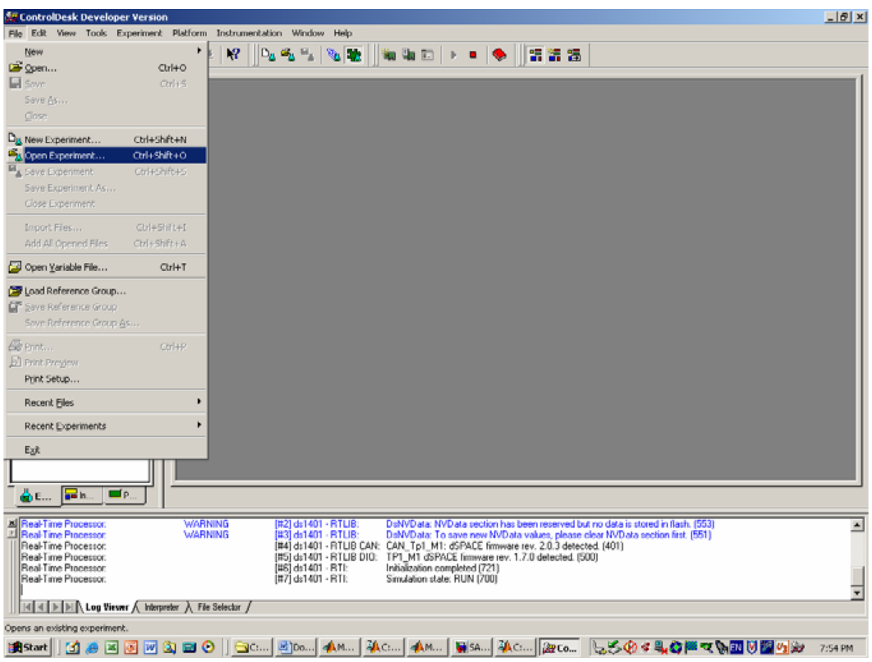
The car must be running and the communication cable must be connected between the dSpace MicroAutobox and the support PC.



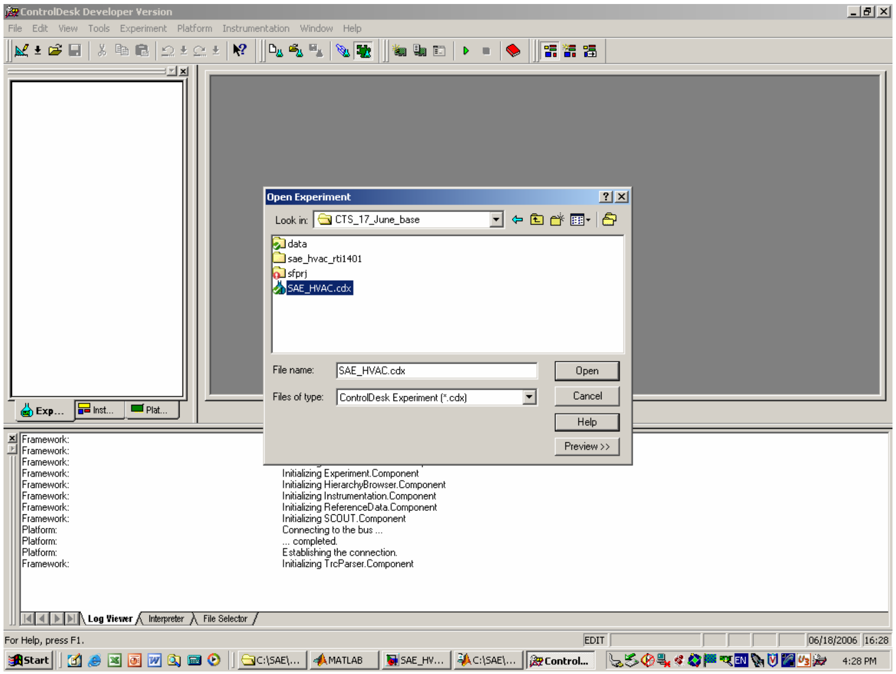
Watch for a successful start (see Log Viewer at the bottom of the page) with communication established between the PC and the dSpace MicroAutobox. The Log should end with "Simulation state: RUN". Try restating the program if startup fails.

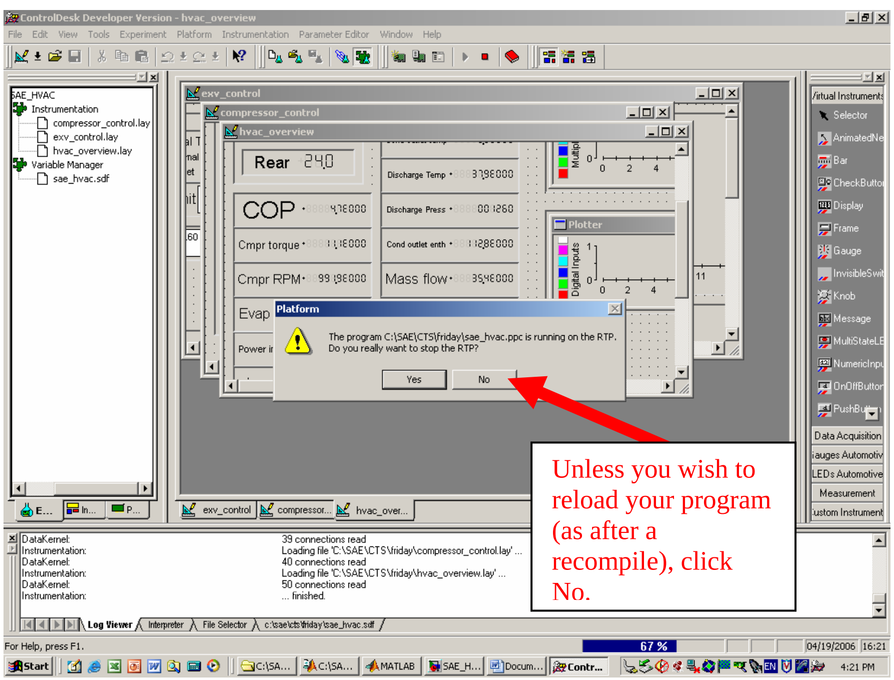


Next click on File, then Open Experiment



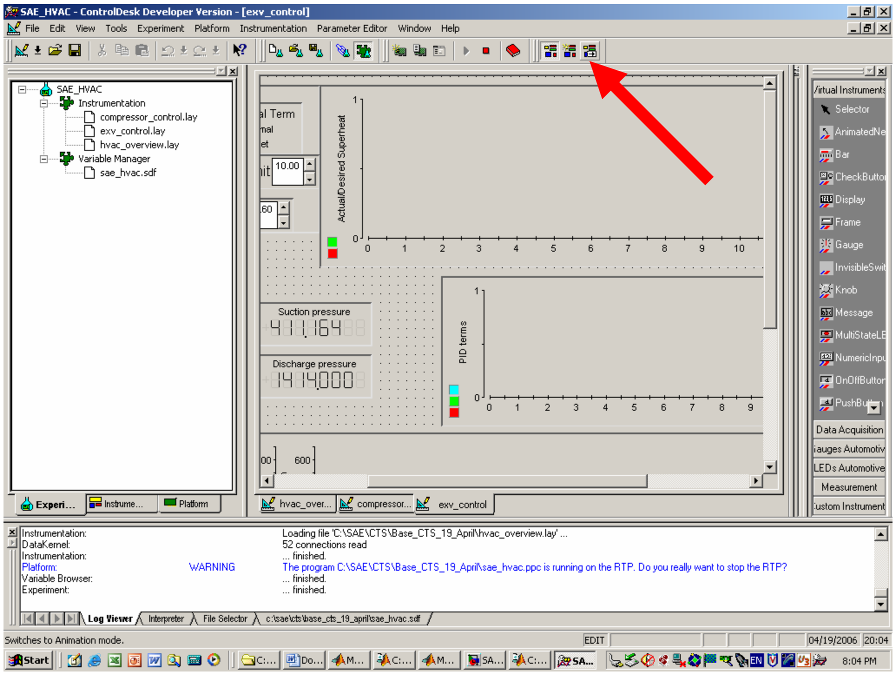
Select SAE_HVAC.cdx in the directory where your code has been compiled as shown below.



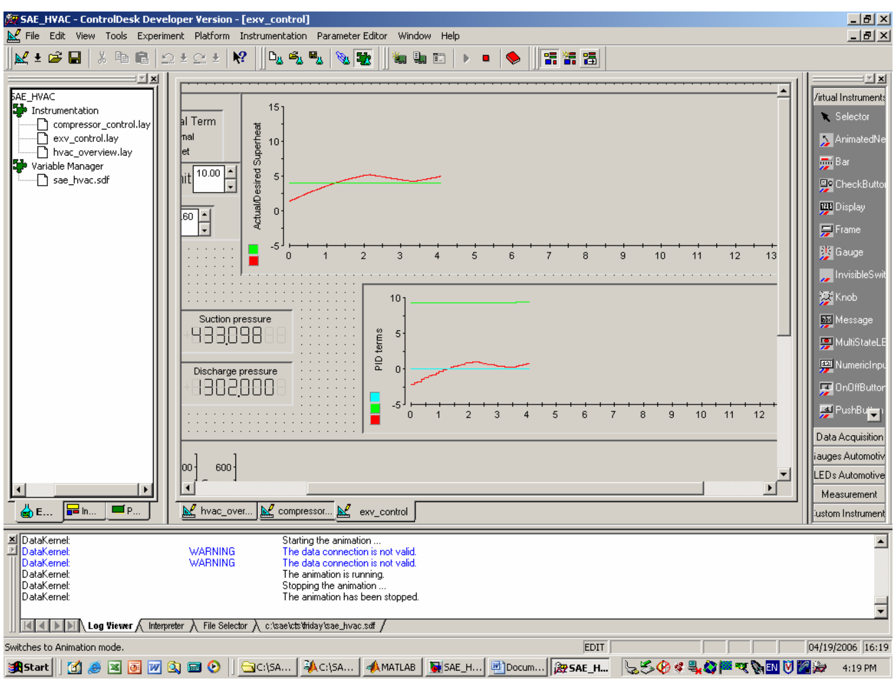


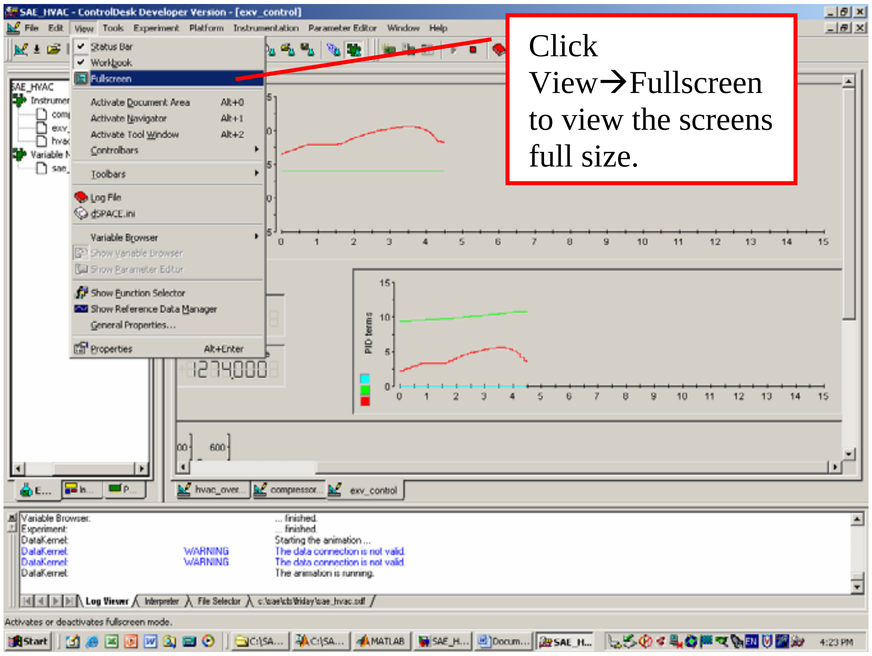
If you have recompiled and wish to reload, be certain the air conditioner is turned off and then click Yes. After a reload, be sure to rezero the EXV (see Topic 3).

The custom display screens are now visible, but data scanning is not started. The screens can be edited in this mode. Click on the icon indicated by the arrow to start updating the display screens.

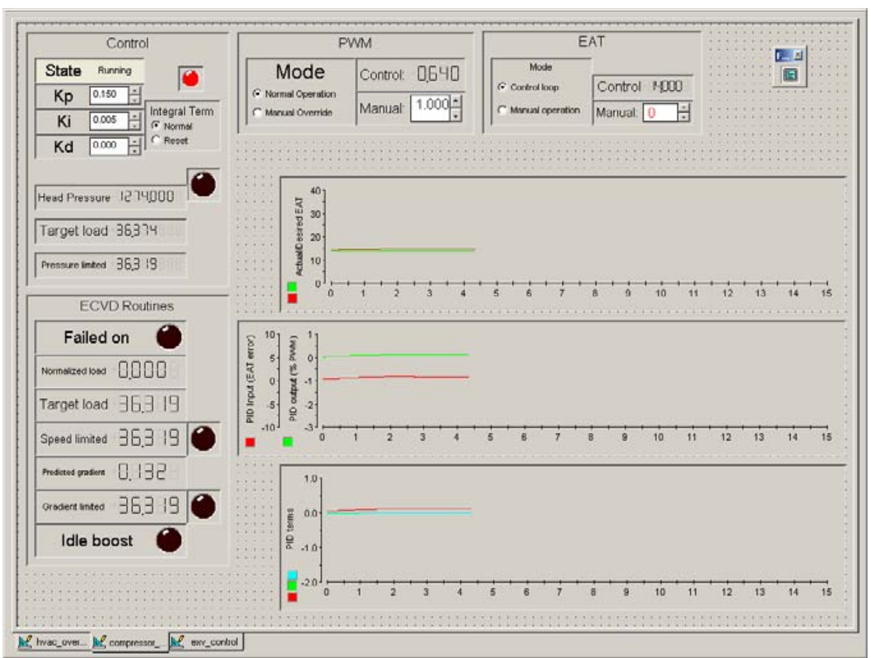


The updating EXV screen is shown below.



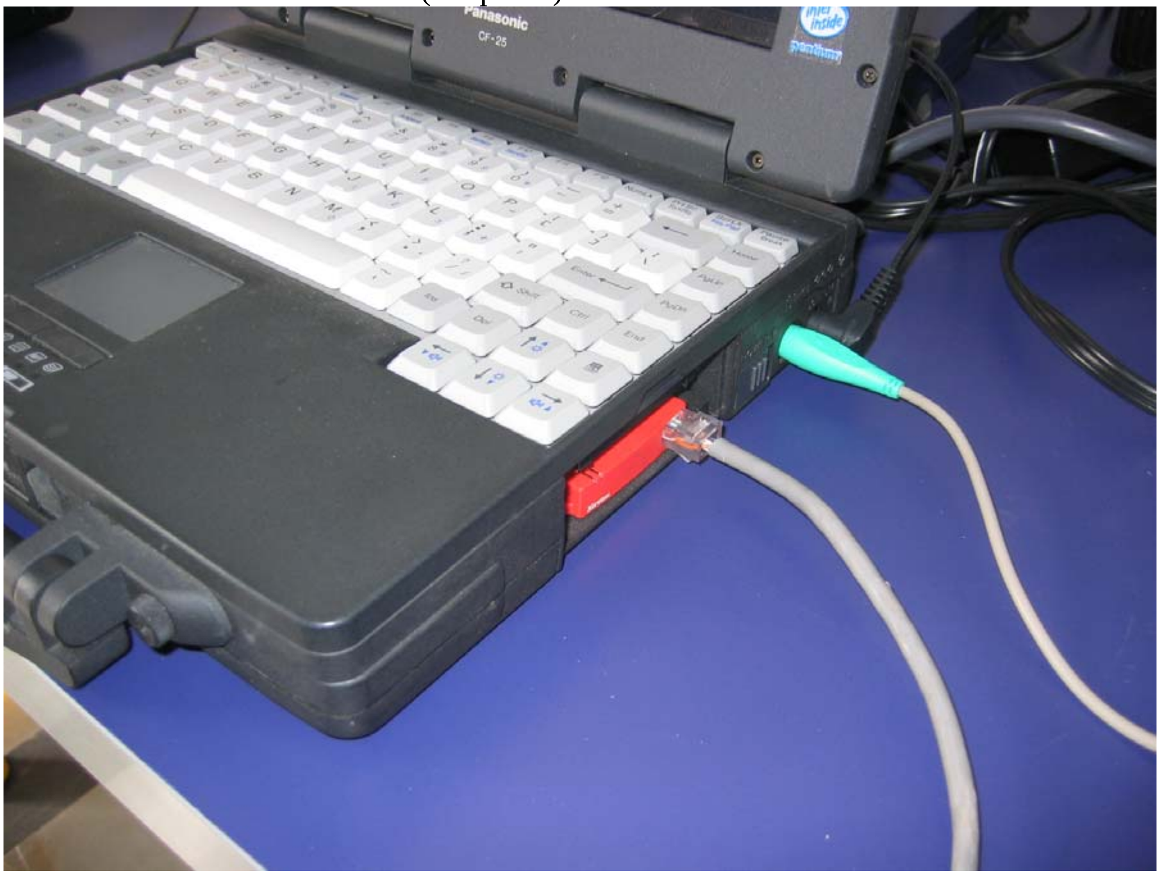


A full size screen appears below. Press the “Esc” key to leave the full screen mode.



2. Starting STI data acquisition

1. Connect the Panasonic support computer to the STI data acquisition system using its communication cable (see photo).



2. Click on the STI icon labeled “STI_B12c” on the desktop.

3. The STI must be powered on (box on rear tunnel of vehicle).

4. Click on File->Start Test.

5. Use the default Vehicle File and Config File.

6. Change Data File as desired. Notice the directory where it is stored. Currently the directory is C:\sti\65DP4229 2005 STS\data.

7. The screen should show all vehicle transducers.

8. Enter an integer 1, 2, 3, etc. to start saving data. The number 1 saves data at one second intervals.

9. Press F7 to stop the test and exit.

10. Open the data file you have just collected (suffix dat).

11. Click “Convert” on screen to convert file to a *.csv file compatible with Excel.

3. Rezeroing the EXV

It is advisable to rezero the EXV after loading code into the MicroAutobox. After downloading code and starting simulation, be certain the AC system is switched off (see Topic 4). The Stepper box on the left of the ControlDesk EXV screen is used to establish valve zero.

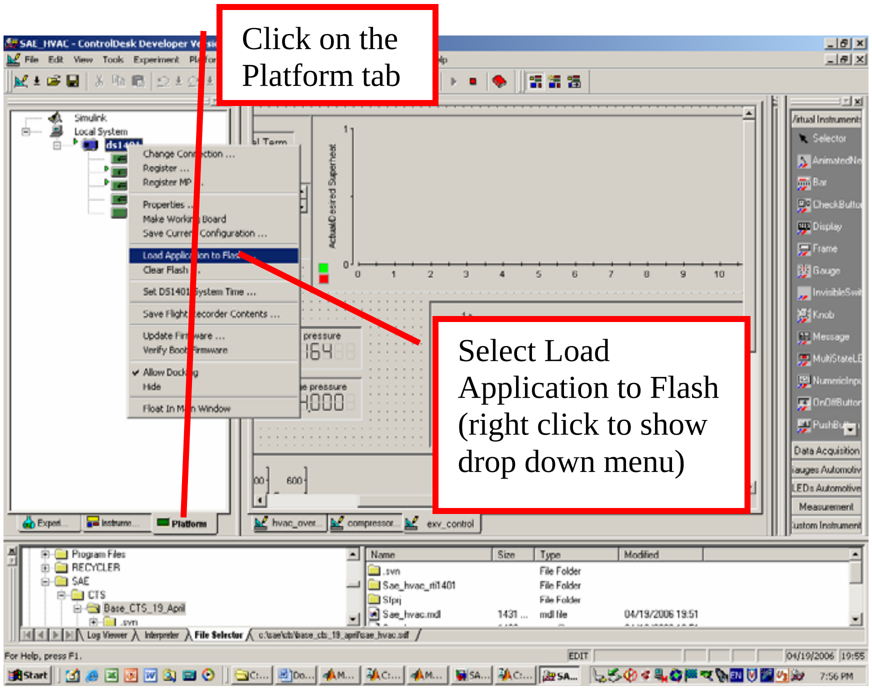
1. Note the current controlled valve position.
2. Click the button to place the valve in Manual Operating mode.
3. Set the Manual valve position to a negative number. -2000 will always completely close the valve, but -1 may be sufficient. Try something like -50 and listen for the valve tapping when fully closed. (The tapping is obvious in the car with the doors closed.) You can always use a larger negative number if your first choice does not close the valve.
4. After the valve has audibly closed and stopped tapping, click the button to disable the coils (this will prevent the motor from really turning).
5. Set the Manual valve setting to 0 and wait for the red EXV Setpoint and green EXV Position curves to converge at zero. The controller's counter and the physical valve position now match at 0.
6. Click the button to return to normal coil sequencing.
7. Set the Manual valve position to the position noted in step 1.

