

## Lens Control PCB

|                     |           |                    |           |
|---------------------|-----------|--------------------|-----------|
| <b>Part Number:</b> | 700005359 | <b>Where Used:</b> | Xevo TQ-S |
|---------------------|-----------|--------------------|-----------|

### Functional description



- Provides communication between the instrument and the EPC.
- Vacuum control incorporating input and output circuits to control the turbo pumps, an interface to use and control the vacuum gauges, and drivers for vent valves.
- Generates all the lens high voltages (mostly +/-200 V) from the on board +/-430 V Spellman PSU (using +24Voperate as an input voltage).
- Connects to the backplane PCB via three Din connectors that provide power supplies, and transfers bussed signals to and from other PCBs in the backplane.
- A supply called 24Voperate is used for many circuits and functions. This voltage can be switched on and off. The logic signal that controls the 24Voperate is also an output to the backplane and is used as control over 24Voperate on other PCBs.
- Generally used signals such as global reset, positive or negative ion, vacuum ok, and operate are set on this board and are output to the backplane.
- MSI buses are used for point to point communication with user event I/O board.
- Component changes allow the PCB to work off 24 V only, with the other supplies being derived from the onboard DC/DC converters.
- The PCB layers have been modified to achieve a substantial improvement in the synchronous noise levels.

**CAUTION:** *Follow suitable antistatic precautions at all times. Ensure the instrument electronics are switched off before removing / installing this PCB.*

**WARNING:** *Lethal voltages are present on this board. Do not work on this PCB with the electronics switched on.*

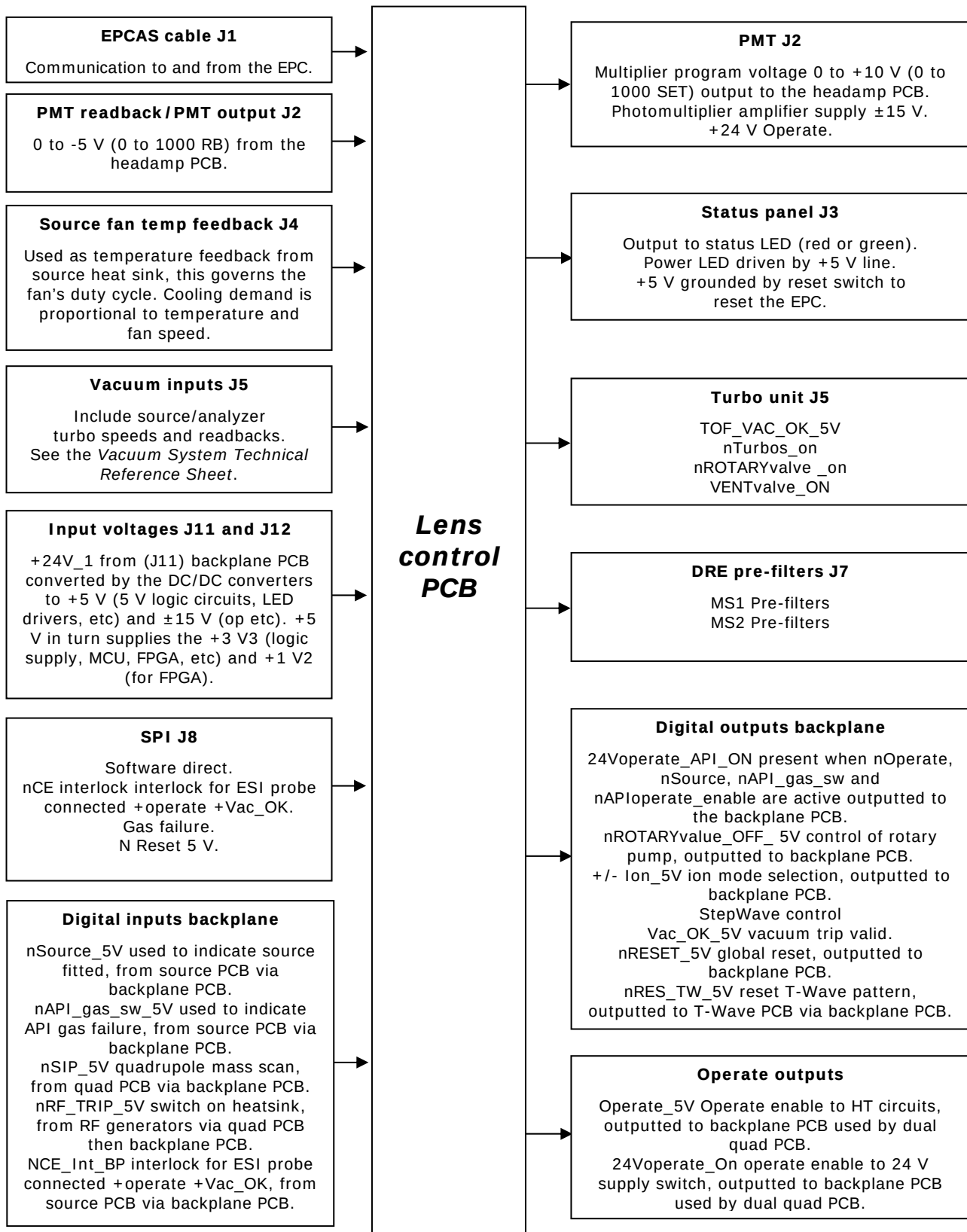
## Location

The lens control PCB is located within the electronics unit and is in the second position from the left hand side of the instrument.



