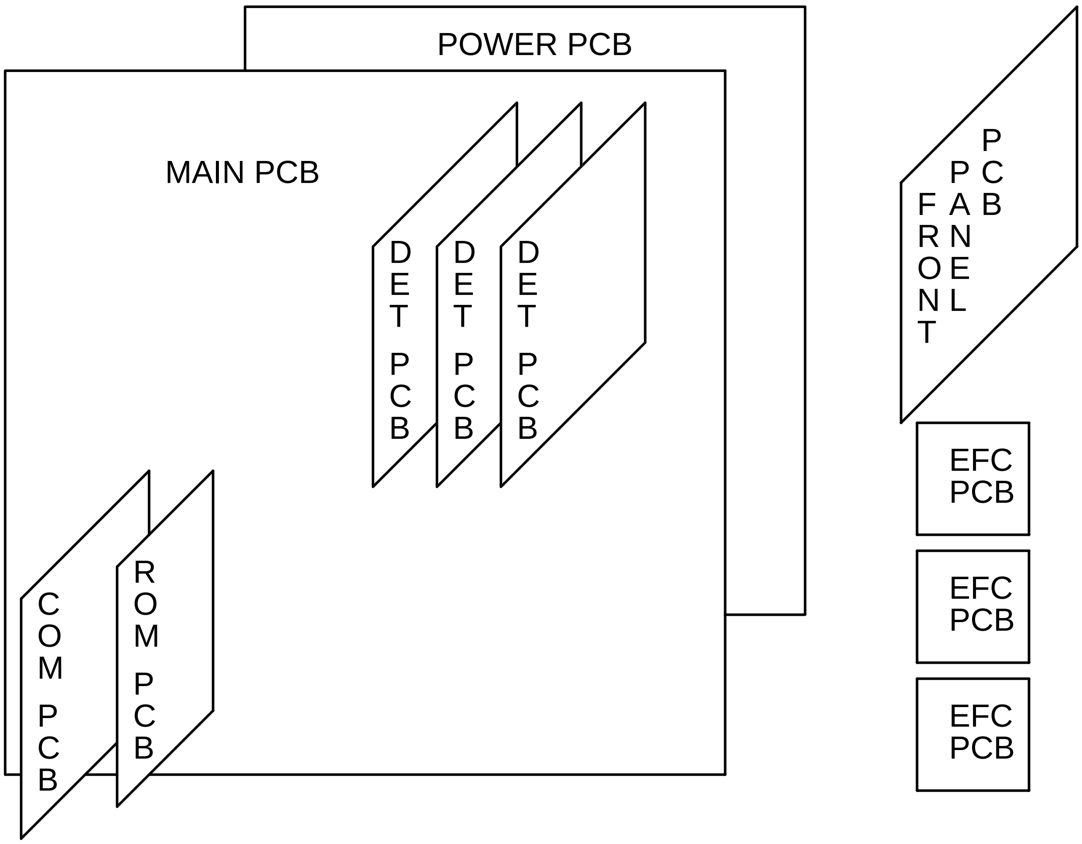
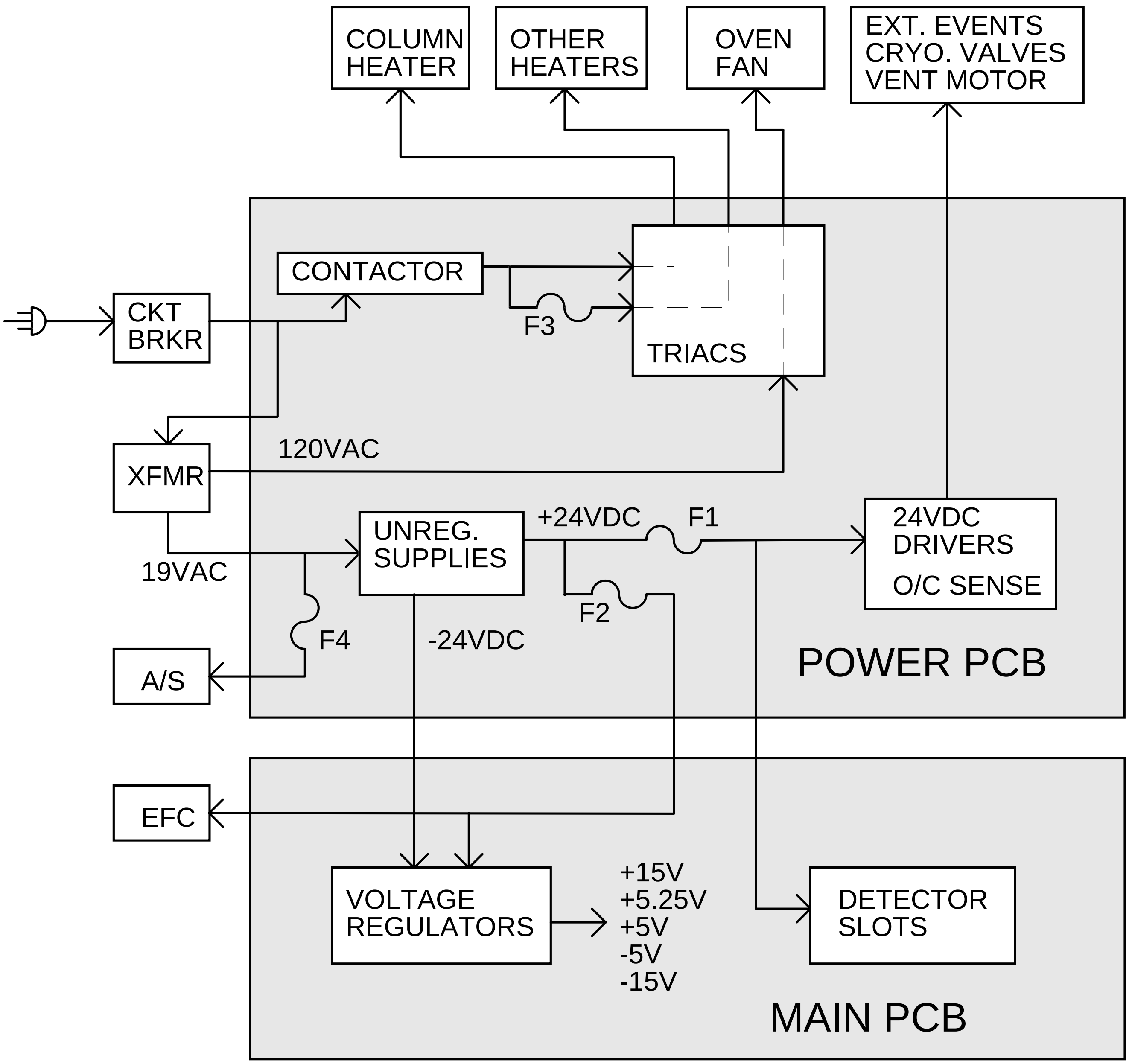
3800 PC BOARDS



