MODEL 300 HFID/MHFID (CE VERSION)

HEATED HYDROCARBON ANALYZER

INSTRUCTION MANUAL

This manual describes the installation, calibration and operation of California Analytical Instruments, Inc. Model 300 HFID/MHFID Heated Total Hydrocarbon Gas Analyzer.

To assure correct operation and accurate results, it is recommended that the user carefully read this document.

August 21, 1997

Version 1.01

PRELIMINARY

P/N 970040

MODEL 300 HFID INSTRUCTION MANUAL (CE Version)

$25.00 EACH

DANGER

POSSIBLE EXPLOSION HAZARD

Do not apply power to the analyzer or attempt to ignite the burner until **ALL** leak checks have been performed and until the analyzer environment has been determined to be non-hazardous.

This analyzer has been designed to be used in a **NON-HAZARDOUS** environment.

This analyzer uses a fuel which contains a **FLAMMABLE LEVEL OF HYDROGEN.** Any leakage from this fuel can result in an explosion. The fuel supply system, both inside and outside the analyzer, should be carefully checked for leaks upon installation, before initial start-up, during any maintenance, or after the integrity of the system is broken.

This analyzer has not been designed to be used with a hazardous sample.

DANGER

Tampering or use of substitute components may cause a safety hazard. Use only factory authorized replacement parts.

ELECTRICAL SHOCK HAZARD

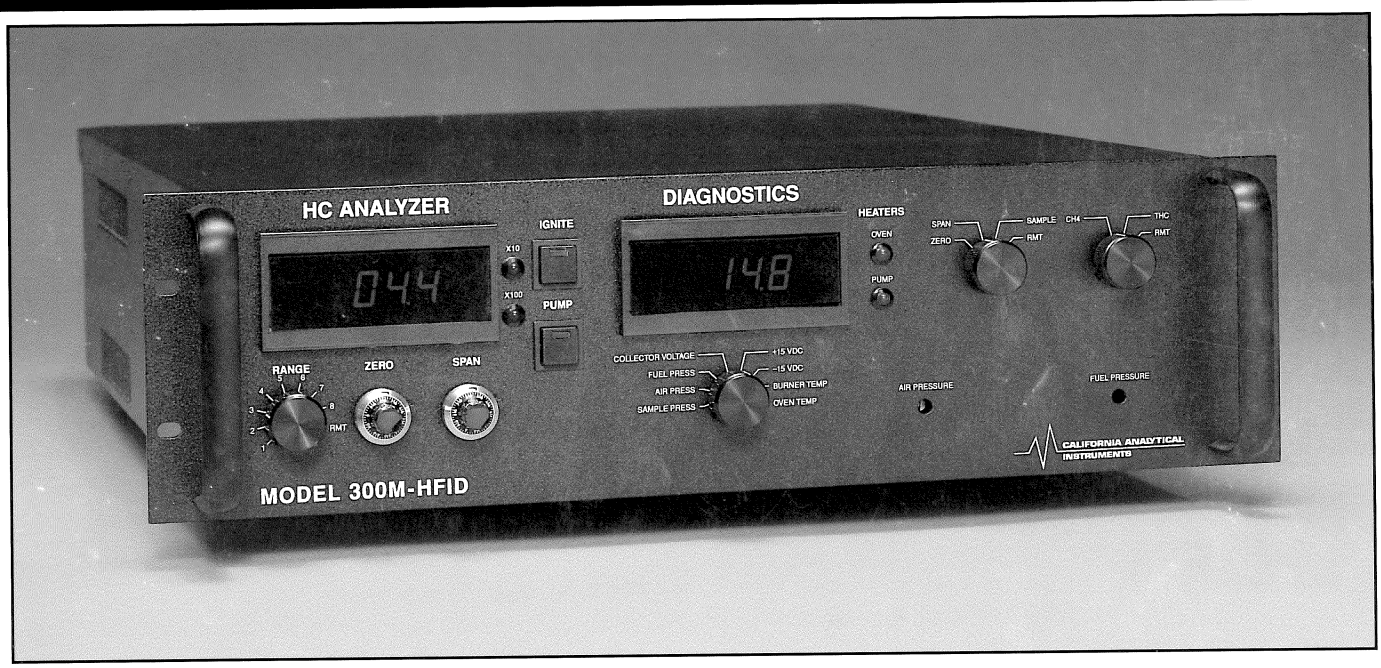
Do not operate without the cover secured. Servicing requires access to live electrical components which can cause death or serious injury. Refer servicing to qualified service personnel. For safety and proper performance, this instrument must be connected to a properly grounded three wire receptacle.

CAUTION

The CAI Model 300 HFID may be purchased to be used with either 100% Hydrogen or 40%/60% Hydrogen/Helium Fuel. Please make sure to use the **CORRECT** fuel.

Use of **INCORRECT** fuel will **DAMAGE** the instrument and could cause an **EXPLOSION**.

HEATED HYDROCARBON ANALYZER



Model 300-HFID

FEATURES

- Sensitivity 0.1 ppm
- Automatic ignite capability – local or remote
- Automatic fuel/air shut off
- Adjustable oven temperature 60 to 200°C (internally adjustable)
- Internal heated filter with external access
- Complete digital presentation including sample/fuel/air pressures (no gauges)
- Electronic proportional pressure sample controller
- Multiple range capability
- Optional continuous methane only
- Digital diagnostics
- 19″ rack mount (only 5¼″ high)

APPLICATIONS

- EPA Method 25A compliance monitoring of source hydrocarbons
- Stack gases (CEM)
- Diesel emissions
- Process chemical gas analysis
- Solvent recovery
- Vehicle emissions
- Carbon bed breakthrough detection
- Fenceline (perimeter) monitoring
- Non-methane hydrocarbon measurements

FACTORY QA CHECKOUT SHEET

FID SERIAL NUMBER: 27J03007

FACTORY AIR PRESSURE SETTING: 4.6

FACTORY FUEL PRESSURE SETTING: 4.6

FACTORY SAMPLE PRESSURE SETTING: 2.0

Oven ~190°C
(~1 hr to stabilize)
Autoclave
+ 1/2 hr with flame

Steve X203

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SECTION I

UNPACKING INSTRUCTIONS

Open the shipping container and carefully remove the analyzer from the packing materials. Inspect the instrument for any sign of damage. Remove the Top Cover retaining screws. Visually check for loose parts or connectors that are not properly seated. Verify all smaller circuit boards (4) are properly seated in the main circuit board edge connectors. If all internal components look normal, re-install the cover.

REPORTING DAMAGE

Should there be any apparent damage to either the inside or outside of the instrument, due to shipping or handling, immediately notify the shipper. Shipping container or packing materials should be saved for inspection by the shipper.

SECTION II

INTRODUCTION

The CAI Model 300 HFID Heated Total Hydrocarbon Analyzer utilizes a highly sensitive flame ionization detector (FID) gas analyzer for measuring gas concentrations in industrial and vehicle emission applications. The CAI Model 300 MHFID Heated Total Hydrocarbon Analyzer is exactly the same instrument as the Model 300 HFID, except contains a catalyst which may be switched in and out of the sample stream, with the front panel switch or via a contact closure, to analyze the methane content of the sample. This catalyst (Methane Cutter) removes all hydrocarbons from the sample stream except methane. The heated sample gas is maintained above the dew point by a self contained internal adjustable temperature oven. The oven temperature may be adjusted between 60 and 200 degrees C. The sample gas is maintained at an elevated temperature until it exits the FID burner assembly. This prevents any loss of hydrocarbon concentration in the sample due to condensation. The instrument contains a front panel, nine position, range switch which allows the selection of eight full scale ranges or remote from 3 to 10,000 or 10 to 30,000 ppm Carbon. The instrument has a 0 to 10 VDC and 4-20/0-20 MADC analog (recorder) output signal for each selected range. The ranges may be remote selected externally.

