HELIUM COMPRESSOR MONITORING SYSTEM

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CONTENTS

CONTENTS (continued)

1. Design goals

Helium refrigerators cool the cryogenically-operated HEMT receivers. Compressors provide the high-pressure helium gas required by the refrigerators. This source of compressed gas is connected to the bottom of cylinder C (FIG. 1) through inlet valve A. Valve B is in the exhaust line leading to the low-pressure side of the compressor. With the piston at the bottom of the cylinder, and with exhaust valve B closed and inlet valve A open, the piston is caused to move upward and the cylinder fills with compressed gas. When valve A is closed and valve B is opened, the gas expands into the low-pressure discharge line and cools. The resulting temperature gradient across the cylinder wall causes heat to flow from the load into the cylinder. As a result, the gas warms to its original temperature. With valve B open and valve A closed, the piston is then lowered, displacing the remaining gas into the exhaust line, and the cycle is completed.

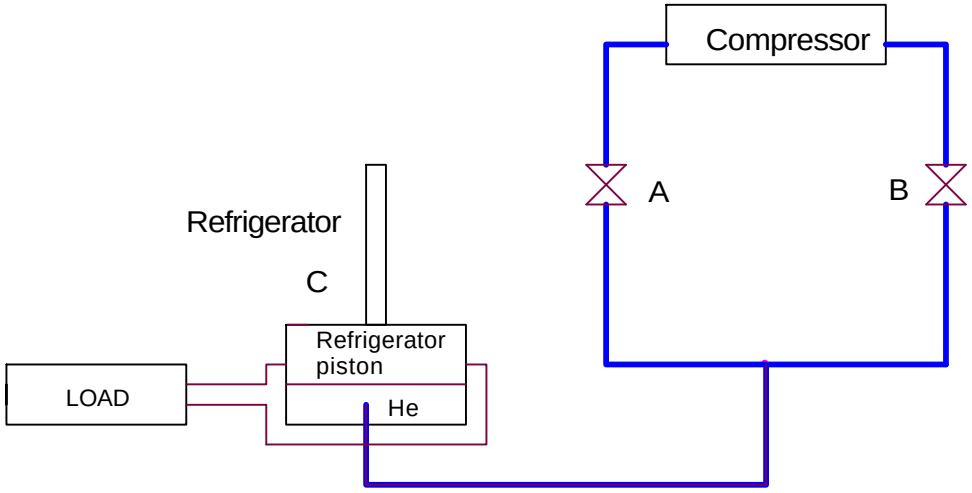


FIG. 1 Schematic of helium refrigerator cooling system

Early detection of a potential or actual compressor failure can minimize recovery time and thereby minimize downtime of the receivers. It is therefore desirable to remotely monitor the condition of the each compressor as indicated by the supply and return line pressure, the on/off status, the compressor motor temperature, and loss of phase in the compressor motor.

1.1 Features of the compressor monitoring system

A system to monitor these parameters with an EDAS (Ethernet Data Acquisition System) from Intelligent Instrumentation (Burr Brown) has been developed. Planning for a maximum of 10 compressors, features of the monitoring system include

- Display compressor supply pressure
- Display compressor return pressure
- Display compressor motor temperature
- Monitor compressor motor phase loss
- Monitor ON/OFF status
- Check if supply pressure has exceeded user-defined limits
- Check if temperature has exceeded user-defined limits
- Detect and display minimum supply pressure since last reset
- Detect and display maximum temperature reached since last reset
- Display trigger levels
- Indicate when compressor is due for service
- Indicate if compressor is offline
- Provision to change mapping of receivers to compressors
- Provision for changing alarm limits
- Provision for entering most recent date of service
- Provision for a monitor window, which expands to full display at onset of alarm state
- Datalogging

2. EDAS : The basis of the data acquisition

EDAS provides real-time I/O over Ethernet, making data available on other networked resources, PC's, workstations, and/or databases. The compressor monitoring system is based on the EDAS-1002E Multifunction Ethernet Data Acquisition System. LabWindows/CVI (*C V*irtual *I*nstrumentation), a programming environment for developing data acquisition applications in ANSI C, is used to analyze and display data received from the EDAS over Ethernet on a PC using the Net Link Software Libraries for the EDAS unit. The PC does not need to have the LabWindows application installed. A stand-alone disk containing the required runtime engine is sufficient to run the monitoring system application.

The three LabWindows displays developed to facilitate remote monitoring of the helium compressors are shown in FIGS. 2a,b, and c. The Compressor Status display in FIG. 2a presents conditions as a function of compressor, the desired compressor chosen via a pulldown window. The supply pressure, return pressure, and temperature are shown on virtual analog gages as well as in strip chart form. Provision to reset alarms, view extremes reached, and to view trigger levels is also included. The status (on/off, in service, off line, and alarm states) of all 10 compressors is displayed via virtual LEDs. From this window, one can select the other displays: the Configuration/Reconfiguration Page, the EDAS Monitor, and a display of the file containing the logged data.

FIG. 2b shows the Configuration/Reconfiguration Page. This window is used to change the mapping of receivers to compressors, to set alarm levels, and to record the last date of service. Changing these parameters requires a password.

FIG. 2c shows the Monitor Window. This panel provides a miniature overview of the compressor status, consuming only a small amount of space on the screen. If a compressor changes to an alarm state when the EDAS Monitor is displayed, the main Compressor Status display will automatically open to signal trouble.

Specifications of the monitoring system are shown in TABLE 2.1.

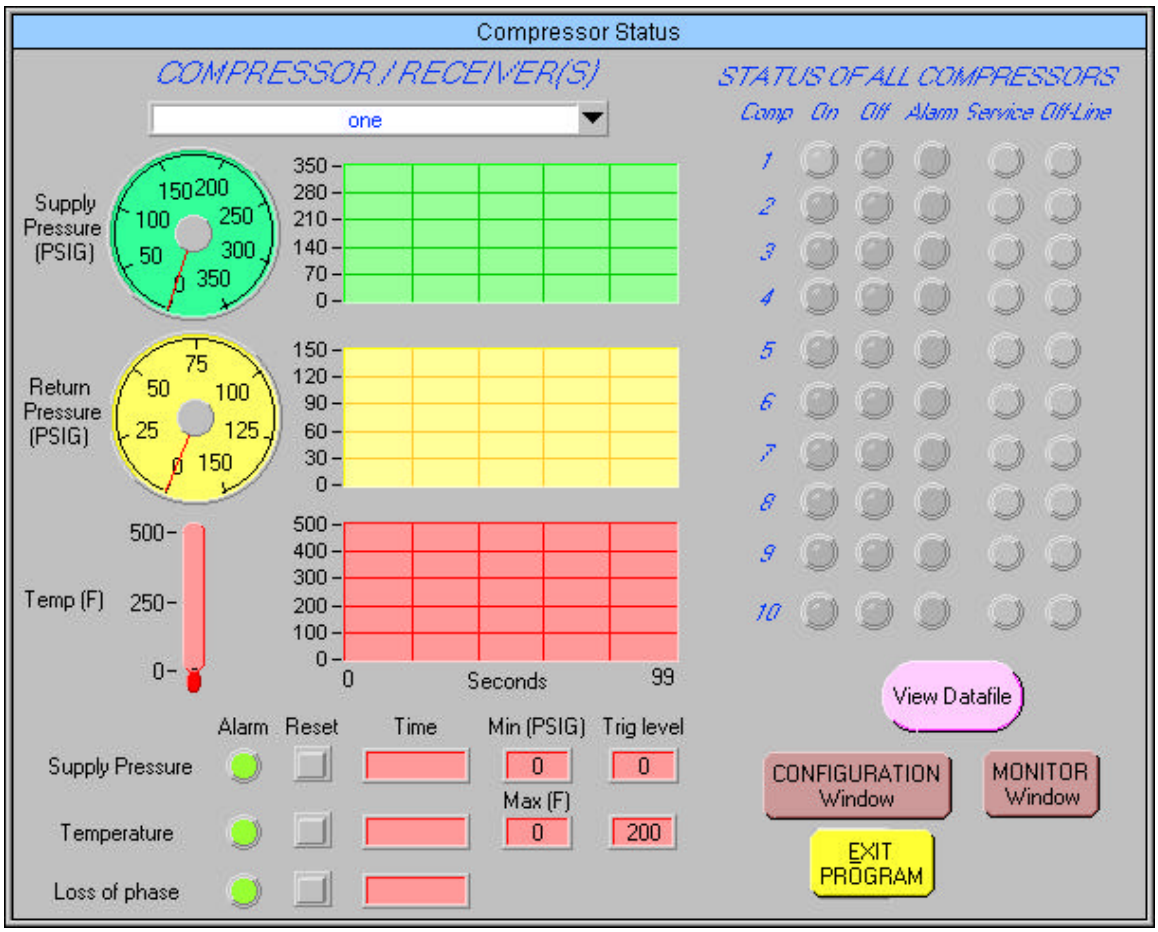


FIG. 2a Compressor Status window

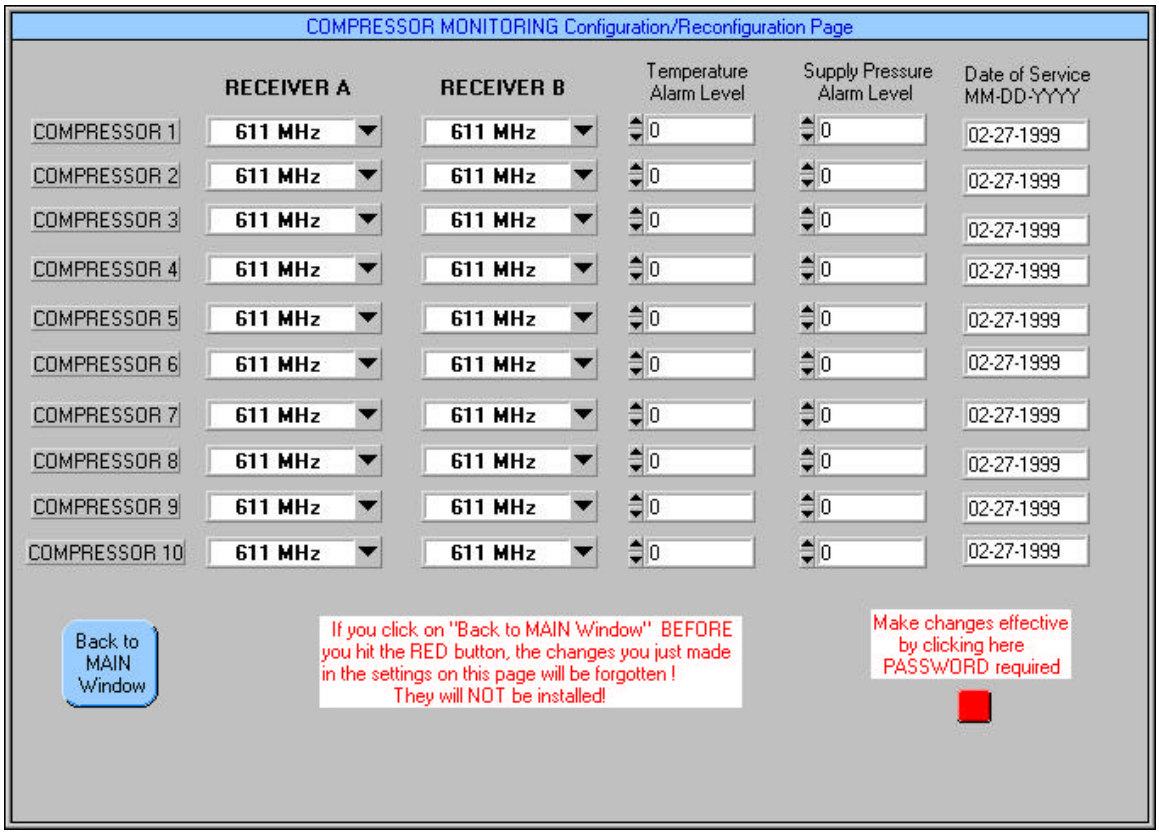


FIG. 2b Configuration/Reconfiguration Page

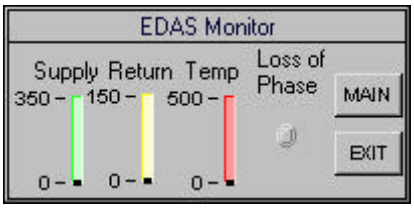


FIG. 2c EDAS Monitor display

Parameter	Alarm	Reset-able alarm	Variable alarm level	Time-stamp alarm	Record data 1/10s
Supply pressure	yes	yes	yes	yes	yes
Return pressure	no	no	no	no	yes
Temp	yes	yes	yes	yes	yes
ON/OFF	yes	no		no	yes
Loss of Phase	yes	yes		yes	yes
Being Serviced	yes	yes		yes	yes
Needs Service	yes	yes	yes	yes	yes

TABLE 2.1 Compressor parameters to be monitored

2.1 EDAS Analog Input/Output Resolution

The EDAS-1002E provides 16 single-ended or 8 differential analog inputs at 12-bit resolution. Programmable input range options are ± 0.1 V, ± 1 V, ± 10 V and 0-0.1 V, 0-1.0 V, and 0 - 10V. In this application, the EDAS is programmed to use 8 differential inputs using the ± 10 V range, which corresponds to 2.44mV/bit.