3800 POWER DISTRIBUTION



Primary power considerations

- Three line voltage settings: 100VAC, 115VAC, and 230VAC (all ±15%)
- Phase-phase operation okay
- Dedicated configurations: no line voltage switching in field
- Contactor interlocked to cooling fan and heater connectors (must be plugged in for contactor to engage)
- Fuse F3 protects all heaters except for column oven
- Main transformer has internal over-temperature cutoff (affects column oven fan on autotransformer tap, as well as all DC loads)
- Column oven heater is protected by circuit breaker (main power switch) only

24VDC power considerations

- External Events, cryo valves, and vent motor drivers have over-current protection - overload on any load turns off all of these loads.
- Fuse F1 protects valves, vent motor, and detector supplies - check for sound of cooling fan if any of these functions are disabled. *Note: Loads are connected between +24V and current-sinking drivers; a short from the +24V side of the load to ground will blow this fuse (5x20mm type T) in spite of over-current protection!*
- Fuse F2 protects DC supplies and EFC - no signs of life if blown, except for instrument cooling fan running.
- -24V supply (drives negative voltage regulators only) protected by “trace fuse” - must be replaced by fuse and clips on power pcb if blown.
- CPU shuts down all loads possible if 24V supply overheats - check cooling air flow and DC loads.
- 19VAC transformer output for 24VDC supplies also available to supply autosamplers through fuse F4 (not used at this time).

Power PCB troubleshooting

Heater controls

- Be sure interlocked connectors (heaters and cooling fan) are plugged in, and that no overheated condition is keeping the contactor off.

- If no zones are heating, check fuse F3. If 24VDC loads are also dead, serial control bus between Main board and Power board may be faulty (could be either board or the cable).