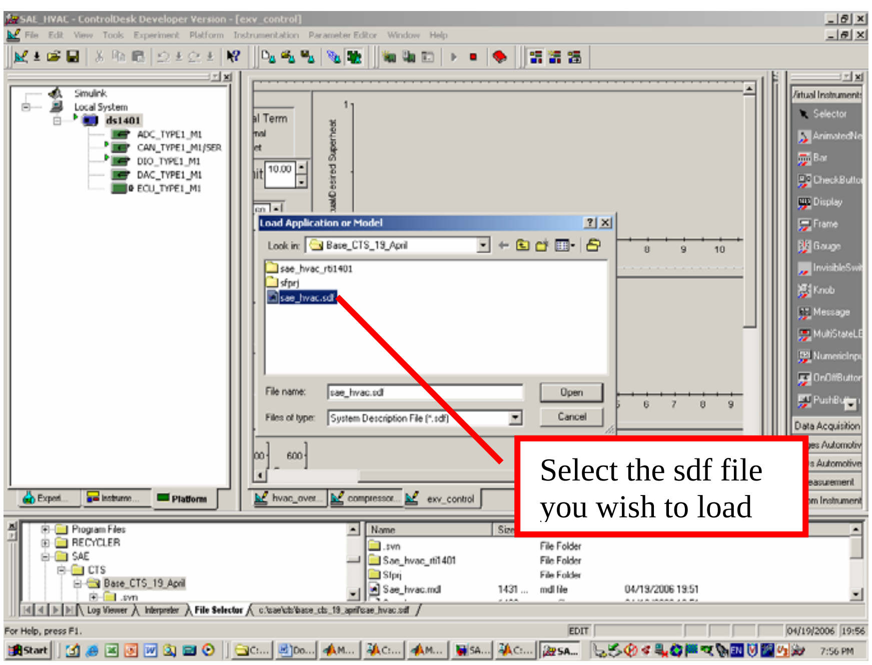
8. After the valve moves to that position (note the EXV Setpoint and Position plots), click the top button to return to Control mode.

Note that this procedure should never be necessary if the system runs normally and the controller code is not reloaded. Note also that whenever the car’s engine is switched off (ignition off event), the system goes through an automatic valve rezero operation. The valve is driven to -500 steps, the counter reset to zero and then the valve is opened to the system default valve position.

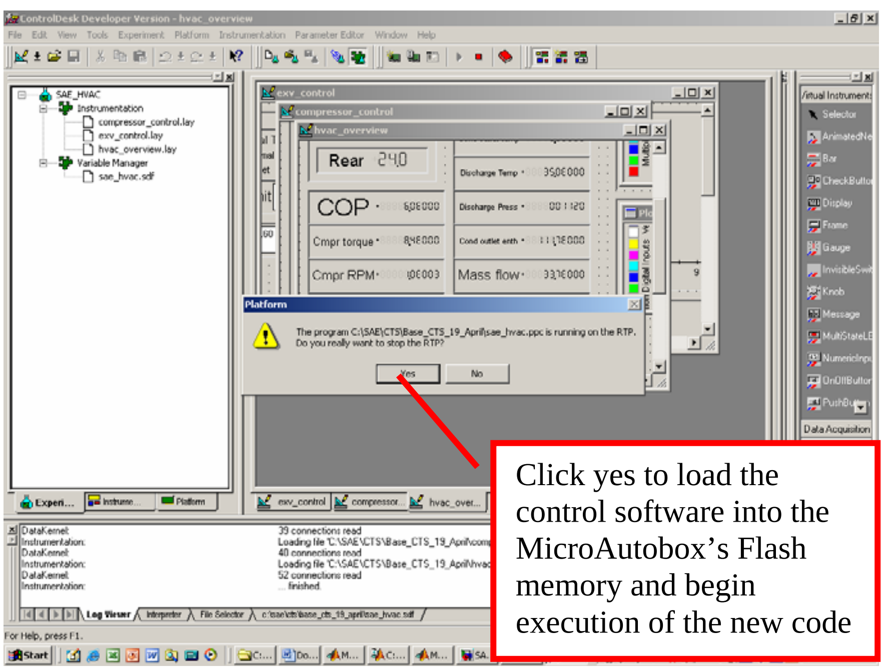
4. Permanently storing code in the system controller (dSpace MicroAutobox)

Start ControlDesk (see Topic 1).





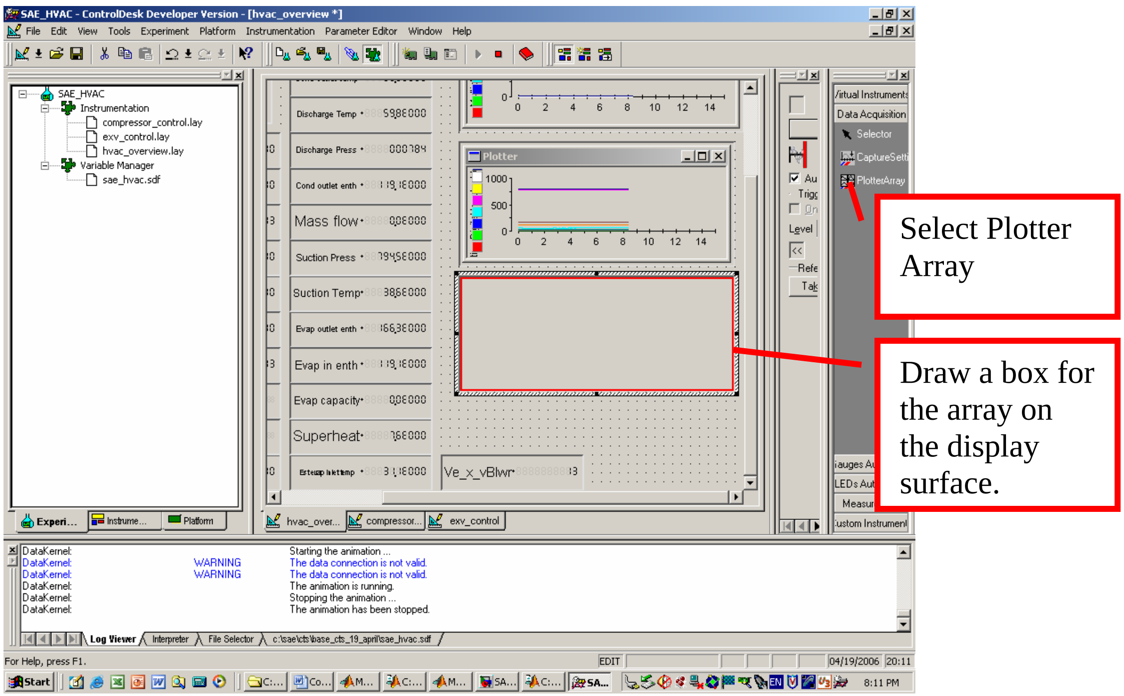

Cadillac
TUESDAY
4:16 PM
APR 18 06
STS
BAND
AUX
SRCE
CONFIG
The AC system should be switched off
This button toggles the AC system

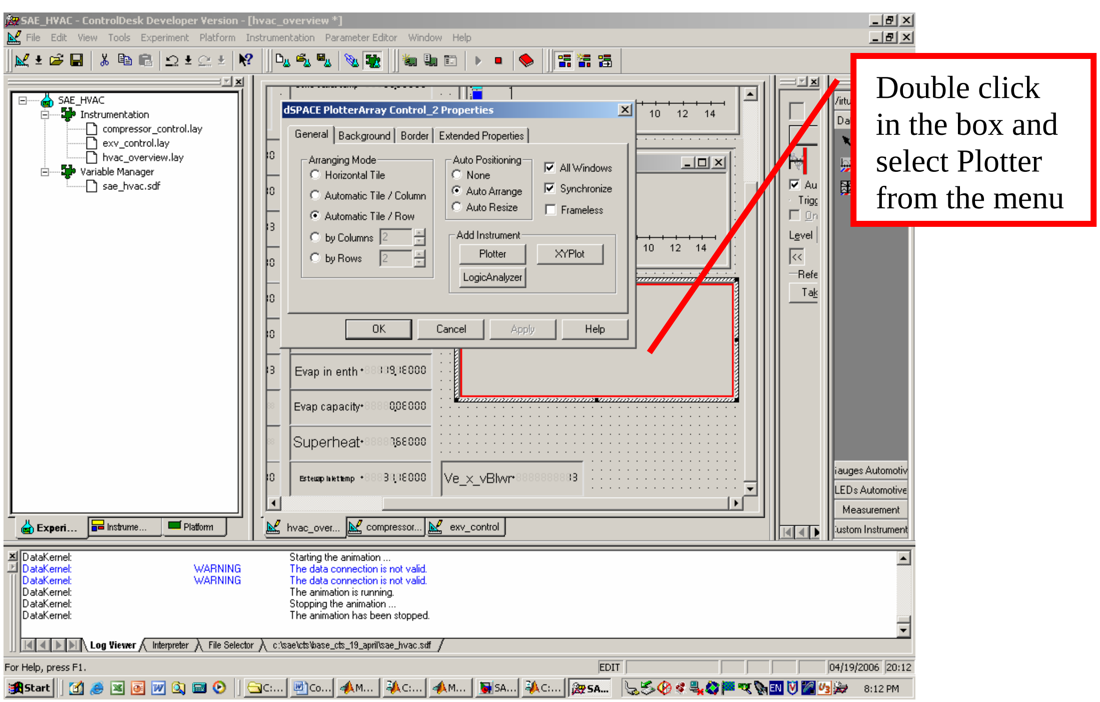

ControlDesk Developer Version - hvac_overview
exv_control
compressor_control
hvac_overview
Rear
COP
Cmpr torque
Cmpr RPM
Discharge Temp
Discharge Press
Mass flow
Platform
The program C:\SAE\CTS\Base_CTS_19_April\sae_hvac.ppc is running on the RTP. Do you really want to stop the RTP?
Yes
No
Click yes to load the control software into the MicroAutobox's Flash memory and begin execution of the new code

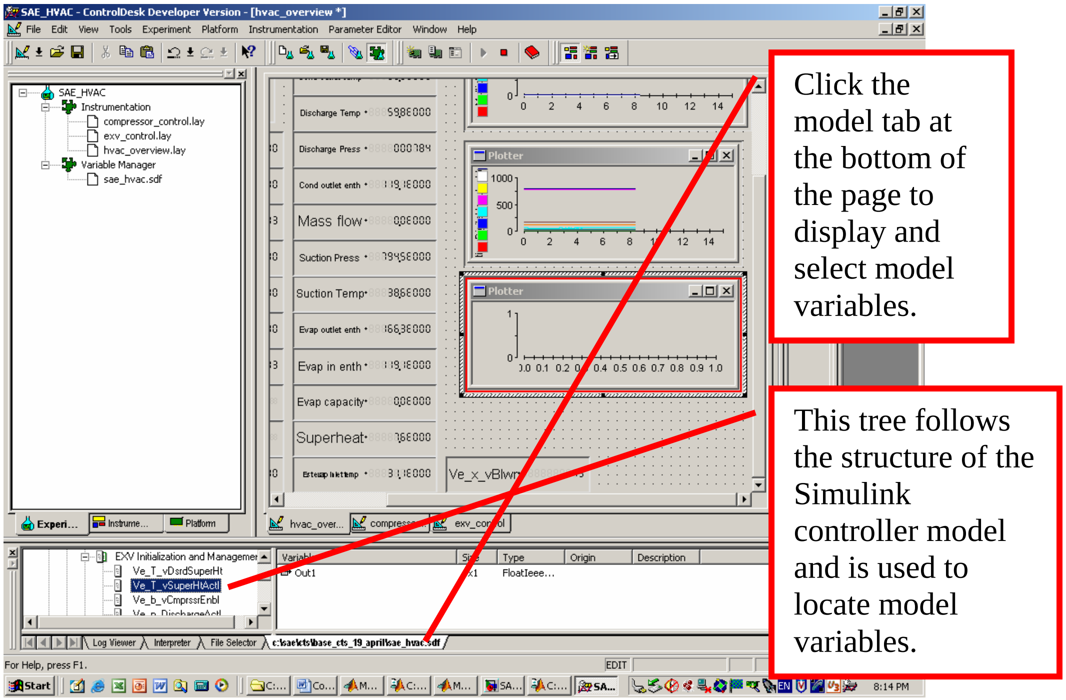
Note that control is lost during download of code. This is why the AC system should be turned off during code download. After the code has been downloaded and starts running on the MicroAutobox, rezero the EXV (see Topic 3) since its position is sometimes lost when new code is loaded.

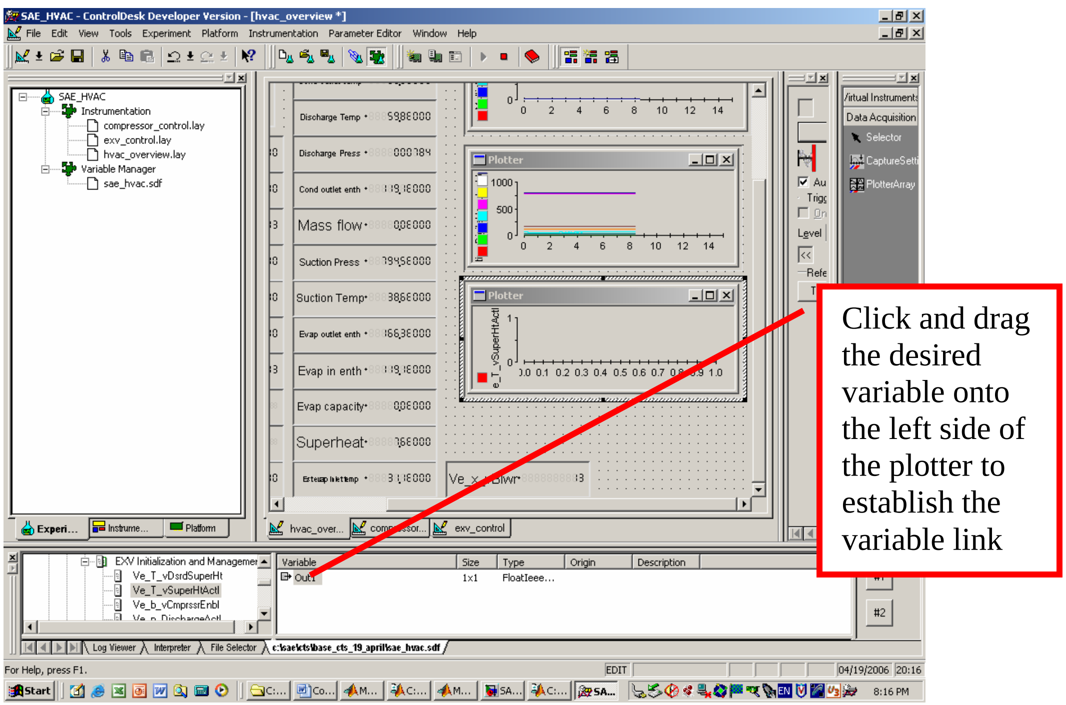
5. Setting up instrumentation in dSpace ControlDesk

This section illustrates how to set up a plotter array. Other instruments are set up in a similar fashion. It is often convenient to copy and paste an existing instrument.



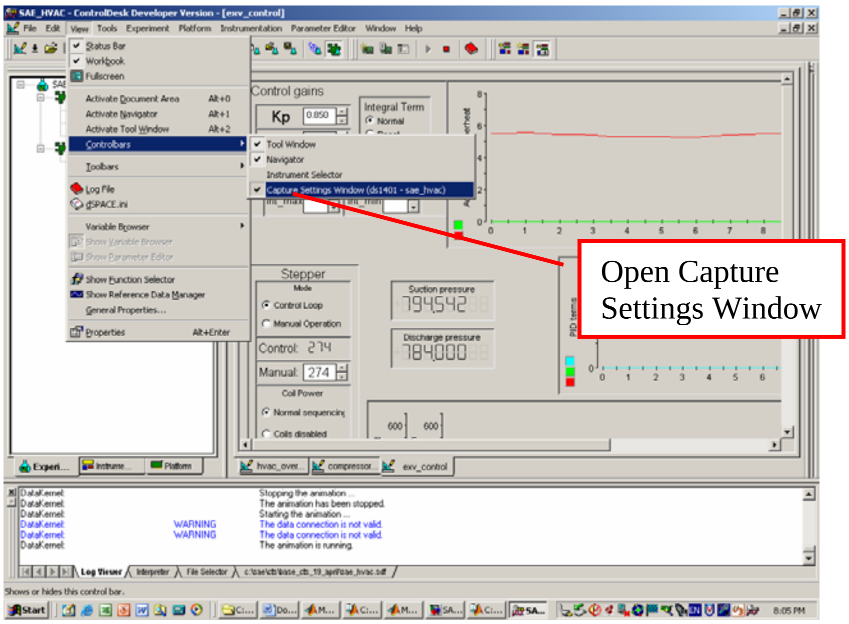



Click the model tab at the bottom of the page to display and select model variables.
This tree follows the structure of the Simulink controller model and is used to locate model variables.

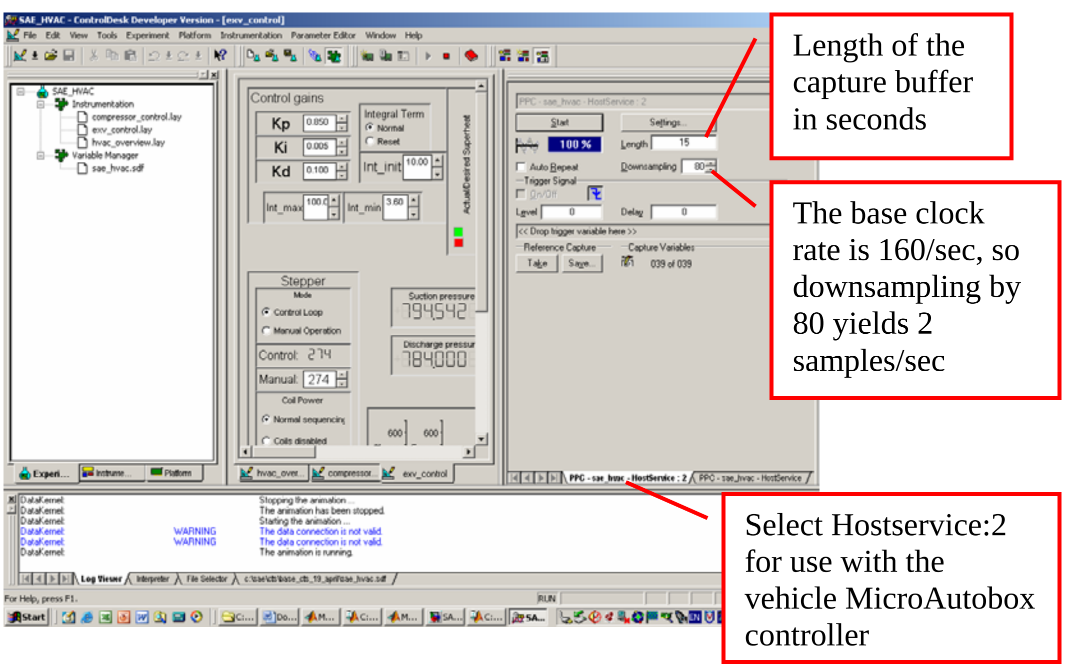

Click and drag the desired variable onto the left side of the plotter to establish the variable link

6. Setting up a data capture in ControlDesk and using the captured data

ControlDesk can capture and save buffers of data. Only data displayed on a plotter will be buffered and saved. To include data on a plotter, see Topic 5. The stored data duration and sample rate is established using the Capture Settings Window.



The Window may be hidden by the display windows, use the Window dropdown menu to locate.



To capture a buffer of data, Auto Repeat should not be checked. (To view normal strip chart displays, check Auto Repeat and set Downsampling to 40 or so.) For a basic scan, no trigger is selected. Press “Start” to begin the scan. Wait until the buffer is 100% full and press “Save” to write the buffer of data to a file. The file is a MatLab “.mat” file. The data is stored as a structure. (Use simple file names for compatibility with MatLab. In particular do not use a number at the beginning of a file name and do not use characters like ‘-‘ or blanks. Use ‘_’ instead of blanks.) CTS has developed a MatLab function “DSpaceExcel.m” that can convert either the entire data file or a portion of the file into an Excel spreadsheet. The function is located in the directory ~\ CTS\(latest directory data)\data and has been placed under TortoiseSVN version control (see Topic 9). The function runs only under MatLab ver. 7. (The Simulink control program must be compiled under MatLab ver. 6. Both versions of MatLab are available on the HP support computer.) The usage of this function follows (car_data is the *.mat file saved from a dSpace ControlDesk capture):

Usage:

```
load car_data
DSpaceExcel(car_data, 'filename')
```

This exports all the data cleaning up the exported names and printing messages as it works.