The contents of this manual include:

- **Electrical Specifications**
- **Installation Requirements, Mechanical & Electrical**
- **Operation & Calibration Instructions**
- **Burner Description with Procedures for Disassembly of its Component Parts**
- **Function Explanation of the Electronic Circuitry**
- **Complete Schematic Circuit Diagrams**

SPECIFICATIONS

ANALYSIS METHOD: Flame Ionization Detector (FID)

TOTAL RANGES: 0-3, 10, 30, 100, 300, 1,000, 3,000, 10,000, 30,000 ppm Carbon

8 OPERATING RANGES: Switch Selectable from the Front Panel or Remote Range Change.

RESOLUTION: 0.01 ppm Carbon

REPEATABILITY: Better than 0.5% of Full Scale

LINEARITY: Better than 1% of Full Scale to 10,000
Better than 1% of Full Scale above 10,000

O_2 EFFECT: Less than 1% of Full Scale

CH4 EFFECT: Less than 1.2 Times Propane

RESPONSE TIME: 90% of Full Scale in 1.5 seconds

SAMPLE FLOW RATE: With Pump 3.0 L/min. ±1.5 L/min.

EXTERNAL SAMPLE FILTER: 40 micron Required

INTERNAL SAMPLE FILTER: 0.1 micron Replaceable Filter

NOISE: Less than 0.5% of Full Scale

ZERO & SPAN DRIFT: Less than 1% of Full Scale per 24 hours

ZERO & SPAN ADJUSTMENT: Ten Turn Potentiometer

FLOW CONTROL: Electronic Proportional Pressure Valve

FUEL REQUIREMENTS: 40% H_2 60% He 120 cc/min. or 100% H2 at Specified Flow Rate (Model 300HFID Only)

AIR REQUIREMENTS: Less than 1 ppm THC See Individual Sheet for Specific Flow Rates

DISPLAY: 3½ Digit Panel Meter.

DIAGNOSTICS: 3½ Digit Meter with 7 Position Switch

Collector Voltage	+15 VDC
Fuel Pressure	-15 VDC
Air Pressure	Burner Temperature
Sample Pressure	Oven Temperature

ANALOG OUTPUT: 0-10 VDC & 4-20/0-20 MADC

FUEL/AIR CONTROL: Forward Pressure Regulator & Capillaries

IGNITION: Momentary Push-Button With Flame-On Indicator (Manual Or Remote Control)

FLAME OUT INDICATOR: Automatic Fuel Shut Off

AMBIENT TEMPERATURE: 5 to 45 Degrees C

SAMPLE TEMPERATURE: 0 to 50 Degrees C

WARM-UP TIME: 1 Hour

FITTINGS: 1/4 Inch Tube

POWER REQUIREMENTS: 115/230 (±10%) VAC 50/60 Hz; 600 Watts

DIMENSIONS: 5¼ H × 19 W × 24 D (Inches)

RELATIVE HUMIDITY: Less than 90% RH

WEIGHT: 38 Pounds

FID OPTIONS

Methane Cutter (Reads Only Methane in Sample)
Specify Fuel Type
19 Inch Rack Mount Slides
Remote In-Line Filter

SECTION III

INSTALLATION

GENERAL

The instrument is designed for industrial and vehicle emission applications. These installation instructions are for a typical site. Any questions regarding specific installation situations should be directed to the **Technical Service** Department of California Analytical Instruments, Inc.

SITE & MOUNTING

NOTE

The following **precautions** must be carefully observed.

1. Select a site free from direct sunlight, radiation from a high temperature surface, or abrupt temperature variations.

2. When installed outdoors, shelter the instrument from wind and rain.

3. Select a site where the air is clean. Avoid exposing the instrument to corrosive or combustible gases.

4. The instrument must not be subjected to severe vibration. If severe vibration is present, use isolation mounts.

5. The instrument is designed for rack-mounting. Optional rack-mount slides are available.

NOTE

A rear supporting brace or equivalent is required if the rack-mount slides are not used.

6. Do not install near equipment emitting electromagnetic interference (EMI). See page 6.

INSTALLATION (Continued)

ELECTRICAL

All output and control wiring is terminated in a connector at the rear of the instrument. Connect wiring as shown in Figure 1. The 115/240 VAC, 50/60 Hz power enters the plug/switch assembly.

NOTE

A defective ground may affect the operation of the instrument.

A rear mounted connector is provided for the output and control signals. These are the remote range change inputs for ranges 1 through 8 and the analog output signal. Other external control signals are also terminated on the rear panel and include auto ignite, etc.

Remote Range Operation

Remote range identification and range selection is obtained by the rear panel connections (Figure 1, Page 6). When a range is selected, the corresponding control line is pulled low to zero VDC. Ranges not selected will remain at approximately 5 VDC. When remote range control is selected on the front panel switch, a contact closure is provided at the rear panel connector. Remote range selection and FID ignite is made by connection of the control wire at the rear panel connector. FID "Flame Out" is indicated by a contact closure at the rear panel connector.

NOTE

Shielded wiring is recommended for output signals.

CAUTION

Electromagnetic interference (EMI) may affect the operation of the instrument. Do not install the instrument in the vicinity of electrical noise (such as high frequency furnaces, electric welding machines, etc.). If the instrument must be installed at such locations, a separate power line and ground must be provided. Noise from a relay or solenoid valve should be controlled by the use of a spark suppresser (RC circuit) across the power wiring close to the component (see Figure 2).

INSTALLATION (Continued)

ELECTRICAL (Continued)

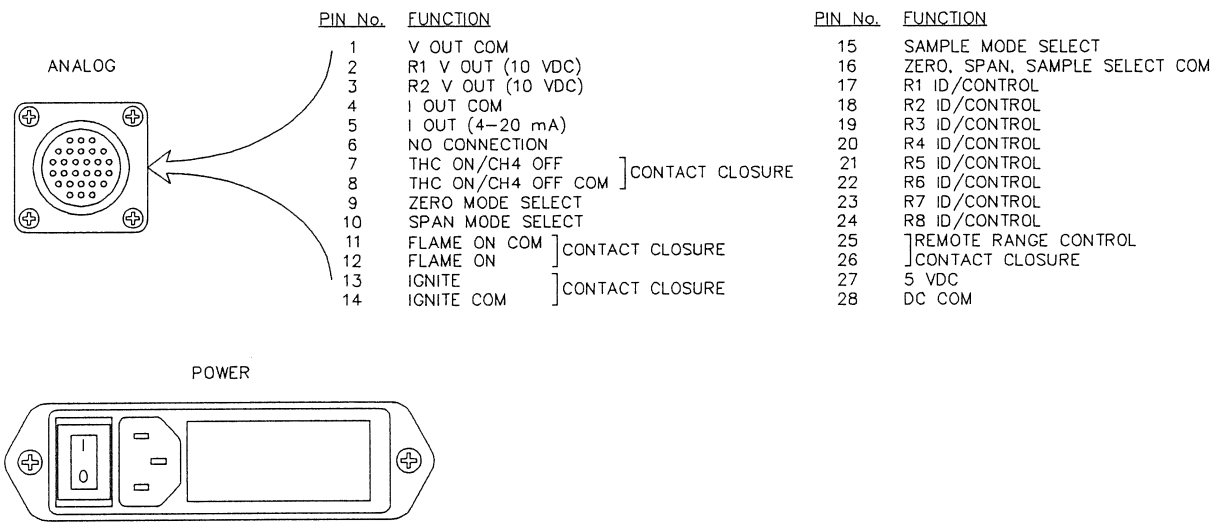


Figure 1: External Wiring Connections

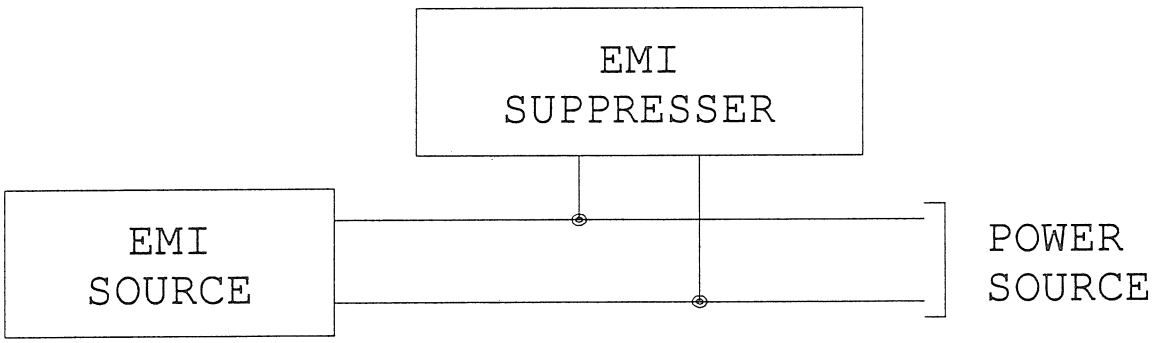


Figure 2: EMI Noise Control

NOTE

The spark suppresser must be placed close to the noise source.