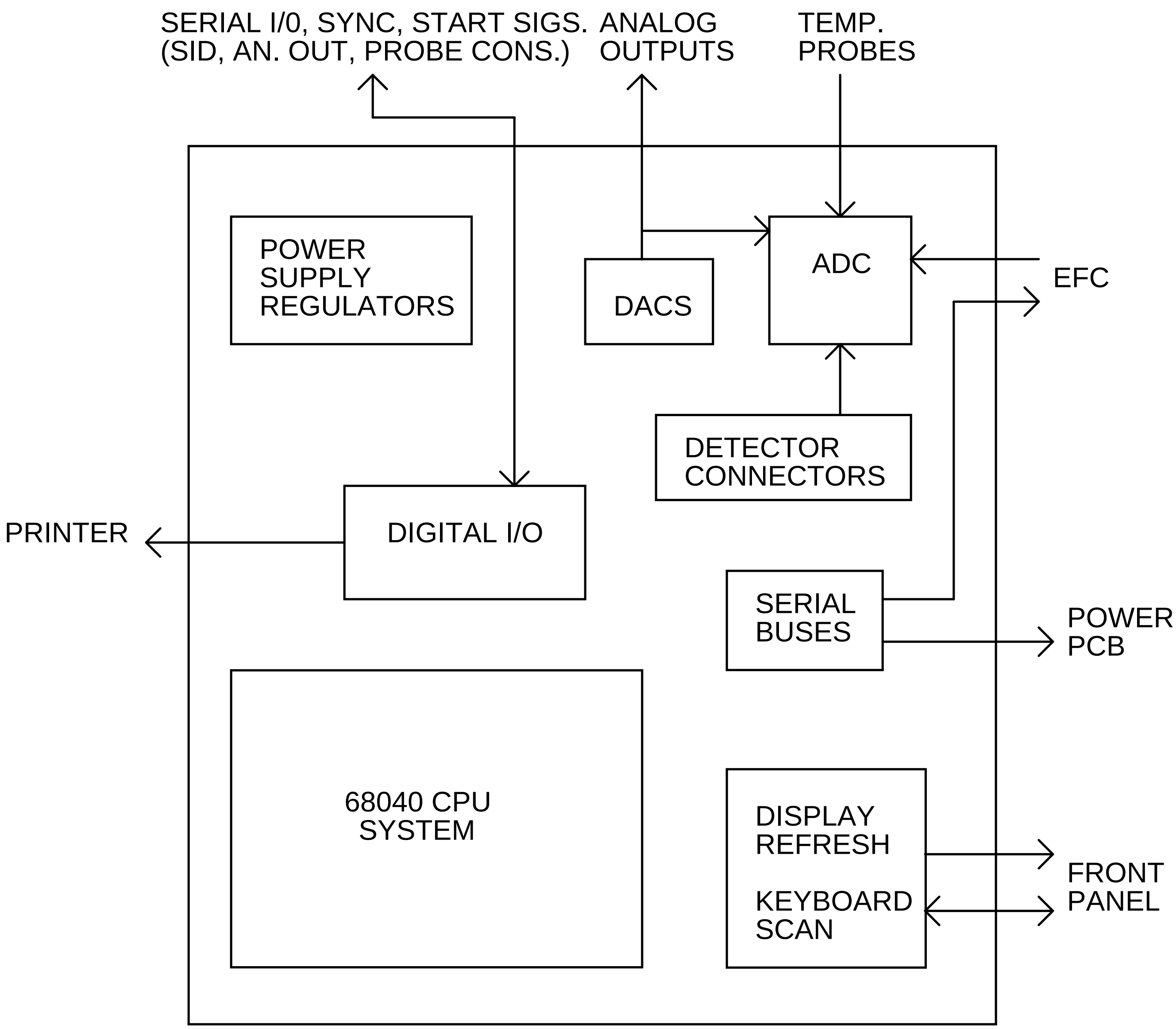
- If a single zone is not heating, check the heater resistance at the connector. Normal resistance indicates Power PCB problem.

24V Drivers

- If all loads are off, check fuse F1. Then use ETS-CSR software to turn loads on one at a time. When a driver is found that causes shut-down of all drivers, that load is probably shorted.

- If a single load is not working, check the resistance of the load at the connector, or check the switched voltage at the connector, while turning the driver on and off with ETS-CSR software.

3800 MAIN PCB
BLOCK DIAGRAM



Main PCB troubleshooting

- Power: Check green LED for presence of +5V; use meter to check other supplies at test points. (Any supply fault will cause an ADC self-test fault.) If a supply appears to be shorted, disconnect cables to EFC and front panel, remove detector and COM pc boards, and check supply voltages again. *(Be sure cable from Power PCB is connected!)*

- CPU/ROM: Check that yellow STOP LED is on, and that both red LEDs (RESET and HALT) are off, to verify basic system operation; install ETS_CSR ROM board to isolate ROM faults from main board faults.

- Front Panel: If Main board LEDs are okay, but display is dead, replace front panel and/or cable to isolate front panel from main board circuitry.

- Digital I/O: Use loop-back cable with ETS-CSR software to check digital inputs and outputs. Monitor inject switch status with test software while depressing switch.

- ADC: System software should catch faults during normal operation. To observe actual readings through input multiplexers, use ETS-CSR software to monitor any ADC input. Detector voltages, DAC outputs, EFC signals, barometric pressure sensor, and RAM back-up battery voltage are all available.