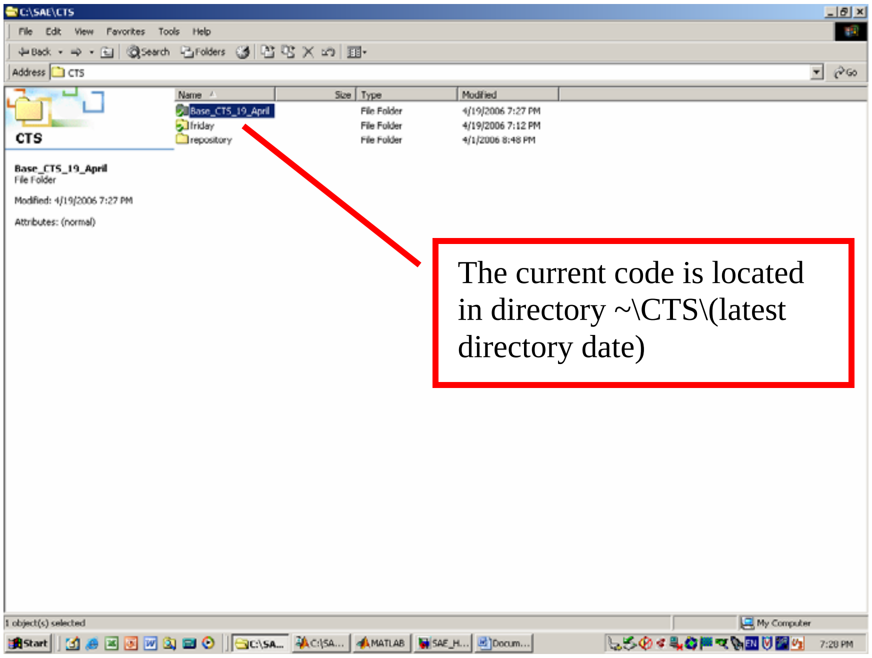
Added features:

```
DSpaceExcel(car_data, 'filename', [2 5 7])
```

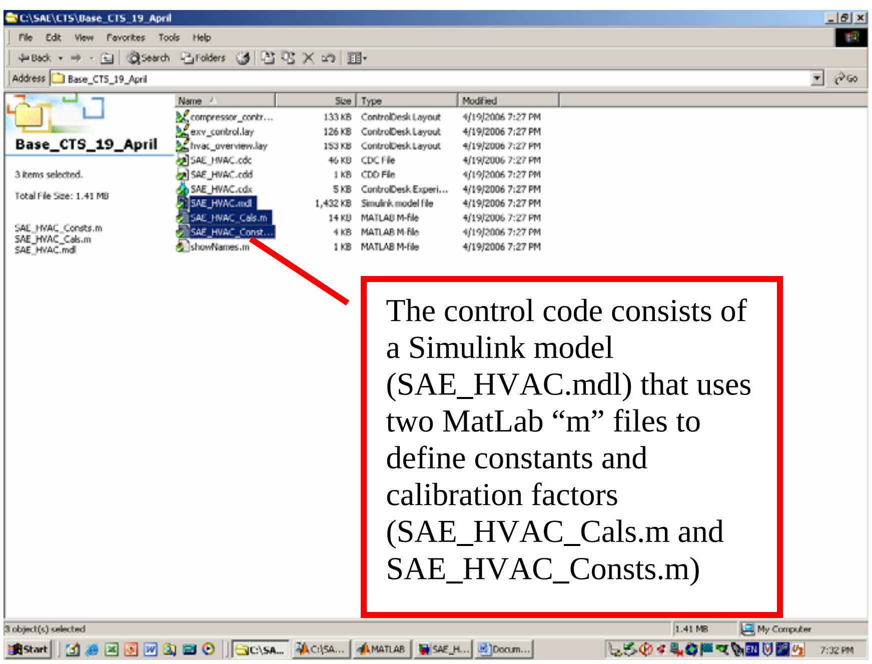
Will only export the second, fifth, and seventh data sets. Use standard Matlab array notation to select which entries you need. For example, [1:5, 10:12] is the same as [1 2 3 4 5 10 11 12].

7. The control system model

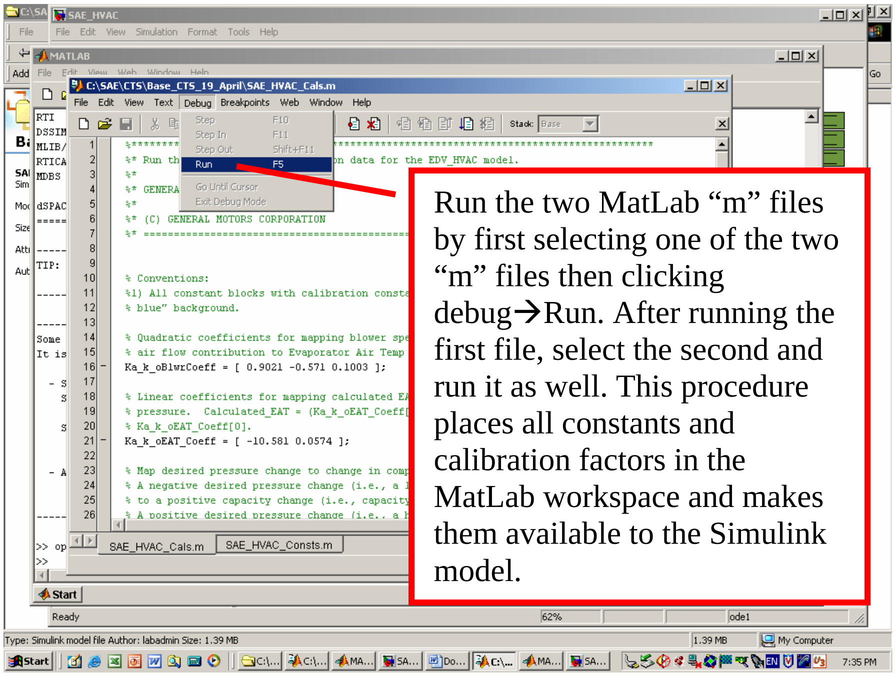
It may be necessary or desirable to modify and recompile the control system model.

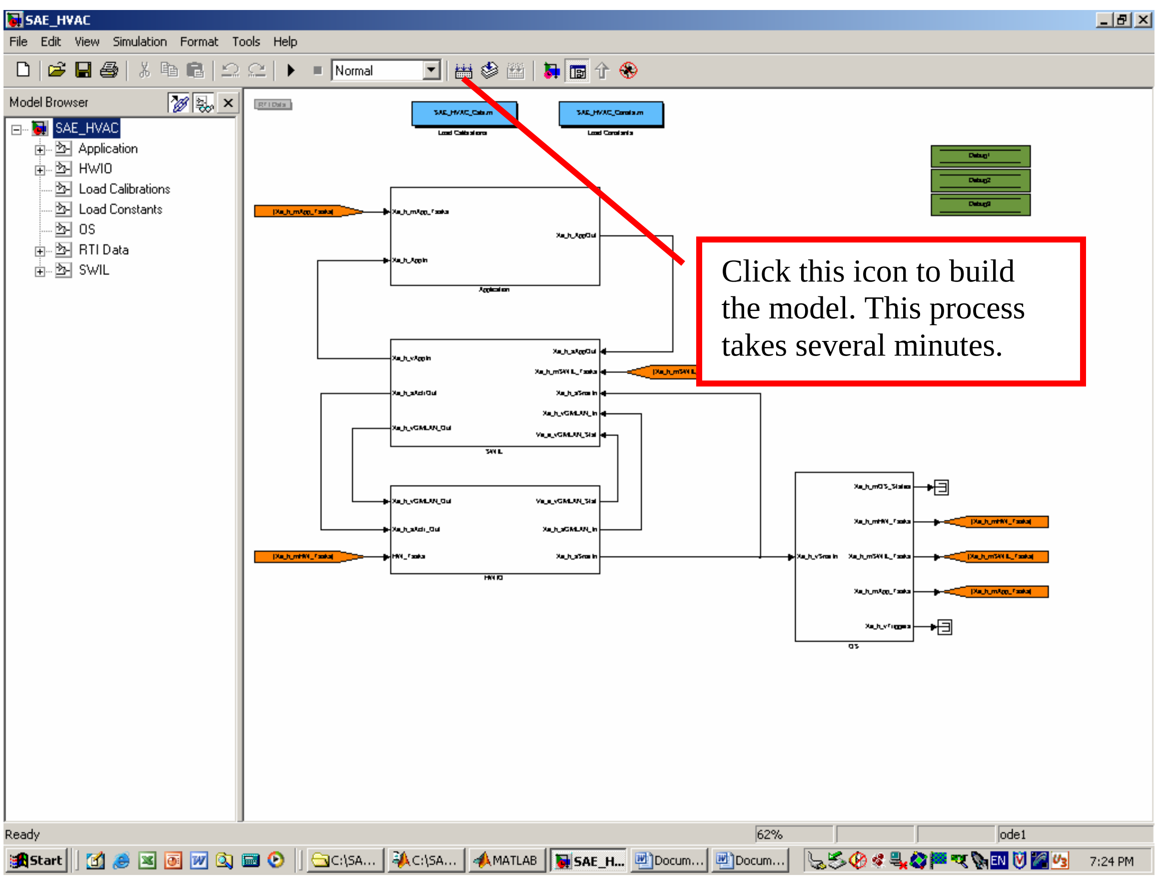


The control code has been placed under source code control (see Topic 9).

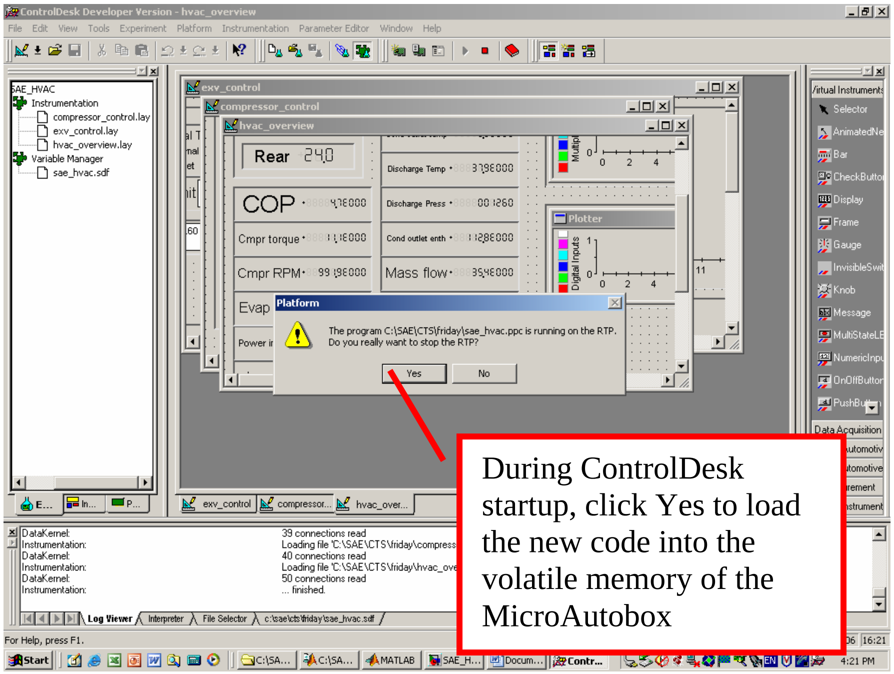


Double click on SAE_HVAC.mdl to start MatLab (version 6 – required to generate code for the MicroAutobox) and Simulink. Load SAE_HVAC_Cals and SAE_HVAC_Consts from MatLab.





The code must be loaded into the MicroAutobox controller (see Topics 1 and 4).



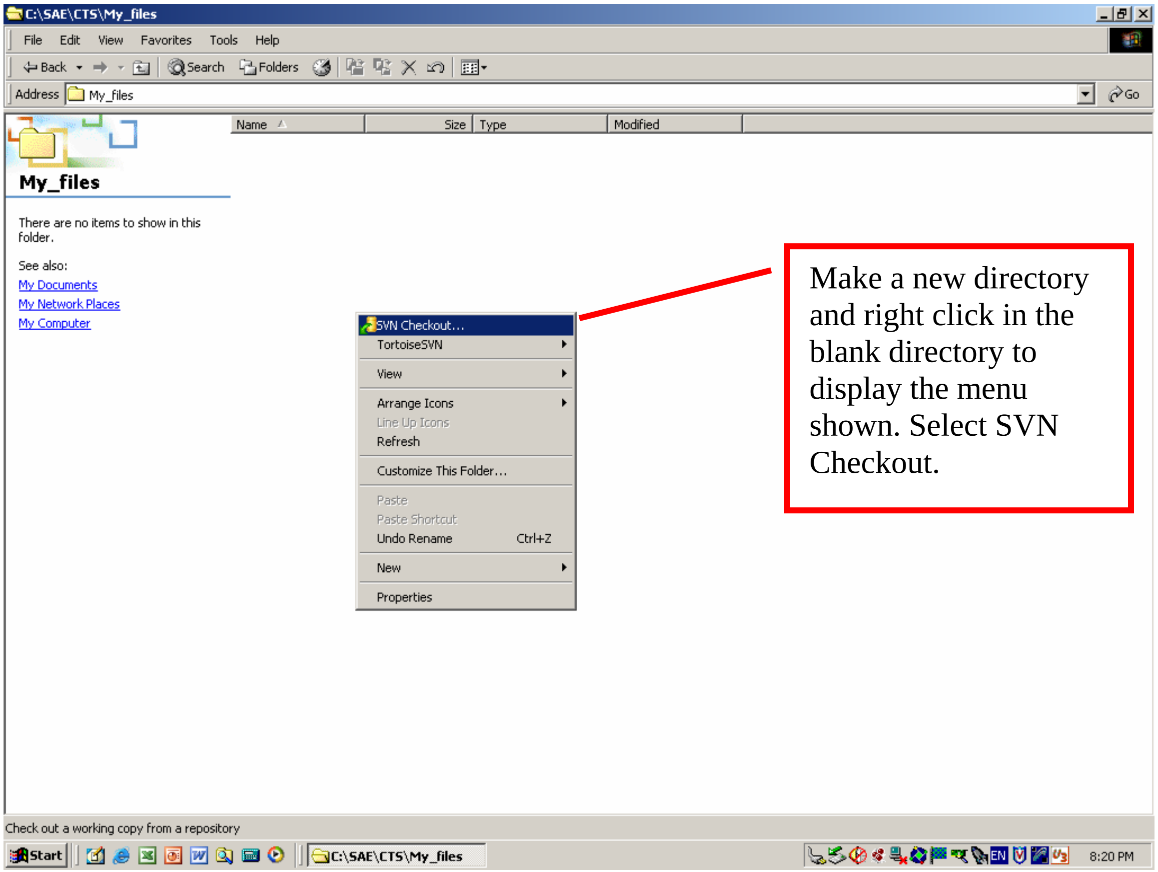
See Topic 4 to load code into the MicroAutobox's FLASH memory. Note that code written only to volatile memory is persistent as long as vehicle battery power is not removed. (It is suggested that vehicle battery power be removed overnight by removing the supply fuse - see Topic 10.)

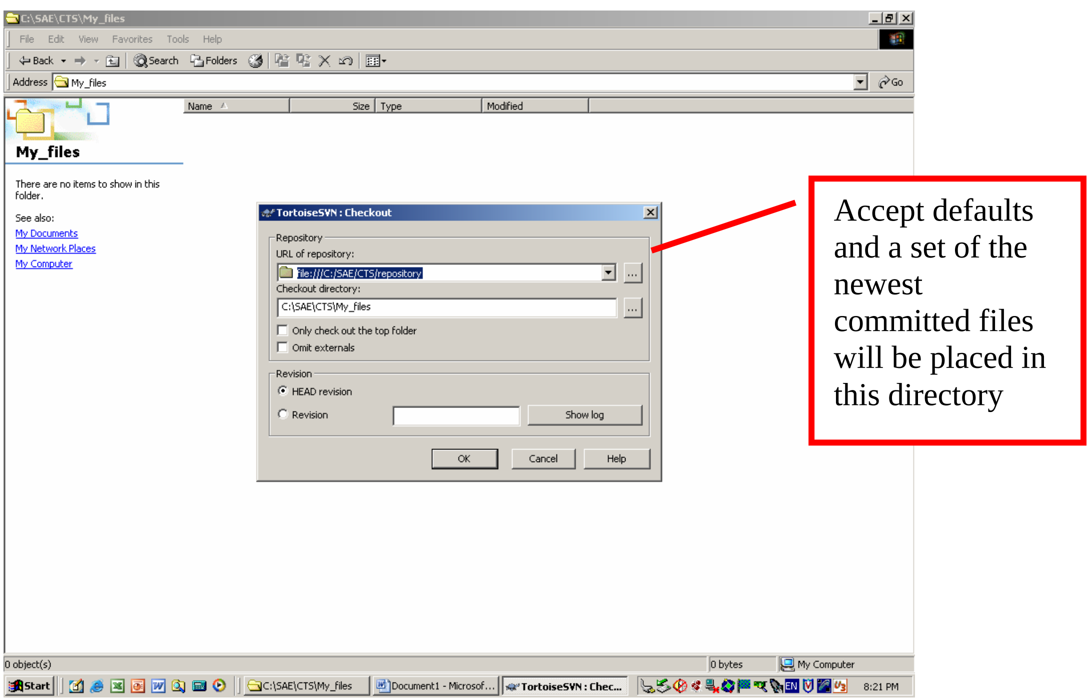
8. Model variables that may require modification

The file SAE_HVAC_Cals.m contains systems calibration constants and setup parameters. You may wish to change some of the values. An effort has been made to place the variables that may need to be modified near the start of the file and to document every variable. Many of them can be modified during runs using dSpace ControlDesk. If a new set of constants are identified during a run using ControlDesk, you will need to modify the constants in SAE_HVAC_Cals.m and recompile and reload the code into the MicroAutobox to make the changes permanent (see Topic 7).

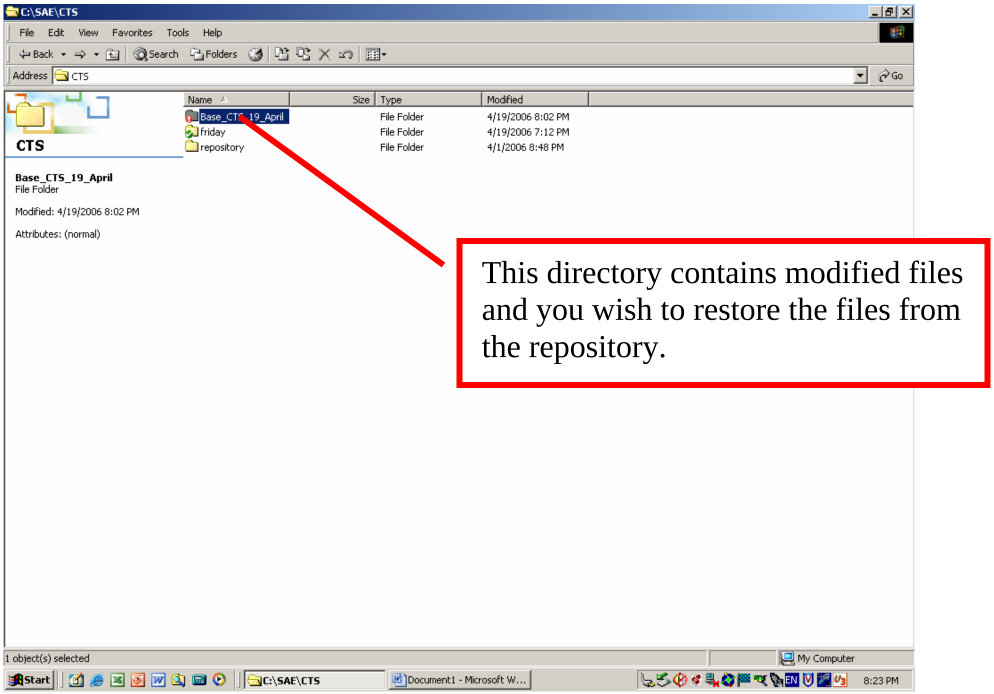
9. Source code control (TortoiseSVN)