Note: Analog data is returned in A/D "common format counts". If a bipolar range is used, the data values will be from -32768 to 32767. If a unipolar range is used, the data values will be from 0-65535. Observation of these ranges (verified from observation of counts from acquired data) would imply 16-bit resolution ($2^{16} = 65536$). Per consultation with a technical consultant at Intelligent Instruments, it was learned that although the EDAS has a pair of 8-bit registers, the lower 4 bits are ignored by the processor. Therefore, The EDAS really only uses 2^{12} (4096) bits, resulting in 12-bit resolution. A data acquisition system newly released by Intelligent Instruments implements all 16-bits of resolution.

2.2 EDAS Analog Input/Output Speed

The speed of the EDAD-1002E is specified as "up to 100 kHz input sample rate (built-in timebase generator)".

A LabWindows timing function, Timer (), was used to clock the analog reads. According to the LabWindows Standard Library Reference Manual, the resolution on Windows is normally 1 ms. The following code was run to measure the data-read rate. The number of iterations of the read statement was varied from 100 to 1,000,000 in an effort to minimize the fraction of time included for implementing the loop. Note that 8 differential analog inputs are read per read statement. The results shown in TABLE 2.2 indicate a rate of inputs read of about 25 kHz. This is probably consistent with the maximum rate of 100 kHz specified for the EDAS, because the code used for the test includes the time required to increment the loop.

```
before_seconds = Timer();

for (transducer=0; transducer<1000000; ++transducer)
{
        nAIRead(tcpid, ALL_CHANNELS, 1, counts);
}

after_seconds =Timer();
difference = after_seconds - before_seconds;
rate = (transducer * 8)/difference;   /* 8 = number of channels / read  */
printf("BEFORE AFTER %d %f %f %f\n\n", transducer, before_seconds, after_seconds,
rate);
```

Number of iterations	Frequency (inputs read/sec)
100 (300 inputs read)	26,667
1000 (3000 inputs read)	26,490
10,000 (80,000 inputs read)	25,873
100,000 (800,000 inputs read)	25,554
1,000,000 (8,000,000 inputs read)	25,490

TABLE 2.2 Measured data read rate for EDAS

3. Multiplexer options

The EDAS-1002E can be configured for 16 single-ended (SE) or 8 differential analog inputs and provides 16 TTL compatible digital I/O channels. In order to monitor the proposed 30 differential analog inputs and 20 digital inputs, two approaches for expansion were proposed. One approach is to use the analog expansion system, AI-MAX, accompanied by an EDAS-1001E Digital I/O Ethernet Data Acquisition System, both provided by Intelligent Instrumentation. The other option, which has been implemented, is to design and build an analog and digital multiplexer circuit to interface with the EDAS-1002E Multifunction Ethernet Data Acquisition System. Note that both options use the EDAS-1002E Multifunction Ethernet Data Acquisition System, and both options would use LabWindows/CVI and the Net Link Software Libraries to interface the data acquisition hardware with the PC. Each option is described below.

3.1 AI-MAX option (*analog multiplexer and digital expansion purchased from Burr-Brown*)

The EDAS-1002E is expandable to up to 256 SE or 128 differential analog inputs using the AI-MAX analog channel expansion system available from Intelligent Instrumentation. The additional digital channels required would be provided by an EDAS-1001E Series Digital I/O Data Acquisition System which provides 32 digital I/O channels. The required hardware and costs are shown in TABLE 3.1.

Quantity	Part number	Name	Price	Subtotal
1	EDAS-1002E-SK1	Multifunction EDAS Starter Kit	$1645.00	Already acquired
1	EDAS-1001E-1A	EDAS Digital I/O Data Acquisition System	$749.00	$749.00
1	PCI-20308H-1	Card Cage, Euro Style	$150.00	$150.00
2	PCI-20305T-1	Digital Termination Panel	$100.00	$200.00
4	PCI-20303T-1	Analog Signal Termination Panel, Euro-style	$80.00	$320.00
2	PCI-20811A-1	Digital Cable, Euro Style	$55.00	$110.00
1	EDAS-1012A-1	50-pin unshielded cable	$25.00	$25.00
1	PCI-20488A-1	AI-MAX Expansion Backplane	$210.00	$210.00
4	PCI-20489A-1	AI-MAX Multiplex Board	$85.00	$340.00
4	EDAS-1013A-1	34-pin unshielded cable	$20.00	$80.00
1	LPP002	Power Supply 90-120VAC	$20.00	Already procured
TOTAL				$2244.00

TABLE 3.1 AI-MAX Intelligent Instrumentation Expansion Option (Burr Brown)

3.2 Analog and digital multiplexer (*designed and built by AO*)

The multiplexer circuit is shown in the APPENDIX in the drawing COMPRESSOR STATUS, Analog and Digital Multiplexers. All associated circuit drawings may also be viewed in the APPENDIX.

3.2.1 Analog multiplexer design

The 30 differential analog inputs are switched to the EDAS-1002E's 8 differential analog input channels with DG409 Single 8-Channel/ Differential 4-Channel CMOS Analog Multiplexers. The DG409 was chosen for its low drain-source ON resistance (100Ω) and low leakage current (10nA) as shown in FIG 3.1.

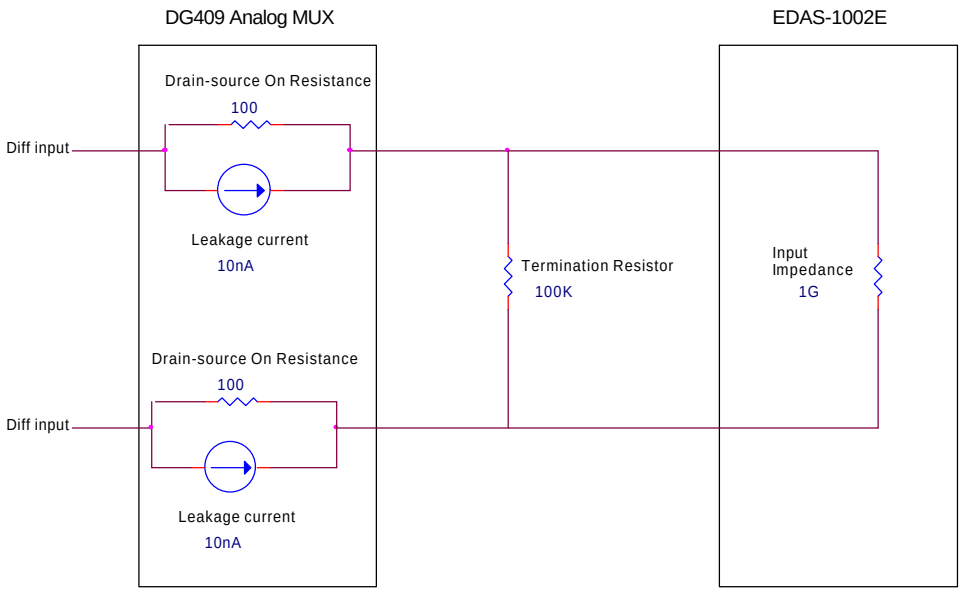


FIG. 3.1 Circuit to determine of termination resistance

With these properties, a 100KΩ termination resistor placed between the differential signals at the analog multiplexer outputs, as shown in FIG. 4, limits the offset voltage to 2mV and producing a voltage drop of only 0.2%. This offset voltage, $V_{offset,max}$ was calculated by

$$V_{offset,max} = I_{leakage,max} R_{termination},$$

$$V_{offset,max} = (20mA)(100{,}000\Omega),$$

$$V_{offset,max} = 2mV.$$

The voltage drop, V_{drop}, is found via

$$V_{drop} = \left(\frac{2R_{source-drain}}{R_{termination} + 2R_{source\text{-}drain}} \right) V_{input},$$

$$V_{drop} = \left(\frac{200\Omega}{100{,}200\Omega} \right) V_{input},$$

$$V_{drop} = 0.2\% V_{input}.$$

Each of the eight pairs of differential signals will be filtered at the output of the analog multiplexer by a 0.001uF capacitor. This will block high frequency glitches and will not interfere with the data, which is being acquired at a rate of only 0.1Hz.

The drawing COMPRESSOR STATUS, Termination Resistors and Filter Capacitors, in the APPENDIX, shows the implementation of the termination resistors and the filter capacitors.

It was verified that the voltage and current limits of the analog multiplexers and of the analog EDAS inputs will not be exceeded as shown in TABLE 3.2.

	Maximum voltage	Maximum current
Pressure transducer	7.2V	0.25mA
Thermistor		
DG409 (input)	44V	30mA (100mA peak/ms)
DG409 (output)		
EDAS (input)	10V	

TABLE 3.2 Analog voltages and currents

3.2.2 Digital multiplexer

The EDAS-1002E has two digital ports with 8 bits per port. The 20 digital inputs are switched to the 8 digital input channels of Port 0 with CD74HCT153 High Speed CMOS Dual 4-Input Multiplexers. Four of Port 1's 8 digital are programmed for output and provide the select and enable signals for the analog and digital multiplexers. The DG409's required logic level current is $\leq 10uA$ and the 74HCT153's logic level current is $\leq 1uA$, therefore the 15mA/64mA TTL Compatible Source/Sink levels of Port 1 are sufficient to power the select or enable bits of the eight analog multiplexers or the select or enable bits of the four digital multiplexers.

It was verified that the voltage and current limits of the digital multiplexers and to the digital EDAS inputs will not be exceeded.

Transients caused by loss of power to the EDAS or to the transducers were checked and verified to be minimal.

3.2.3 Transducer signal conditioning: Analog inputs

The positive and negative Supply Pressure signals and the positive and negative Return Pressure inputs can be fed directly into the differential inputs of the EDAS.

The Temperature signal is referenced to common *at the compressor* and only the positive Temperature signal appears on the cable from the compressor. Therefore, in order to have a *differential* input signal to feed to the EDAS, one of the differential inputs for each temperature signal is tied to ground *at its input to the multiplexer* (shown in drawing COMPRESSOR STATUS, Analog and Digital Multiplexers). In this way, the differential input to the EDAS is composed of the temperature signal from the compressor and the grounded input at the MUX.

3.2.4 Transducer signal conditioning: Digital inputs

The ON/OFF signal can be input directly into the digital multiplexer.

A TTL Phaseloss signal is generated on the circuit board using a signal generated by a phaseloss detection device located at the compressor, as shown in FIG. 3.2.