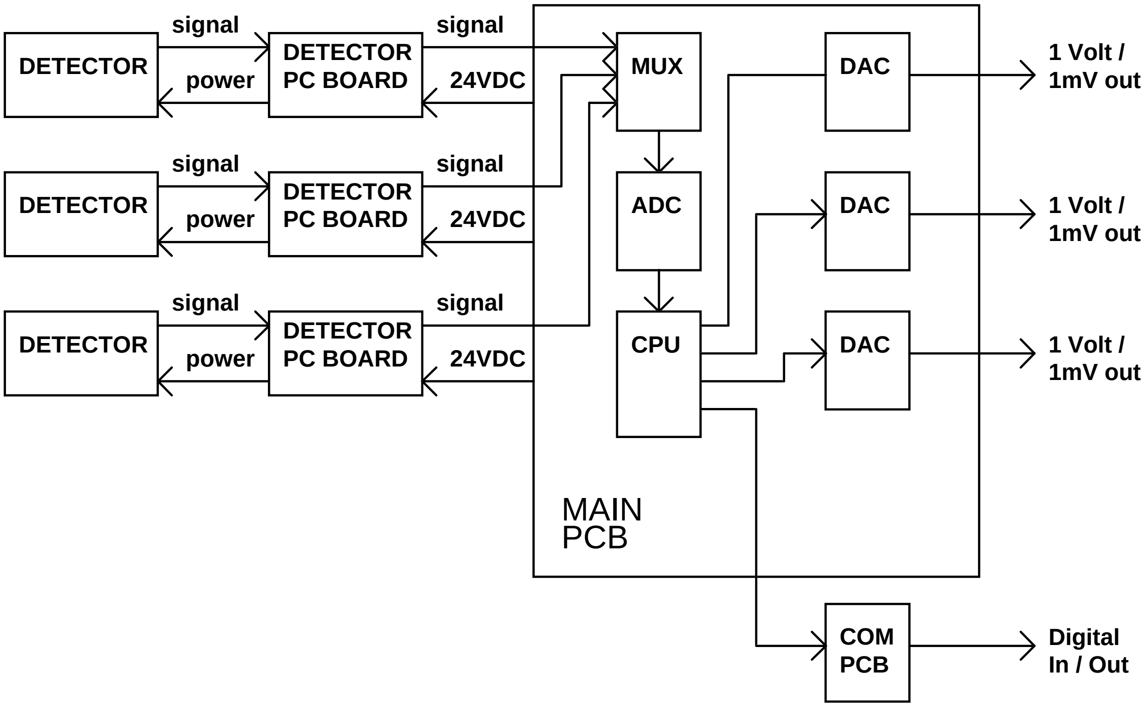
- DACs: Use ETS-CSR software to set each DAC to any desired voltage between -0.1V and +1.0V. Output may be measured with a voltmeter, or by monitoring the DAC output with the 3800 system ADC. Test software shows values measured at low (10mV) and high (990mV) calibration settings. If these readings are wrong, calibration may have failed due to a short or low-resistance load at the DAC output during calibration. Run the calibration again, with the analog output cable disconnected.

- Temperature measurement: Install a probe simulator (7 equal-value resistors mounted in a connector) in place of the temperature probe connector. Using ETS-CSR or normal system software, all temperature readings should equal the expected value (e.g., 0°C for 100Ω, 206°C for 178Ω, 406°C for 249Ω).

- COM board: Install a dual terminator on the ethernet connector, and use ETS-CSR software to run an external loop-back test.

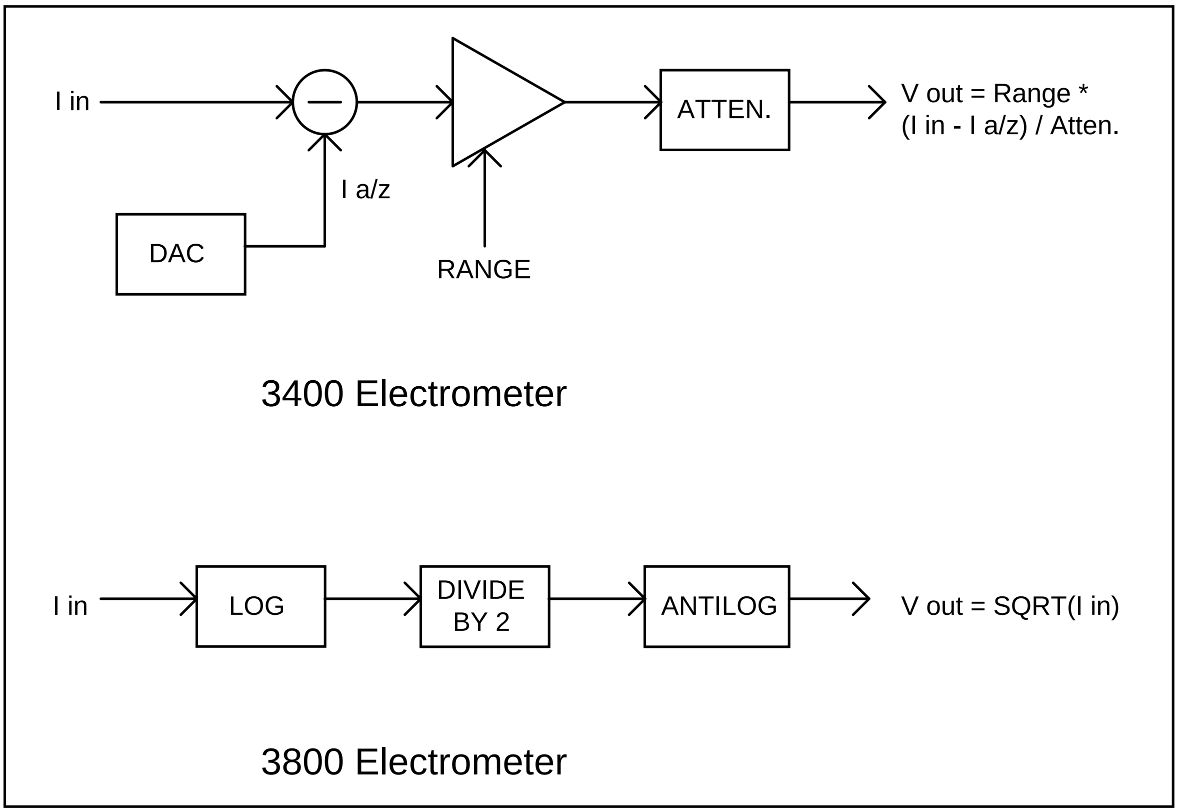
- Memory: ROM and EEPROM checksums can be verified from ETS-CSR software, and RAM read/write tests can be performed.