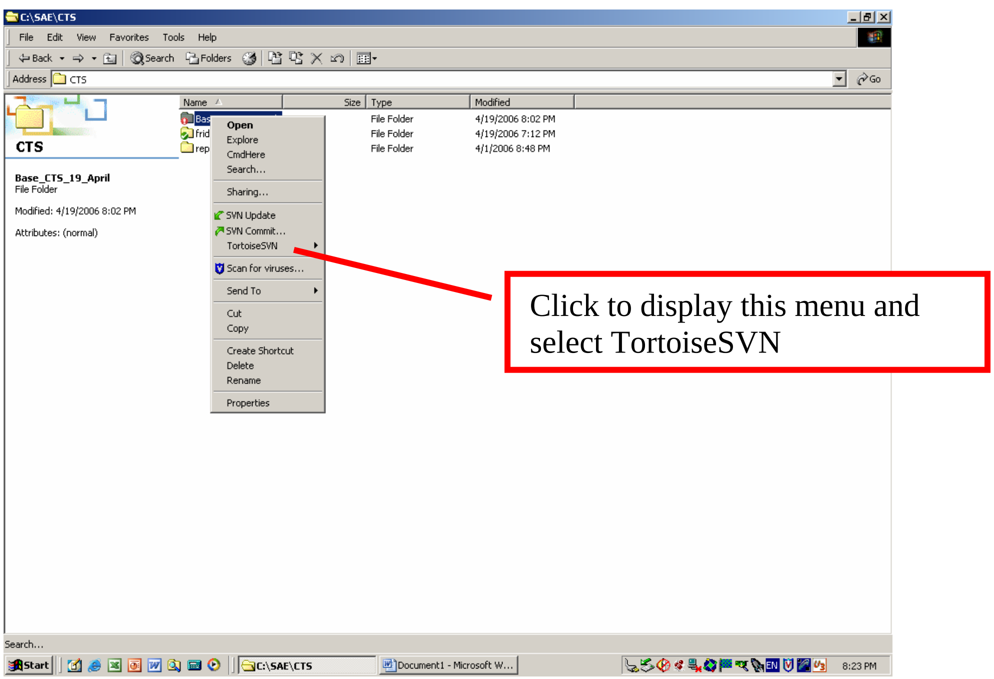
The control code, the dSpace ControlDesk Experiment files, as well as some support files have been placed under source code control using TortoiseSVN. When using Windows Explorer, controlled files (and directories containing controlled files) will usually be indicated by a checkmark (if committed to the repository), or an exclamation point (if the latest version is not yet committed). The source code control system provides a way to return to previous version of the code. In particular, it is important to commit the entire development directory (Base_CTS_19_April at present) before making significant changes in the code. That way, mistakes can be rectified quickly by using the Revert feature of TortoiseSVN. The following shows how to start a new development directory and commit a copy of the code before beginning new development. Reversion to the last version of the code is also illustrated. See the TortoiseSVN help files for the many other features of this software. **Note, the "repository" directory must never be deleted.**

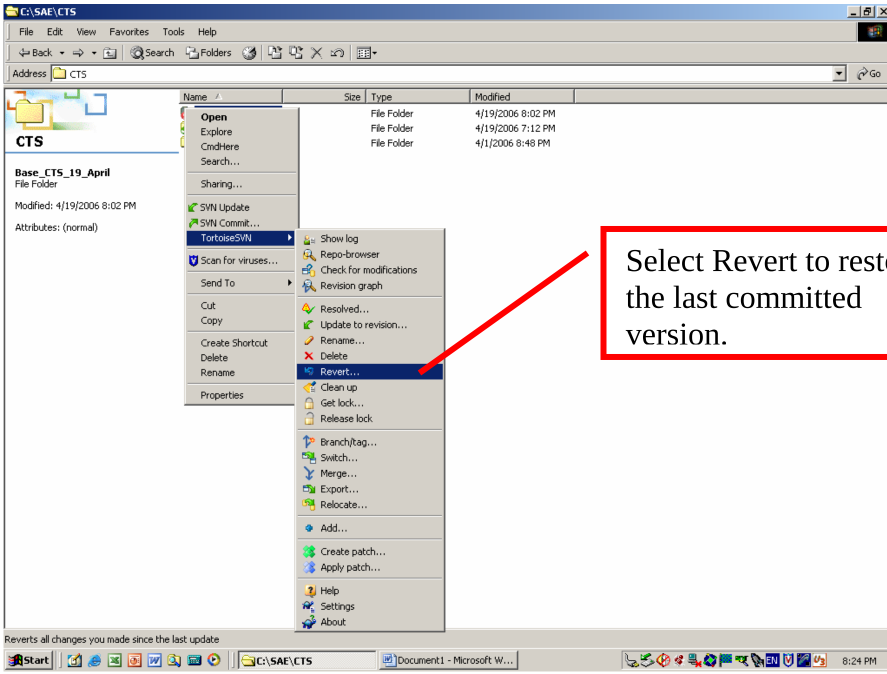




In the case that you wish to revert to a previous version of controlled code:


C:\SAE\CTS
CTS
Base_CTS_19_April
friday
repository
This directory contains modified files and you wish to restore the files from the repository.

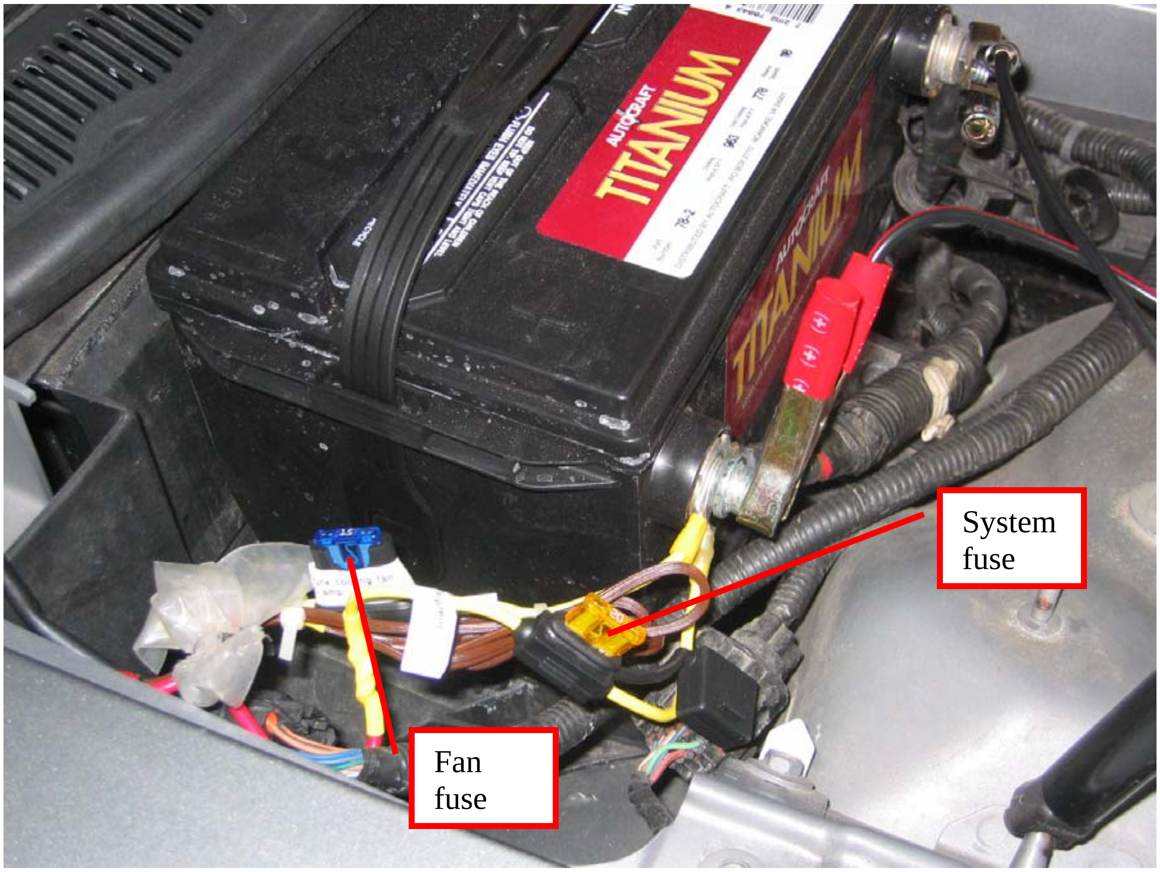

C:\SAE\CTS
Open
Explore
CmdHere
Search...
Sharing...
SVN Update
SVN Commit...
TortoiseSVN
Scan for viruses...
Send To
Cut
Copy
Create Shortcut
Delete
Rename
Properties
Click to display this menu and select TortoiseSVN



Select Revert to restore to the last committed version.

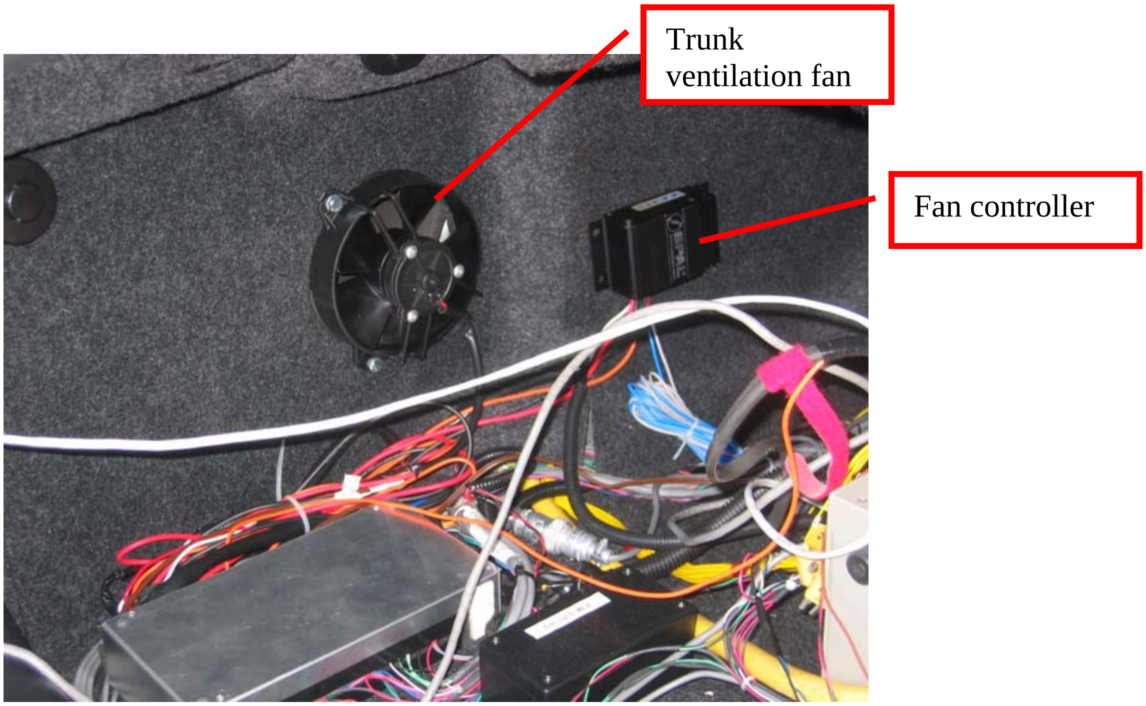
10. Hardware issues

The entire system is powered from a line attached directly to the positive terminal of the vehicle battery. The system draws current sufficient to run down the vehicle battery even when completely shut down. It is suggested that the system fuse be removed when the vehicle is not running for any extended period of time.



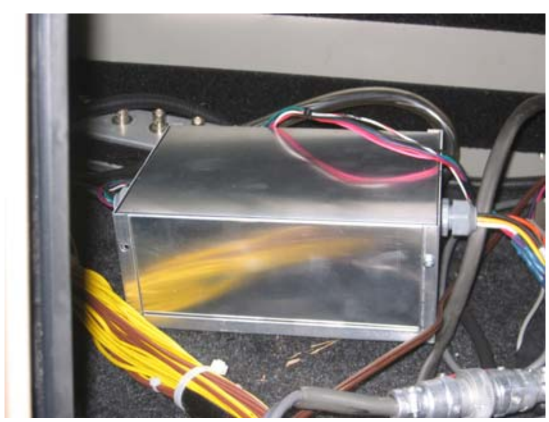
12 Volt battery current consumption when the vehicle ignition is off, the key fob far from the vehicle, and with various loads is:

1. System fuse installed, 9 pin vehicle bus connector in trunk connected and STI system turned on (toggle switch on rear tunnel)– 4.35A
2. System fuse installed, 9 pin bus connector in trunk connected – 0.158 A
3. System fuse installed, 9 pin bus connector in trunk disconnected – 0.135 A
4. System fuse removed, 9 pin bus connector in trunk connected – 0.028 A
5. System fuse removed, 9 pin bus connector in trunk disconnected – 0.044 A



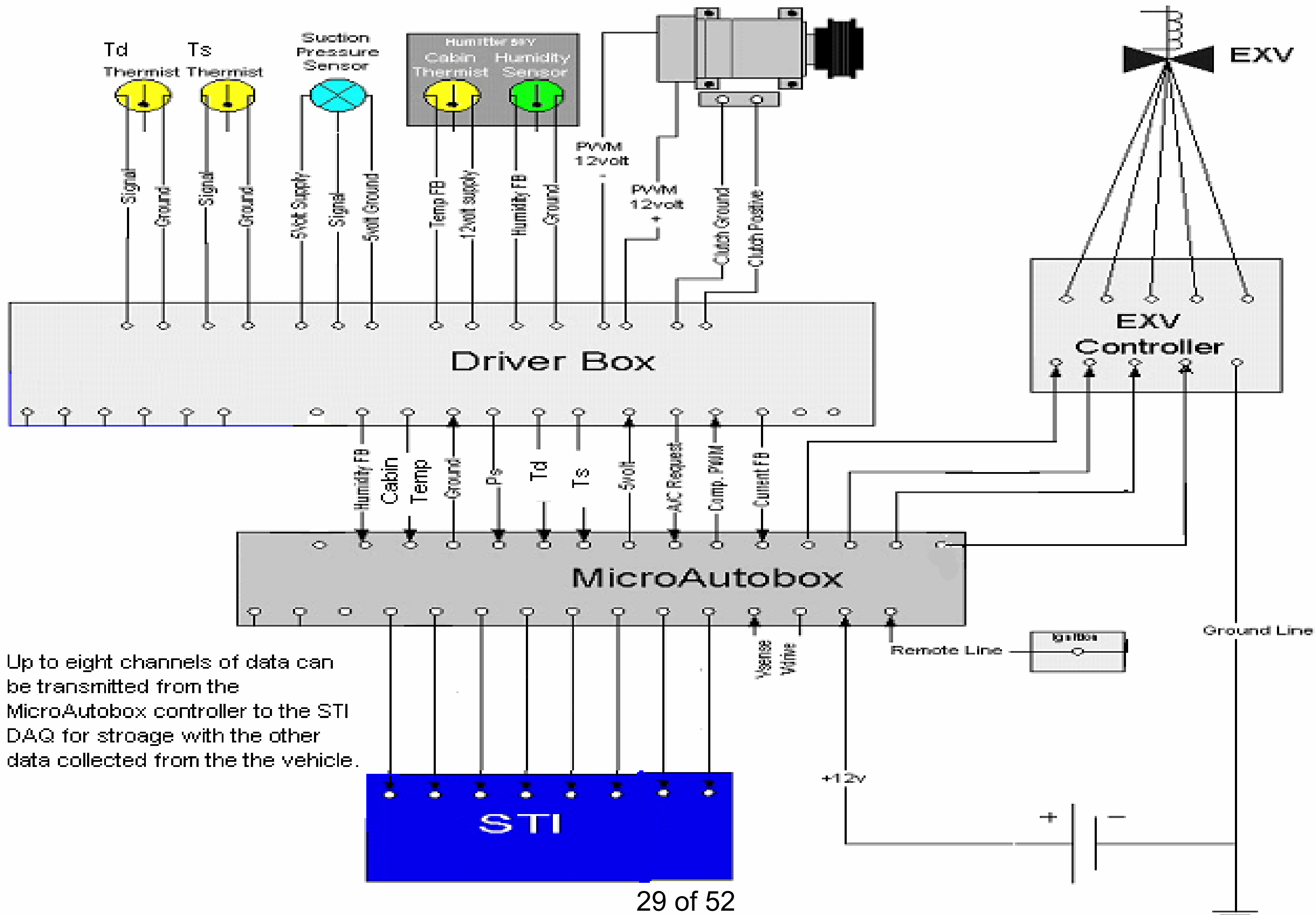
A small SPAL fan (VA31-A101-46S) and controller (FAN-PWM) have been installed to exhaust air from the trunk into the fender vent. Documents that cover the fan and its controller appear in the **Hardware Reference** at the end of this document. The fender vent flap has not been removed or taped open, so improved air flow could be obtained if necessary. Fan power is taken directly from the battery positive terminal (with return grounded on the same ground post on the passenger door upright as the control and data acquisition system). The fan controller is armed with an ignition line. The line is connected to the positive lead of the STI data acquisition system power cable. Thus the fan can only operate when the STI system is powered up. At present the fan starts running at a temperature of 116 F and reaches full velocity at 150 F. The fan can easily be reprogrammed to other temperature thresholds. For further information see the documents in the appendix of go to www.spalusa.com.

The custom Fujikoki stepper motor driver box is located in the trunk, accessible through the opening in the back seat. The driver is documented in the **Hardware Reference** that follows.



Hardware Reference

System Mechanization

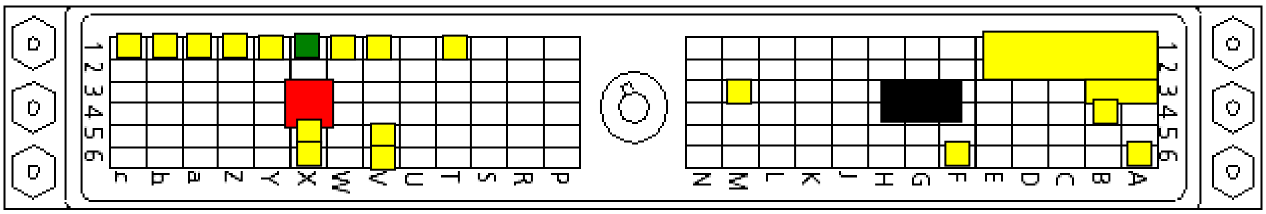


Up to eight channels of data can be transmitted from the MicroAutobox controller to the STI DAQ for stroage with the other data collected from the the vehicle.

MicroAutobox I/O Connector Pinouts

The I/O connector is a 156-pin Zero Insertion Force (ZIF) connector giving access to the input and output signals provided by MicroAutoBox.

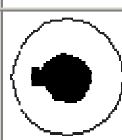
The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):



Note

There are pins identified via capital letters (A, B, C, ...) and pins identified via small letters (a, b, c).

The following table shows the signals of the I/0 connector: Pins used highlighted in yellow. Power (+12 Volt vehicle power) highlighted in red. Common (ground) highlighted in black.

1		2		3		4		5		6		
DAC 7	out	DAC 8	out	Group 1 ch 1	out	Group 1 ch 2	out	Group 1 ch 3	out	Group 1 ch 4	out	A
DAC 5	out	DAC 6	out	Group 1 ch 5	out	Group 1 ch 6	out	Group 1 ch 7	out	CTM ch 1	out	B
DAC 3	out	DAC 4	out	CTM ch 2	out	CTM ch 5	out	CTM ch 6	out	CTM ch 7	out	C
DAC 1	out	DAC 2	out	CTM ch 8	out	CTM ch 3	out	CTM ch 4	out	Group 6 ch 1	out	D
VDRIVE	in	VSENS	out	Group 6 ch 2	out	Group 6 ch 3	out	Group 6 ch 4	out	Group 6 ch 5	out	E
Group 6 ch 6	out	Group 6 ch 7	out	GND	in	GND	in	Group 6 ch 8	out	TPU ch 1	out	F
TPU ch 2	out	TPU ch 3	out	GND	in	GND	in	GND	in	TPU ch 4	out	G
TPU ch 5	out	TPU ch 6	out	GND	in	GND	in	TPU ch 7	out	TPU ch 8	out	H
TPU ch 9	out	TPU ch 10	out	TPU ch 11	out	TPU ch 12	out	TPU ch 13	out	TPU ch 14	out	J
TPU ch 15	out	TPU ch 16	out	Group 2 ch 1	out	Group 2 ch 2	out	Group 2 ch 3	out	Group 2 ch 4	out	K
Group 2 ch 5	out	Group 2 ch 6	out	Group 2 ch 7	out	Group 2 ch 8	out	Group 3 ch 1	out	Group 3 ch 2	out	L
Group 3 ch 3	out	CTM ch 1	in	REMOTE	in	CTM ch 2	in	CTM ch 3	in	CTM ch 4	in	M
Group 6 ch 1	in	Group 6 ch 2	in	Group 6 ch 3	in	Group 6 ch 4	in	Group 6 ch 5	in	Group 6 ch 6	in	N
												
Group 6 ch 7	in	Group 6 ch 8	in	TPU ch 1	in	TPU ch 2	in	TPU ch 3	in	TPU ch 4	in	P