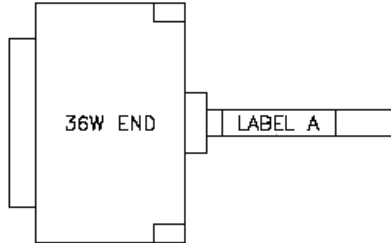
*Figure 1 - Top internal view of the instrument*

## Inputs/outputs



**J1 - EPCAS parallel port (link to EPC) via cable - 4185053BC2 (7000004267)**

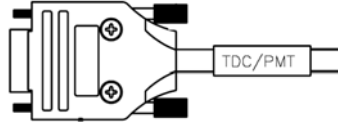
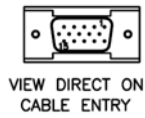
**NOTE:** *It is not possible to measure any voltages on this connection.*



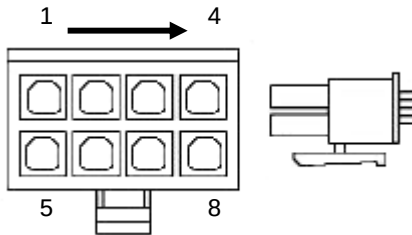
| Pin      | Signal      | Direction     |
|----------|-------------|---------------|
| 1        | PARAbusY10  | output        |
| 2        | PARAbusY13  | output        |
| 3        | PARAbusY9   | output        |
| 4        | PARAbusY12  | output        |
| 5        | PARAbusY11  | output        |
| 6        | PARAbusB1   | bidirectional |
| 7        | PARAbusB2   | bidirectional |
| 8        | PARAbusB3   | bidirectional |
| 9        | PARAbusB4   | bidirectional |
| 10       | PARAbusB5   | bidirectional |
| 11       | PARAbusB6   | bidirectional |
| 12       | PARAbusB7   | bidirectional |
| 13       | PARAbusB8   | bidirectional |
| 14       | PARA busC16 | input         |
| 15       | PARA busC14 | input         |
| 16       | PARA busC17 | input         |
| 17       | PARA busC15 | input         |
| 18       | nc          | -             |
| 19 to 35 | GND         | -             |
| 36       | nc          | -             |

**J2 - Headamp cable, PMT to headamp via cable - 4300032BC1**

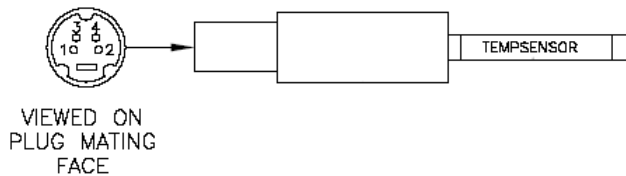
15W HD D-TYPE PLG



| Pin | Signal        | Note                                                                       |
|-----|---------------|----------------------------------------------------------------------------|
| 4   | +15_FILT      | Amplifies PMT anode current                                                |
| 2   | AGND          | -                                                                          |
| 11  | -15_FILT      | Amplifies PMT anode current                                                |
| 3   | RB_OFFSET     | PMT readback offset (factory set)                                          |
| 1   | HEADAMP-      | HEADAMP- (reference for headamp + signal)                                  |
| 9   | HEADAMP+      | HEADAMP+ (amplified 0 to 10 V signal from the PMT) for 0 to 1.38 e8 counts |
| 10  | MULT_PRG      | Program output 0 to +10 V for 0 to -1000 V on PMT                          |
| 12  | MULT_RIB      | Readback voltage input 0 to -5 V for 0 to -1000 V                          |
| 5   | 24Voperate_ON | thermal fuse = 250 mA                                                      |

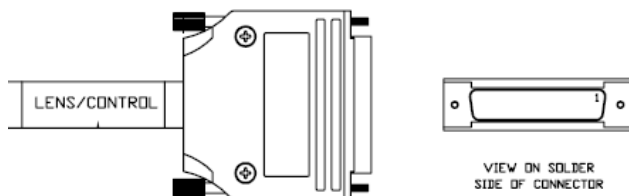
**J3 - Status panel connector to J2 on status panel via cable - 4185051CC2 (700003389)**

| Pin | Signal           | Note             |
|-----|------------------|------------------|
| 3   | GND              | Ground           |
| 4   | GREEN_STATUS_LED | Green status LED |
| 5   | RED_STATUS_LED   | Red status LED   |
| 6   | GND              | Ground           |
| 8   | +5 V             | Green power LED  |

**J4 - Temperature conversion PCB for source fan duty via cable - 4265065BC1 (700004299)**

| Pin  | Signal | Direction |
|------|--------|-----------|
| 4    | +Vs    | Output    |
| 3    | TEMP   | Input     |
| 2    | EGND   | Ground    |
| Body | SCREEN | Screen    |

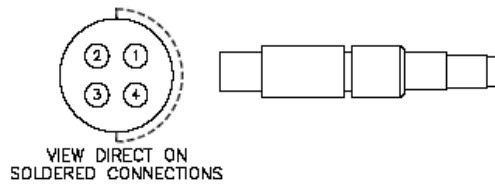
## J5 - Turbo unit connector to turbo control unit via cable - 4300027BC1 (700005299)



| Pin | Signal             | Direction | Note                |
|-----|--------------------|-----------|---------------------|
| 2   | Penning3-enable    | output    | Analyzer Pirani     |
| 4   | Pirani2-value      | input     | Collision cell      |
| 8   | SCE_TURBO_SPEED_RB | input     | Source turbo speed  |
| 9   | EGND               | ground    | -                   |
| 10  | EGND               | ground    | -                   |
| 12  | EGND               | ground    | -                   |
| 14  | 24VR_1             | output    | 24 V supply return  |
| 15  | 24VR_1             | output    | 24 V supply return  |
| 17  | Penning2_value     | input     | Quad Penning        |
| 19  | nPirani2-OK        | input     | Collision cell      |
| 22  | EGND               | ground    | -                   |
| 24  | ANA_TURBO_TRIP     | input     | -                   |
| 28  | VENTvalve_ON       | output    | -                   |
| 29  | EGND               | ground    | -                   |
| 30  | +24V               | output    | Thermal fuse 1.1 A  |
| 31  | Penning2-enable    | output    | Quad Penning        |
| 32  | Penning3_value     | input     | Analyzer Pirani     |
| 33  | EGND               | ground    | -                   |
| 34  | EGND               | ground    | -                   |
| 38  | SCE_TURBO_TRIP     | input     | -                   |
| 39  | ANA_TURBO_SPEED_RB | input     | Anal Turbo Speed    |
| 42  | nTURBOS_ON         | output    | Turbos on           |
| 43  | nROTARYvalve_ON    | output    | Backing pump relay  |
| 44  | +24V               | output    | Connected to pin 30 |

**NOTE:** It is not possible to measure any voltages on this connection.

The signals used on the turbo midplane may not appear to correspond to the inputs. The lens control PCB is used on other instruments and has the option to interface more Pirani, Penning and turbos than the Xevo TQ-S. For example, the analyzer Pirani used to generate the Vac\_OK signal interfaces with the Penning 3 input; this is because the input generates the Vac\_OK on the TOF instruments.