3800 Detector Architecture

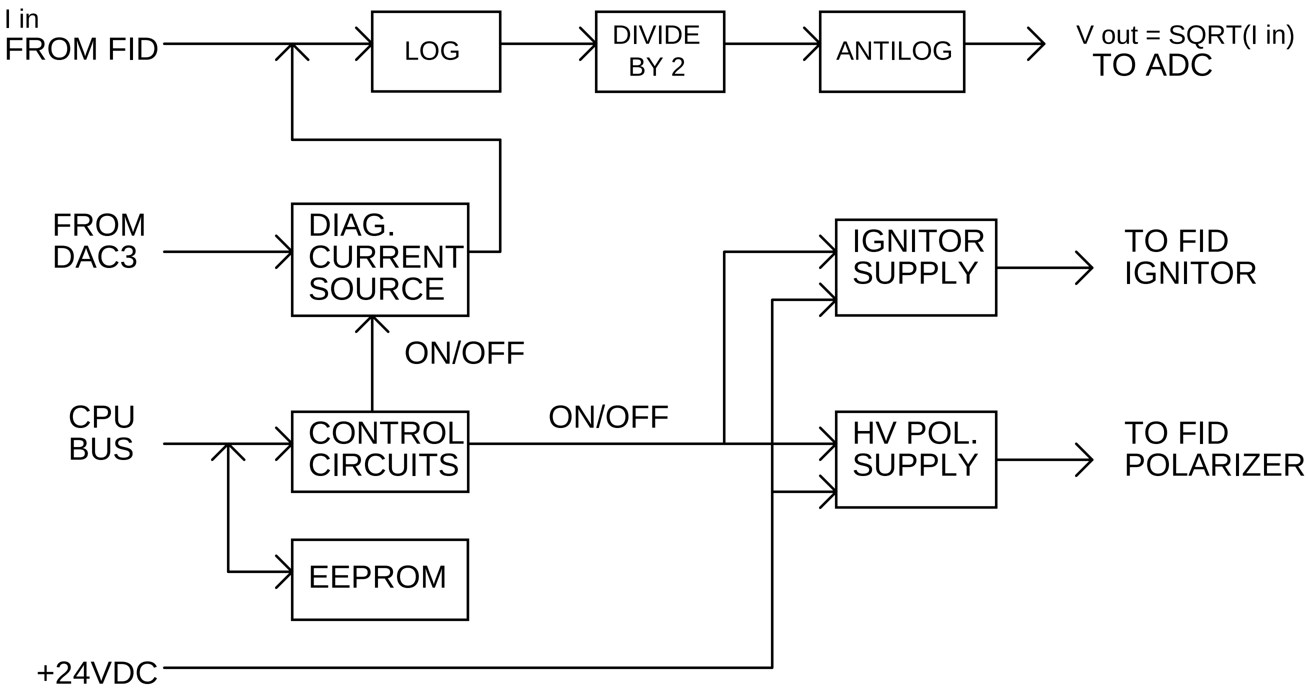


- All supplies converted from +24VDC to accomodate all combinations, specials, and new designs
- No adjustments or switches on pcbs (all done through front panel)
- ADC digitizes each detector output at 40 conversions per second
- All detector data available through Ethernet connection
- Flexible assignment of 3 output DACs
- Software provides time-constant filters and attenuation
- Linearization (e.g., PFPD square-root mode for sulfur) done in software

Comparison of
3400 & 3800 ELECTROMETERS



3800 FID BLOCK DIAGRAM



3800 FID Features

- Log-antilog square root circuit
- No hardware range switching, attenuation, or autozero (software ranging required for analog out)
- Only 4 parts on critical node for less susceptibility to contamination & mishandling
- Lower noise at low currents (shot noise vs. Johnson noise)
- Software linearization to 0.2%; 0.2% reproducibility board-to-board
- Built-in test current source
- Positive polarizer
- High-frequency igniter
- *Slow response at very low currents*

FID field test procedures

- Electrometer

    1. Disconnect cable; cap or shield BNC connector.

    2. Use ETS-CSR software to enable diagnostic current waveform (generated by analog output DAC 3).

    3. Observe electrometer output: 1pA ±10% for 70 seconds, 20 seconds recovery time, repeating indefinitely; noise <10fA p-p. Output level may be read on ETS-CSR screen on 3800, or may be observed on chart recorder connected to DAC 1.

    4. Connect signal cable and probe (with flame off) to test these parts.

- High voltage

    Measure at pcb or tower, as in 3400; nominal value = +175VDC with 10M meter.
    - or -
    Use ETS-CSR software to turn on high voltage; read value on 3800 display (+190VDC nominal).

- Ignitor supply

    Measurements with AC voltmeter may be inaccurate, due to 50kHz square-wave drive. Check ignitor resistance at probe and through cable; PCB faulty if resistance okay (about 1 Ohm) and coil does not glow.

- Calibration EEPROM

    Software will indicate errors reading CRC integrity check in EEPROM.