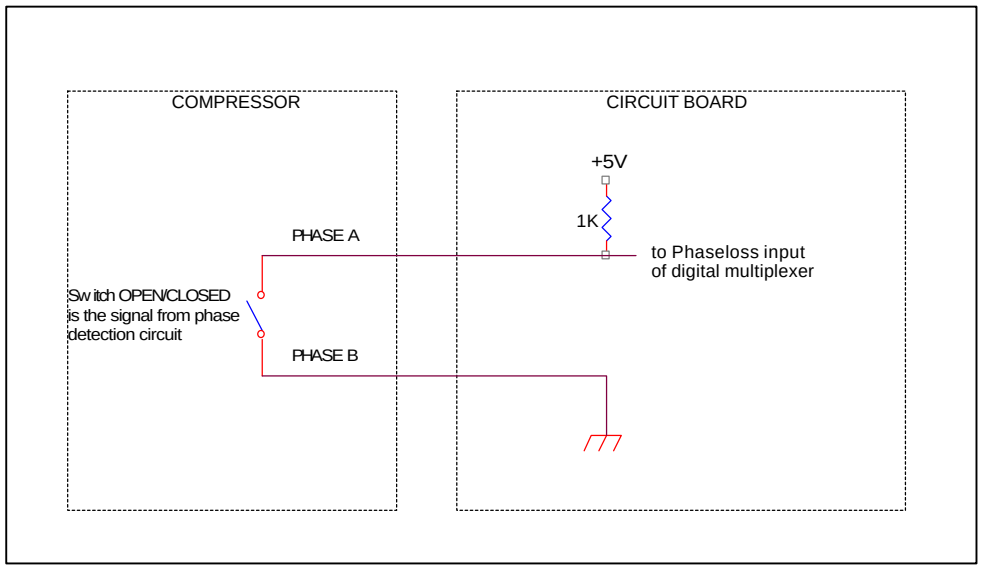


FIG. 3.2 Circuit to generate TTL signal for Phaseloss

3.2.5 Power budget

The digital multiplexers are powered directly from the EDAS-1002E's 5VDC on-board power supply. The analog multiplexers' required ±15V are supplied by a 5V-±15V DC/DC converter which is powered by the EDAS-1002E's 5VDC on-board power supply. The power budget, shown in TABLE 3.3, shows that the on-board 5VDC, 1A (5W) supply is able to supply the required power (0.65W) to all the multiplexers. All multiplexer power inputs are bypassed by 0.1uF capacitors (shown in the drawing COMPRESSOR STATUS, Analog and Digital Bypass Capacitors). The EDAS-1002E is powered by 24VAC via a 120VAC transformer.

	Voltage	Current	Efficiency of DC/DC converter	Power/MUX	Number of MUXs	Total power required by the EDAS +5V Power Supply
Analog multiplexers	±15V	2mA	75%	0.075W	8	0.60W
Digital multiplexers	5V	2.5mA	NA	0.0125W	4	0.05W
Phaseloss TTL signal generation	5V	5mA	NA	0.25W		0.25W
TOTAL						0.90W (5W available)

TABLE 3.3 Power budget

3.2.6 Construction costs

The multiplexer circuit will be constructed with wirewrap connections. The multiplexer board will be connected to the EDAS1002E by a ribbon cable, both housed in the same enclosure.

The required hardware and costs are shown below (TABLE 3.4).

Quantity	Part number	Name	Price	Subtotal
16	DG409DJ	CMOS Analog Multiplexer	$2.10	$33.60
8	CD74HCT153E	CMOS Logic Dual 4-Input Multiplexer		$5.75
2	222-53134H VERO Electronics	PTH Square Pad Board 100X220mm	$73.48	$146.95
4	609-5030 Thomas & Betts	Socket connector 50 pin female (ribbon)	$4.28	$17.12
4	609-5047 Thomas & Betts	IDC connector 50 pin male (wirewrap)	$7.61	free samples
10	609-1030 Thomas & Betts	Socket connector 10 pin female (ribbon)	$1.15	$11.50
10	609-1047 Thomas & Betts	IDC connector 10 pin male (wirewrap)	$2.81	free samples
1	DGP12U5D15 Power One	DC/DC Converter	$69.31	$69.31
8		100K resistors		
8		0.001uF capacitor		
20		0.01uF capacitor		
8		100K resistor		
TOTAL				$284.23

TABLE 3.4 Analog and Digital Multiplexer Option built by AO

4. Comparison of options

4.1 Costs/Time

TABLE 4.1 illustrates additional costs, common to both expansion options. This includes items as the enclosure, connectors, and Ethernet-to-fiber converter.

Quantity	Part number	Name	Price	Subtotal
10	FPT021210P Amphenol Dan Dean 607-563-5355	Filtered 10 pin 20 gage cylindrical bulkhead connector	$220.78	$2207.80
10	PT06E1210SR Amphenol	Circular 10 pin 20 gage connector + strain relief	$20.96	$209.60
1	C-SD 201606-LG-EMC Model - Concept Hoffman 612-421-2240	EMI/RFI & weather proof Enclosure 16 X 20 X 6”	$158.07	$158.07
1	CP 2016 Hoffman 612-421-2240	Interior panel for enclosure	$25.70	$25.70
1	Transition Networks DIC1462	Media converter 10Base-T to 10BaseFL MultiMode	$166.75	$166.75
12	Altech Corp 502-1560 BKA2.5/10	Panel mount terminal blocks	$6.00	$72.00
TOTAL				$2839.92

TABLE 4.1 Required hardware common to both options

TABLE 4.2 compares the total costs of both options.

	Intelligent Instruments	Analog and digital multiplexer design *built by AO*
Cost (parts unique to each expansion system)	$2244.00	$284.23
Cost (parts common to both expansion option)	$2839.92*	$2839.92*
TOTAL	5083.92*	$3124.15*

TABLE 4.2 Comparison of options*

**Bulk of this TOTAL is due to fancy EMI/RFI weatherproof connectors; if substituted by simple, unfiltered connectors, the cost would be reduced by about $2000*

While the cost of the hardware for Intelligent Instruments option is substantially more, there is no time required to build the circuits. The Intelligent Instruments hardware can be delivered with 2-3 weeks notice. The time to develop the software is expected to be similar for either option.

4.2 Expansion

If this mode of data acquisition were to be extended to more than 10 compressors or to monitoring the status of other systems (i.e. receiver temperatures) either options would require additional hardware.

4.2.1 Expansion via Intelligent Instruments Hardware

For up to 64 differential inputs, 4 additional multiplex and termination panels would be required. To accommodate 128 differential inputs, another AI-MAX expansion backplane would be required to accommodate 8 more multiplex and termination panels (with 8 differential inputs each). The addressing capability of the EDAS-1002E limits its capacity to 128 differential inputs. Beyond 128 differential inputs, another EDAS-1002E would be required.

To accommodate more than 32 digital inputs, another EDAS-1001E would be required.

4.2.2 Expansion via analog and digital multiplexer built by AO

To expand beyond 30 differential analog and 20 digital inputs, additional multiplexer circuits would need to be built.

5. Location and Control

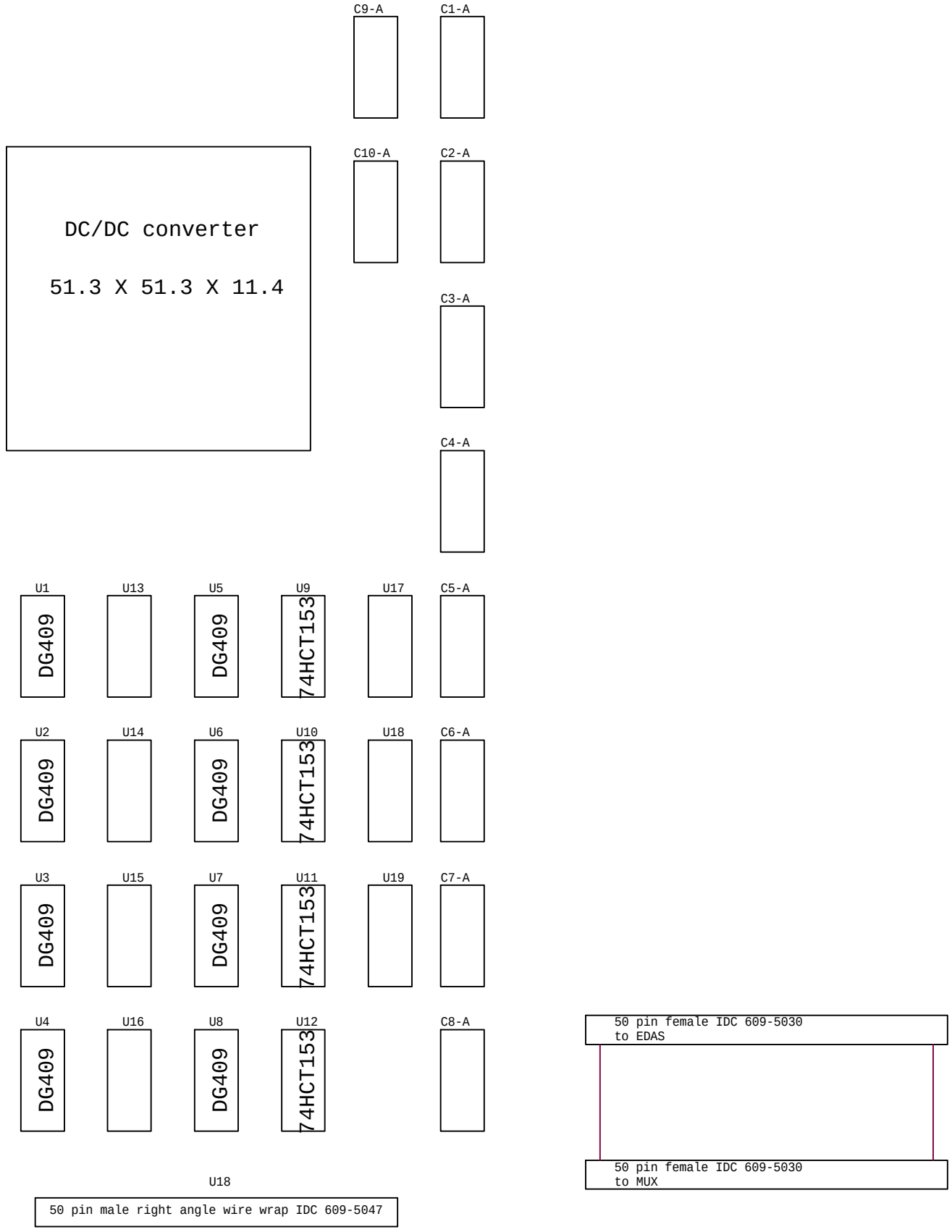
5.1 Location

The hardware is housed in a weatherproof, rfi-shielded enclosure. The signals from each compressor are fed through the enclosure, one connector/compressor, to the multiplexer. An advantage of locating the enclosure local to the compressors is that only the Ethernet cable needs to be routed to the transmitter room, where the Ethernet fiber link is located. If the enclosure were located near the Ethernet, all of the compressor cables would need to be routed.

5.2 Control

The power to the entire system can be controlled via a TTL input from an HP 3488A Switch Control Unit. The TTL signal is input to a fiber transmitter. The transmitted signal is received by a fiber receiver in the multiplexer enclosure. This circuit is shown in the circuit diagram "Remote control of 120VAC to Compressor Monitoring System" in the APPENDIX.