**J7 - DRE connector to analyzer lid assembly via cable - 4300013BC1**

| Pin | Signal              | Direction |
|-----|---------------------|-----------|
| 2   | MS2 pre/post-filter | output    |
| 3   | N/C                 | output    |
| 4   | MS1 pre/post-filter | output    |

**J8 - SPI / MSI bus connector to event I / O PCB via cable - 4185012CC3**

- MSI (blue) to event I/O
- SPI to B (not used)
- SPI to D (not used)
- SPI to E (not used)

| Pin | Signal                                               | Direction     | Note      |
|-----|------------------------------------------------------|---------------|-----------|
| 1C  | +3.3 V current limited supply                        | output        | Event I/O |
| 2C  | +3.3 V_RTN                                           | input         |           |
| 3C  | Capillary electrophoresis interlock (open collector) | output        |           |
| 4C  | Clock+ (differential signal)                         | bidirectional |           |
| 5C  | Clock- (differential signal)                         | bidirectional |           |
| 6C  | Gas fail interlock (open collector)                  | output        |           |
| 7C  | Data- (differential signal)                          | bidirectional |           |
| 8C  | Data+ (differential signal)                          | bidirectional |           |

**NOTE:** *It is not possible to measure any voltages on this connection.*

## Diagnostic procedures

### Tune page Lens Diagnostics tab

1. Click **View > System Diagnostics** on the Tune page.
2. Type **1147** as the password.
3. Click **Lens Diagnostics**.

| ScanWave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Resolution | Board Diagnostics | Lens Diagnostics | Quad Diagnostics |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------|------------------|------------------|
| <div> <div> <div>Power (V)</div> <div> <div>+1.5V</div> <div>1.19</div> </div> <div> <div>+3.3V</div> <div>3.30</div> </div> <div> <div>+5V</div> <div>4.91</div> </div> <div> <div>+15V</div> <div>14.8</div> </div> <div> <div>-15V</div> <div>-14.9</div> </div> <div> <div>+24V</div> <div>24.0</div> </div> <div> <div>API 24V Operate</div> <div>22.0</div> </div> <div> <div>INT 24V Operate</div> <div>23.9</div> </div> <div> <div>EXT 24V Operate</div> <div>24.0</div> </div> <div> <div>+430V</div> <div>439.7</div> </div> <div> <div>-430V</div> <div>-440.2</div> </div> </div> <div> <div>Lenses (V)</div> <div> <div>MS1 Pre Filter</div> <div>2.7</div> </div> <div> <div>MS2 Pre Filter</div> <div>-5.5</div> </div> </div> <div> <div>Detector (V)</div> <div> <div>Multiplier</div> <div>513.3</div> </div> </div> <div> <div>Cooling Fan</div> <div> <div>Duty Cycle (%)</div> <div>0</div> </div> </div> </div> <div> <div>Board Statuses</div> <div> <div>Operate</div> <div>Interlocks</div> <div>Vacuum</div> <div>Switch</div> <div>Turbo Pump</div> <div>Pumping</div> <div>Main</div> </div> </div> <div> <div>Vacuum (V)</div> <div> <div>Penning MS2 Analyser</div> <div>6.74</div> </div> <div> <div>Pirani 2 Collision</div> <div>3.53</div> </div> <div> <div>Pirani 3 Analyser</div> <div>1.89</div> </div> <div> <div>Pirani 4 Ion Guide 2</div> <div>3.68</div> </div> </div> <div> <div>Temperatures (°C)</div> <div> <div>Board</div> <div>23.0</div> </div> <div> <div>Enclosure</div> <div>55</div> </div> </div> <div> <div>Turbos</div> <div> <div>Vent Cycles</div> <div>10</div> </div> <div> <div>Speed (%)</div> <div>Operation Time (Hrs)</div> </div> <div> <div>Source</div> <div>102.87</div> <div>863</div> </div> <div> <div>Analyser 1</div> <div>102.52</div> <div>863</div> </div> <div> <div>Analyser 2</div> <div>102.99</div> <div>863</div> </div> </div> |            |                   |                  |                  |

Figure 2 - Tune page Lens Diagnostics tab

## Tune page readbacks

### Power readbacks

Power [V]

|                 |        |
|-----------------|--------|
| +1.2V           | 1.20   |
| +3.3V           | 3.31   |
| +5V             | 4.92   |
| +15V            | 14.7   |
| -15V            | -14.9  |
| +24V            | 24.0   |
| API 24V Operate | 21.9   |
| INT 24V Operate | 23.8   |
| EXT 24V Operate | 23.9   |
| +430V           | 439.2  |
| -430V           | -442.1 |

| Parameter         | Expected Readback | Notes                                                                    |
|-------------------|-------------------|--------------------------------------------------------------------------|
| +1.2 V            | ~1.2              | Generated on lens control from +3.3 V.                                   |
| +3.3 V (MCU)      | ~3.3              | Generated on lens control from +5 V.                                     |
| +5 V              | ~5                | Generated on lens control from +24 V.                                    |
| +15 V             | ~+15              | Generated on lens control from +24 V.                                    |
| -15 V             | ~-15              | Generated on lens control from +24 V.                                    |
| +24 V             | 24 ±1.25          | Supplied by power module PCB.                                            |
| API 24 V Operate  | ~24               | Generated on lens control outputted to source PCB. Used to power HV PSU. |
| Int. 24 V Operate | ~24               | Generated on lens control. Used to supply the ±430 V Spellman PSU.       |
| EXT 24 V Operate  | ~24               | Generated on lens control.                                               |
| +430 V            | ~+430             | Generated on Spellman PSU (lens control), for lens voltages.             |
| -430 V            | ~-430             | Generated on Spellman PSU (lens control), for lens voltages.             |