TPU ch 5	in	TPU ch 6	in	TPU ch 7	in	TPU ch 8	in	TPU ch 9	in	TPU ch 10	in	R
TPU ch 11	in	TPU ch 12	in	TPU ch 13	in	TPU ch 14	in	TPU ch 15	in	TPU ch 16	in	S
Group 2 ch 1	in	Group 2 ch 2	in	Group 2 ch 3	in	Group 2 ch 4	in	Group 2 ch 5	in	Group 2 ch 6	in	T
Group 2 ch 7	in	ADC Type 1 Con 4 Ch 4	in	Serial 2 K / LIN	i/o	Serial 2 L	in	Serial 1 TXD	out	Serial 1 RXD	in	U
ADC Type 1 Con 2 Ch 4	in	ADC Type 1 Con 3 Ch 4	in	VBAT	in	VBAT	in	CAN 1 low	i/o	CAN 1 high	i/o	V
ADC Type 1 Con 1 Ch 4	in	ADC Type 1 Con 4 Ch 3	in	VBAT	in	VBAT	in	VBAT	in	Group 2 ch 8	in	W
ADC Type 1 Con 2 Ch 3	in	ADC Type 1 Con 3 Ch 3	in	VBAT	in	VBAT	in	CAN 2 low	i/o	CAN 2 high	i/o	X
ADC Type 1 Con 1 Ch 3	in	ADC Type 1 Con 4 Ch 2	in	Group 4 ch 1	in	Group 4 ch 2	in	ECU / IF RX+	in	Group 4 ch 3	in	Y
ADC Type 1 Con 2 Ch 2	in	ADC Type 1 Con 3 Ch 2	in	Group 4 ch 4	in	Group 4 ch 5	in	ECU / IF RX-	in	Group 4 ch 6	in	Z
ADC Type 1 Con 1 Ch 2	in	ADC Type 1 Con 4 Ch 1	in	Group 4 ch 7	in	Group 4 ch 8	in	ECU / IF TX-	out	Group 5 ch 1	in	a
ADC Type 1 Con 2 Ch 1	in	ADC Type 1 Con 3 Ch 1	in	Group 5 ch 2	in	Group 5 ch 3	in	ECU / IF TX+	out	Group 5 ch 4	in	b
ADC Type 1 Con 1 Ch 1	in	VBAT prot	out	Group 5 ch 5	in	Group 5 ch 6	in	Group 5 ch 7	in	Group 5 ch 8	in	c
1		2		3		4		5		6		

MicroAutobox I/O Connector Signals by Pin

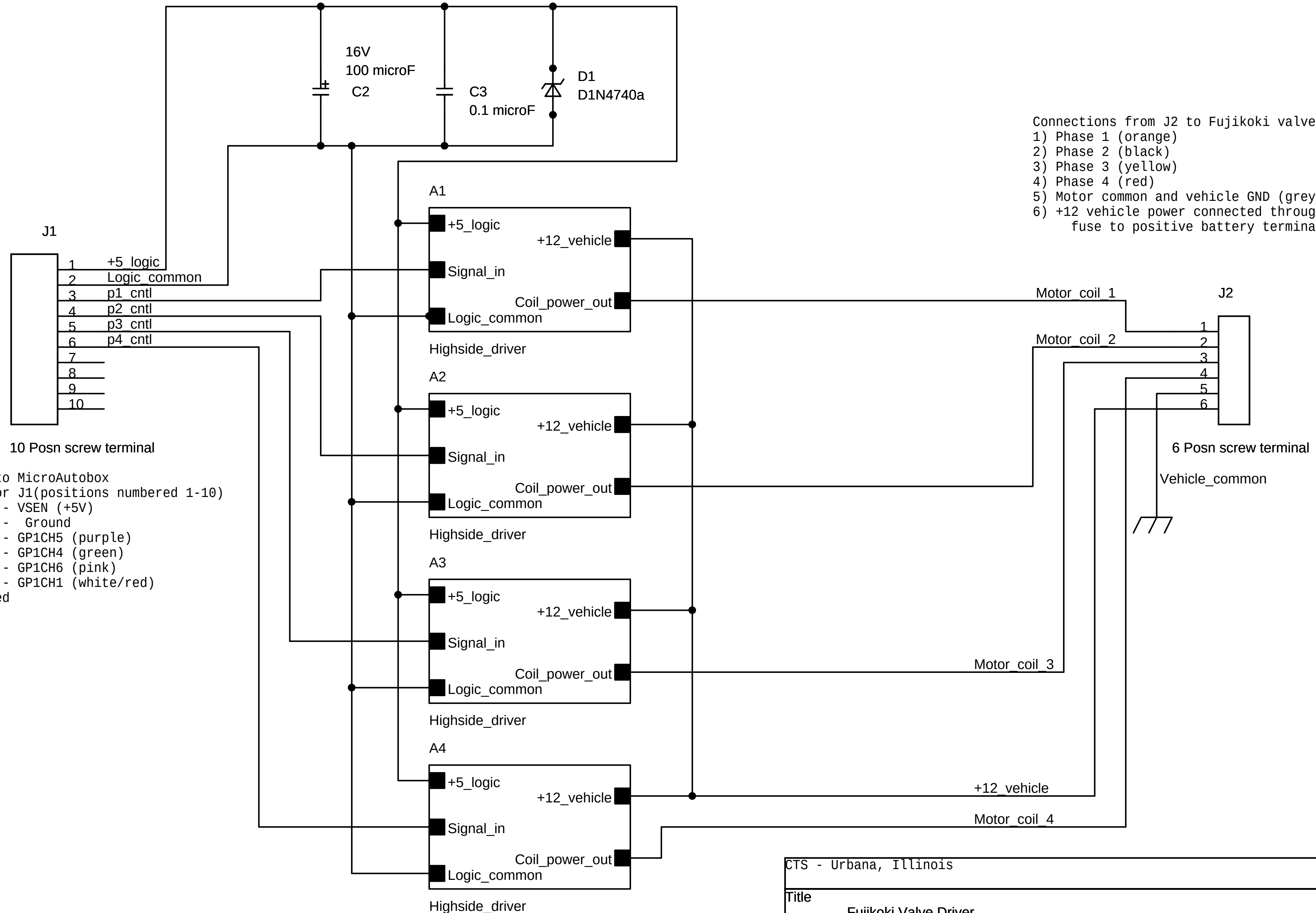
Pin	Name (MicroAutobox)	Signal Name	Wire color
A1	DAC7	Compressor command to STI	
A2	DAC8	EAT setpoint to STI	
A3	Group1 ch1	Fujikoki valve driver-phase 4	
A6	Group1 ch4	Fujikoki valve driver-phase 2	
B1	DAC5	Suction pressure to STI	
B2	DAC6	Compressor torque to STI	
B3	Group1 ch5	Fujikoki valve driver-phase 1	
B4	Group1 ch6	Fujikoki valve driver-phase 3	
C1	DAC3	Superheat to STI	
C2	DAC4	Evap capacity to STI	
D1	DAC1	COP to STI	
D2	DAC2	Compressor current FB to STI	
E1	VDRIVE		
E2	VSENS		
F3	GND	Common	
F4	GND	Common	
F6	TPU ch1	PWM (compressor command)	brown
G3	GND	Common	
G4	GND	Common	
H3	GND	Common	
H4	GND	Common	
M3	REMOTE	To vehicle ignition (system on)	
T1	Group2 ch1	compressor request	green/blk
V1	ADC Type1 Con2 Ch4	Compressor current FB	light purple
V5	CAN1 low	Low speed CAN low	
V6	CAN1 high	Low speed CAN high	
W1	ADC Type1 Con1 Ch4	Suction Temperature	orange/white
X1	ADC Type1 Con2 Ch3	Compressor outlet temperature	
X3	VBAT	+12 vehicle power	
X4	VBAT	+12 vehicle power	
X5	CAN2 low	High speed CAN low	
X6	CAN2 high	High speed CAN high	
Y1	ADC Type1 Con1 Ch3	Discharge temperature	orange

Z1	ADC Type1 Con2 Ch2	Cabin Temperature	green
a1	ADC Type1 Con1 Ch2	Suction pressure	yellow
b1	ADC Type1 Con2 Ch1	Cabin humidity	
c1	ADC Type1 Con1 Ch1	Supply ref. feedback	orange

MicroAutobox I/O Connector Signals by MicroAutobox signal name

Name (MicroAutobox)	**Pin**	**Signal Name**	**Wire color**
ADC Type1 Con1 Ch1	c1	Supply ref. feedback	orange
ADC Type1 Con1 Ch2	a1	Suction pressure	yellow
ADC Type1 Con1 Ch3	Y1	Discharge temperature	orange
ADC Type1 Con1 Ch4	W1	Suction Temperature	orange/white
ADC Type1 Con2 Ch1	b1	Cabin humidity	
ADC Type1 Con2 Ch2	Z1	Cabin Temperature	green
ADC Type1 Con2 Ch3	X1	Compressor outlet temperature	
ADC Type1 Con2 Ch4	V1	Compressor current FB	light purple
CAN1 high	V6	Low speed CAN high	
CAN1 low	V5	Low speed CAN low	
CAN2 high	X6	High speed CAN high	
CAN2 low	X5	High speed CAN low	
DAC1	D1	COP to STI	
DAC2	D2	Compressor current FB to STI	
DAC3	C1	Superheat to STI	
DAC4	C2	Evap capacity to STI	
DAC5	B1	Suction pressure to STI	
DAC6	B2	Compressor torque to STI	
DAC7	A1	Compressor command to STI	
DAC8	A2	EAT setpoint to STI	
GND	F3	Common	
GND	F4	Common	
GND	G3	Common	
GND	G4	Common	
GND	H3	Common	

GND	H4	Common	
Group1 ch1	A3	Fujikoki valve driver-phase 4	
Group1 ch4	A6	Fujikoki valve driver-phase 2	
Group1 ch5	B3	Fujikoki valve driver-phase 1	
Group1 ch6	B4	Fujikoki valve driver-phase 3	
Group2 ch1	T1	compressor request	green/blk
REMOTE	M3	To vehicle ignition (system on)	
TPU ch1	F6	PWM (compressor command)	brown
VBAT	X3	+12 vehicle power	
VBAT	X4	+12 vehicle power	
VDRIVE	E1		
VSENS	E2		

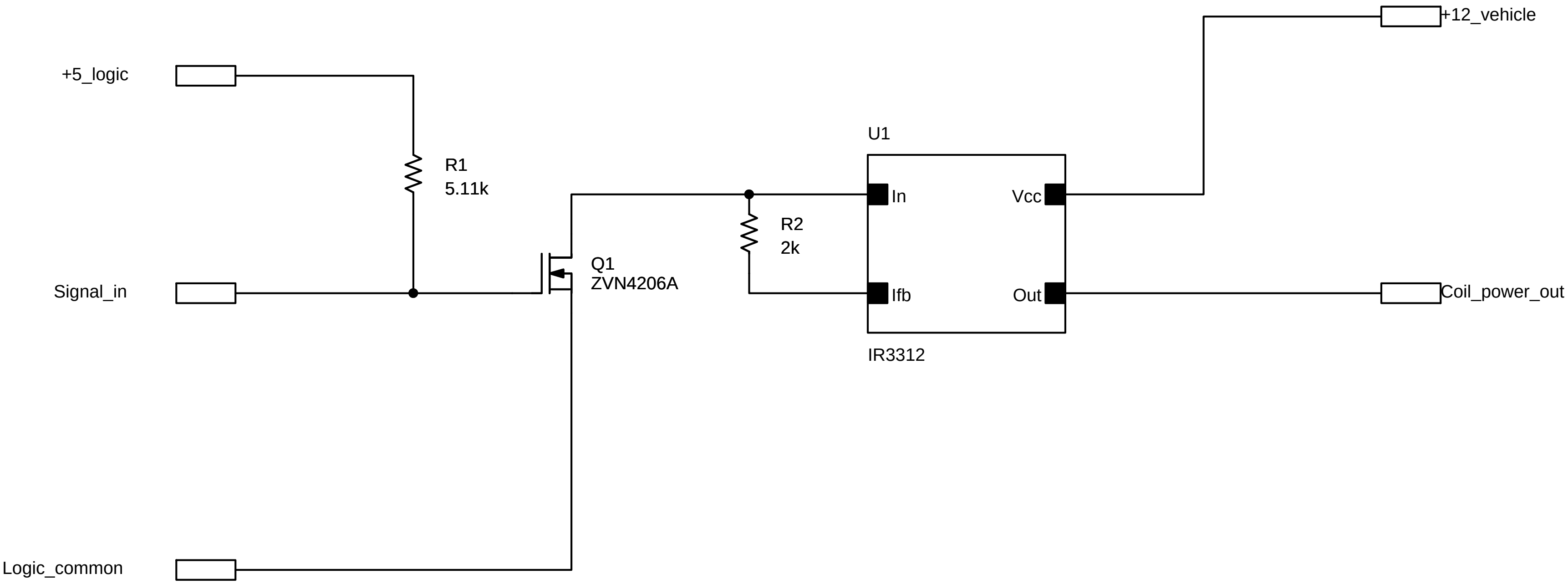



```
Connections from J2 to Fujikoki valve
1) Phase 1 (orange)
2) Phase 2 (black)
3) Phase 3 (yellow)
4) Phase 4 (red)
5) Motor common and vehicle GND (grey)
6) +12 vehicle power connected through
     fuse to positive battery terminal
```

```
Connections to MicroAutobox
from Connector J1(positions numbered 1-10)
1) To pin E2 - VSEN (+5V)
2) To pin F3 -  Ground
3) To pin B3 - GP1CH5 (purple)
4) To pin A6 - GP1CH4 (green)
5) To pin B4 - GP1CH6 (pink)
6) To pin A3 - GP1CH1 (white/red)
7-10) not used
```

CTS - Urbana, Illinois

Title	Fujikoki Valve Driver	
Size A	Document Number CTS_010	Rev 01
Date:	Tuesday, July 25, 2006	Sheet 1 of 2



High side coil driver circuit based on International Rectifier IR3312 part.

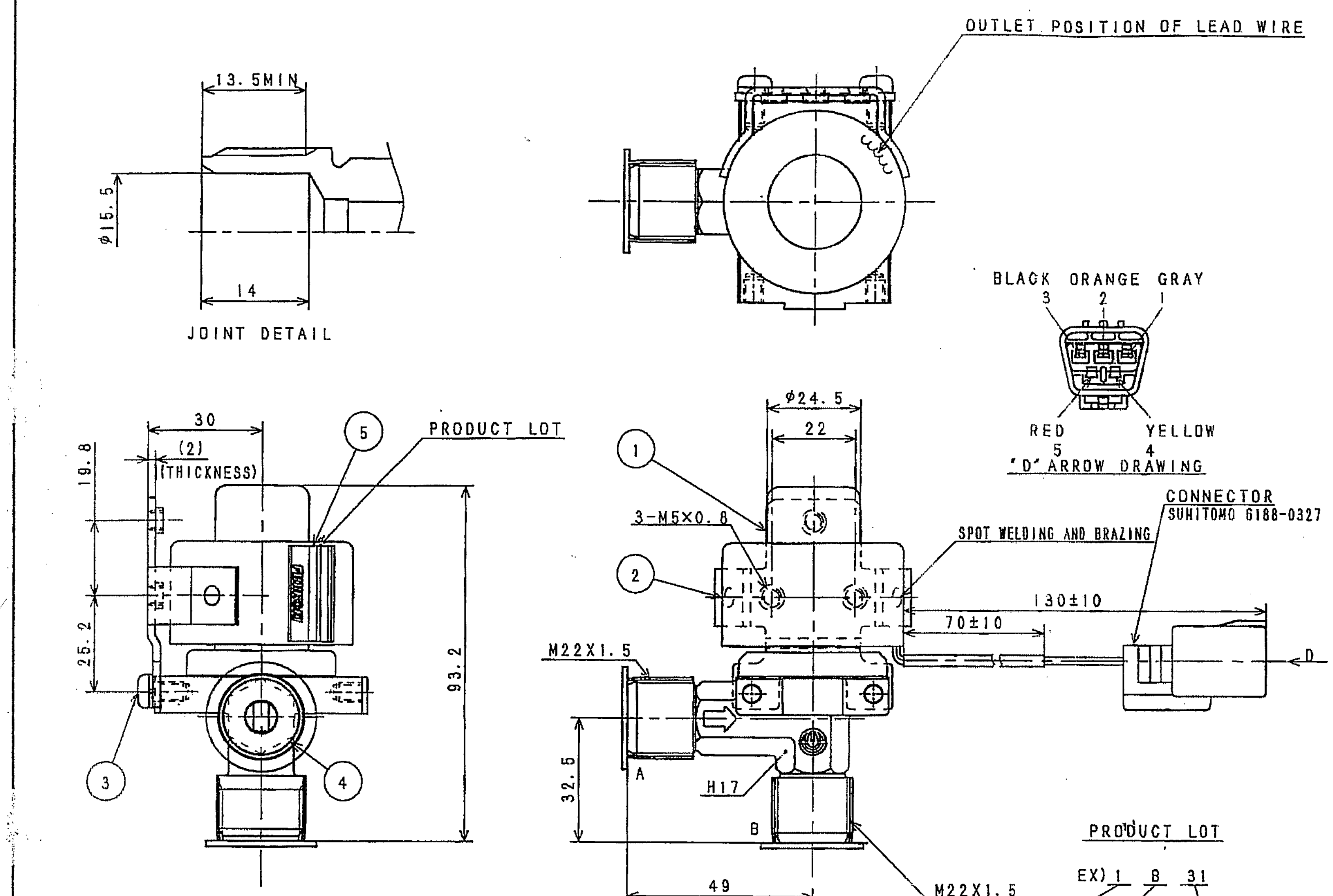
CTS - Urbana, Illinois

Title	Fujikoki Valve Driver - Highside Driver	
Size: A	Document Number: CTS_011	Rev: 01
Date: Tuesday, July 25, 2006	Sheet 2 of 2	

Original

CUSTOMER CODE

Reference only



PRODUCT LOT

EX) 1 8 31

MONTH YEAR DATE

MONTH	JAN~SEP:1~9 OCT:X NOV:Y DEC:Z
YEAR	2000:B 2001:C : :
DATE	1:01 2:02 : :

THE PRODUCT SHAPE, THE DIMENSION AND MATERIAL, etc.
MIGHT BE MODIFIED.

REVISION RECORD	DATE	DR
	. .	
	. .	
	. .	
	. .	
	. .	

I SPECIFICATION

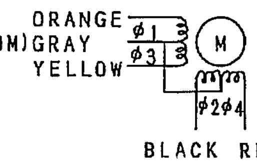
1. REFRIGERANT FOR USE:HFC-134a (CF_3CH_2F) +ESTER OIL
2. AMBIENT TEMPERATURE:-30~+60℃ (COIL DUTY RATIO:50% MAX.)
3. FLUID TEMPERATURE:-30~+60℃ (COIL DUTY RATIO:50% MAX.)
4. AMBIENT HUMIDITY:95%RH MAX.
5. ORIENTATION:MOTOR UPSIDE OR TO VERTICAL (±15° MAX.)
6. OPERATING PRESSURE:0~2.75MPaG
7. FLOW DIRECTION:BI-DIRECTIONAL
8. INSULATION CLASS FOR COIL:CLASS E
9. INSULATION RESISTANCE:100 MEG-OHM MIN (500V DC MEGGER)
10. DIELECTRIC STRENGTH:ENDURES 600V AC X 1 SECOND (OR 500V AC X 1 MINUTE)
11. OPERATING VOLTAGE:12V DC±10% (AT COIL TERMINALS) :REFERENCE
12. ELECTRIC CURRENT:0.35A/PHASE (20℃)
13. ACTUATOR:4-PHASE PERMANENT MAGNET TYPE STEPPING MOTOR (24 POLES) DIRECT-DRIVE
14. EXCITATION TYPE:1-2 PHASE DISTRIBUTION
15. PULSE RATE:83.3PPS
16. VALVE PORT DIAMETER:φ3.5
17. FULL STROKE LIFTS:4.13mm
18. FULL STROKE PULSE:680 PULSES

(CAUTION) DO NOT APPLY MORE THAN 700 PULSES TO OPEN THE VALVE FROM THE CLOSED POSITION.