APPENDIX


C9-A
C1-A
C10-A
C2-A
DC/DC converter
51.3 X 51.3 X 11.4
C3-A
C4-A
U1
DG409
U13
U5
DG409
U9
74HCT153
U17
C5-A
U2
DG409
U14
U6
DG409
U10
74HCT153
U18
C6-A
U3
DG409
U15
U7
DG409
U11
74HCT153
U19
C7-A
U4
DG409
U16
U8
DG409
U12
74HCT153
C8-A
U18
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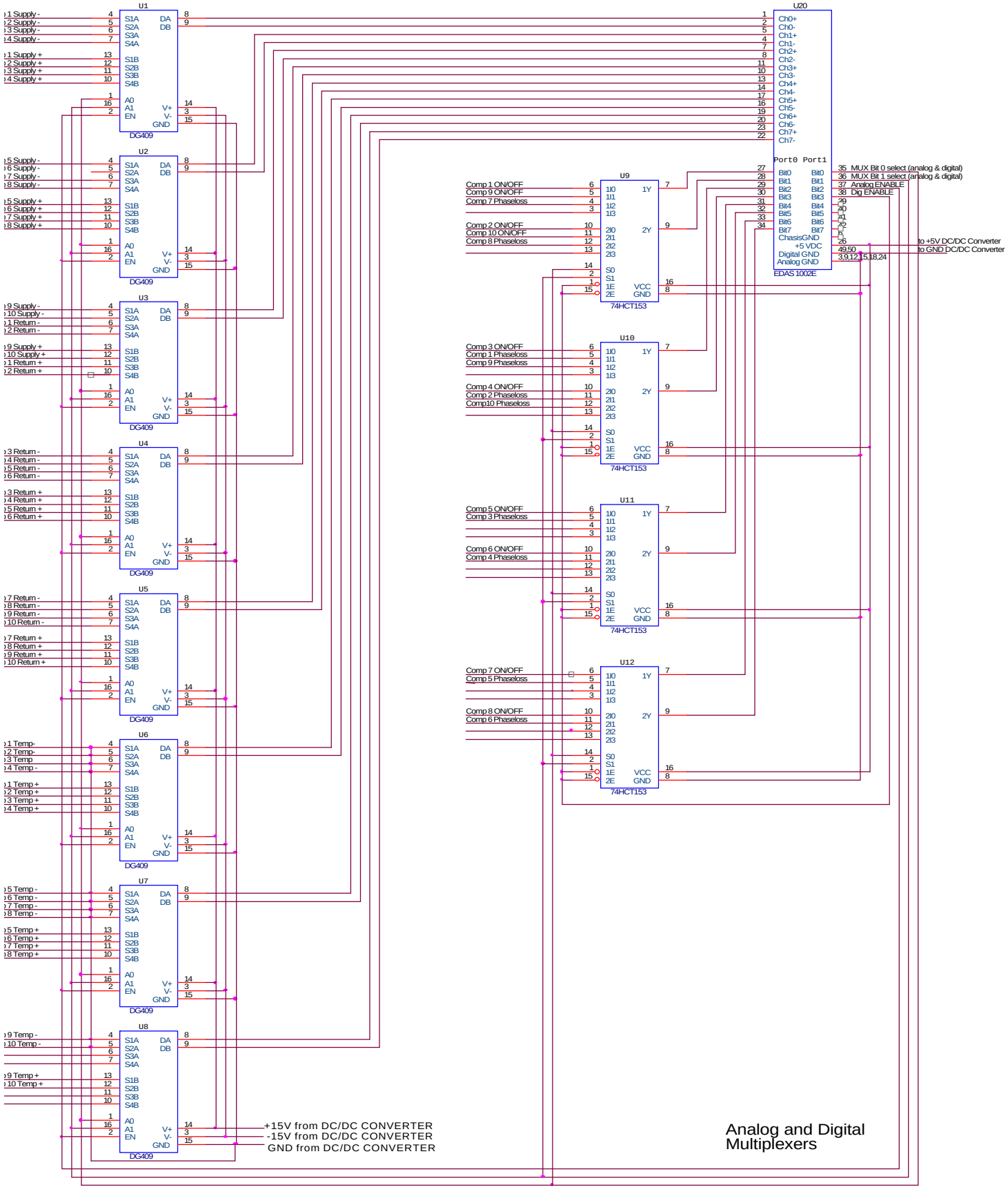
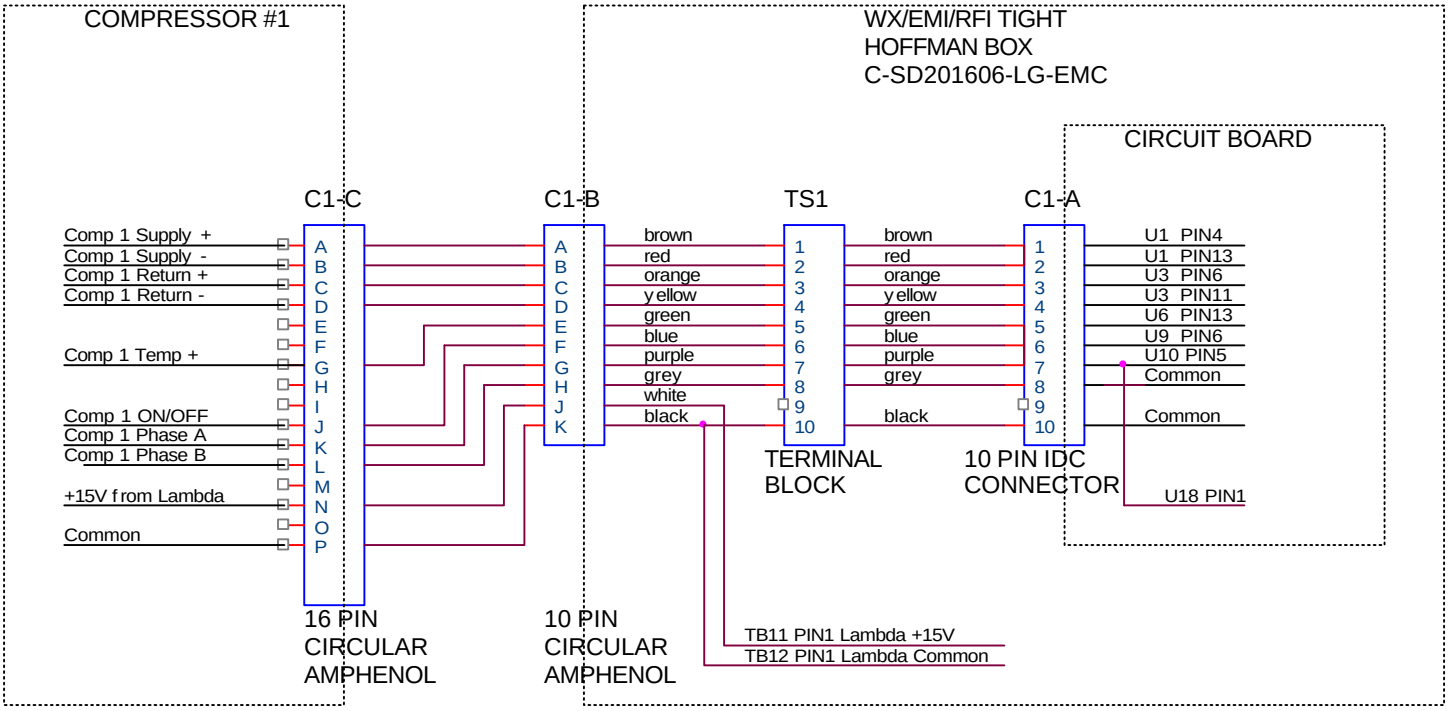
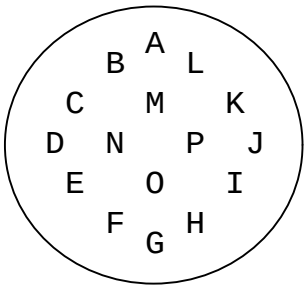
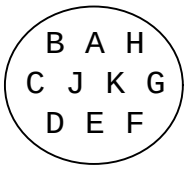
50 pin female IDC 609-5030
to EDAS
50 pin female IDC 609-5030
to MUX


U1
U2
U3
U4
U5
U6
U7
U8
DG409
S1A
S2A
S3A
S4A
S1B
S2B
S3B
S4B
DA
DB
A0
A1
EN
V+
V-
GND
1 Supply -
2 Supply -
3 Supply -
4 Supply -
1 Supply +
2 Supply +
3 Supply +
4 Supply +
5 Supply -
6 Supply -
7 Supply -
8 Supply -
5 Supply +
6 Supply +
7 Supply +
8 Supply +
9 Supply -
10 Supply -
1 Return -
2 Return -
9 Supply +
10 Supply +
1 Return +
2 Return +
3 Return -
4 Return -
5 Return -
6 Return -
3 Return +
4 Return +
5 Return +
6 Return +
7 Return -
8 Return -
9 Return -
10 Return -
7 Return +
8 Return +
9 Return +
10 Return +
1 Temp-
2 Temp-
3 Temp
4 Temp -
1 Temp +
2 Temp +
3 Temp +
4 Temp +
5 Temp -
6 Temp -
7 Temp -
8 Temp -
5 Temp +
6 Temp +
7 Temp +
8 Temp +
9 Temp -
10 Temp -
9 Temp +
10 Temp +
+15V from DC/DC CONVERTER
-15V from DC/DC CONVERTER
GND from DC/DC CONVERTER
U20
EDAS 1002E
Ch0+
Ch0-
Ch1+
Ch1-
Ch2+
Ch2-
Ch3+
Ch3-
Ch4+
Ch4-
Ch5+
Ch5-
Ch6+
Ch6-
Ch7+
Ch7-
Port0 Port1
Bit0
Bit1
Bit2
Bit3
Bit4
Bit5
Bit6
Bit7
ChasisGND
+5 VDC
Digital GND
Analog GND
35 MUX Bit 0 select (analog & digital)
36 MUX Bit 1 select (analog & digital)
37 Analog ENABLE
38 Dig ENABLE
to +5V DC/DC Converter
to GND DC/DC Converter
U9
U10
U11
U12
74HCT153
1I0
1I1
1I2
1I3
2I0
2I1
2I2
2I3
S0
S1
1E
2E
1Y
2Y
VCC
GND
Comp 1 ON/OFF
Comp 9 ON/OFF
Comp 7 Phaseloss
Comp 2 ON/OFF
Comp 10 ON/OFF
Comp 8 Phaseloss
Comp 3 ON/OFF
Comp 1 Phaseloss
Comp 9 Phaseloss
Comp 4 ON/OFF
Comp 2 Phaseloss
Comp10 Phaseloss
Comp 5 ON/OFF
Comp 3 Phaseloss
Comp 6 ON/OFF
Comp 4 Phaseloss
Comp 7 ON/OFF
Comp 5 Phaseloss
Comp 8 ON/OFF
Comp 6 Phaseloss
Analog and Digital
Multiplexers



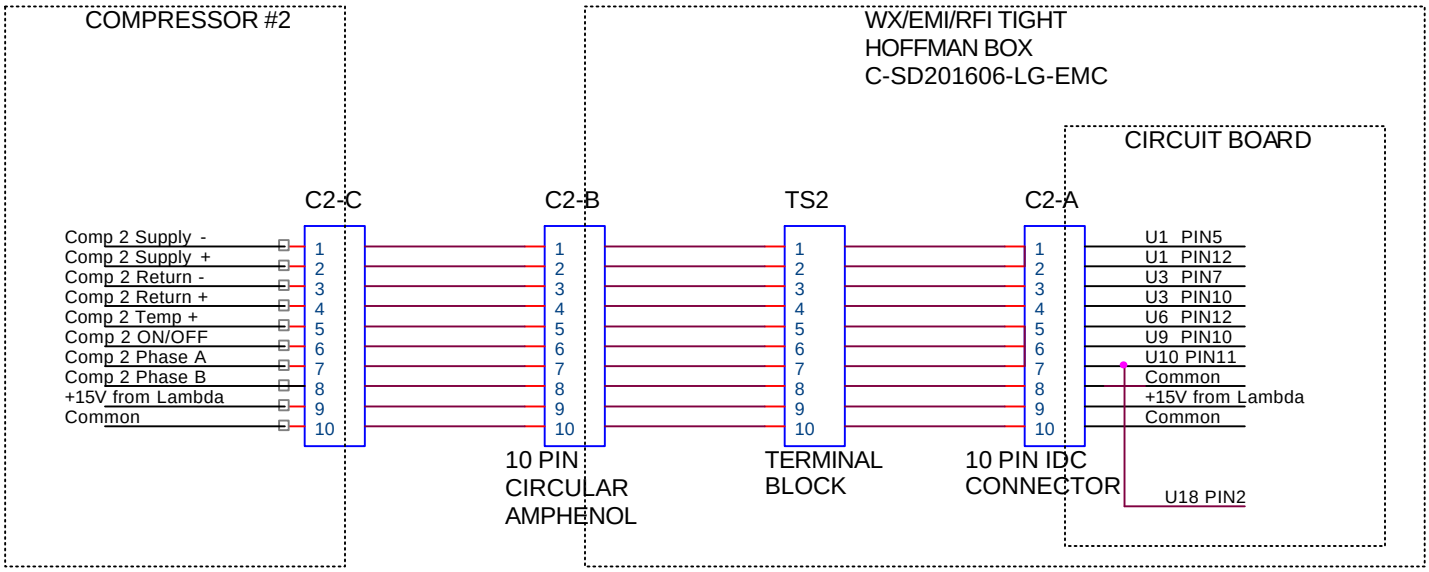
16 PIN
CIRCULAR
AMPHENOL
viewed from solder
terminal side
of plug