### Lenses readbacks

Lenses [V]

|                |      |
|----------------|------|
| MS1 Pre Filter | 2.7  |
| MS2 Pre Filter | -5.5 |

| Parameter      | Expected Readback                          | Notes |
|----------------|--------------------------------------------|-------|
| MS1 pre-filter | * See potential energy diagram for details |       |
| MS2 pre-filter |                                            |       |

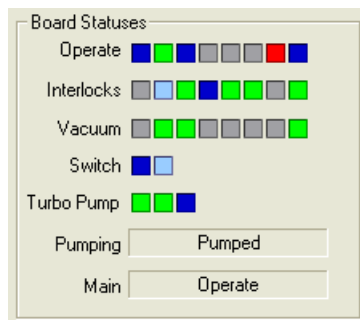
### Detector readbacks

Detector [V]

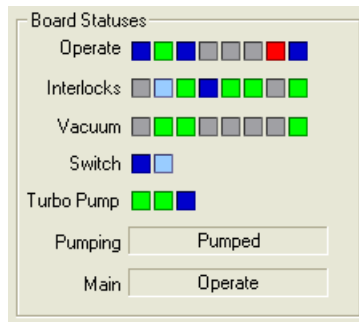
|            |       |
|------------|-------|
| Multiplier | 542.6 |
|------------|-------|

| Parameter  | Expected Readback                                                                                                              |
|------------|--------------------------------------------------------------------------------------------------------------------------------|
| Multiplier | Factory set with Detector Gain Wizard, see the <i>Whisper Detector Assembly Technical Reference Sheet</i> for more information |

## Board status LEDs



|                | Feature                                           | Color      | Meaning                |
|----------------|---------------------------------------------------|------------|------------------------|
| Operate LEDs   | Ion Mode                                          | Dark Blue  | Positive ion mode      |
|                |                                                   | Light Blue | Negative ion mode      |
|                | Operate/Standby                                   | Dark Blue  | Operate                |
|                |                                                   | Light Blue | Standby                |
|                | Last Operate request from EPC (Doperate)          | Dark Blue  | Operate                |
|                |                                                   | Light Blue | Standby                |
|                | -                                                 | Grey       | Not used               |
|                | Pump Override                                     | Dark Blue  | Override active        |
|                |                                                   | Light Blue | Auto (software) active |
|                | Operate Status (operate5V and operate24V enabled) | Dark Blue  | Operate                |
|                |                                                   | Light Blue | Standby                |
| Interlock LEDs | Penning Status                                    | Dark Blue  | Enabled                |
|                |                                                   | Light Blue | Disabled               |
|                | Analyzer Penning                                  | Dark Blue  | Enabled                |
|                |                                                   | Light Blue | Disabled               |
|                | Vacuum Status (TOF_VAC_OK)                        | Green      | Vacuum OK              |
|                |                                                   | Red        | Vacuum not OK          |
|                | Instrument Status                                 | Dark Blue  | Operate                |
|                |                                                   | Light Blue | Standby                |
|                | Safety Interlock (nInterlock)                     | Green      | Interlock OK           |
|                |                                                   | Red        | Interlock not OK       |
|                | RF Trip                                           | Green      | RF Trip OK             |
|                |                                                   | Red        | RF Trip not OK         |
|                | Source fitted (source interlocks)                 | Green      | API source fitted      |
|                |                                                   | Red        | -                      |
|                | -                                                 | Grey       | Not Used               |

**Board status LEDs (continued)**

|                 | Feature                                   | Color      | Meaning     |
|-----------------|-------------------------------------------|------------|-------------|
| Vacuum LEDs     | Analyzer Pirani<br>Vac Trip               | Green      | Good vacuum |
|                 |                                           | Red        | Bad vacuum  |
|                 | -                                         | Grey       | Not used    |
|                 | API Gas                                   | Green      | OK          |
|                 |                                           | Red        | -           |
| Switch LEDs     | 24 V Operate Switch<br>Status * (OP_RQST) | Dark Blue  | High        |
|                 |                                           | Light Blue | Low         |
|                 | 24 V Operate Switch<br>Status (OP_RQST)   | Dark Blue  | High        |
|                 |                                           | Light Blue | Low         |
| Turbo Pump LEDs | Source turbo speed                        | Green      | OK          |
|                 |                                           | Light Blue | Below 80%   |
|                 | Analyser turbo 1 speed                    | Green      | OK          |
|                 |                                           | Light Blue | Below 80%   |
|                 | Analyser turbo 2 speed                    | Green      | OK          |
| Pumping         | Pumped                                    | -          | -           |
| Main            | Operate                                   | -          | -           |

### Vacuum readbacks

Vacuum (V)

|                      |      |
|----------------------|------|
| Penning MS2 Analyser | 6.74 |
| Pirani 2 Collision   | 3.53 |
| Pirani 3 Analyser    | 1.89 |
| Pirani 4 Ion Guide 2 | 3.68 |

| Parameter            | Expected Readback | Notes                              |
|----------------------|-------------------|------------------------------------|
| Penning MS2 analyzer | 0.00              | Penning off                        |
| -                    | 5.74              | 4.62 e-6 - Col gas off             |
| -                    | 6.74              | 1.08 e-5 -Col gas on               |
| Pirani 2 collision   | 3.53              | 3.73 e-3 - Col gas on              |
| -                    | <2.11             | Collision gas off                  |
| Pirani 3 analyzer    | <2.05             | Collision gas on or off, vacuum OK |
| Pirani 4 Ion Guide 2 | 3.68              | 2.71e-3                            |
| -                    | 3.68              | 2.71e-3                            |