TSD field test procedures

- Electrometer & EEPROM: same as FID

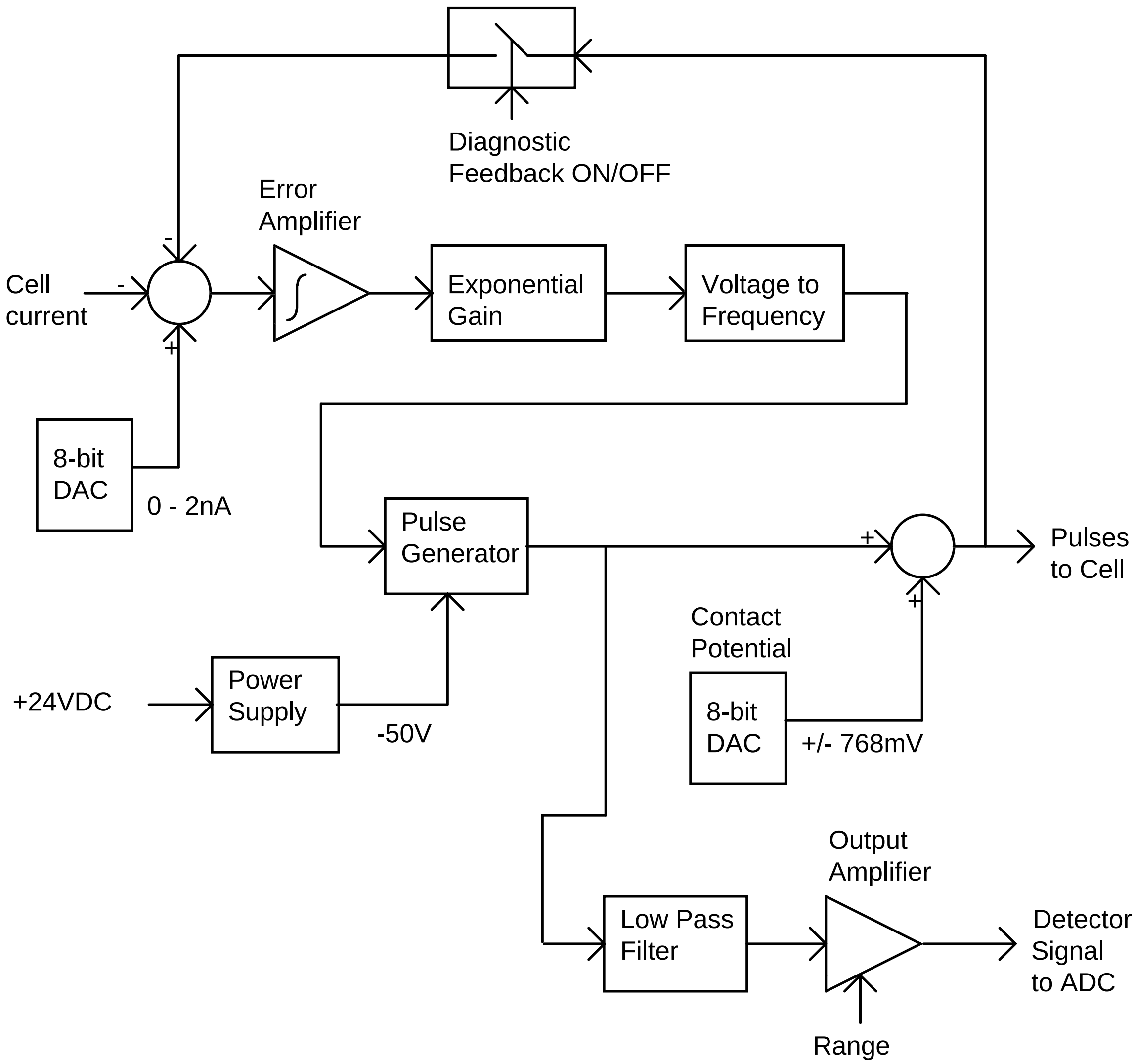
- Bead bias and current supplies

  Check bead resistance at connector. If normal (about 0.5 to 1 Ohm), but bead does not glow, PCB is faulty.

  -or-

  Use ETS-CSR software to turn on bead supply, set to 2.4A, with bead connected. Check displayed bead voltages on screen. Bias side should be -4V, and other side should be about -2V. Supply is bad if there is no voltage drop across bead, and bead is open if the high side reads above 0V.

3800 ECD BLOCK DIAGRAM



Main changes from 3400

- Integrating error amplifier
- Exponential gain compensation for constant loop gain
- DAC control of cell current and contact potential compensation
- No hardware autozero
- Closed-loop diagnostics replace open-loop diagnostics

ECD Field test procedures

- Pulser supply voltage

  Read value of -50V supply off of ETS-CSR screen.

- Contact potential DAC

  Disable the pulser, using ETS-CSR software. Pulser output DC voltage, measured with a meter at the pulser connector, should vary from -769mV to +769mV, as the contact potential DAC setting is raised from 0 to 255.

- Electronic Noise

  Use ETS-CSR software to enable diagnostic mode, and select Range 1. Set the cell current DAC to 4, and the contact potential DAC to zero. Observe baseline voltage, using on-screen numeric display, or chart recorder on DAC1 output. Noise should be less than 300μV peak-to-peak on the screen display, or 30μV peak-to-peak on the chart recorder. The DC level of the output voltage should be between -25mV and +75mV.