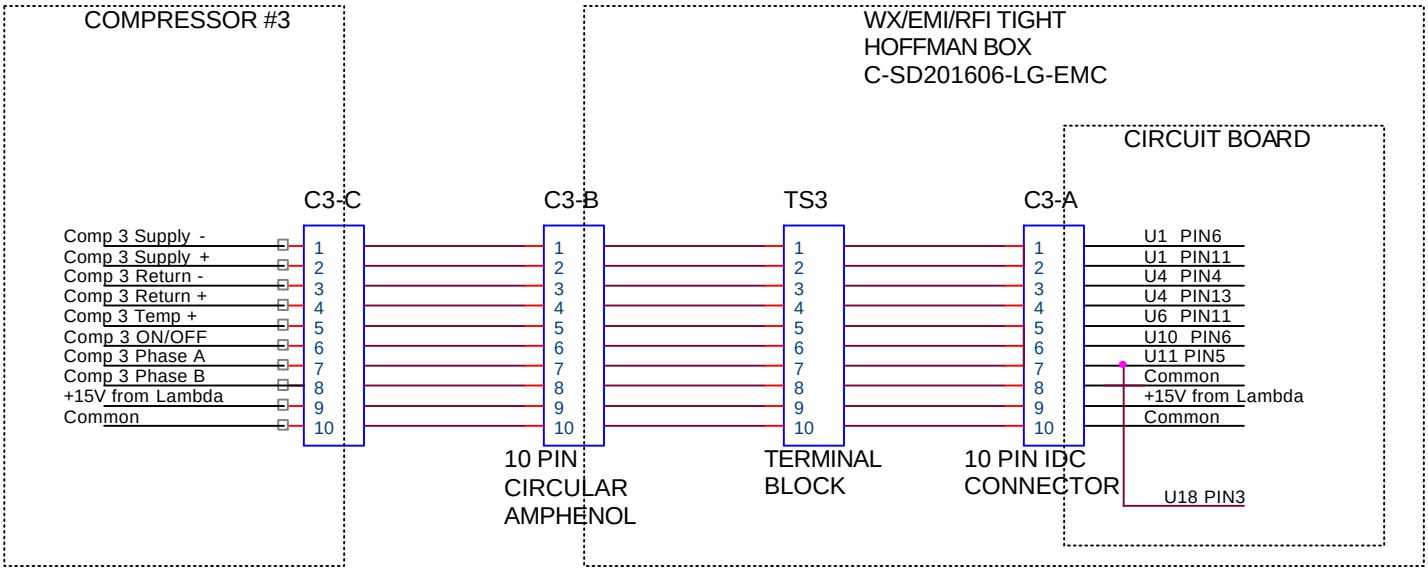


10 PIN
CIRCULAR
AMPHENOL
viewed from solder
terminal side
of bulkhead connector

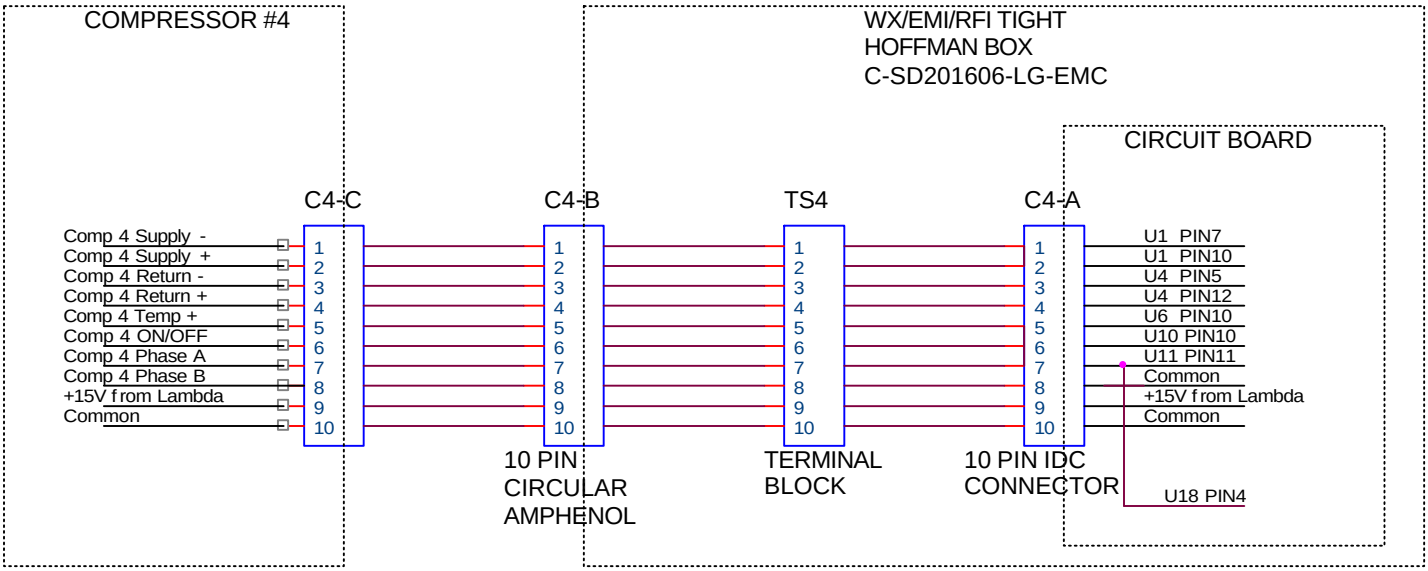
COMPRESSOR STATUS		
Title	Compressor #1 Connectors	
Size A	Document Number	
Date: Tuesday, December 07, 1999		Sheet 1



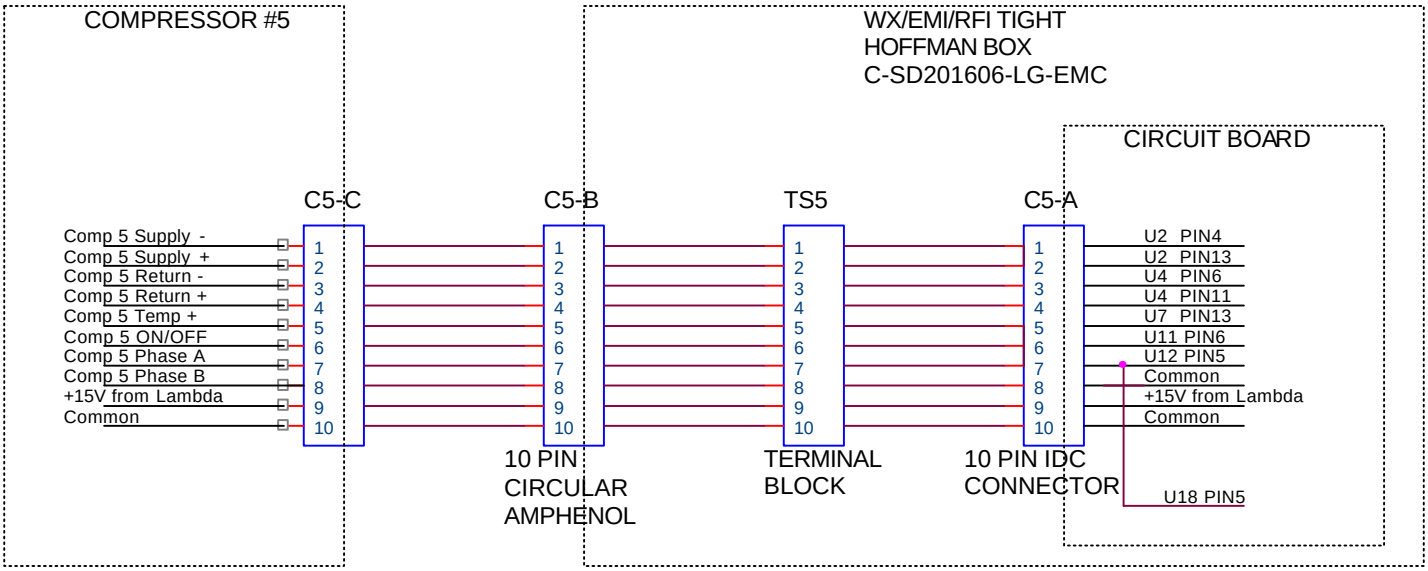
COMPRESSOR STATUS		
Title	Compressor #2 Connectors	
Size A	Document Number	
Date: Tuesday, December 07, 1999		Sheet 1



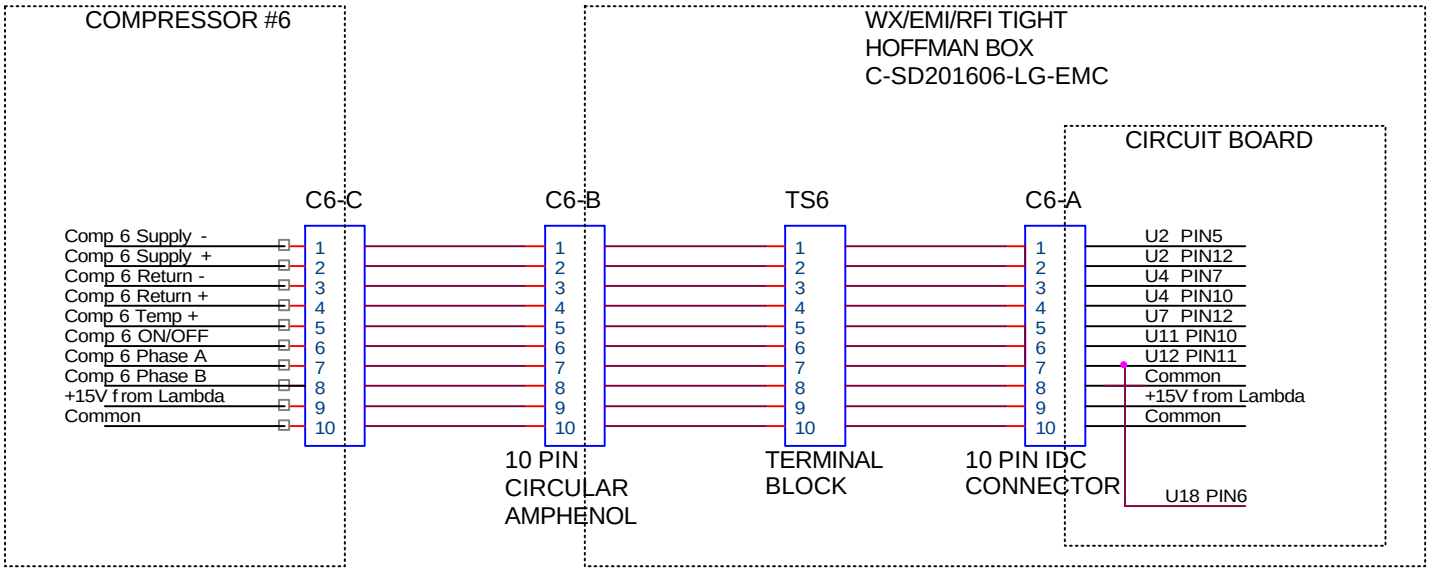
COMPRESSOR STATUS		
Title	Compressor #3 Connectors	
Size A	Document Number	
Date: Tuesday, December 07, 1999		Sheet 1