INSTALLATION (Continued)

GASES

1. Air (zero and burner air, < 1 ppm C) in pressurized cylinder.
2. Fuel 40% H2/60% He or 100% H2 in pressurized cylinder. (As Specified)
3. Standard span gas(es) near full scale concentration with an air balance, in a pressurized, certified cylinder.

GAS HANDLING EQUIPMENT

1. Pressure regulators for zero, fuel and span gas cylinders.
2. Corrosive - resistant gas tubing.

GAS CONNECTIONS (Heated Sample Line)

The tubing from the sampling system to the gas analyzer should be made from corrosive-resistant material such as Teflon*, stainless steel or polyethylene. Even when the gases being sampled are corrosive themselves, rubber or soft vinyl tubing should not be used, since readings may be inaccurate due to gas absorption into the piping material. To obtain fast response, the tube should be as short as possible. Optimum tube internal diameter is 0.16 inch (4 mm). In general, heated sample lines are used for measuring heavy hydrocarbons. The temperature in the external heated lines is not controlled by this instrument. Provisions are made to terminate heated sample lines at the rear of the instrument to eliminate "cold" spots. Couplings to the instrument are ¼ inch tube.

NOTE

Be sure tubing and joints are clean.
Dust entering the instrument may cause it to malfunction.

SAMPLING REQUIREMENTS

1. **Filtration**

   Remote: A remote heated filter is recommended. A minimum of 40 microns is required.

   Internal: The instrument includes an internal 0.1 micron filter located in the heated oven compartment. This fiberglass filter is easilly replaceable.

INSTALLATION (Continued)

SAMPLING REQUIREMENTS (Continued)

2. **Condensation**

   Dew point of the sample gases must be lower than the temperature of the heated sample line to prevent accidental hydrocarbon condensation.

3. **Presence of Corrosive Gases**

   Useful service life of the instrument will be shortened if high concentrations of corrosive gases such as Cl_2, F_2, HCl, etc., are present in the sampled gas.

4. **Sample Gas Temperature**

   In general, "heavy" hydrocarbon measurement is best accomplished at approximately 190 degree C. The Model 300 HFID is factory set at 190 C unless specified at other temperatures.

5. **Pressure and Flow Rates**

   The fuel and burner air entering the instrument are controlled by internal pressure regulators. The fuel and burner air cylinder pressures should be set at 30 PSIG. The fuel and air regulators are factory set for proper air/fuel ratio as indicated on the QA Check Sheet and as included in this manual.

Fuel	+/- 1.0 PSIG of Indicated Setting
Air	+/- 1.0 PSIG of Indicated Setting
Sample	+/- 1.0 PSIG of Indicated Setting

   The sample entering the instrument is controlled by a factory set precision electronically controlled proportional flow controller. For proper flow control, the sample gas entering the instrument should be at a pressure between 6 and 25 PSIG at a flow rate of 4 ± 1.5 liters/min. If ordered with the internal heated sample pump, this pressure is automatically maintained. The calibration/span and zero gas cylinder pressures should be set at 30 PSIG.

6. **Sample Gas By-Pass Outlet (Vent)**

   A sample gas by-pass outlet connector is located on the rear panel (¼ Inch Tube). Pressure at this outlet should be kept at atmospheric level. **ANY** back pressure may cause an error in reading. This gas should be vented away from the instrument.

SECTION IV

CALIBRATION & OPERATION

IDENTIFICATION OF CONTROLS, INDICATORS & MAJOR COMPONENTS

Front Panel
(Numbers refer to annotations on Figure 3)

1. **Digital Indicator (3 1/2 Digits):** Displays analyzer output.

2. **Digital Indicator (3 1/2 Digits):** Displays diagnostic functions.

3 **Diagnostic Switch:** Seven Position Switch Displays:

Collector Voltage (DCV)	Plus 15 VDC Supply
Fuel Pressure (PSIG)	Cutter Temperature (C)
Air Pressure (PSIG)	Burner Temperature (C)
Sample Pressure (PSIG)	Oven Temperature (C)

4. **Span Control:** Sets fine gain of instrument. (Adjusted while span gas is flowing through instrument.)

5. **Zero Control:** Sets zero level of instrument. (Adjusted while zero gas is flowing through instrument.)

6 **Ignite Switch:** Depressing the momentary push-button ignite switch starts the burner ignite sequence. Burner ON condition is indicated by the illuminated LED in the switch and a contact closure on the rear panel connector. Remote ignite may be accomplished via a contact closure on the rear panel connector.

7. **Range Switch:** Allows selection of ranges 1 through 8 or remote. The remote position allows for remote computer control of ranges via a contact closure on the rear panel connector. An internal jumper selects ranges 3 to 10,000 or 10 to 30,000 ppm C.

8. **Multiplier LED's:** Meter Reading Times 10 or 100.

9. **Heated Cycle Switch:** Indicates Pump, Oven and Cutter Heaters are Cycling.

10. **Pump Switch:** Turns On Heated Internal Sample Pump

11. **Sample/Zero/Span/Remote Switch:** Activates Internal Solenoids.

12. **Methane Cutter Switch:** Turns On Methane Cutter.

CALIBRATION & OPERATION (Continued)

IDENTIFICATION OF CONTROLS, INDICATORS & MAJOR COMPONENTS (Continued)

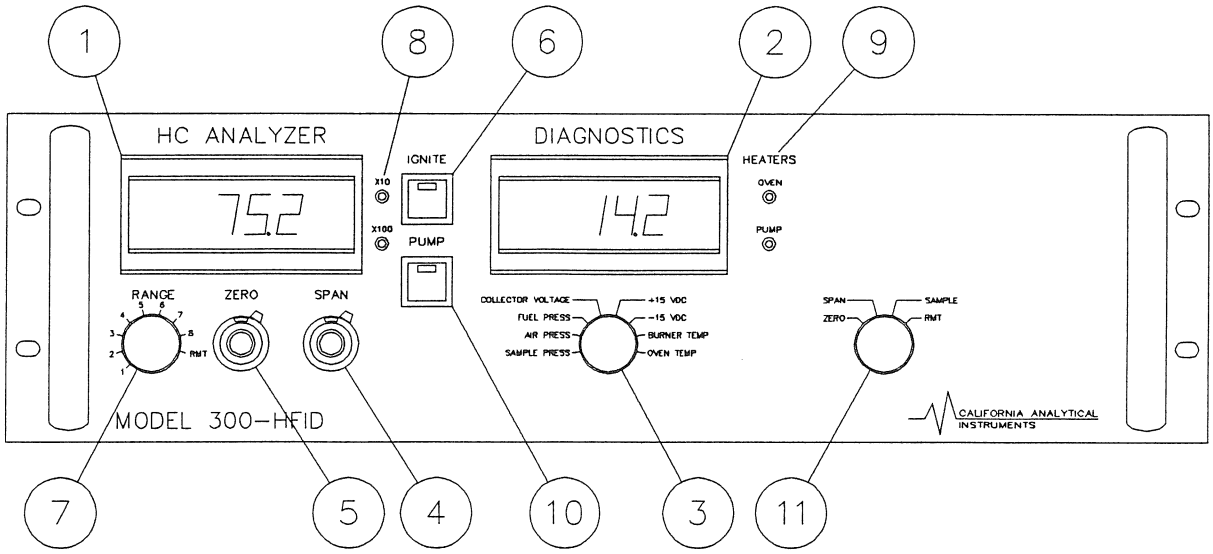


Figure 3-1: Front Panel Model 300 HFID
(Standard Instrument)