19. OPERATING PRESSURE DIFFERENCE:0~1.97MPa
20. MAXIMUM PRESSURE DIFFERENCE TO OPEN VALVE WHEN BACK PRESSURE APPLIED:1.27MPa (B→A)
21. SWITCHING MODE & VALVE MOVEMENT

PHASE No.	LEAD WIRE COLORS	SWITCHING MODE 1	2	3	4	5	6	7	8
φ1 A	ORANGE	ON	ON	OFF	OFF	OFF	OFF	OFF	ON
φ2 B	BLACK	OFF	ON	ON	ON	OFF	OFF	OFF	OFF
φ3 $\bar{A}$	YELLOW	OFF	OFF	OFF	ON	ON	ON	OFF	OFF
φ4 $\bar{B}$	RED	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
COM	GRAY								

1→2→3→4→5→6→7→8 (CLOSE)
8→7→6→5→4→3→2→1 (OPEN)



II NOTE

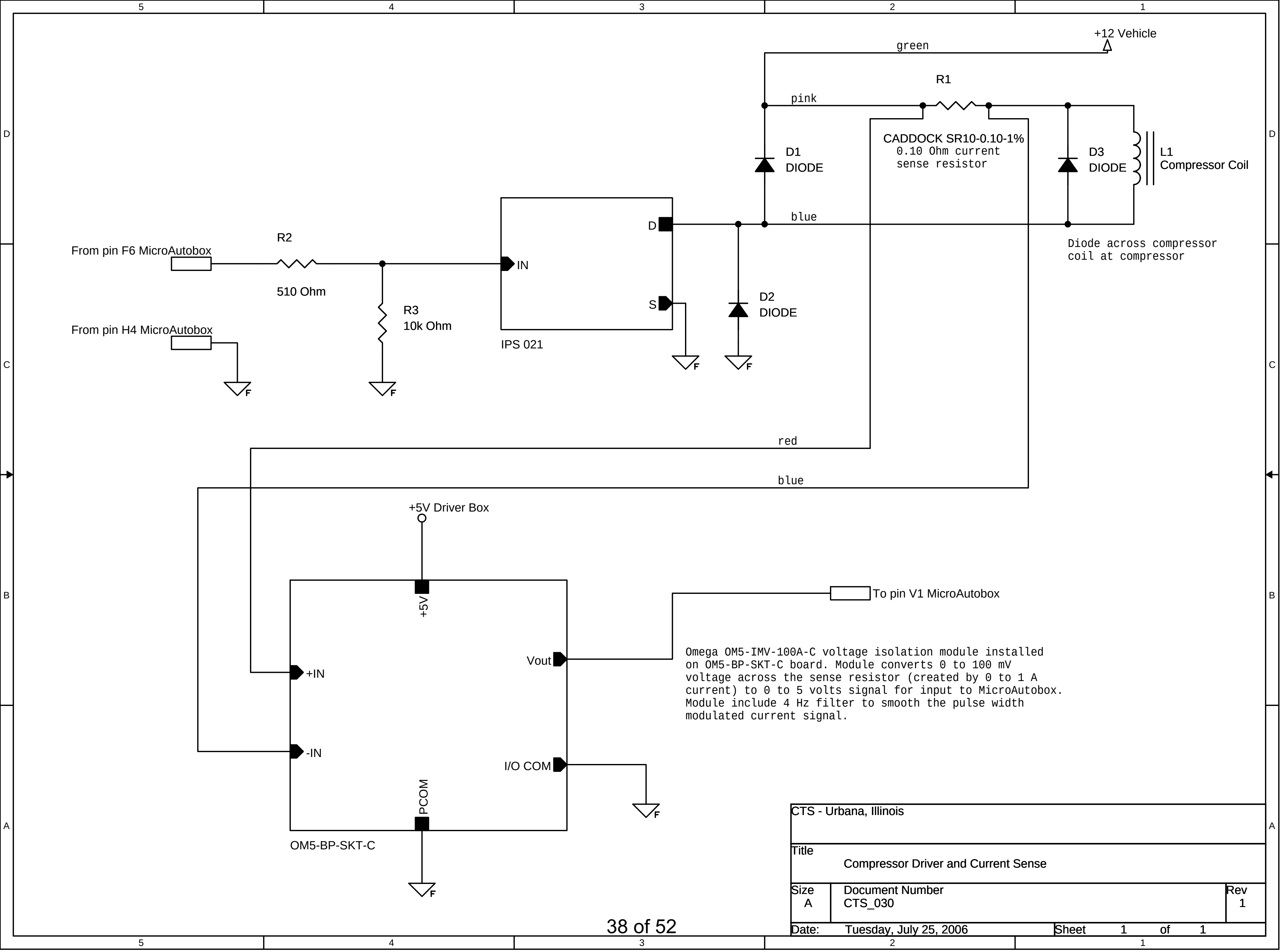
1. WHEN HANDLING THE LEAD.WIRE, DON'T BEND IT EXTREMELY OR PULL IT STRONGLY NOT TO CAUSE THE WATER PROOF DETERIORATING BY THE EXFOLIATION OR THE CRACK OF THE MOLD.
2. ABNORMALITIES DUE TO THE FOLLOWING REASONS ON THE SYSTEM ARE NOT INCLUDED IN SPEC.
   - CORROSION DUE TO HYDROYSIS OF REFRIGERANT OIL
   - PLUG, EROSION AND IRREGULAR OPERATION DUE TO FOREIGN MATERIALS IN REFRIGERANT LINE.

NO.	PART NO.	DESCRIPTION	QTY	MATERIAL	SURFACE TREATMENT	REMARKS
5		RABEL	1			
4		CAP	2			
3		SCREW	2			
2		MOTOR A'SSY	1			
1		BODY A'SSY	1			

(Gr) DIMENSION (THICKNESS, DIAMETER, WIDTH, LENGTH·····)

MASS	SCALE: Free	NAME: ZKFM-60PQFKA-1B-A
MATERIAL	SURFACE TREATMENT	DWG. NO. PLM13-5024027
DWN.	DATE . .	
DWN. CHECKED	DATE . .	
ENGR. N. Kurosawa	DATE 01-31-00	
ENGR. CHECKED 2000.2.-2	DATE . .	FUJIKOKI CORPORATION
CHIEF	DATE . .	

Gr	PRE. DRW. NO	PRE. PARTNAME


+12 Vehicle
green
pink
R1
CADDOCK SR10-0.10-1%
0.10 Ohm current
sense resistor
D1
DIODE
D3
DIODE
L1
Compressor Coil
blue
Diode across compressor
coil at compressor
From pin F6 MicroAutobox
R2
510 Ohm
R3
10k Ohm
D
IN
S
IPS 021
D2
DIODE
From pin H4 MicroAutobox
red
blue
+5V Driver Box
+5V
To pin V1 MicroAutobox
Vout
+IN
-IN
I/O COM
PCOM
OM5-BP-SKT-C
Omega OM5-IMV-100A-C voltage isolation module installed
on OM5-BP-SKT-C board. Module converts 0 to 100 mV
voltage across the sense resistor (created by 0 to 1 A
current) to 0 to 5 volts signal for input to MicroAutobox.
Module include 4 Hz filter to smooth the pulse width
modulated current signal.
CTS - Urbana, Illinois
Title
Compressor Driver and Current Sense
Size
A
Document Number
CTS_030
Rev
1
Date: Tuesday, July 25, 2006
Sheet 1 of 1

Installation of current sense measurement circuit (isolation amplifier)

Install OM5-IMV-100A-C module on the OM5-BP-SKT-C board and connect as shown below. An explanation of certain connections follows the diagram.

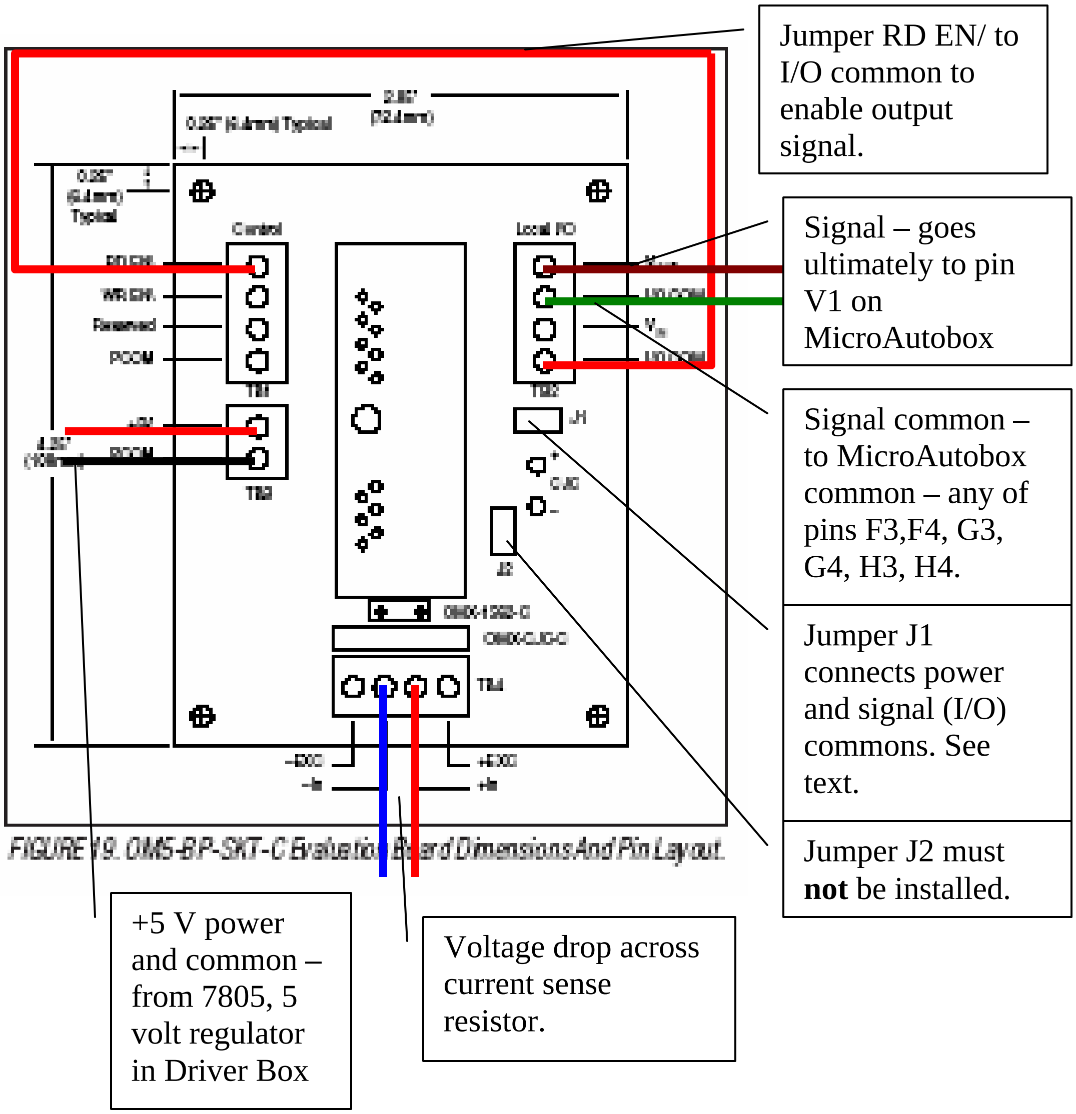
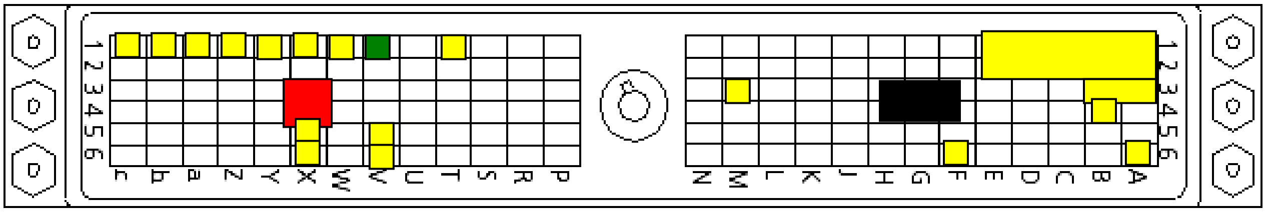


FIGURE 19. OM5-BP-SKT-C Evaluation Board Dimensions And Pin Layout.

See the "Compressor Driver and Current Sense" schematic diagram for connection across the current sense resistor. The current sense resistor is located in an external plastic enclosure.

Jumper J1 should not be installed for this application.

The conditioned current sense resistor voltage signal should go to pin V1 on the MicroAutobox connector. Remove the big connector of the front of the MicroAutobox, you can see how the pins are arranged (see the following diagram).



You should be able to remove the MicroAutobox connector and figure out the pinout from the diagram above (note looking into the connector will be a mirror image of the above – the pins are arranged as shown when looking at the back of the connector after removing its shell. The power and ground pins are shown in red and black respectively. The green pin is the one we are adding. You will have to remove the connector shell. Crimp a pin to a new wire and attach to terminal Vout of the OM5-BP-SKT-C board.

You can go to the dSpace help files and see the instructions on how to take off the connector shell and crimp and install a new pin. (Search for the topic “How to Build the Connector”.)

The OM5-IMV-100A-C module converts the 0 – 100 mV signal across the current sense resistor (100mV corresponds to 1 A) to a 0 to 5 volt signal. The MicroAutobox converts the 0 to 5 volt signal to a number between 0 and 1. Thus the signal measured by the MicroAutobox reads directly in Amps.

Installation of K thermocouple for measurement of compressor outlet temperature.

Install OM5-LTC-K2-C module on the OM5-BP-SKT-C board and connect as shown below. An explanation of certain connections follows the diagram.

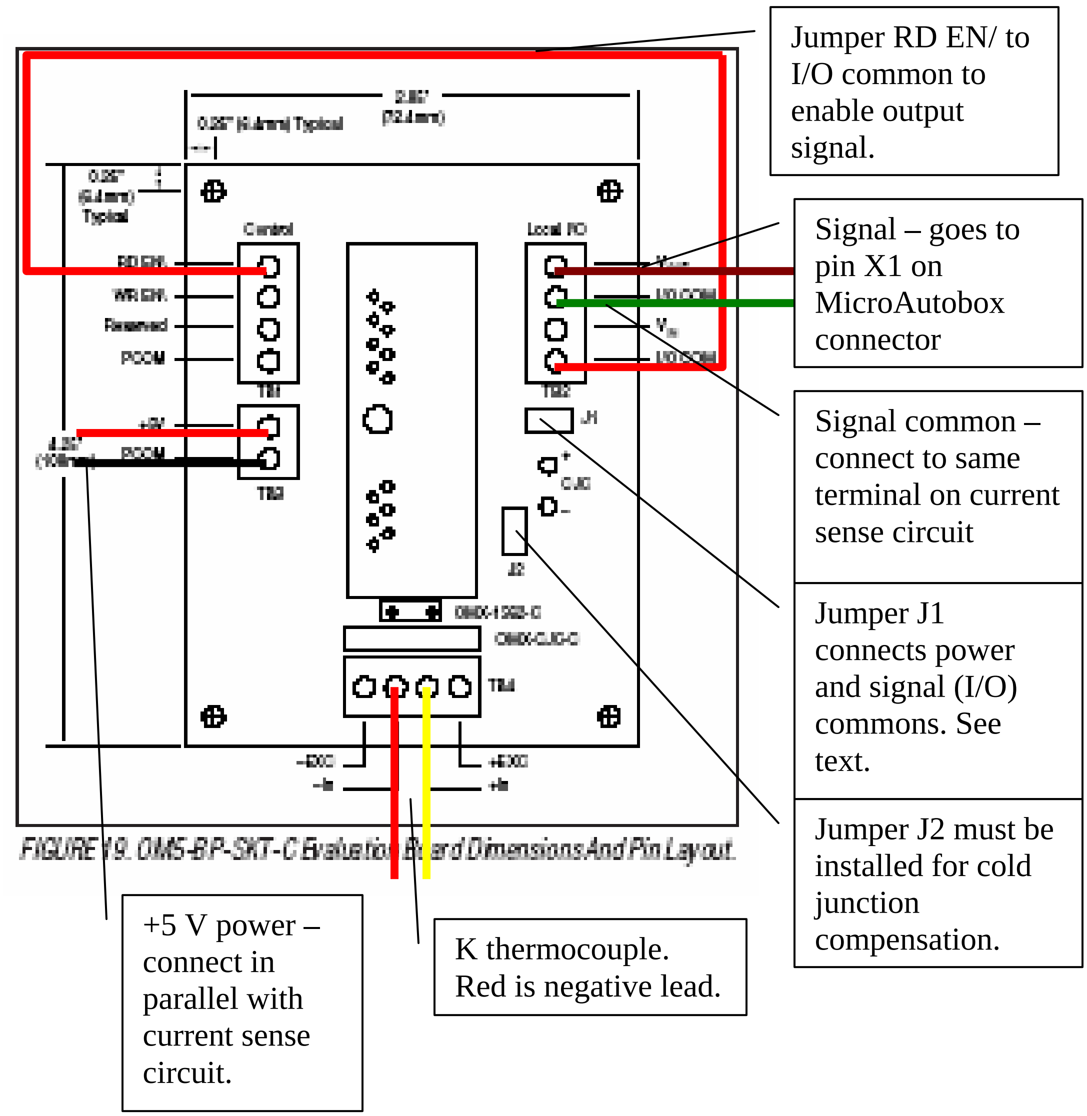
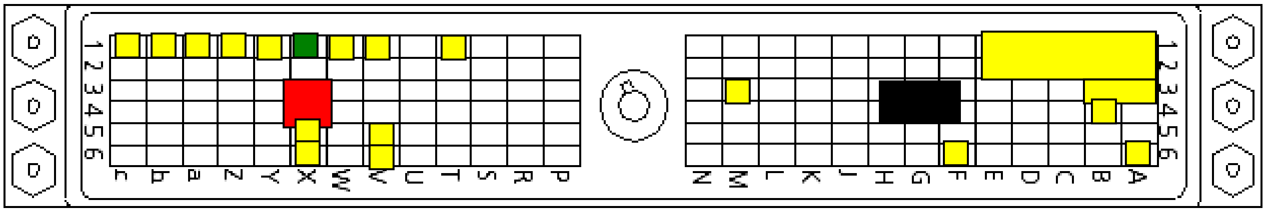


FIGURE 19. OM5-BP-SKT-C Evaluation Board Dimensions And Pin Layout.

The "Compressor Outlet Pipe Temp" thermocouple was wire 38 plugged into physical channel number 26 of the STI data acquisition system.

The installation of jumper J1 depends on the ground status of the thermocouple. Use a DVM to check continuity between one of the thermocouple leads and chassis ground (available in the plastic power distribution box in the floor of the trunk near the bumper). If there is low resistance to chassis ground, do not install jumper J1. If the resistance is larger than, say, 20,000 Ohms, do install the jumper.

The conditioned thermocouple signal should go to pin X1 on the MicroAutobox connector. Remove the big connector of the front of the MicroAutobox, you can see how the pins are arranged (see the following diagram).



You should be able to remove the MicroAutobox connector and figure out the pinout from the diagram above (note looking into the connector will be a mirror image of the above – the pins are arranged as shown when looking at the back of the connector after removing its shell. The power and ground pins are shown in red and black respectively. The green pin is the one we are adding. You will have to remove the connector shell.Crimp a pin to a new wire and attach to terminal Vout of the OM5-BP-SKT-C board.

You can go to the dSpace help files and see the instructions on how to take off the connector shell and crimp and install a new pin. (Search for the topic “How to Build the Connector”.)

The OM5-LTC-K2-C module converts the thermocouple signal to a voltage such that 0 to 500C maps into 0 to 5 volts. The MicroAutobox converts the 0 to 5 volt signal to a number between 0 and 1. This can be checked in the dSpace software. The signal is read by the dSpace system in the software module HWIO, DS1401 Analog Inputs – Mod Spd1. Right click on the ADC_TYPE1_M1_CON2 block and select help. The help topic will tell you the input voltage to internal units mapping. Assuming the 5 volts maps to 1, the conversion relationship between *conversion* and temperature is just:

$$T = (conversion) \bullet 500 \ ^{\circ}\mathrm{C}$$

OM5-WMV/WV
Analog Voltage Input Modules, Wide Bandwidth

FEATURES

- ACCEPTS MILLIVOLT AND VOLTAGE LEVEL SIGNALS
- HIGH LEVEL VOLTAGE OUTPUTS
- 1500Vrms TRANSFORMER ISOLATION
- ANSI/IEEE C37.90.1-1989 TRANSIENT PROTECTION
- INPUT PROTECTED TO 240VAC CONTINUOUS
- 100dB CMR
- 10kHz SIGNAL BANDWIDTH
- ±0.05% ACCURACY
- ±0.02% LINEARITY
- ±1µV/°C DRIFT
- CSA CERTIFIED, FM APPROVED, CE COMPLIANT
- MIX AND MATCH OM5 TYPES ON BACKPANEL

DESCRIPTION

Each OM5 wide bandwidth voltage input module provides a single channel of analog input which is amplified, isolated, and converted to a high level analog voltage output (Figure 1). This voltage output is logic-switch controlled, allowing these modules to share a common analog bus without the requirement of external multiplexers.

The OM5 modules are designed with a completely isolated computer side circuit which can be floated to ±50V from Power Common, pin 16. This complete isolation means that no connection is required between I/O Common and Power Common for proper operation of the output switch. If desired, the output switch can be turned on continuously by simply connecting pin 22, the Read-Enable pin to I/O Common, pin 19.

The input signal is processed through a pre-amplifier on the field side of the isolation barrier. This pre-amplifier has a gain-bandwidth product of 5MHz and is bandwidth limited to 10kHz. After amplification, the input signal is chopped by a proprietary chopper circuit. Isolation is provided by transformer coupling, again using a proprietary technique to suppress transmission of common mode spikes or surges. The module is powered from +5VDC, ±5%.

A special input circuit provides protection against accidental connection of power-line voltages up to 240VAC.