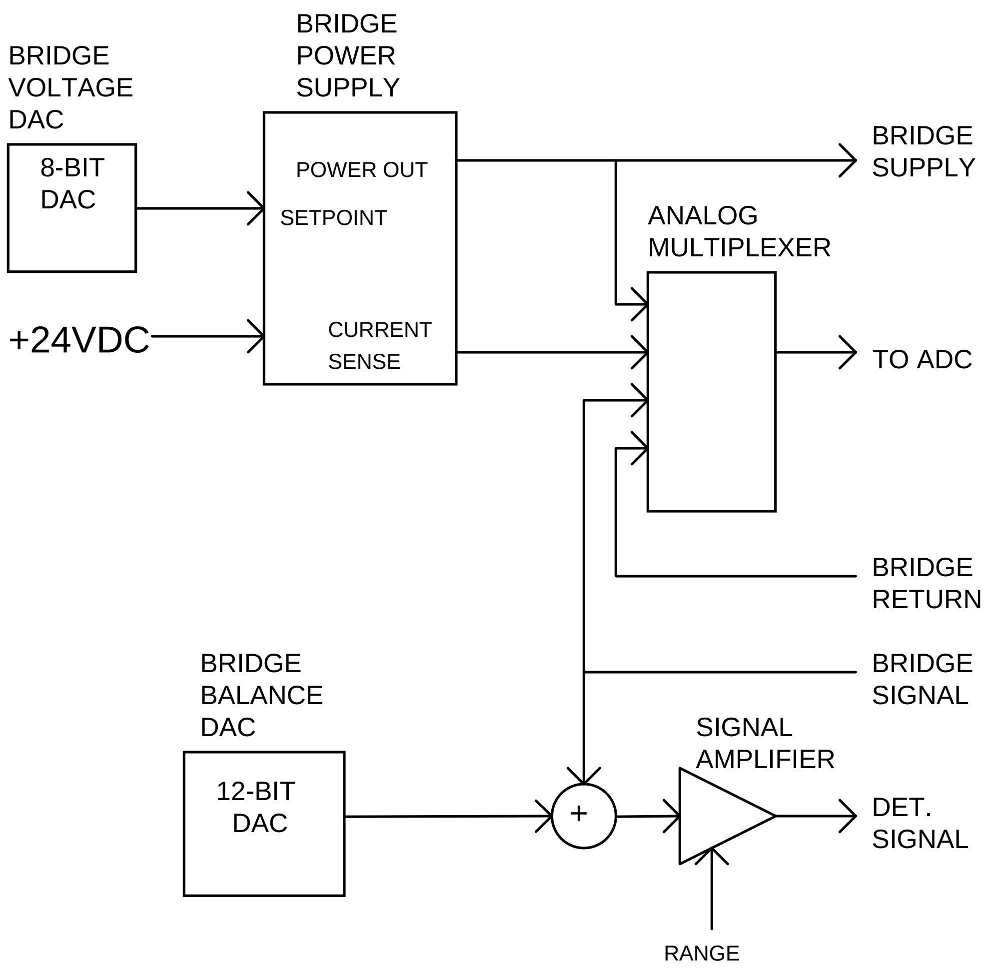
- Electronic response linearity

  Use ETS-CSR software to enable diagnostic mode, and set the contact potential DAC to zero. Set cell current DAC to 128, and note the signal voltage reading on the screen. It should be 4.3V±0.4V. Change the cell current DAC setting to 255. The signal voltage should rise to 8.8V±0.5V.

- Signal amplifier Range 10

  Continuing from the conditions which were set at the end of the Electronic response linearity test, change the range setting to Range 10. The signal voltage should drop to one tenth of its previous value (approximately 880mV).

TCD BLOCK DIAGRAM



Main changes from 3400

- Balance pot replaced by DAC
- Digital Autozero
- Power supply derived from +24V
- Built-in shunt bridge for test
- 390/490 temperature limit switch controlled by software
- Quieter signal amplifier