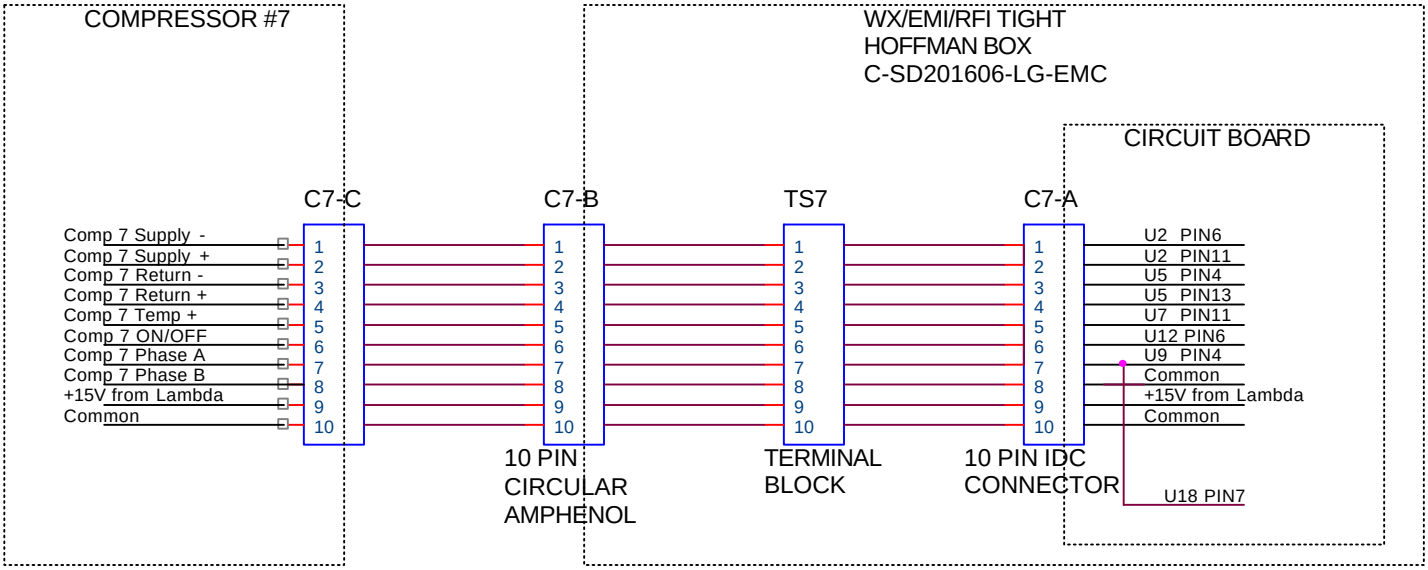
COMPRESSOR STATUS		
Title: Compressor #4 Connectors		
Size: A	Document Number	
Date: Tuesday, December 07, 1999		Sheet 1



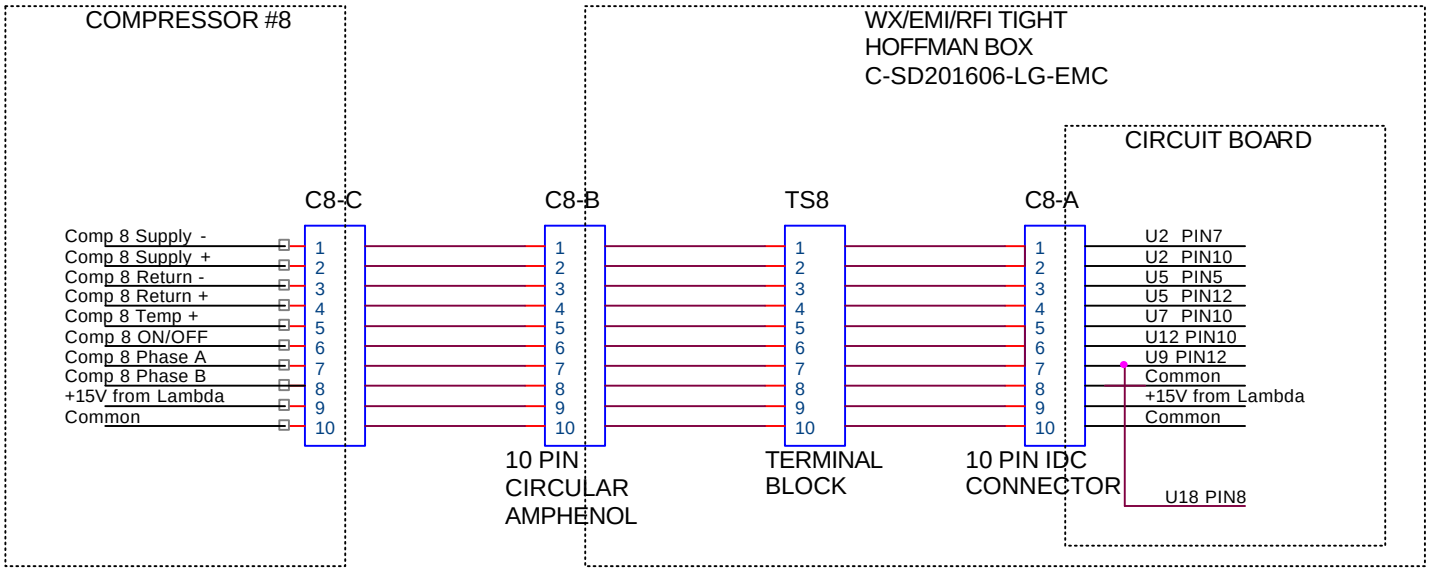
COMPRESSOR STATUS		
Title: Compressor #5 Connectors		
Size: A	Document Number	
Date: Tuesday, December 07, 1999		Sheet 1



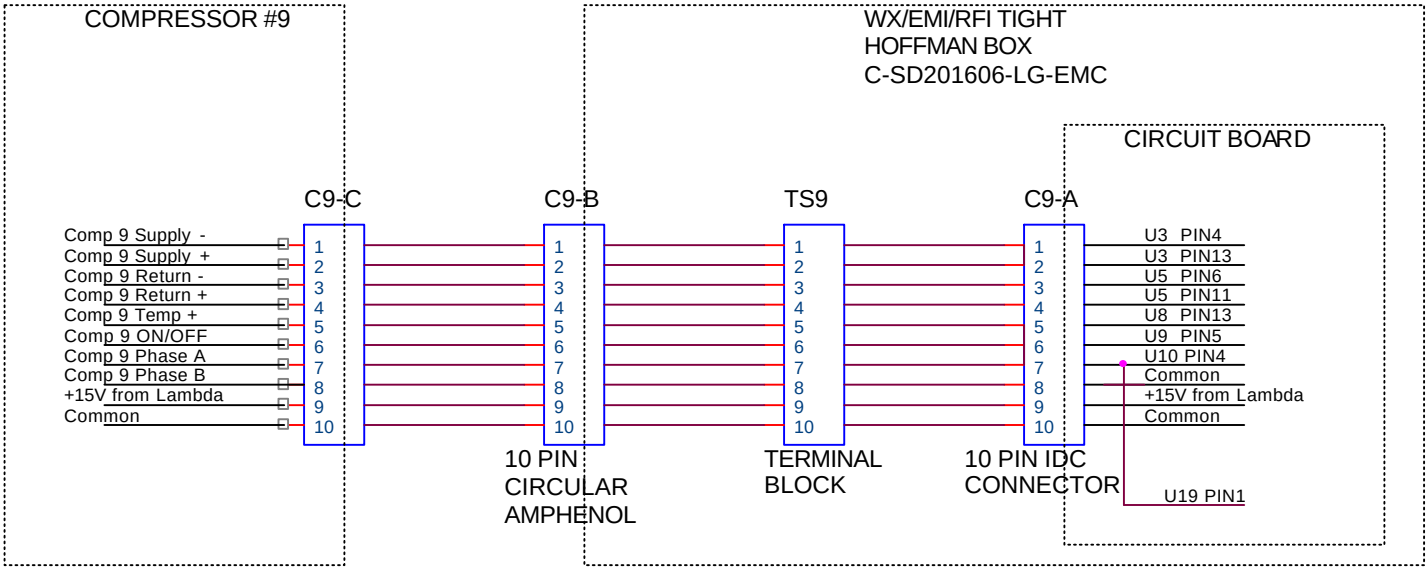
COMPRESSOR STATUS		
Title: Compressor #6 Connectors		
Size: A	Document Number:	
Date: Tuesday, December 07, 1999		Sheet 1



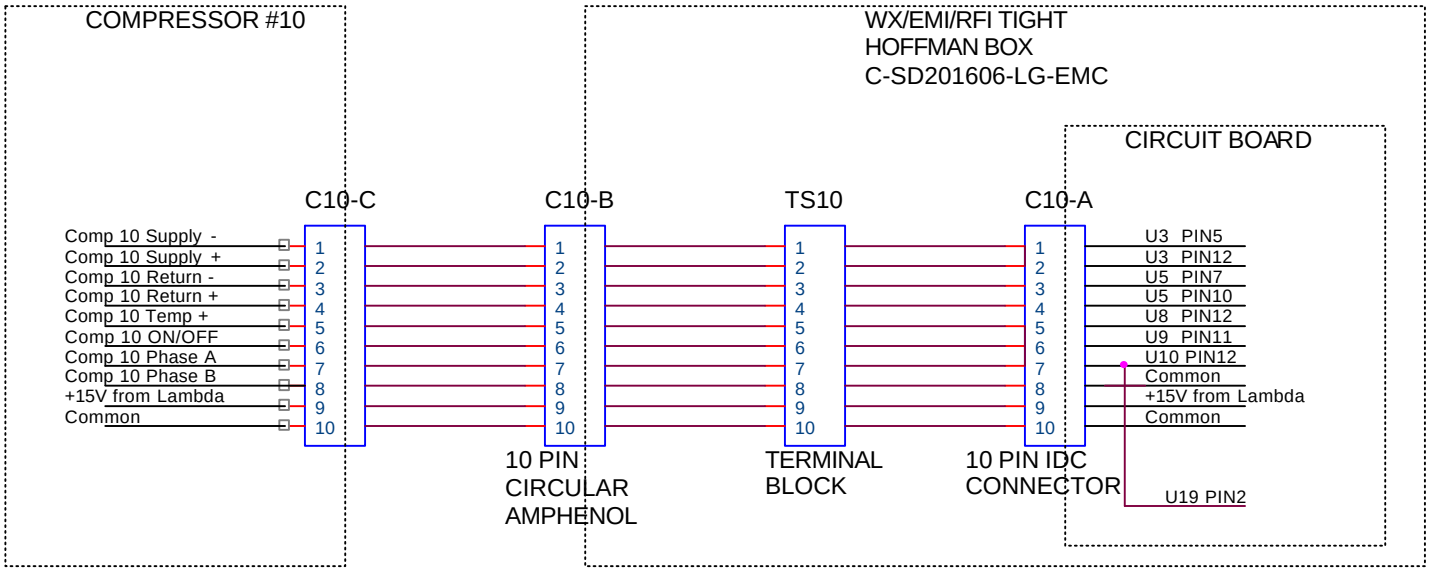
COMPRESSOR STATUS		
Title	Compressor #7 Connectors	
Size A	Document Number	
Date: Tuesday, December 07, 1999		Sheet 1