### Turbo readbacks

Turbos

|             |                      |
|-------------|----------------------|
| Vent Cycles | 10                   |
| Speed (%)   | Operation Time (Hrs) |
| Source      | 102.87 863           |
| Analyser 1  | 102.52 863           |
| Analyser 2  | 102.99 863           |

| Parameter   | Expected Readback                       | Notes    |
|-------------|-----------------------------------------|----------|
| Vent cycles | Counts number of instrument vent cycles |          |
| Source      | ~100 %                                  | Turbo OK |
| Analyser 1  | ~100 %                                  | Turbo OK |
| Analyser 2  | ~100 %                                  | Turbo OK |

### Temperature and cooling fan readbacks

Temperatures (°C)

|           |      |
|-----------|------|
| Board     | 23.0 |
| Enclosure | 51   |

Cooling Fan

|                |   |
|----------------|---|
| Duty Cycle (%) | 0 |
|----------------|---|

| Parameter      | Expected Readback                                                                                                                                                                                       | Notes                                                                                             |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Board          | This is the lens control PCB temperature.                                                                                                                                                               | If this temperature exceeds 60 °C then an error will be logged.                                   |
| Enclosure      | This temperature is received from temperature conversion PCB, it monitors the source enclosure heatsink.                                                                                                | If this exceeds 100 °C the source and desolvation heaters are switched off.                       |
| Duty Cycle (%) | The source heater alone will not drive the temperature of the source enclosure to a level where the fan will turn on. The fan will only turn on if the desolvation heater is set to a high temperature. | The cooling fan % duty cycle is proportional to the temperature of the source enclosure heatsink. |

## Other relevant information

An FPGA and MCU provide the board with some logical intelligence.

A standard parallel bus from the EPC is connected to the FPGA. Normal communication with the boards in the system goes first to the FPGA on the lens/control PCB. The FPGA then communicates with the other PCBs in the backplane via a SPI multi-drop bus.

Commonly used signals such as global reset, positive or negative ion, vacuum ok, and operate are set on this board and are outputted to the backplane.

The following two SPI/MSI buses are used for point-to-point communication with boards located outside the electronics unit:

- MSI bus used for event I/O
- SPI/MSI bus (spare, for future use)

The RS422 bus service bus is connected to other boards.

LEDs are placed along the front of the board to indicate status, errors etc.

## Summary of voltages

This section is a summary of voltages applied to the capillary, sample, and extraction cones in the various operation mode configurations when the instrument is in Operate.

The Xevo TQ-S like the Xevo TQ does not follow the same potential energy diagram as previous tandem quadrupole instruments. The Xevo TQ-S maintains the collision cell at ground potential, adding the collision energy onto the front of the instrument. This means that the collision energy is added on to the lens in reverse order:

- Exit and entrance plates
- MS1 post-filters
- MS1 quad
- MS1 pre-filters
- differential aperture 2
- RF Lens 2 TW
- Differential aperture 1
- RF Lens 1 TW
- Cone voltage
- Capillary voltage

**Table 1: Summary of voltages**

| Operation Mode                    | Capillary                                                                                                                    | Cone Voltage                                                                                                     | Source Offset Voltage                                                                                     |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Gas on-Enhanced Mode              | Capillary + Cone + Source Offset Voltage * + collision energy + storage offset + ScanWave offset + static offset(=0)         | Cone + Source Offset Voltage * + collision energy + storage offset + ScanWave offset + static offset(=0)         | Source Offset Voltage * + collision energy + storage offset + ScanWave offset + static offset(=0)         |
| Gas on-Standard Mode              | Capillary + Cone + Source Offset Voltage * + collision energy + storage offset(=0) + ScanWave offset(=0) + static offset(=0) | Cone + Source Offset Voltage * + collision energy + storage offset(=0) + ScanWave offset(=0) + static offset(=0) | Source Offset Voltage * + collision energy + storage offset(=0) + ScanWave offset(=0) + static offset(=0) |
| Gas off-Enhanced or Standard Mode | Capillary + Cone + Source Offset Voltage * + collision energy(=0) + static offset(=0)                                        | Cone + Source Offset Voltage * + collision energy(=0) + static offset(=0)                                        | Source Offset Voltage * + collision energy(=0) + static offset(=0)                                        |

\* See the StepWave technical reference sheet for more detail.