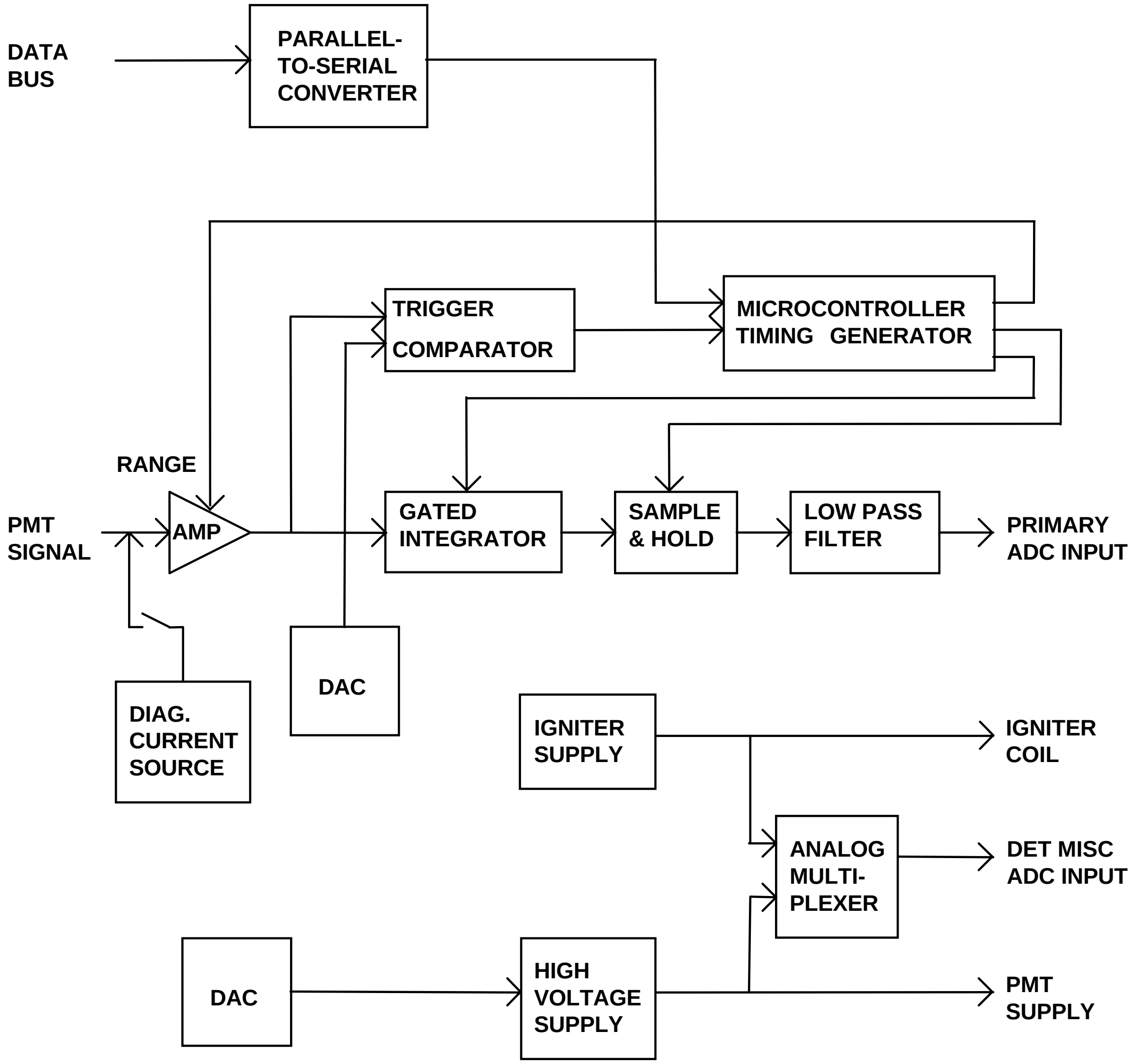
TCD Field test procedures

1. Setup: Disconnect the TCD cell from the pc board. Select Diagnostic mode on the ETS-CSR page for the TCD, to prevent the overtemperature protection from turning off the bridge power. Set the bridge voltage DAC to 128 (14V), the bridge balance DAC to 2048, and the range to .05mV/mV.

2. Bridge excitation voltage: Read the values of bridge supply and bridge return voltage on the ETS-CSR screen. They should be +7V and -7V, respectively, within ±1V.

3. Noise: Read the detector output signal voltage from the screen. If it is outside the range of ±600mV, adjust the value of the bridge balance DAC up or down, one count at a time, to get the value as near to zero as possible. The noise on this reading should be less than 500µV peak-to-peak, as read on the screen display, or 50µV peak-to-peak, as seen on a chart recorder connected to the DAC 1 output.

4. Signal amplifier gain: Decrease the setting of the bridge balance DAC by 20 from the value set in step 3. The detector output voltage displayed on the screen should increase by 7.7V±1V from its previous value. Change the range settings to .5mV/mV and 5mV/mV, successively, and verify that the output voltage decreases by a factor of 10 with each range change (nominal results of about 770mV and 77mV).



PFPD ELECTRONICS BLOCK DIAGRAM

Main changes from 3400

- Automatic tracking of gain with integration time
- DAC control of high voltage (no readout of actual)
- DAC control of trigger level
- Keyboard control of timing and mode
- Built-in diagnostic current source
- Software square root for sulfur
- No hardware autozero
- No trigger LED (software flag for trigger okay)

PFPD Field test procedures

- High voltage supply: Using ETS-CSR software, turn on the detector, and read the displayed value of high voltage. The reading should match the set value within ±5% for normal operating voltages. Note that normal product software displays only the value set through the high voltage DAC, not the actual ADC reading.

- Igniter: Using ETS-CSR software, turn on the detector, and read the displayed value of igniter current. If the reading is below the normal range of 3.0 to 3.5 amps, check the igniter voltage reading. If it is above 5V, the igniter is open or disconnected. If it is below 2V, the PCB is defective.

- Noise: Electronic noise may be tested by simply removing the signal cable from the PMT, and observing the baseline under normal operating conditions.

- Signal response: Using ETS-CSR software, turn on the internal diagnostic current source, and select Range 10. The display should show a detector output signal voltage of 9.7V±0.7V. Changing the range to 9 and 8 should drop the reading to 970mV and 97mV, respectively. The readings should not change by more than 3% for any settings of integration and delay time (or element selection).