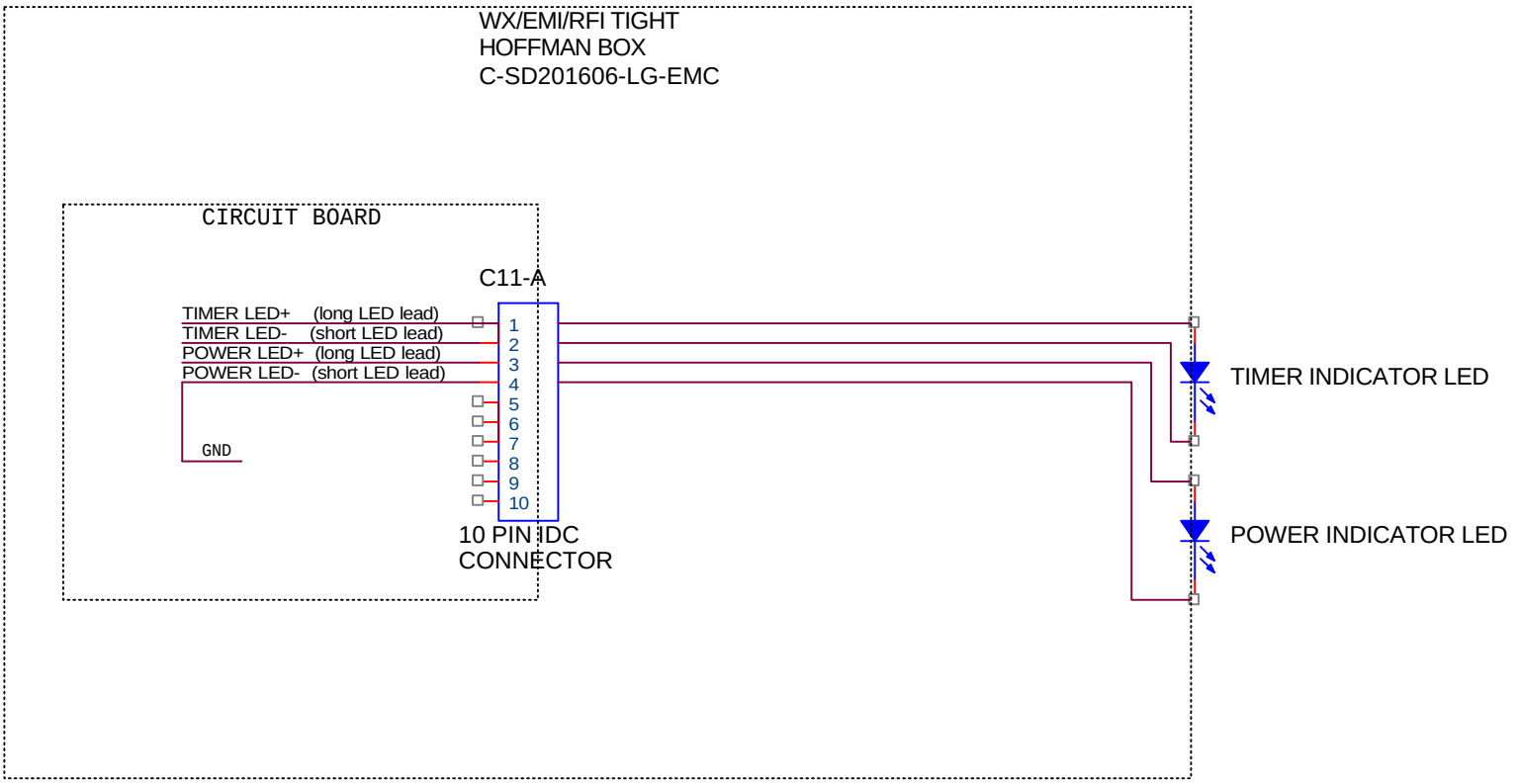
COMPRESSOR STATUS		
Title: Compressor #8 Connectors		
Size: A	Document Number:	
Date: Tuesday, December 07, 1999		Sheet 1



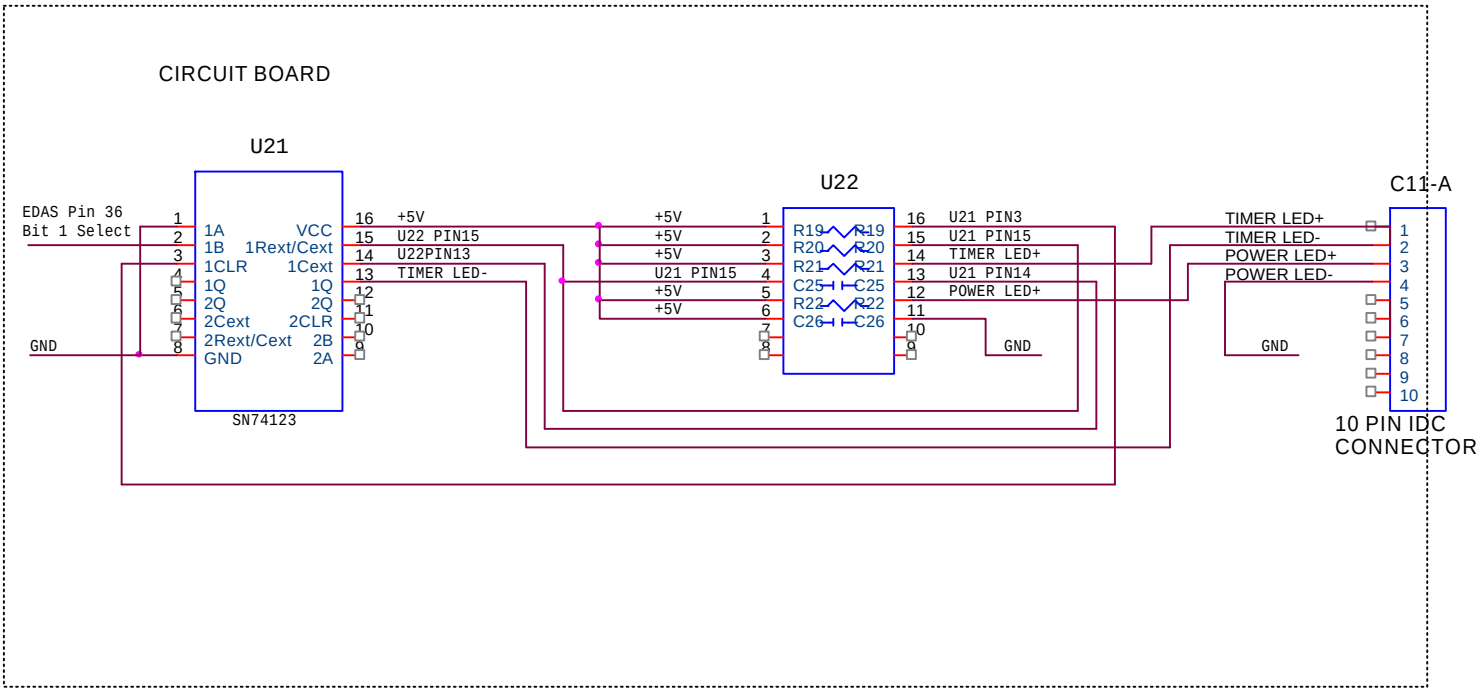
COMPRESSOR STATUS		
Title: Compressor #9 Connectors		
Size: A	Document Number:	
Date: Tuesday, December 07, 1999		Sheet 1



COMPRESSOR STATUS		
Title: Compressor #10 Connectors		
Size: A	Document Number:	
Date: Tuesday, December 07, 1999		Sheet 1

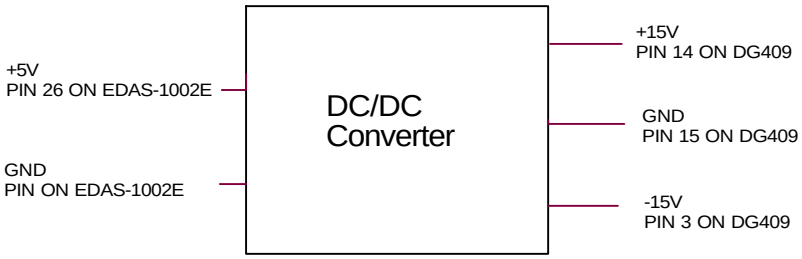


Title	Compressor #11 connector (LEDs)
Size A	Document Number <Doc>
Date: Tuesday, December 07, 1999	Sheet



R19 1K
R20 68K
R21 184
R22 300
C25 47uF
C26 0.1uF (bypass)

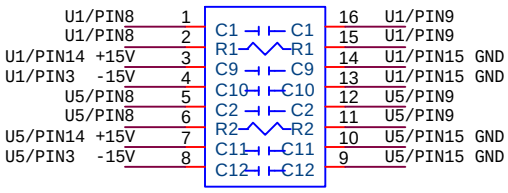
Title	LED TIMER & LED POWER INDICATOR		
Size A	Document Number <Doc>		
Date:	Tuesday, December 07, 1999	Sheet 1 of 1	



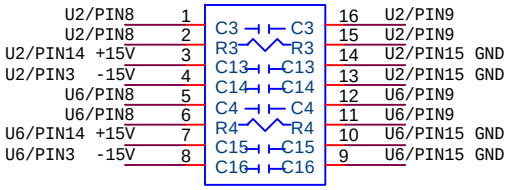
Power One
DGP12U5D15

COMPRESSOR STATUS				
Title: DC-DC Converter				
Size	Document Number			Rev
Date: Saturday, January 29, 2000		Sheet 3 of 3		

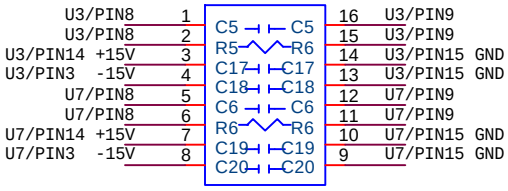
U1



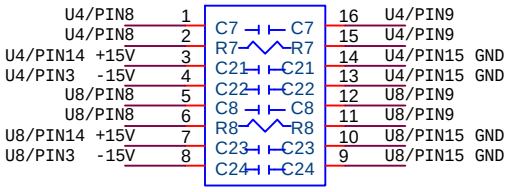
U3



U5



U7

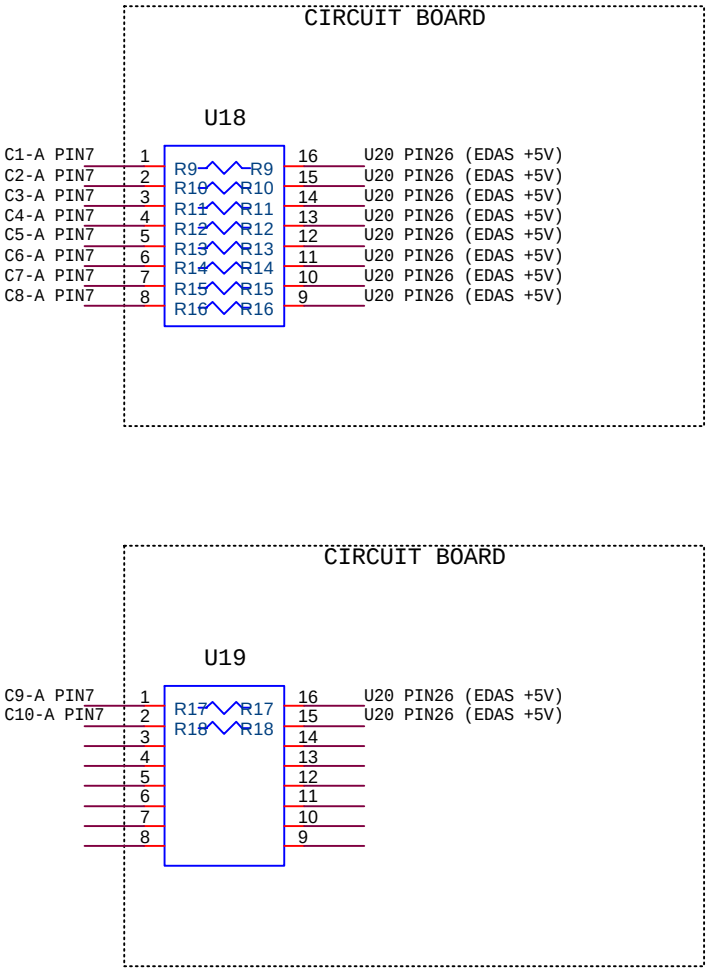


CAPACITORS C1-C8 ARE 0.001uF
CAPACITORS C9-C24 ARE 0.1uF
RESISTORS R1-R8 ARE 100K

Note: U13, U14, U15, U16 hold bypass capacitors, filter capacitors, and termination resistors for the DG409 Analog Multiplexers