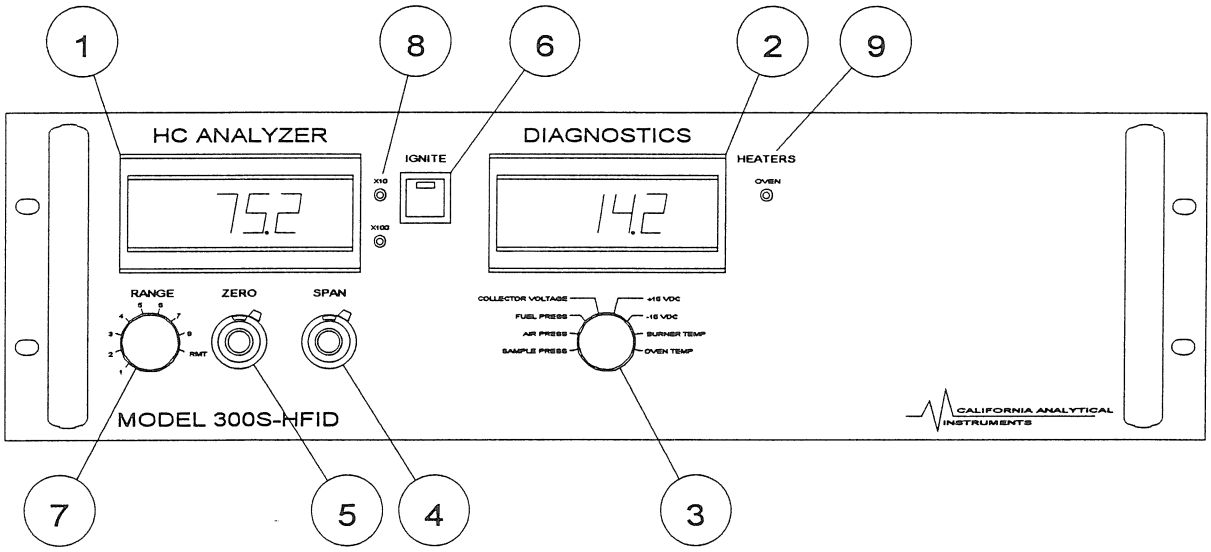


Figure 3-2: Front Panel Model 300S HFID
(System Instrument - No Sample Pump)

CALIBRATION & OPERATION (Continued)

IDENTIFICATION OF CONTROLS, INDICATORS & MAJOR COMPONENTS (Continued)

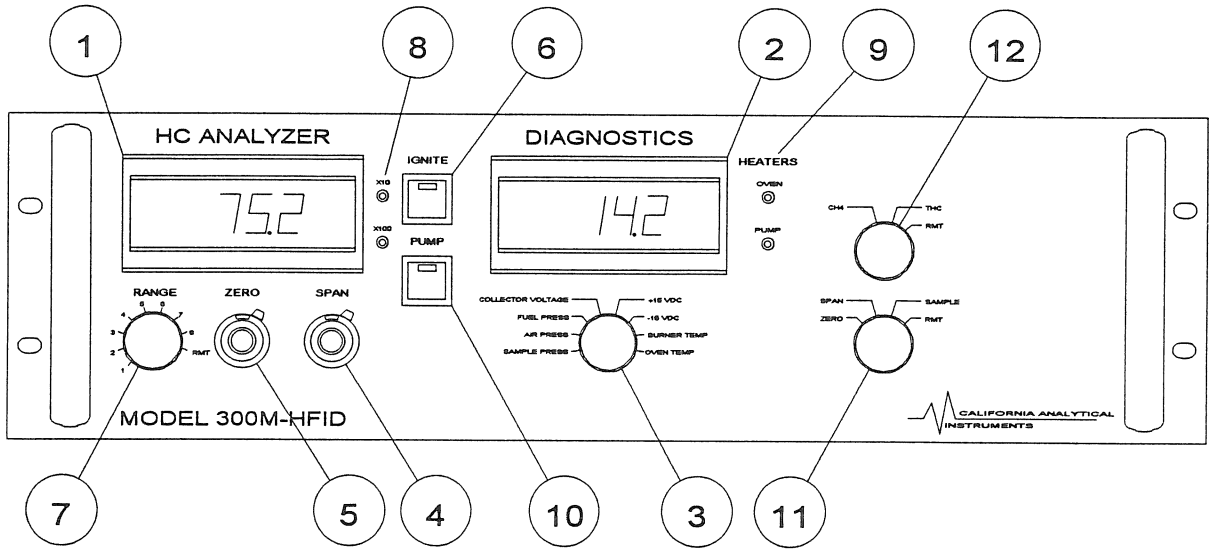


Figure 3-3: Front Panel Model 300M HFID
(Standard Instrument with CH4 Cutter)

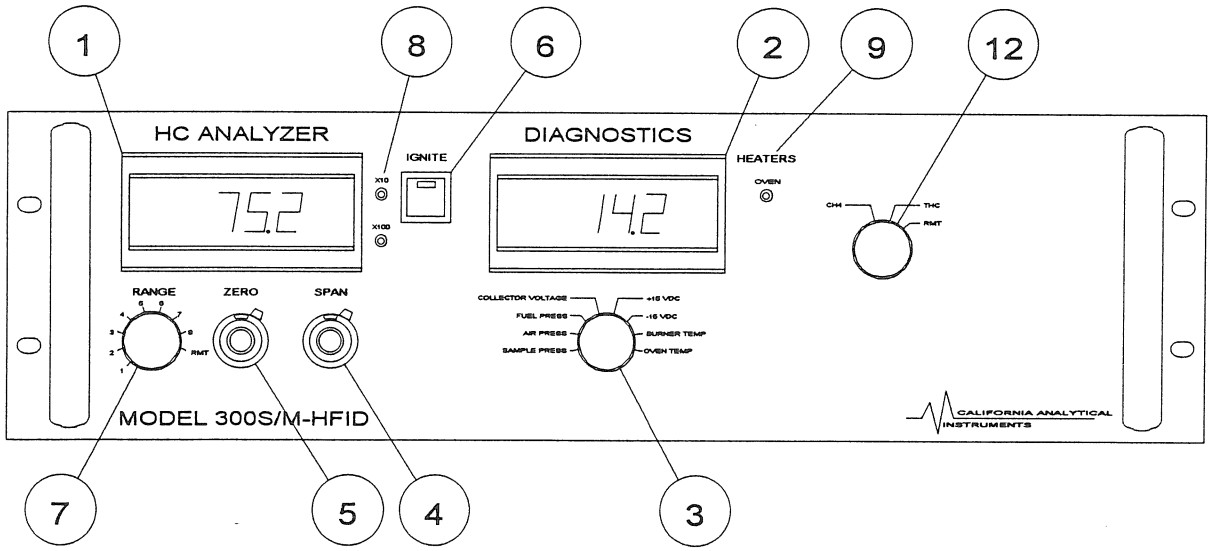


Figure 3-4: Front Panel Model 300S/M HFID
(System Instrument - No Pump with CH4 Cutter)

CALIBRATION & OPERATION (Continued)

IDENTIFICATION OF CONTROLS, INDICATORS & MAJOR COMPONENTS (Continued)

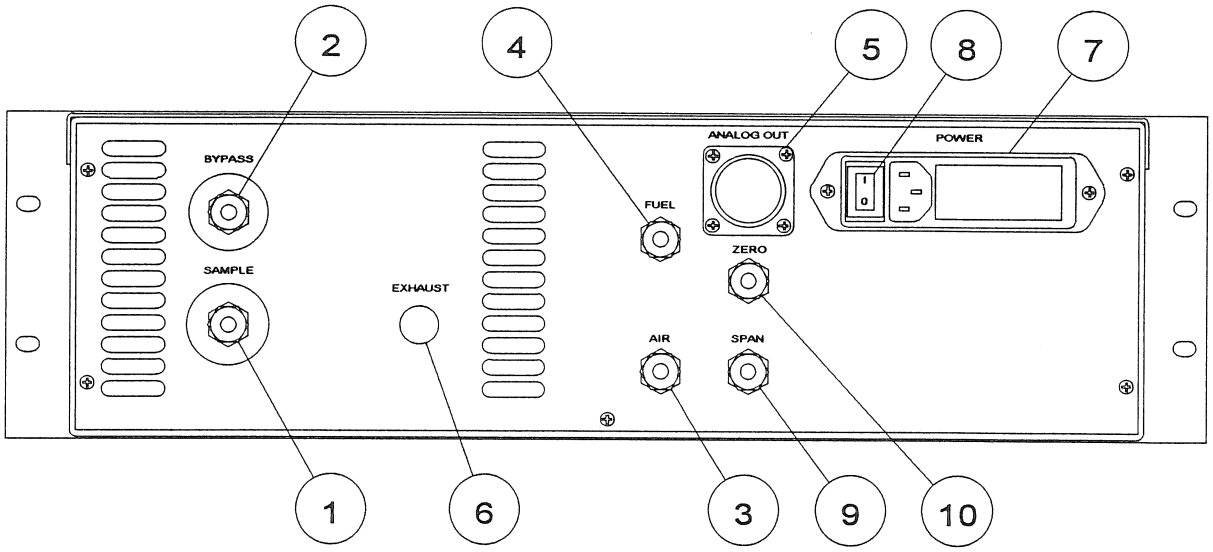


Figure 4: Rear Panel

1. **Sample Gas Inlet:** Feeds sample gas to the analyzer. Threaded ¼ Inch Tube.
2. **Sample Gas By-Pass Outlet (Vent):** Exhaust for sample. Threaded ¼ Inch Tube.
3. **Burner Air Inlet:** For feeding hydrocarbon free air to the burner. See Figure 8. Threaded ¼ Inch Tube.
4. **Fuel Inlet:** For feeding fuel to the burner. See Figure 8. Threaded ¼ Inch Tube.
5. **Connector for External Wiring:**