**NOTE:** The cone voltage does not originate on the Lens Control PCB

## Fuses

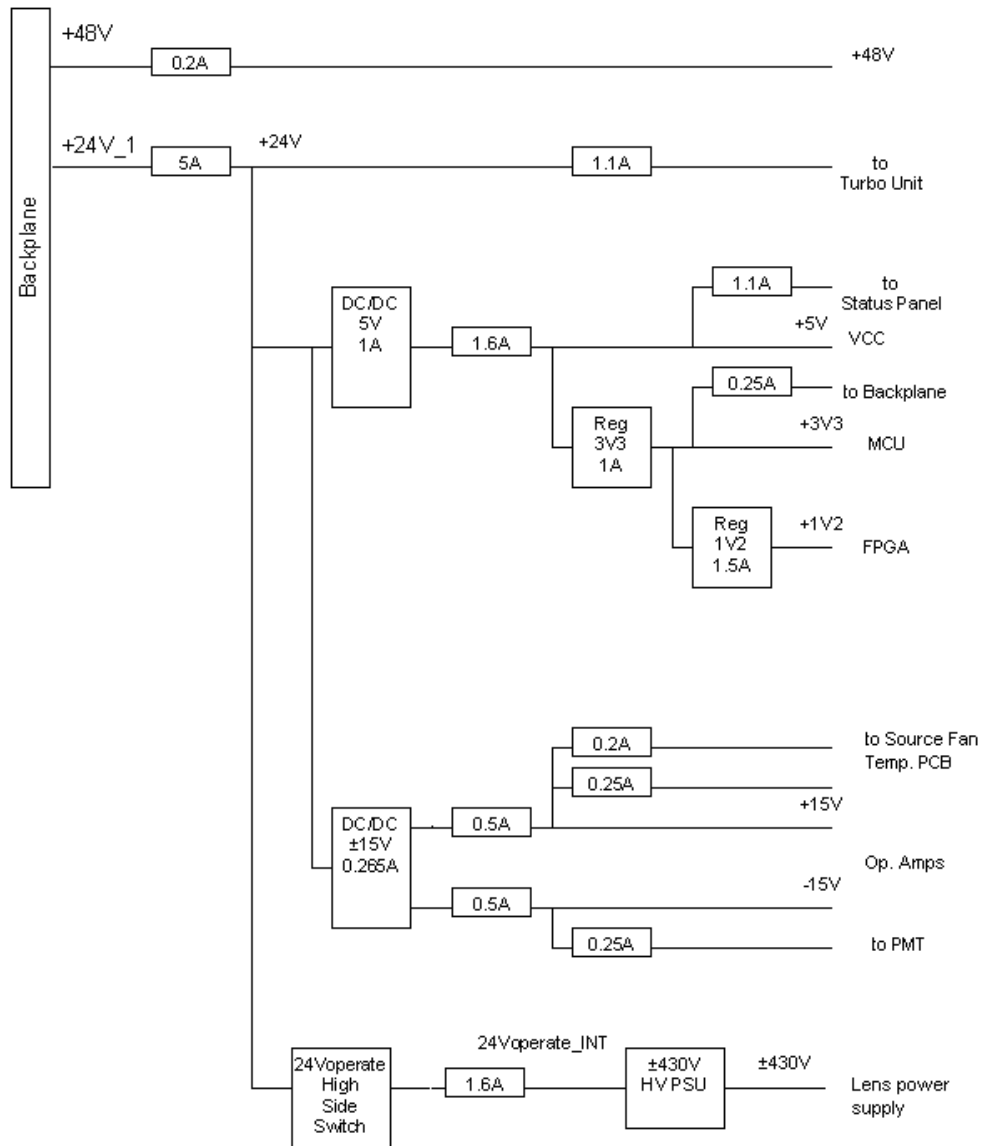


Figure 3 - Fuses

The +24V\_1 is passed through two DC/DC converters to produce the following lower voltage supplies:

- +5 V
- +15 V
- -15 V

The +5 V voltage then generates the following supplies:

- +3V3
- +1V2

**Table 2: Voltages**

| Voltage                         | Rating | Description              |
|---------------------------------|--------|--------------------------|
| +5 V 24 VDC/5 VDC               | 1.6 A  | Thermal fuse 1.6 A       |
| +5 V (to status panel)          | 1.1 A  | Thermal                  |
| +3V3 Linear regulator from +5 V | -      | Regulator foldback 1.6 A |
| +1V2 Linear regul. from +3V3    | -      | Limited by 3V3 regulator |
| +15 V 24 VDC/±15 VDC            | 0.5 A  | Thermal fuse 0.5 A       |
| +15 V (to PMT)                  | 0.25 A | Thermal                  |
| -15 V 24 VDC/±15 VDC            | 0.5 A  | Thermal fuse 0.5 A       |
| -15 V (to PMT)                  | 0.25 A | Thermal                  |
| +48 V from backplane            | 0.2 A  | Thermal                  |
| +24 V from backplane            | 5 A    | Thermal                  |
| +24 V_EXT                       | 2.5 A  | Thermal                  |
| 24Voperate_INT (to HV supply)   | 1.6 A  | Thermal                  |

## Indicator LEDs

Indicator LEDs are placed at the edge of the board and can be used to find errors.

**Table 3: Indicator LEDs**

| Feature             | Controlled from | Color                                                                                     | Note                                                                                |
|---------------------|-----------------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Fifo Half           | FPGA            | Green    | ON when one PMT data transfer is started                                            |
| Fifo Full           | FPGA            | Red      | ON when PMT data fifo is full                                                       |
| Host Ack            | FPGA            | Green    | ON when hostack = 1                                                                 |
| Host Clock          | FPGA            | Green    | ON when hostclk = 0                                                                 |
| Peripheral Ack      | FPGA            | Green    | ON when periphack = 1                                                               |
| Peripheral Clock    | FPGA            | Green    | ON when peripherclk = 0                                                             |
| ScanInProgress      | FPGA            | Green    | ON when nScanInProgress is low                                                      |
| Power OK            | MCU             | Green    | ON when all rails voltage within $\pm 5\%$                                          |
| MCU Error           | MCU             | Red      | ON when error                                                                       |
| 24Voperate_ON *     | voltage         | Green    | ON when voltage                                                                     |
| 24Voperate_API_ON * | voltage         | Green    | ON when voltage - Generated on the lens/control PCB, LED present on the source PCB. |
| Interlock *         | logic gates     | Green  | ON when nInterlock_5V is low                                                        |
| TOF Vacuum OK *     | gate            | Green  | ON when TOF_VAC_OK is high                                                          |
| HT OK               | FPGA            | Green  | ON when $\pm 430$ V supply rails are within tolerance                               |

**NOTE:** \* See the "[On-board logic](#)" section

## On-board logic

### Interlock logic

Interlock logic is used to ensure that high voltages are switched on only when the vacuum is OK. The interlock logic is made with discrete ICs for security reasons.

nInterlock\_5V is low when the vacuum system is OK.

The signal is set by all turbo pump trip signals (used pump trips always indicate OK when the turbos are on):

- Turbo\_ON\_5V
- DOPERATE is set
- TOF\_VAC\_OK\_5V

nInterlock\_5V switches off the 24Voperate\_INT and 24Voperate\_EXT voltages when there is a problem in the vacuum system. It also sets the 24Voperate\_API\_ON signal that is an output from the lens control PCB.

Figure 4 shows the required conditions for the interlock LED to be on (vacuum system is OK).