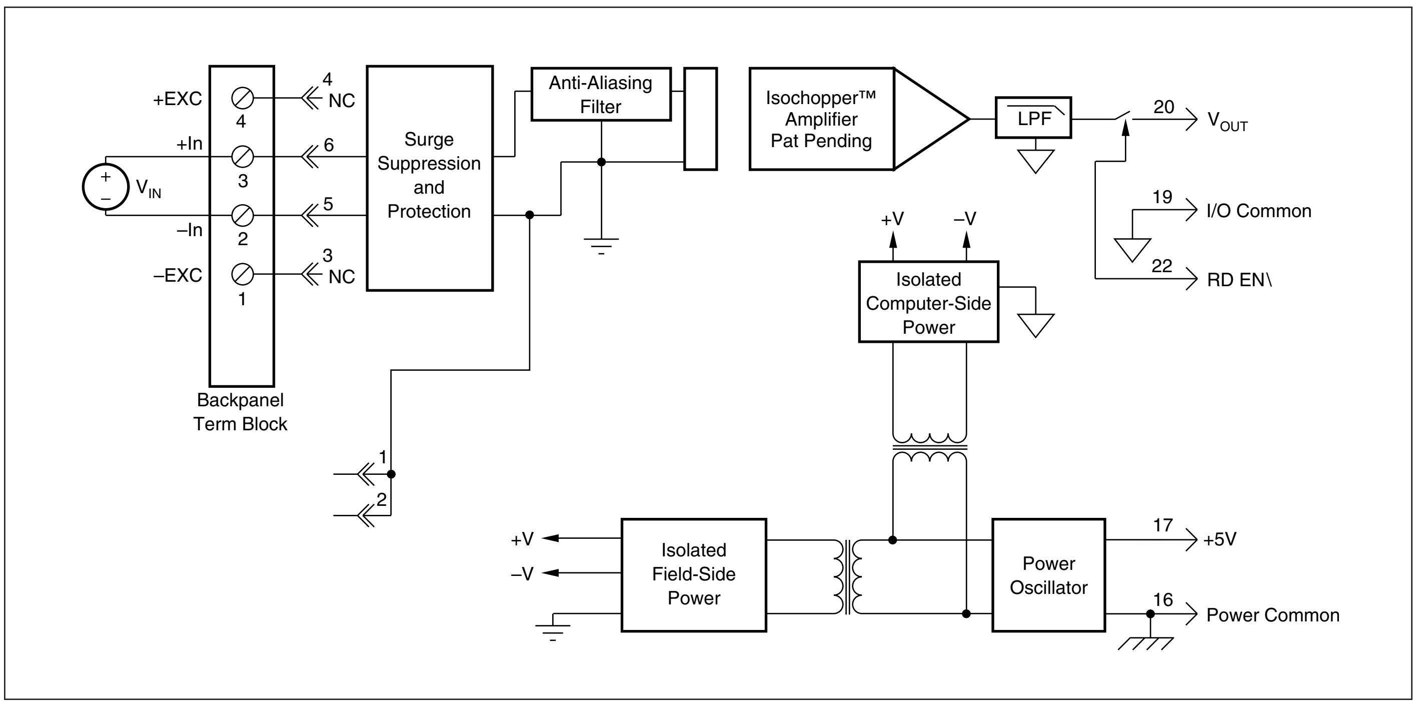


FIGURE 1. OM5-WMV/WV Block Diagram.

SPECIFICATIONS Typical at T_A = +25°C and +5V Power.

Module	OM5-WMV	OM5-WV
Input Range	±10mV to ±100mV	±1V to ±40V
Input Bias Current	±0.5nA	±0.05nA
Input Resistance		
Normal	200MΩ	650kΩ (minimum)
Power Off	40kΩ	650kΩ (minimum)
Overload	40kΩ	650kΩ (minimum)
Input Protection		
Continuous	240Vrms Max	*
Transient	ANSI/IEEE C37.90.1-1989	*
CMV, Input to Output		
Continuous	1500Vrms max	*
Transient	ANSI/IEEE C37.90.1-1989	*
CMR (50Hz or 60Hz)	100dB	*
NMR (–3dB at 10kHz)	120dB per Decade above 10kHz	*
Accuracy(1)	±0.05% Span ±10μV RTI(2) ±0.05%(V_Z(3))	±0.05% span ±0.2mV RTI(2) ±0.05% (V_Z(3))
Nonlinearity	±0.02% Span	*
Stability		
Input Offset	±1μV/°C	±20μV/°C
Output Offset	±40μV/°C	*
Gain	±25ppm/°C	±50ppm/°C
Noise		
Input, 0.1 to 10Hz	0.4μVrms	2μVrms
Output, 100kHz	10mVp-p	*
Bandwidth, –3dB	10kHz	*
Rise Time, 10 to 90% Span	35μs	*
Settling Time, to 0.1%	250μs	*
Output Range	±5V or 0V to +5V	*
Output Resistance	50Ω	*
Output Protection	Continuous Short to Ground	*
Output Selection Time (to ±1mV of V_{OUT})	6μs at C_{load} = 0 to 2000pF	*
Output Current Limit	±8mA	*
Output Enable Control		
Max Logic "0"	+0.8V	*
Min Logic "1"	+2.4V	*
Max Logic "1"	+36V	*
Input Current, "0", "1"	0.5μA	*
Power Supply Voltage	+5VDC ±5%	*
Power Supply Current	30mA	*
Power Supply Sensitivity	±2μV/% RTI(2)	±200μV/% RTI(2)
Mechanical Dimensions	2.28" x 2.26" x 0.60" (58mm x 57mm x 15mm)	*
Environmental		
Operating Temp. Range	–40°C to +85°C	*
Storage Temp. Range	–40°C to +85°C	*
Relative Humidity	0 to 95% Noncondensing	*
Emissions	EN50081-1, ISM Group 1, Class A (Radiated, Conducted)	*
Immunity	EN50082-1, ISM Group 1, Class A (ESD, RF, EFT)	*

* Same specification as OM5-WMV.
NOTES: (1) Includes nonlinearity, hysteresis and repeatability.
(2) RTI = Referenced to input.
(3) V_Z is the input voltage that results in 0V output.

ORDERING INFORMATION

MODEL	INPUT RANGE	OUTPUT RANGE
OM5-WMV-10A-C	–10mV to +10mV	–5V to +5V
OM5-WMV-50A-C	–50mV to +50mV	–5V to +5V
OM5-WMV-100A-C	–100mV to +100mV	–5V to +5V
OM5-WMV-10B-C	–10mV to +10mV	0V to +5V
OM5-WMV-50B-C	–50mV to +50mV	0V to +5V
OM5-WMV-100B-C	–100mV to +100mV	0V to +5V
OM5-WV-1A-C	–1V to +1V	–5V to +5V
OM5-WV-5A-C	–5V to +5V	–5V to +5V
OM5-WV-10A-C	–10V to +10V	–5V to +5V
OM5-WV-1B-C	–1V to +1V	0V to +5V
OM5-WV-5B-C	–5V to +5V	0V to +5V
OM5-WV-10B-C	–10V to +10V	0V to +5V
OM5-WV-20A-C	–20V to +20V	–5V to +5V
OM5-WV-20B-C	–20V to +20V	0V to +5V
OM5-WV-40A-C	–40V to +40V	–5V to +5V
OM5-WV-40B-C	–40V to +40V	0V to +5V

OM5-LTC
Linearized Thermocouple Input Modules

FEATURES

- INTERFACES TO TYPES J, K, T, E, R, S, N, AND B THERMOCOUPLES
- LINEARIZES THERMOCOUPLE SIGNAL
- HIGH LEVEL VOLTAGE OUTPUTS
- 1500Vrms TRANSFORMER ISOLATION
- ANSI/IEEE C37.90.1-1989 TRANSIENT PROTECTION
- INPUT PROTECTED TO 240VAC CONTINUOUS
- 160dB CMR
- 95dB NMR AT 60Hz, 90dB at 50Hz
- ±1μV/°C DRIFT
- CSA CERTIFIED, FM APPROVED, CE COMPLIANT
- MIX AND MATCH OM5 TYPES ON BACKPANEL

DESCRIPTION

Each OM5-LTC thermocouple input module provides a single channel of thermocouple input which is filtered, isolated, amplified, linearized and converted to a high level analog voltage output (Figure 1). This voltage output is logic-switch controlled, allowing these modules to share a common analog bus without the requirement of external multiplexers.

The OM5-LTC modules are designed with a completely isolated computer side circuit which can be floated to ±50V from Power Common, pin 16. This complete isolation means that no connection is required between I/O Common and Power Common for proper operation of the output switch. If desired, the output switch can be turned on continuously by simply connecting pin 22, the Read-Enable pin to I/O Common, pin 19.

The OM5-LTC can interface to eight industry standard thermocouple types: J, K, T, E, R, S, N, and B. Its corresponding output signal operates over a 0V to +5V range. Each module is cold-junction compensated to correct for parasitic thermocouples formed by the thermocouple wire and screw terminals on the mounting backpanel. Upscale open thermocouple detect is provided by an internal pull-up resistor. Downscale indication can be implemented by installing an external 47MΩ resistor, ±20% tolerance, between screw terminals 1 and 3 on the OM5-BP backpanels.

Signal filtering is accomplished with a six-pole filter which provides 95dB of normal-mode-rejection at 60Hz and 90dB at 50Hz. Two poles of this filter are on the field side of the isolation barrier, and the other four are on the computer side.

After the initial field-side filtering, the input signal is chopped by a proprietary chopper circuit. Isolation is provided by transformer coupling, again using a proprietary technique to suppress transmission of common mode spikes or surges. The module is powered from +5VDC, ±5%.

A special input circuit provides protection against accidental connection of power-line voltages up to 240VAC.

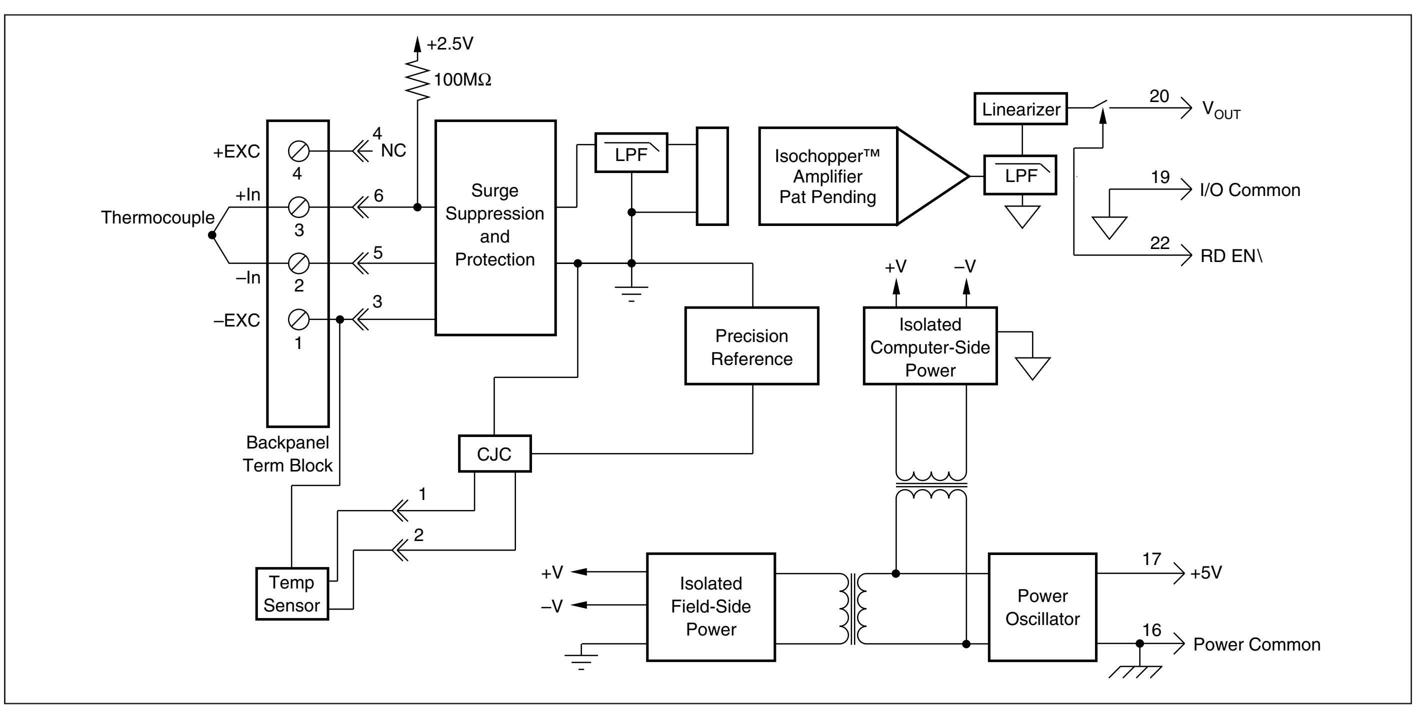


FIGURE 1. OM5-LTC Block Diagram.

SPECIFICATIONS Typical at T_A = +25°C and +5V power.

Module	OM5-LTC
Input Range	–0.1V to +0.5V
Input Bias Current	–25nA
Input Resistance	
Normal	50MΩ
Power Off	40kΩ
Overload	40kΩ
Input Protection	
Continuous	240Vrms max
Transient	ANSI/IEEE C37.90.1-1989
CMV, Input to Output	
Continuous	1500Vrms max
Transient	ANSI/IEEE C37.90.1-1989
CMR (50Hz or 60Hz)	160dB
NMR	95dB at 60Hz, 90dB at 50Hz
Accuracy	See Ordering Information
Stability	
Input Offset	±1µV/°C(1)
Output Offset	±20µV/°C
Gain	±25ppm/°C
Noise	
Input, 0.1 to 10Hz	0.2µVrms
Output, 100kHz	300µVp-p, 150µVrms
Bandwidth, –3dB	4Hz
Response Time, 90% Span	0.2s
Output Range	0V to +5V
Output Resistance	50Ω
Output Protection	Continuous Short to Ground
Output Selection Time (to ±1mV of V_{OUT})	6µs at C_{load} = 0 to 2000pF
Output Current Limit	+8mA
Output Enable Control	
Max Logic "0"	+0.8V
Min Logic "1"	+2.4V
Max Logic "1"	+36V
Input Current, "0", "1"	0.5µA
Open Input Response	Upscale
Open Input Detection Time	10s
Cold Junction Compensation	
Accuracy, 25°C	±0.25°C
Accuracy, +5°C to +45°C	±0.5°C
Accuracy, –40°C to +85°C	±1.25°C
Power Supply Voltage	+5VDC ±5%
Power Supply Current	30mA
Power Supply Sensitivity	±2µV/% RTI(2)
Mechanical Dimensions	2.28" x 2.26" x 0.6" (58mm x 57mm x 15mm)
Environmental	
Operating Temp. Range	–40°C to +85°C
Storage Temp. Range	–40°C to +85°C
Relative Humidity	0 to 95% Noncondensing
Emissions	EN50081-1, ISM Group 1, Class A (Radiated, Conducted)
Immunity	EN50082-1, ISM Group 1, Class A (ESD, RF, EFT)

NOTES: (1) This is equivalent to °C as follows: Type J 0.020 °C/°C, Types K, T 0.025°C/°C, Type E 0.016°C/°C, Types R, S 0.168°C/°C, Type N 0.037°C/°C, Type C 0.072°C/°C.
(2) Referenced to input.

ORDERING INFORMATION

MODEL	TYPE	INPUT RANGE	OUTPUT RANGE	ACCURACY†	
OM5-LTC-J1-C	Type J	0°C to +760°C (+32°F to +1400°F)	0V to +5V	±0.08%	±0.61°C
OM5-LTC-J2-C	Type J	-100°C to +300°C (-148°F to +572°F)	0V to +5V	±0.08%	±0.32°C
OM5-LTC-J3-C	Type J	0°C to +500°C (+32°F to 932°F)	0V to +5V	±0.07%	±0.36°C
OM5-LTC-J4-C	Type J	-100°C to +760°C (-148°F to +1400°F)	0V to +5V	±0.08%	±0.70°C
OM5-LTC-K1-C	Type K	0°C to +1000°C (+32°F to +1832°F)	0V to +5V	±0.08%	±0.80°C
OM5-LTC-K2-C	Type K	0°C to +500°C (+32°F to +932°F)	0V to +5V	±0.08%	±0.38°C
OM5-LTC-K3-C	Type K	-100°C to +1350°C (-148°F to +2462°F)	0V to +5V	±0.08%	±1.2°C
OM5-LTC-T1-C	Type T	-100°C to +400°C (-148°F to +752°F)	0V to +5V	±0.16%	±0.80°C
OM5-LTC-T2-C	Type T	0°C to +200°C (+32°F to +392°F)	0V to +5V	±0.13%	±0.25°C
OM5-LTC-E-C	Type E	0°C to +1000°C (+32°F to +1832°F)	0V to +5V	±0.10%	±1.0°C
OM5-LTC-R-C	Type R	+500°C to +1750°C (+932°F to +3182°F)	0V to +5V	±0.10%	±1.3°C
OM5-LTC-S-C	Type S	+500°C to +1750°C (+932°F to +3182°F)	0V to +5V	±0.10%	±1.3°C
OM5-LTC-B-C	Type B	+500°C to +1800°C (+932°F to +3272°F)	0V to +5V	±0.15%	±2.0°C

†Includes conformity, hysteresis and repeatability. Does not include CJC accuracy.

OM5-BP-SKT-C ANALOG MODULE EVALUATION BOARD

DESCRIPTION

The OM5-BP-SKT-C is a single channel board with a test socket for OM5 module evaluation (Figure 19). All signal input/output, control, and power connections are connected to terminal blocks for ease of user access. A cold junction temperature sensor circuit is included for evaluation of thermocouple modules. (See Figure 20 for schematic).

The OM5-BP-SKT-C is mechanically compatible with DIN rail mounting using the following elements:

- 2 OM7-DIN-SF base elements with snap foot
- 2 OM7-DIN-SE side elements
- 4 OM7-DIN-CP connection pins

Two jumpers are provided for customer use. The first, J1, provides a current path between +5V Power Common (module pin 16) and I/O Common (module pin 19). A path must exist between the host control logic power common and module I/O Common for proper operation of the module output switch or track-and-hold circuit. If this connection exists elsewhere in the system, jumper J1 should be removed since possible ground loops could exist. Other connections of power ground and signal ground usually occur at the A/D or D/A converter of the host measurement system.

Jumper J2 is used in the cold junction compensation circuit. If it is installed, the compensation circuit is enabled and will provide the proper compensation voltage to correct for the thermoelectric effect at the +In and –In screw terminals. If an external simulation voltage is desired for cold junction compensation, J2 should be removed. The external voltage is applied at the sockets labled CJC+ and CJC–. An external voltage of 510.0 mV corresponds to an ambient temperature of +25 °C. The transfer function of the onboard compensation circuit is V_{CJC} = 0.510 –0.0025(T–25)V.

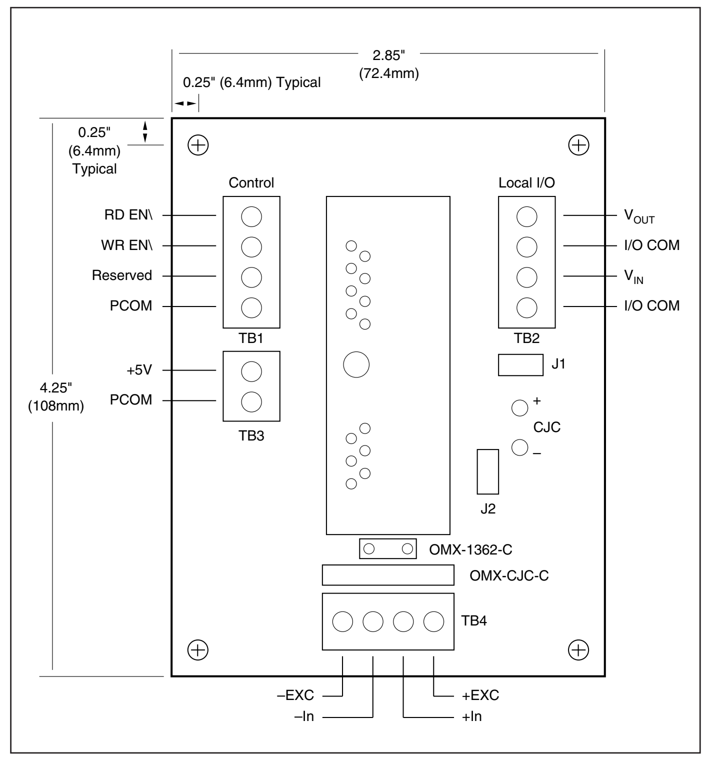


FIGURE 19. OM5-BP-SKT-C Evaluation Board Dimensions And Pin Layout.