1. V Out Common	9.	17. R1 ID/Control	25. Remote Range Control
2. Optional V Out	10.	18. R2 ID/Control	26. Remote Range Common
3. 0- 10 VDC	11. Flame On Output	19. R3 ID/Control	27. 5 VDC
4. I Out Common	12. Flame On Common	20. R4 ID/Control	28. DC Common
5. I Out (4-20 MADC)	13. Ignite On	21. R5 ID/Control	
6.	14. Ignite Common	22. R6 ID/Control	
7.	15	23. R7 ID/Control	
8.	16	24. R8 ID/Control	

6. **Burner Outlet (Vent):** Exhaust for burner (No fitting required)
7. **Power Entry Module:** Power cord connection, power switch, fuse compartment.
8. **Rear Panel Power ON/OFF Switch:** Turns ON/OFF line power to instrument.
9. **Span Gas Inlet:** Inputs Span Gas to Optional Solenoids
10. **Zero Gas Inlet:** Inputs Zero Gas to Optional Solenoids

CALIBRATION & OPERATION (Continued)

MAJOR INTERNAL COMPONENTS

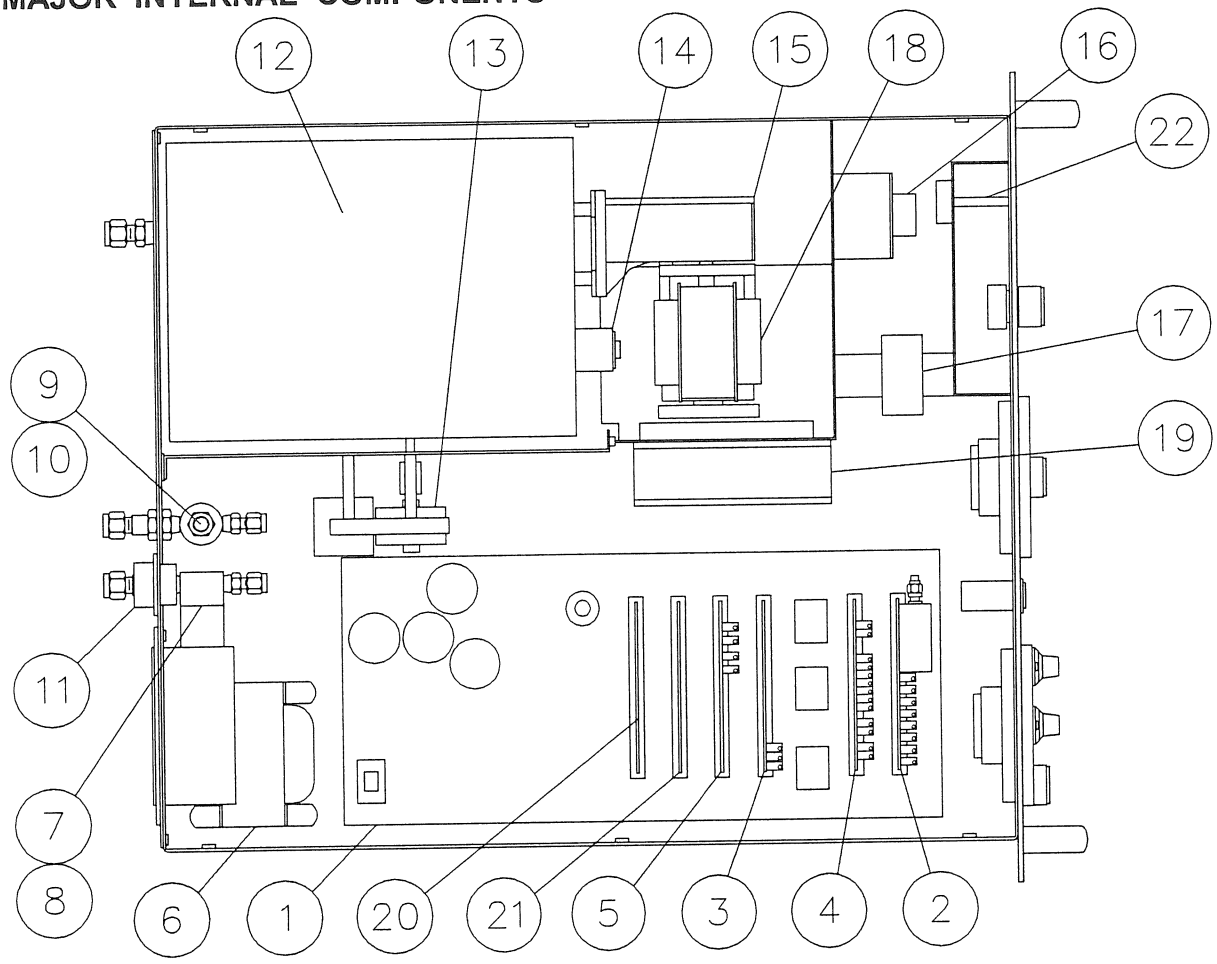


Figure 5 Major Internal Components

1. **Mother Board:** Includes components for all power supplies and connector for the individual plug in boards.
2. **Amplifier Board:** Includes components for processing and amplifying burner output signal.
3. **Ignition Control Board:** Includes components for initiating the automatic ignite cycle.
4. **Diagnostic Board:** Includes components to process the pressure and voltage signals
5. **Temperature Control & Electronic Proportional Control Valve Control Board:** Controls the Heated Oven Temperature and Regulates Sample Flow to Burner Assembly.
6. **Power Transformer:** Converts line voltage to several lower AC voltages and delivered to the main circuit board.

7. **Zero Solenoid Valve:** Allows Zero Calibration Gas To Flow to Burner
8. **Span Solenoid Valve:** Allows Span Calibration Gas To Flow to Burner (Optional)
9. **Fuel Solenoid Valve:** Automatic Fuel Shut Off.
10. **Air Solenoid Valve:** Automatic Air Shut Off.
11. **Output Connector:** See Page 11.
12. **Heated Oven:** Maintains All Sample Components at Set Temperature.
13. **Oven Circulation Fan Motor:** Maintains Constant Oven Temperature.
14. **Proportional Contorl Valve:** Regulates pressure to sample orifice.
15. **Heated Sample Pump:** Provides Sample to Burner Assembly.
16. **Fuel Proportional Contorl Valve:** Regulates pressure to fuel orifice.
17. **Air Pressure Regulator:** Regulates pressure to air orifice.
18. **Heated Sample Pump Motor:**
19. **Oven Circulation Fan:**

CALIBRATION & OPERATION (Continued)