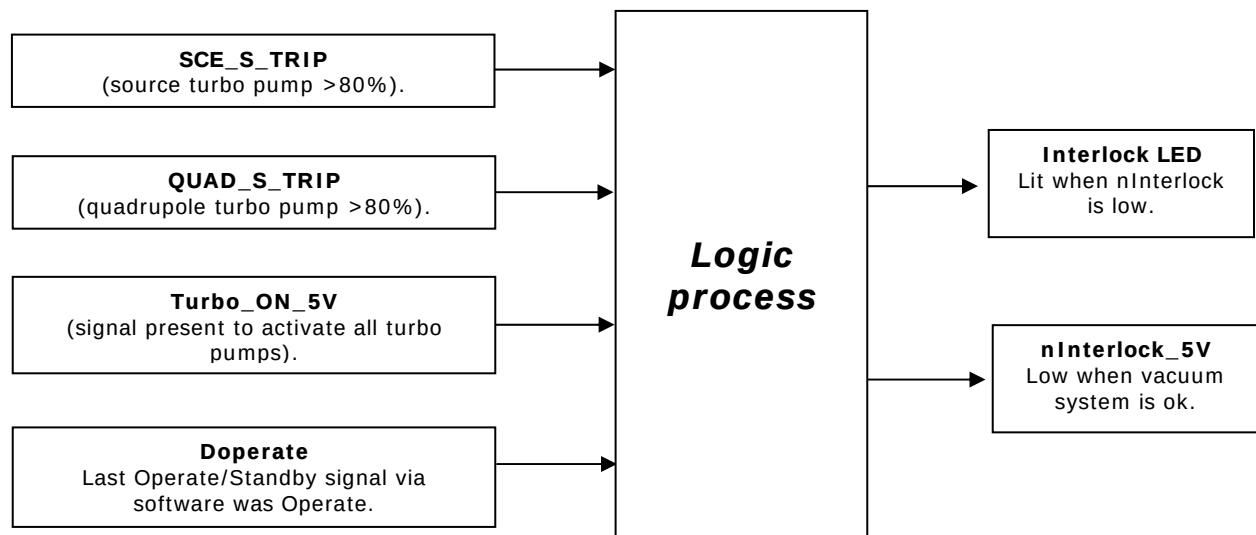


Figure 4 - Interlock logic process

**NOTE:** The TOF\_VAC\_OK\_5V signal name originates from SYNAPT, and indicates that the analyzer pressure is OK.

## 24Voperate logic

The high-side switches on the lens control PCB are controlled with the following 5 V logic signals:

- 24Voperate\_ON            Used on the lens/control PCB
- 24Voperate\_API\_ON    Output signal from the lens/control PCB to the backplane

To be switched on, 24Voperate\_ON requires that both Interlock\_5V and nOPERATE are low.

24Voperate\_API\_ON is on when the four low signals, nOPERATE, nSource, nAPI\_gas\_sw, nAPIoperate\_enable are active.

The following diagram shows the required conditions for the 24Voperate\_ON (Operate command used on the lens control PCB) and 24Voperate\_API\_ON (operate command to source PCB) to be on.