Note: U17 holds the bypass capacitors for the 74HCT153 Digital Multiplexers

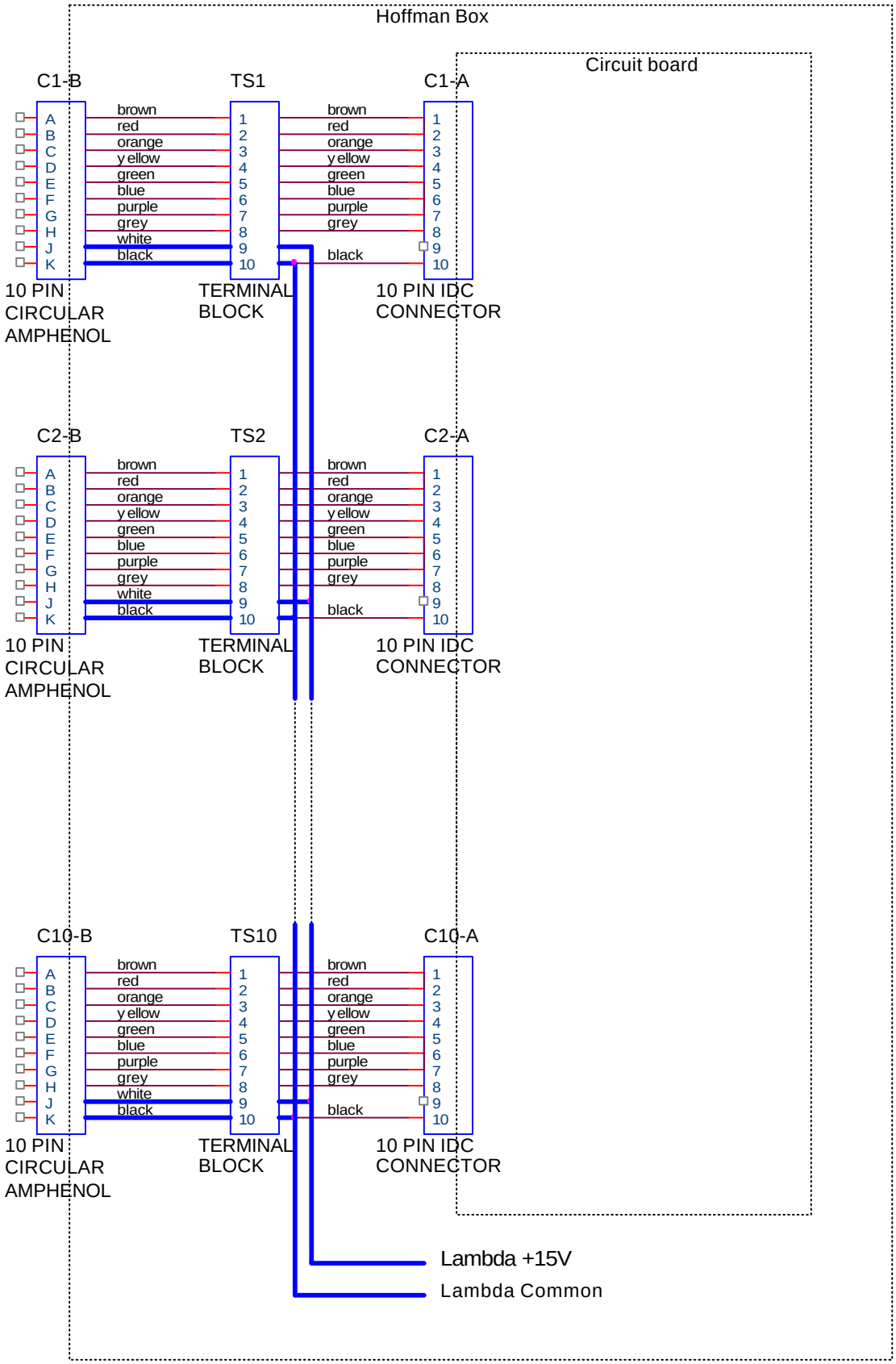
COMPRESSOR STATUS		
Title: TERMINATION RESISTORS AND FILTER CAPACITORS		
Size: Custom	Document Number: <Doc>	Rev: <RevCode>
Date: Saturday, January 29, 2000	Sheet 1 of 1	



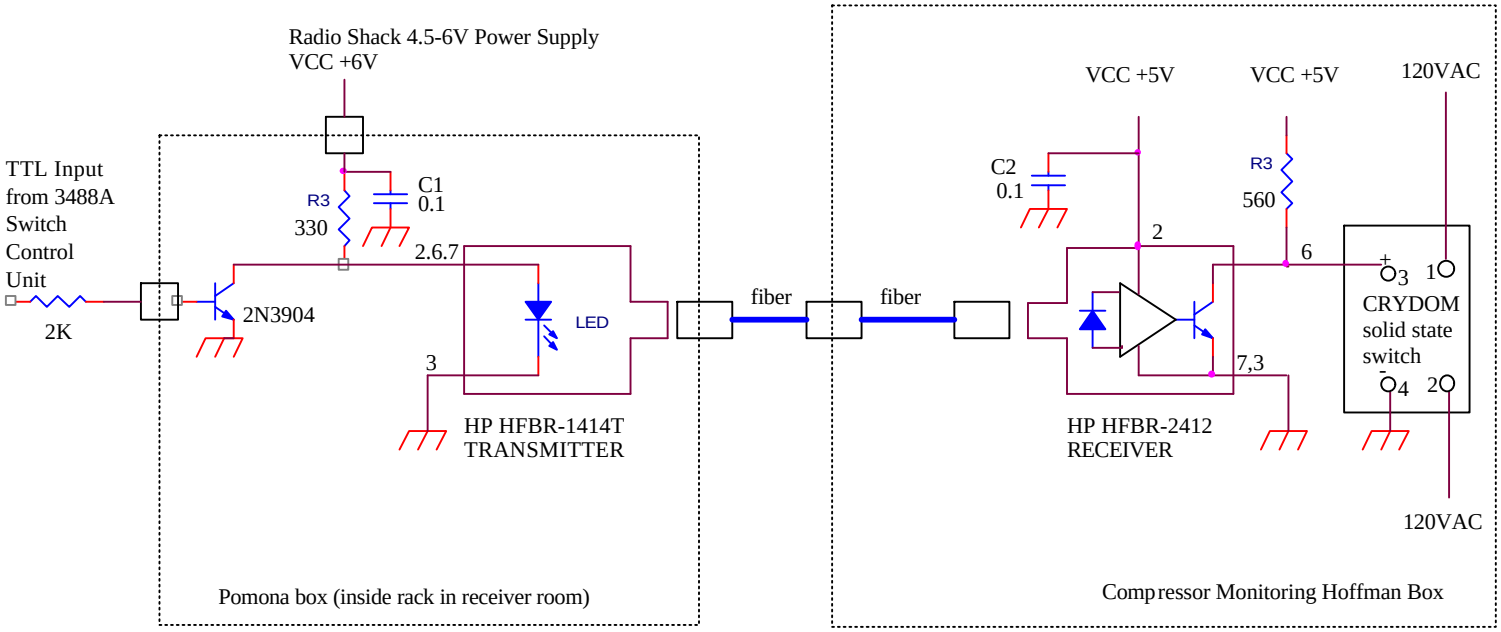
RESISTORS R9-R18 ARE 1K

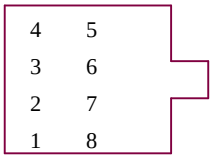
NOTE: These resistors connected to +5V
form the pull-up circuit which generates a
TTL indicator from the phaseloss signal

COMPRESSOR STATUS		
Title: CIRCUIT TO GENERATE TTL SIGNAL FOR PHASELOSS DETECTION		
Size: Custom	Document Number: <Doc>	Rev: <RevCode>
Date: Saturday, January 29, 2000	Sheet 1 of 1	

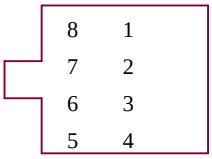


Title	Lambda +15V Power Supply Distribution	
Size	Document Number	Rev
Date: Saturday, January 29, 2000	Sheet 1 of 1	



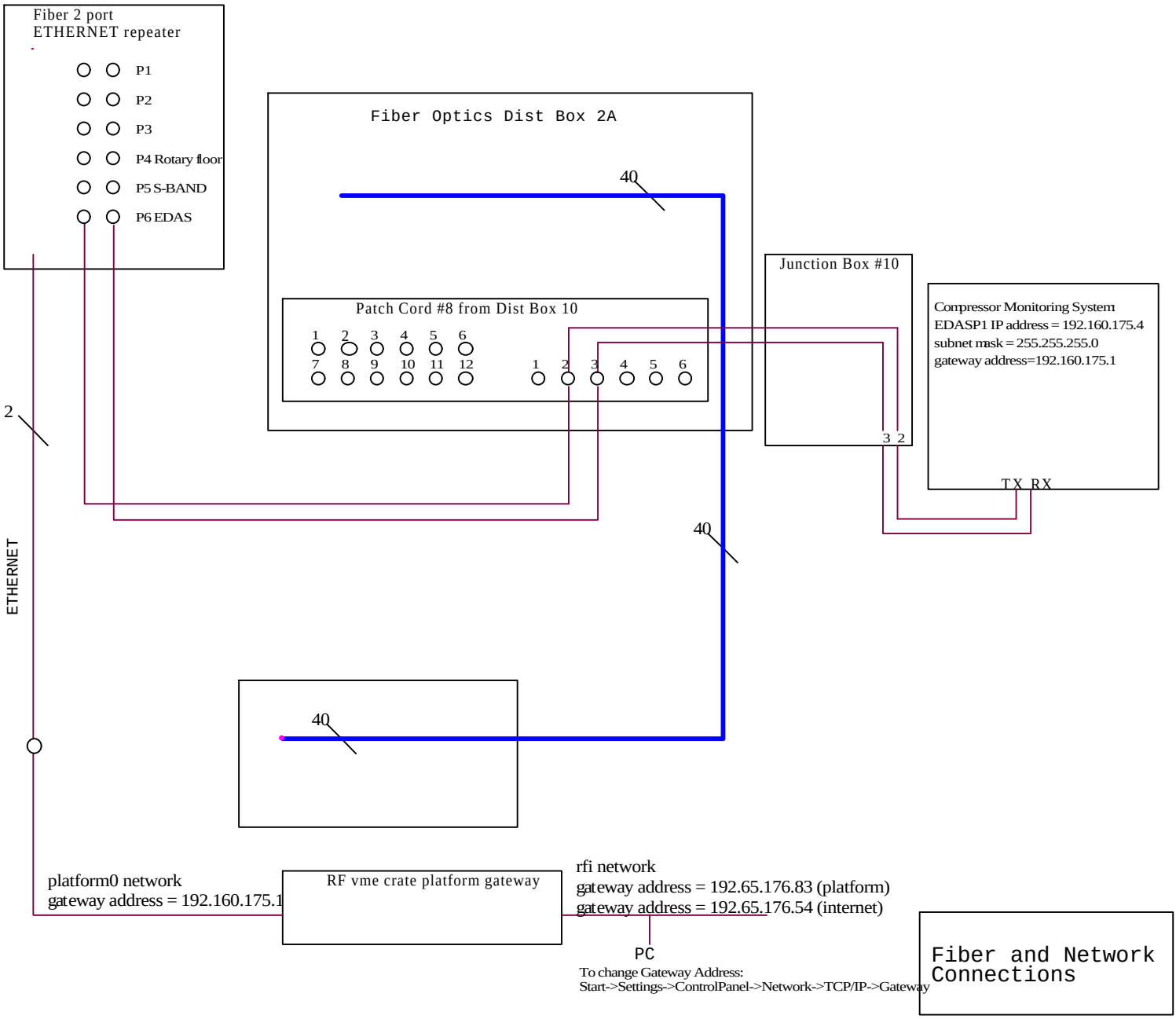


HP HFBR-1414
Bottom view



HP HFBR-2412
Bottom view

Title: Remote Control of 120VAC to Compressor Monitoring System		
Size: A	Document Number: <Doc>	Rev:
Date: Saturday, January 29, 2000	Sheet 1 of 1	


Fiber 2 port
ETHERNET repeater
P1
P2
P3
P4 Rotary floor
P5 S-BAND
P6 EDAS
Fiber Optics Dist Box 2A
40
Patch Cord #8 from Dist Box 10
1 2 3 4 5 6
7 8 9 10 11 12
1 2 3 4 5 6
Junction Box #10
3 2
Compressor Monitoring System
EDASP1 IP address = 192.160.175.4
subnet mask = 255.255.255.0
gateway address=192.160.175.1
TX RX
2
ETHERNET
40
40
platform0 network
gateway address = 192.160.175.1
RF vme crate platform gateway
rfi network
gateway address = 192.65.176.83 (platform)
gateway address = 192.65.176.54 (internet)
PC
To change Gateway Address:
Start->Settings->ControlPanel->Network->TCP/IP->Gateway
Fiber and Network Connections