MAIN CIRCUIT BOARD COMPONENTS

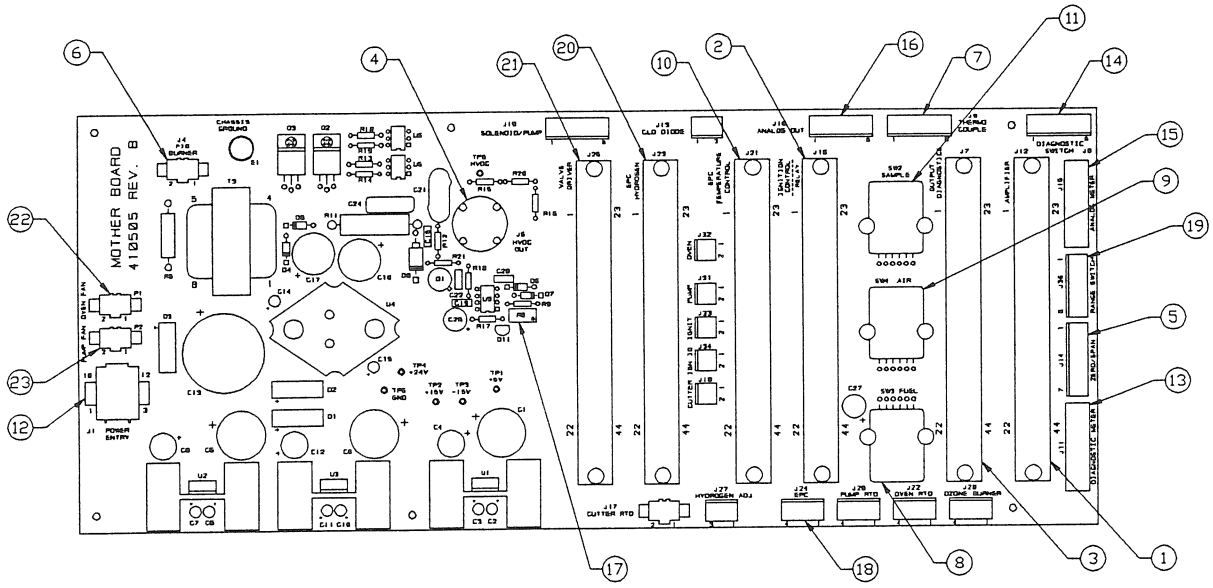


Figure 6 Main Circuit Board Locations

1. **Amplifier Board Location: J12**
2. **Ignite Board Location: J16**
3. **Diagnostic Board Location: J7**
4. **Collector Voltage Connection: J5**
5. **Zero & Span Pot Connection: J14**
6. **Burner, Igniter Connection: J4**
7. **Burner, Oven & Cutter TC's: J9**
8. **Fuel Pressure Connection: SW3**
9. **Air Pressure Connection: SW4**
10. **EPC/Temp Control Board: J21**
11. **Sample Pressure Connection: SW2**
12. **Transformer Connection: J1**
13. **Diagnostic Meter Connection: J11**
14. **Diagnostic Switch Connection: J8**
15. **Analog Meter Connection: J15**
16. **Analog Output Connection: J10**
17. **Collector Voltage Potentiometer: R8**
18. **Proportional Valve Connection: J24**
19. **Range Switch Connection: J36**
20. **H2 & Cutter & Temp Board Location: J23**
21. **Valve Driver Control Board: J25**
22. **Oven Circulatiing Fan Location: P1**
23. **Pump Fan Location: P2**

CALIBRATION & OPERATION (Continued)

MAIN AMPLIFIER BOARD COMPONENTS

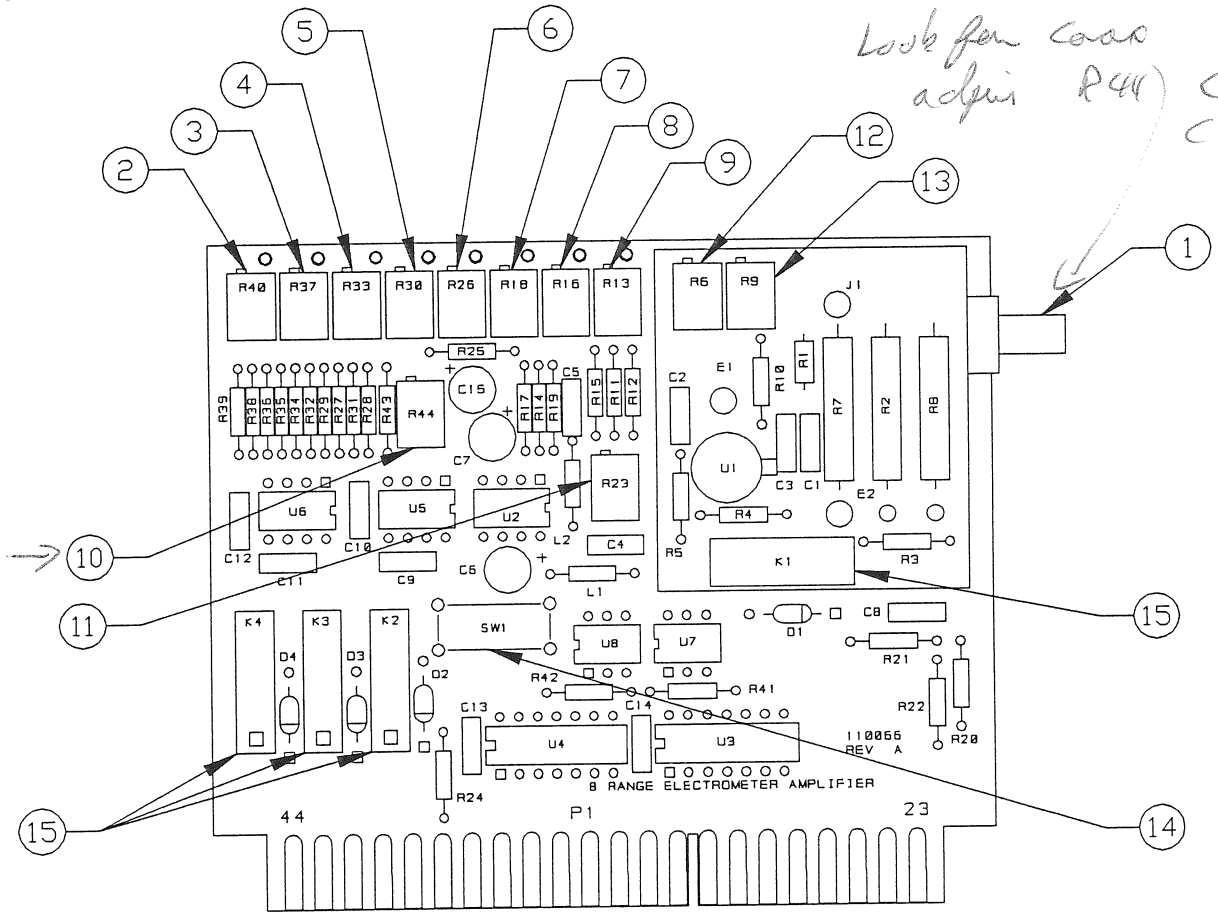


Figure 7 Main Amplifier Board Components

1. **Input Connection: SMA Connector**
2. **Amplifier Gain Adjust: R40**
3. **Amplifier Zero Adjust: R37**
4. **Gain Signal Attenuator Adjust: R33**
5. **Amplifier Zero Adjust: R30**
6. **Signal Attenuator Adjust: R26**
7. **Course Gain Adjust: R18**
8. **Amplifier Zero Adjust: R16**
9. **Signal Attenuator Adjust: R13**
10. **Filter Time Constant Adjust: R44**
11. **Course Zero Adjust: R23**
12. **Amplifier Zero Adjust: R6**
13. **Amplifier Gain Change Adjust: R9**
14. **PPM/% Switch: SW1**
15. **Range Change Relays: K1-K4**

CALIBRATION & OPERATION (Continued)