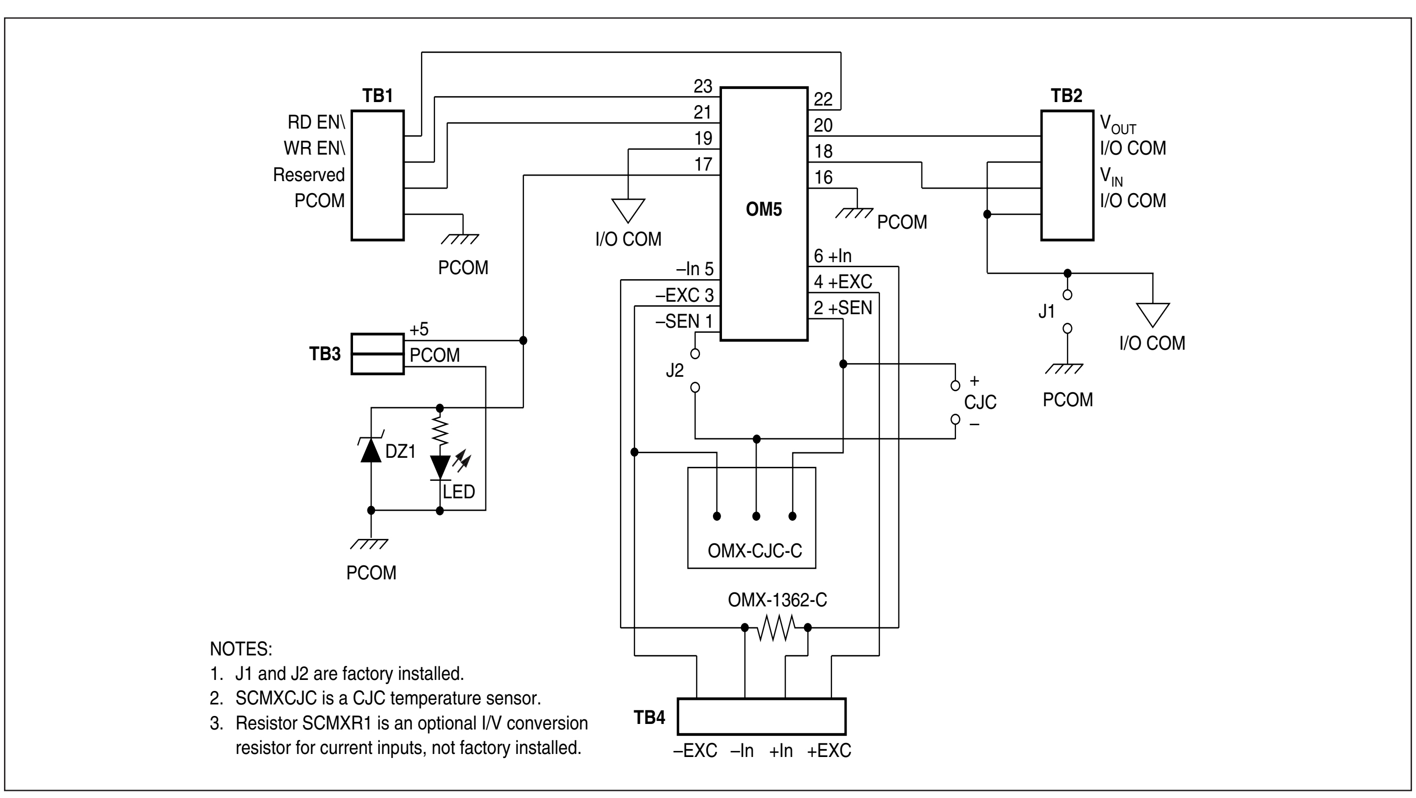


FIGURE 20. OM5-BP-SKT-C Evaluation Board Schematic.

SPAL USA
LIMITED WARRANTY STATEMENT

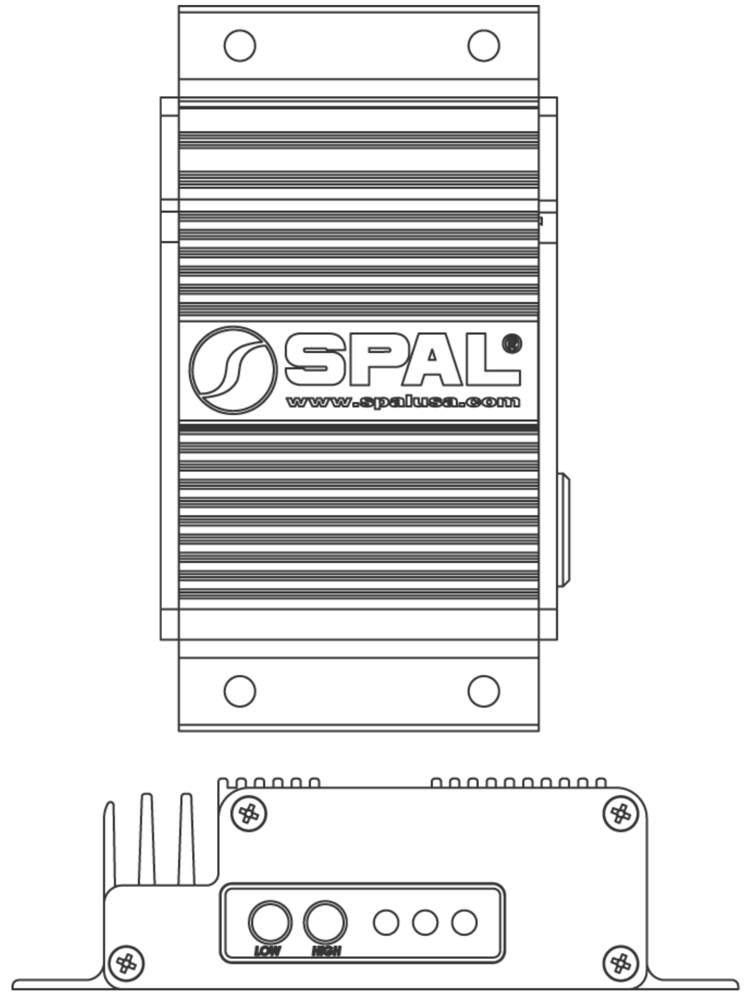
SPAL USA warrants this product to be free from defects in material and workmanship for a period of eighteen (18) months from the date of sale to the original purchaser. SPAL USA will repair this product free of charge if, in the judgment of SPAL USA, it has been proven defective within the warranty period. The product should be returned, at the customer expense, to the location of original purchase. This warranty does not cover any expenses incurred in the removal and/or reinstallation of the product.

This warranty does not apply to any product damaged by improper installation, misuse, abuse, improper line voltage, fire, flood, lightning, or other acts of God, or a product altered or repaired by anyone other than SPAL USA.

This warranty is in lieu of other warranties, expressed or implied, including any implied warranty of merchantability. No person is authorized to assume for SPAL USA any other liability concerning the sale of this product.

IMPORTANT-KEEP YOUR INVOICE WITH THIS WARRANTY STATEMENT!

FAN-PWM
INSTALLATION INSTRUCTIONS



SPAL
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The SPAL Electric Fan Controller (FAN-PWM) will Pulse Width Modulate a single SPAL electric fan allowing the unit to vary the fan speed based on engine temperature. A second fan can be added with the use of an additional fan wiring kit (SPAL part number FRH). The second fan will not be PWM controlled; it will be ON/OFF only.

Low Setting

When the Low setting is reached the yellow LED will light and the fan will run at 100% for 1/2 second to get the fan rotating. After the initial kick-start, the fan will run at 50%, or 1/2 speed.

High Setting

When the High setting is reached the red LED will light and the fan will run at 100%, or full speed, until the engine cools to the point that the fan can lower its speed. When the red LED lights, a negative output will also be sent on the grey wire. This is used to trigger a secondary fan relay.

Wiring

The SPAL Electric Fan Controller is waterproof and can be mounted inside the vehicle or the engine compartment.
Mount the Fan Controller away from high heat sources such as engine exhaust. A wheel well, the radiator support, or the firewall are good mounting locations.

Single Fan

Please see Single Fan wiring instructions on pages 5-8.

Dual Fan

A dual fan set-up requires a Fan Relay Harness (SPAL part number FRH) to power the secondary fan.
Please see Dual Fan wiring instructions on pages 9-12.

Factory (OEM) Temperature Sensor

The SPAL Fan Controller can be connected to the factory (OEM) temperature sensor or an aftermarket electric gauge sensor. This eliminates the need for an additional sensor. (The FAN-PWM is designed to use the OEM factory type sensor on fuel-injected vehicles. Some older style sensors will not work.)

- If using the factory OEM style sensor, the SPAL Fan Controller must be programmed.
- Please see the programming section on pages 3 and 4.

SPAL Temperature Sensor (FAN-PWM-TS)

If your vehicle is not equipped with an OEM temperature sensor, you can purchase a SPAL temperature sensor that plugs directly into the Fan Controller.
This sensor should be located in the engine head or intake manifold for optimal performance.

- When using the SPAL temperature sensor, the Fan Controller is preset from the factory with a Low setting of 160°, and a High setting of 200°.
- If different settings are required, please see the programming section on pages 3 and 4.

Introduction / Overview

If you are using Air Conditioning you can connect the Blue wire to the 12V wire of the air conditioning compressor. When the compressor turns on, the fan(s) will run at 100%. and the green LED will light.

Unused Wires

Depending on your specific system, you may have extra wires that are not being used. These wires can be coiled and contained in a non-conspicuous location. Or for a cleaner installation the unused wires may be cut. However, if cutting the wires, be sure to cover the ends of the wires with electrical tape or equivalent.

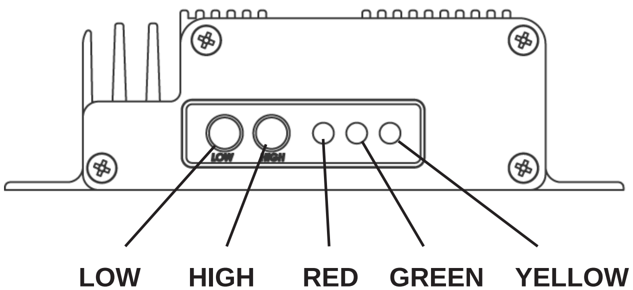
Suggested Fuse Values

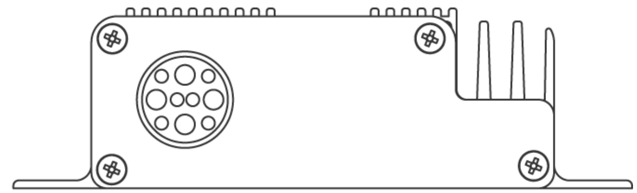
The fusing of the FAN-PWM is dependent upon the size and style of fan used. Please reference the suggested fuse values table on Page 13.

Programming Section

LED's:

Red: Indicates high temperature setting has been reached.
•Fan(s) run at full speed.
Yellow: Indicates low temperature setting has been reached.
•Fan starts at half-speed and increases until high temperature setting is reached.
Green: Indicates the Air Conditioning has been powered ON.
•Fan(s) run at full speed.





WIRE HARNESS CONNECTOR

Programming

The fan must remain unplugged during programming.

- Unplug fan.
- Start vehicle.
- Allow engine to warm-up to desired "low" temperature.
- Once temperature has been reached, press and hold the "Low" button for 3 seconds to set the "low temperature."
- Yellow LED will light.
- When desired "high temperature" setting is reached, press and hold the "High" button for 3 seconds.
- Red LED will light.
- Programming is complete. Turn off ignition.
- Allow vehicle to cool.
- Plug in your fan.
- Start vehicle and confirm the fan turns on at the correct temperatures.

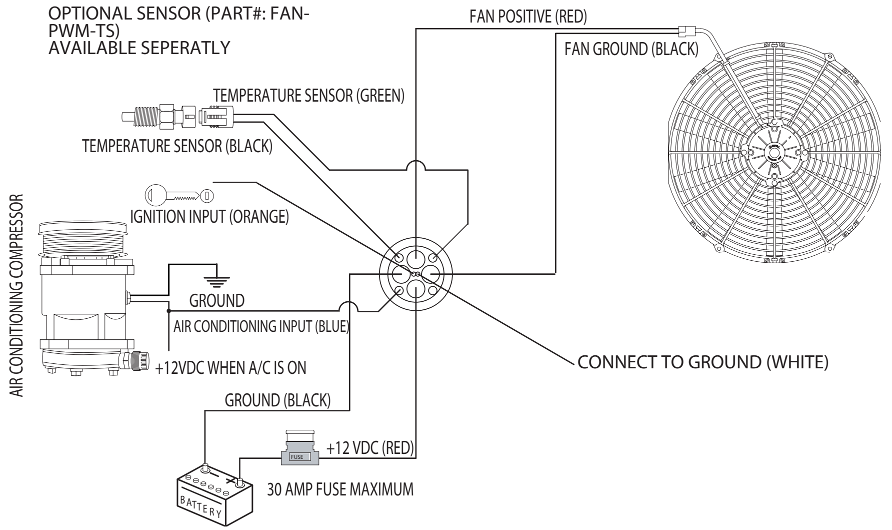
Example

If you want your fan to spin at half-speed at 160 degrees, and spin at full-speed at 200 degrees, you would:

- Unplug fan.
- Warm-up vehicle to 160 degrees.
- Press and hold Low Button for 3 seconds.
- Yellow LED lights
- Continue to warm-up vehicle to 200 degrees.
- Press and hold High Button for 3 Seconds.
- Red LED lights
- Turn off the vehicle.
- Allow vehicle to cool.
- Plug in your fan.
- Start vehicle and confirm the fan turns on at the correct temperatures.

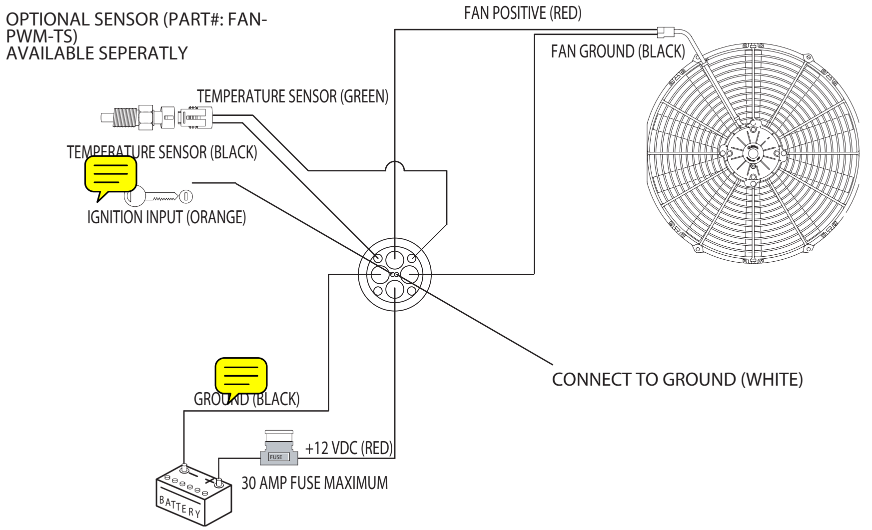
Single Fan - SPAL Sensor - with AC:

PWM Wire	Connects To:
Large Gauge	
Red	Positive 12 VDC Directly to Battery
Black	Ground Directly to Battery
Red	Primary Fan Positive
Black	Primary Fan Ground
Small Gauge	
Orange	Ignition
Blue	Air Conditioning Input
Grey	Secondary Fan Output (Not Used)
Green/Black	SPAL Temperature Sensor
White	Ground

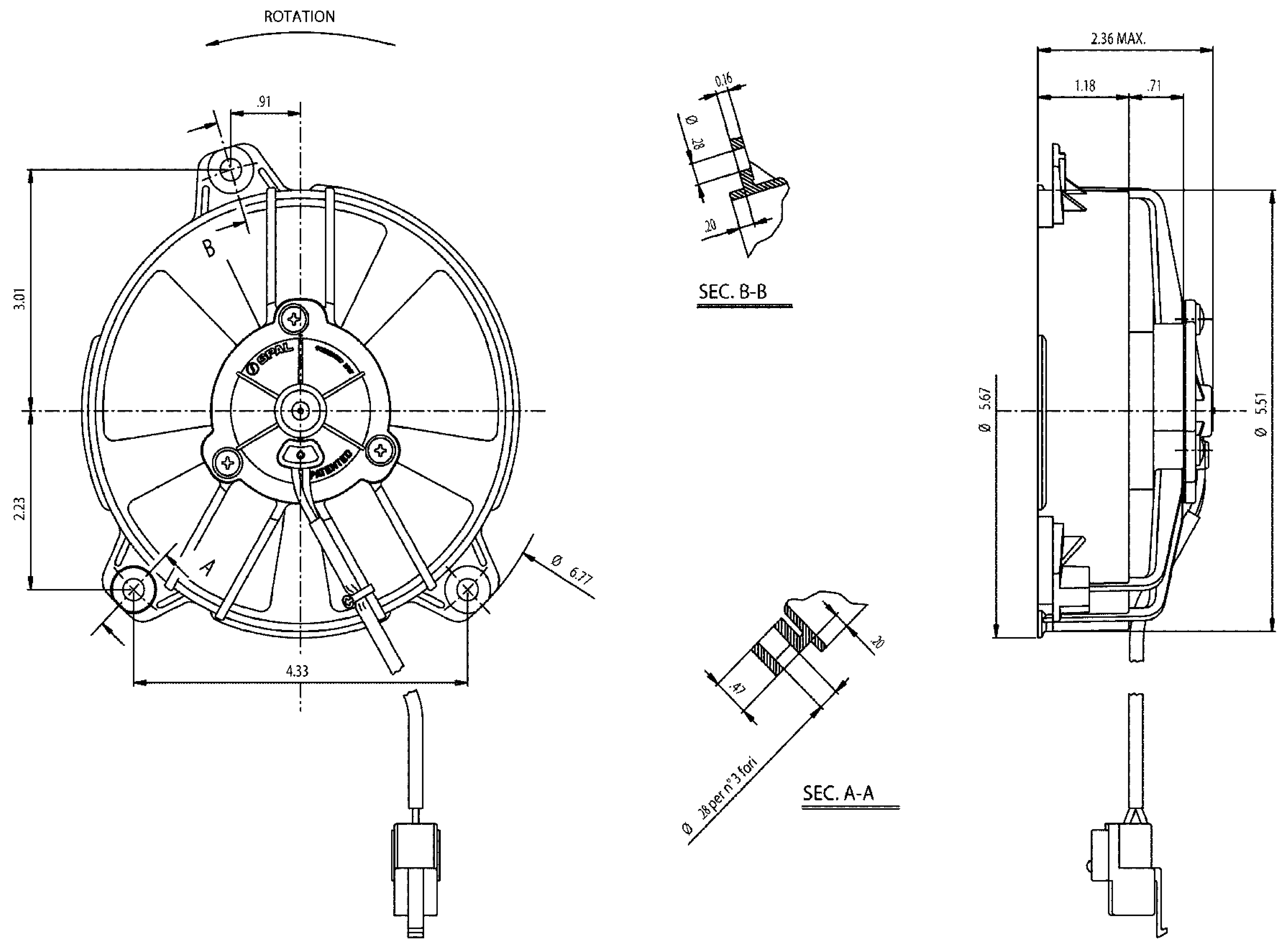


Single Fan - SPAL Sensor - without AC:

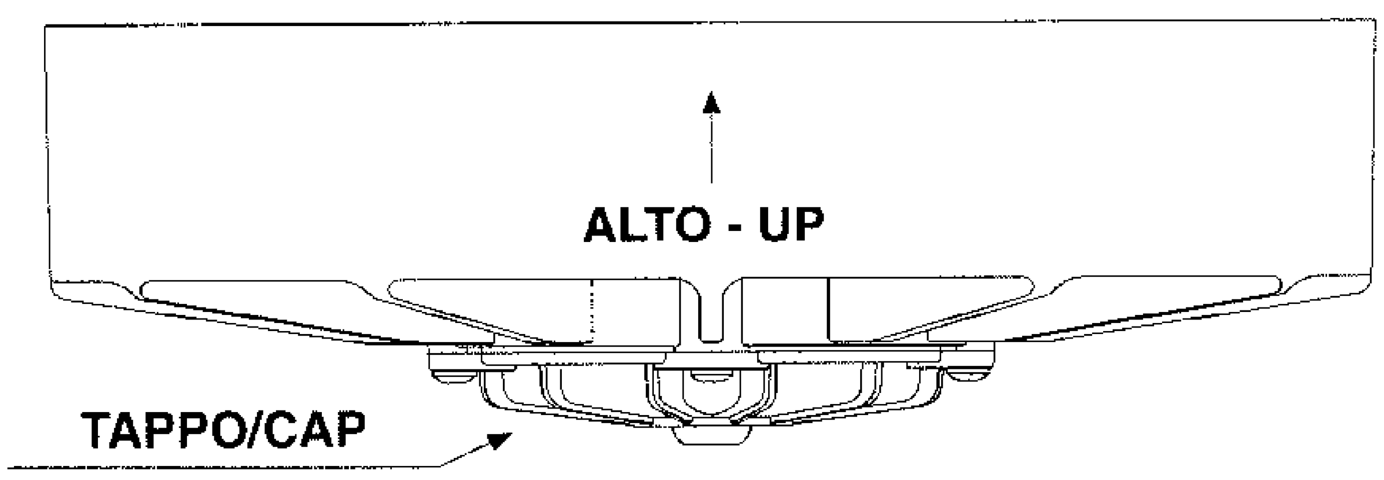
PWM Wire	Connects To:
Large Gauge	
Red	Positive 12 VDC Directly to Battery
Black	Ground Directly to Battery
Red	Primary Fan Positive
Black	Primary Fan Ground
Small Gauge	
Orange	Ignition
Grey	Secondary Fan Output (Not Used)
Green/Black	SPAL Temperature Sensor
White	Ground
Blue	Air Conditioning Input (Not Used)



Art.	Type	Fan diameter
30103011 **30103013**	VA31-A101-46 A Pull VA31-A101-46 S Push	5.1"



(All dimensions are in inches)



-For mounting with vertical motor axle remove the cap for the condensate discharger

*Weight .90 lbs. approx.

*Closed Motor

*Long Life

*Available accessories: all the mounting kits

Test voltage 13 V DC

Static pressure in. H_2O	Airflow cfm	Current input A
0	313	3.6
0.2	283	3.7
0.4	224	3.9
0.5	195	4.0
0.6	159	4.1
0.8	88.5	4.5

Static pressure: 1 mm H_2O = 0,04 in. H_2O
Airflow: 1 m^3/h = 0,59 cfm