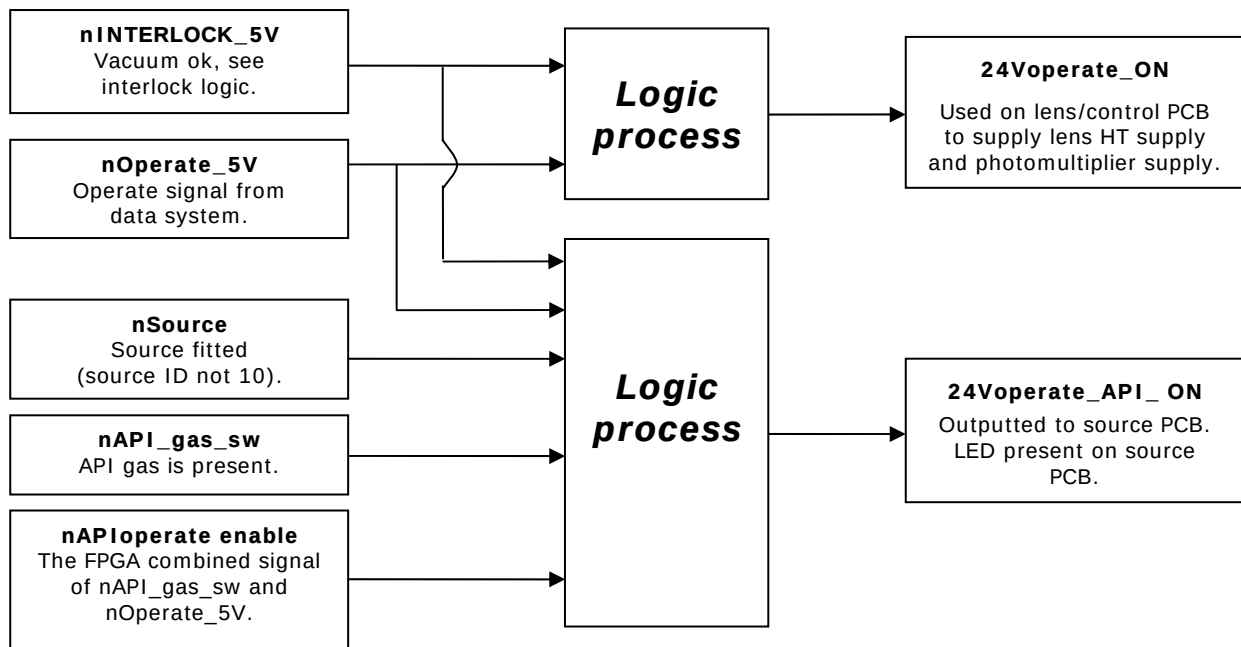
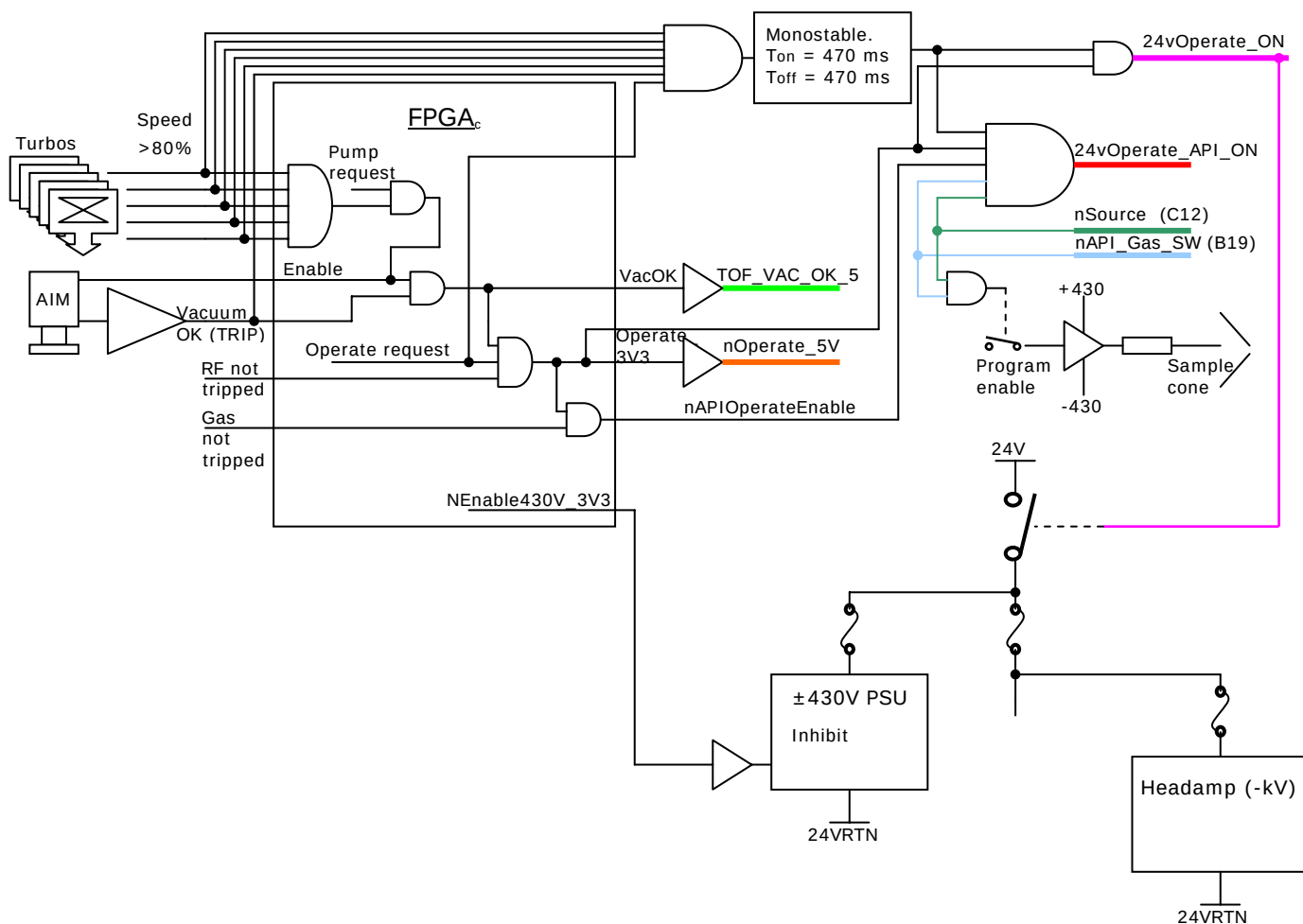


Figure 5 - 24Voperate logic process

## Overview of logic signals output to and from the lens control PCB



|                   |                                                                                                                                                                                 |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| nSource           | Probe recognition/source interlock, originates from the source and is routed through the fluidics/options PCB, source PCB before being logically processed in lens control PCB. |
| nAPI_Gas_SW       | Software API gas switch.                                                                                                                                                        |
| 24Voperate_API_ON | Output to the source PCB for the source and probe heater interlock.                                                                                                             |
| TOF_VAC_OK_5V     | Analyzer pressure is OK, this is generated from the pressure output from the analyzer Pirani and the SET TRIP setpoint being achieved on the Pirani.                            |
| nOperate_5V       | Operate request from the data system.                                                                                                                                           |
| 24VOperate_ON     | HVPSU interlock, this 24 V is output to the backplane for the other boards to use.                                                                                              |

Figure 6 - Logic signals overview

## Removing the lens control PCB from the electronics unit

1. Flip the pump override toggle switch at the rear of the power distribution unit into the override (down) position.
2. Switch off the electronics toggle switch and ensure that all the PCB LEDs are off.
3. Remove the following cables:
  - MSI
  - EPCAS
  - PMT
  - Panel status
  - Turbo control
  - Temperature conversion PCB
  - MALDI focus
  - DRE

**NOTE:** Due to cable-ties, it may also be necessary to remove the RS422 port cable from the power module PCB.

4. Simultaneously press the red tabs of the card ejector clips on either side of the board, and swing the ejector clips outwards, see Figure 7.
5. Gently pull out the PCB to remove.



Figure 7 - Card ejector

## Reinstalling the lens control PCB

1. The lens control PCB fits into the second lowest rail slot within the electronics unit.

**CAUTION:** *To avoid damage to the loom wiring, do not trap any of the wiring when fitting the PCB into the electronics unit.*

2. Align the sides of the PCB with the red spacer supports at either side.
3. Slowly insert the PCB then guide and lock into place with the card ejector clips.
4. Reconnect all the cables, ensuring that the DRE cable is connected correctly.

## Testing after replacing the lens/control PCB

Perform the following checks if the lens control PCB is replaced:

1. Ensure that communications are established.
2. Infuse setup solution and check for an ion beam in positive and negative ion modes.