BURNER ASSEMBLY

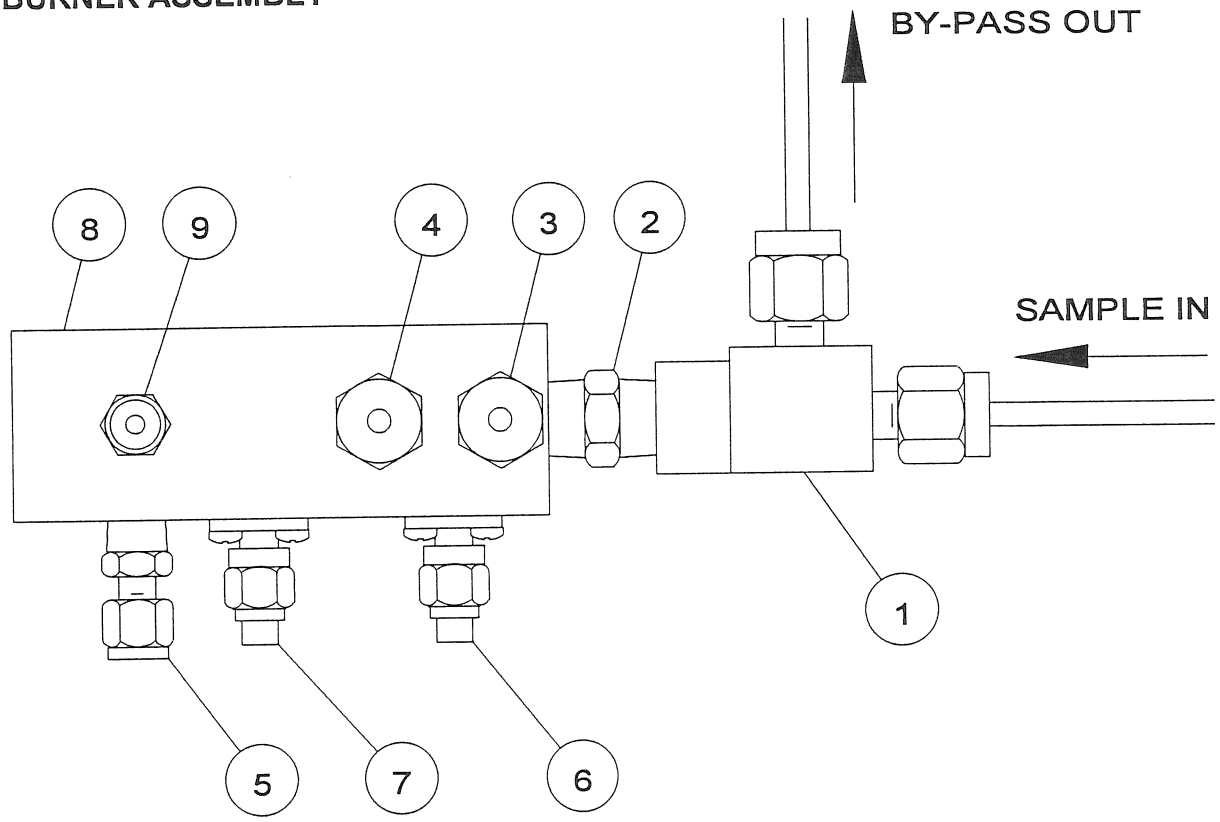


Figure 8 Burner Assembly

1. **Sample "T" Fitting Sample In/By-Pass Out**
2. **Sample Orifice**
3. **Fuel Inlet**
4. **Air Inlet**
5. **Thermocouple Connection**
6. **Collector Voltage Connection**
7. **Burner Output Signal Connection**
8. **Burner Exhaust**
9. **Glow Plug**

CALIBRATION & OPERATION (Continued)

AUTOMATIC IGNITE BOARD COMPONENTS

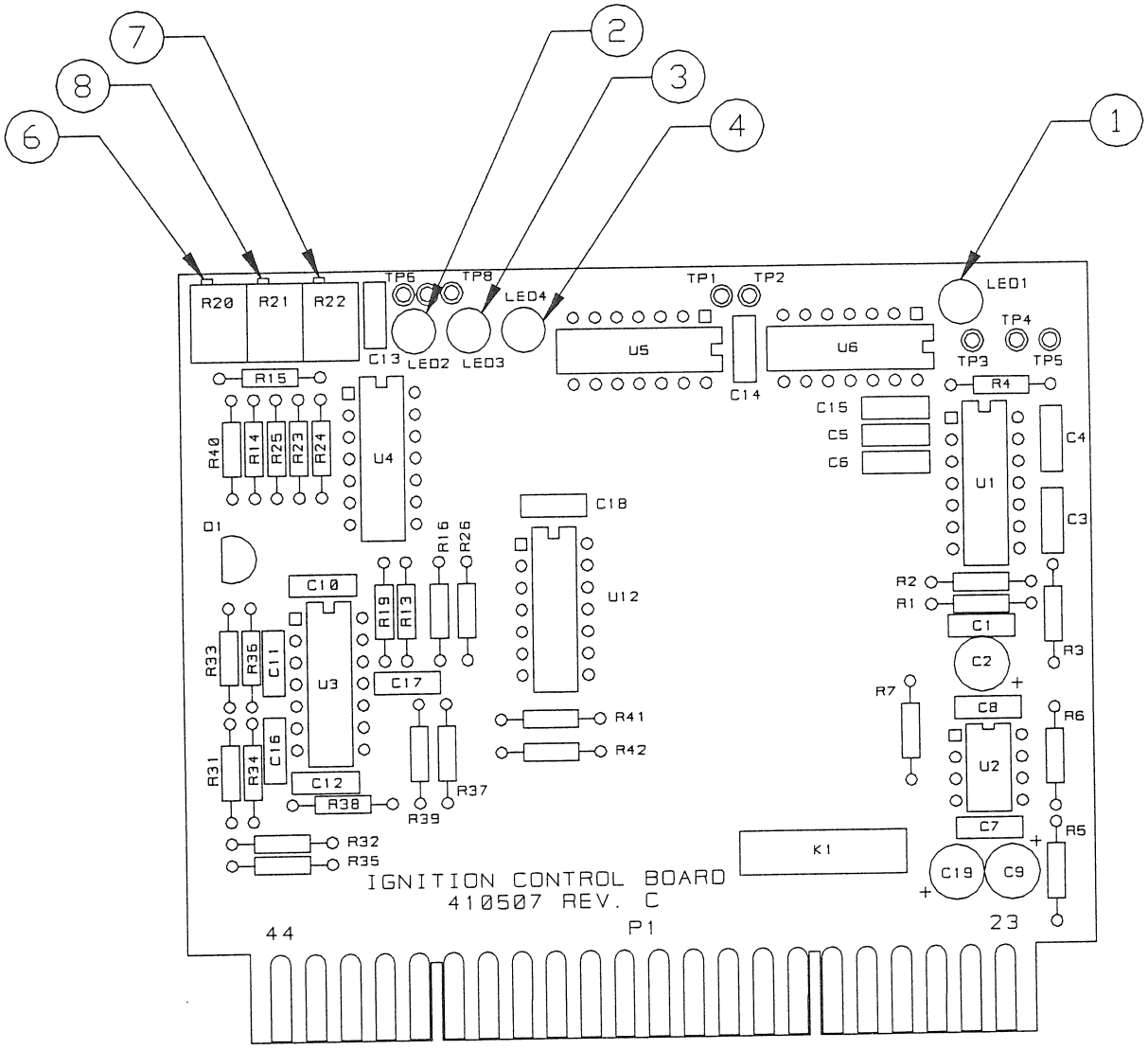


Figure 9 Automatic Ignite Circuit Board Components

1. **Glow Plug: LED 1**
2. **Air Solenoid ON: LED 2**
3. **Fuel Solenoid ON: LED 3**
4. **Ignite ON (Burner TC: LED 4**
5. **Open: LED 5**
6. **Fuel Low Pressure Limit Adjust Pot: R20**
7. **Air Low Pressure Limit Adjust Pot: R22**
8. **Lower Flame Temp Limit Adjust Pot: R21**

CALIBRATION & OPERATION (Continued)

DIAGNOSTIC BOARD COMPONENTS

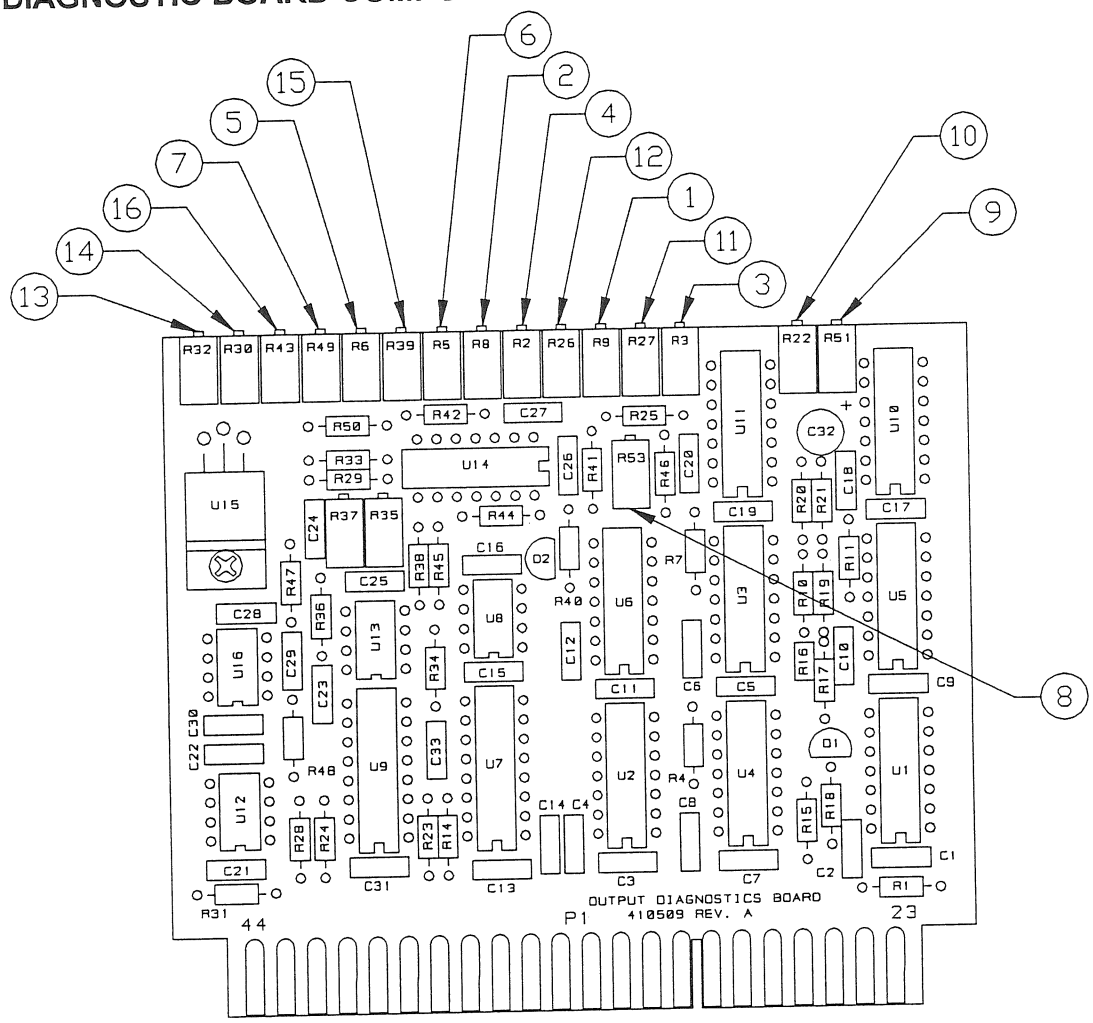


Figure 10 Output Diagnostic Circuit Board Components

1. **Fuel Pressure Zero Pot: R9**
2. **Fuel Pressure Span Pot: R8**
3. **Air Pressure Zero Pot: R3**
4. **Air Pressure Span Pot: R2**
5. **Sample Pressure Zero Pot: R6**
6. **Sample Pressure Span Pot: R5**
7. **Cutter TC Zero Pot: R49**
8. **Cutter TC Span Pot: R53**
9. **Burner TC Zero Pot: R51**
10. **Burner TC Span Pot: R22**
11. **Oven TC Zero Pot: R27**
12. **Oven TC Span Pot: R26**
13. **Analog Voltage Output Zero Pot: R32**
14. **Analog Voltage Output Span Pot: R30**
15. **Analog Current Output Zero Pot: R39**
16. **Analog Current Output Span Pot: R43**

CALIBRATION & OPERATION (Continued)

EPC & DUAL TEMPERATURE CONTROL BOARD COMPONENTS (Continued)

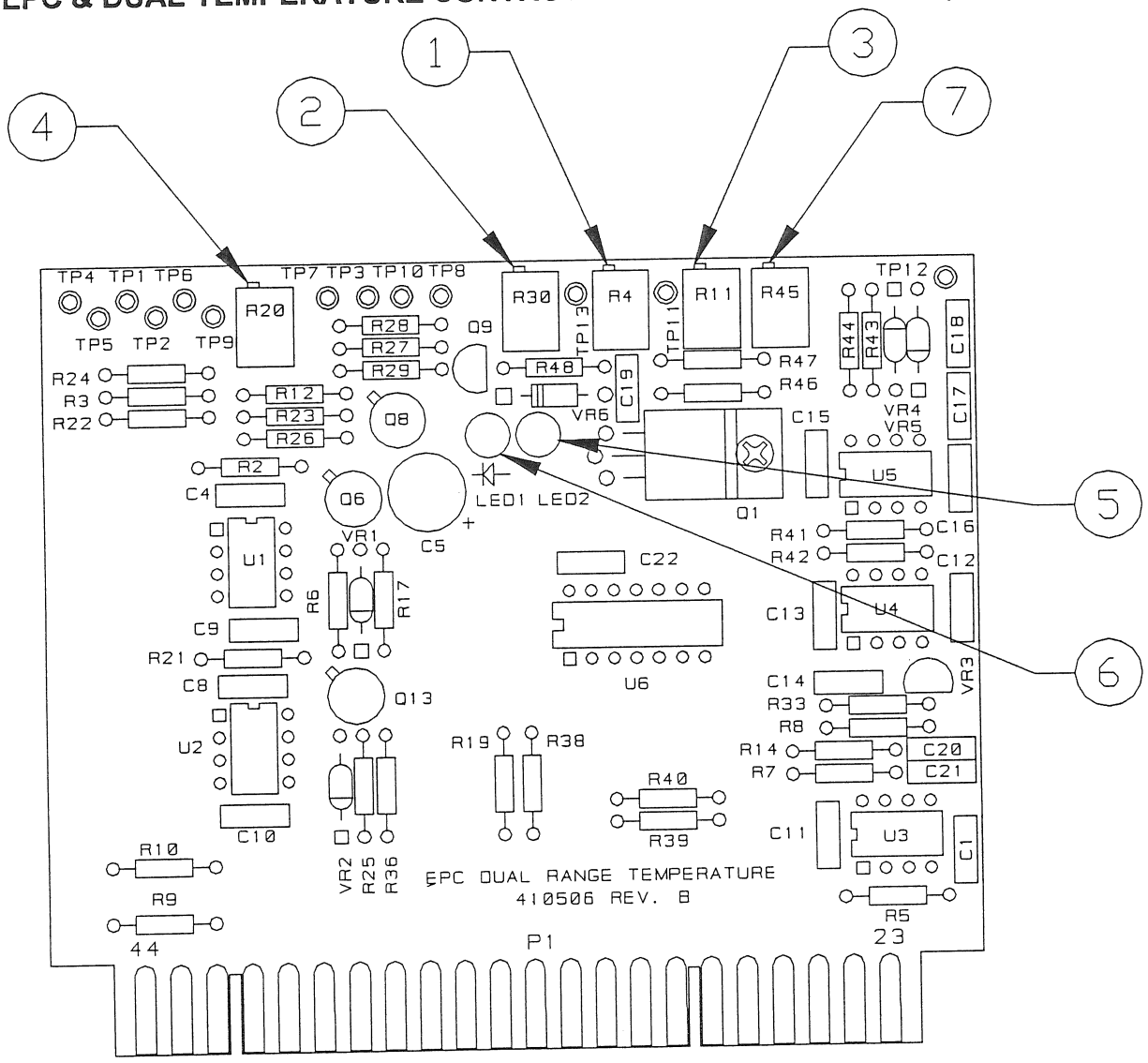


Figure 11 EPC & Dual Range Temperature Control Circuit Board Components

1. **Sample Pressure Cal Pot: R4**
2. **Sample Pressure Adjust Pot: R30**
3. **Sample Pressure Gain Pot: R11**
4. **Oven & Pump Temp Adjust: R20**
5. **Oven Heater Indicator: LED2**
6. **Pump Heater Indicator: LED1**
7. **Amplifier Zero Offset Adjust: R45**

CALIBRATION & OPERATION (Continued)

EPC HYDROGEN CONTROL BOARD COMPONENTS (Continued)

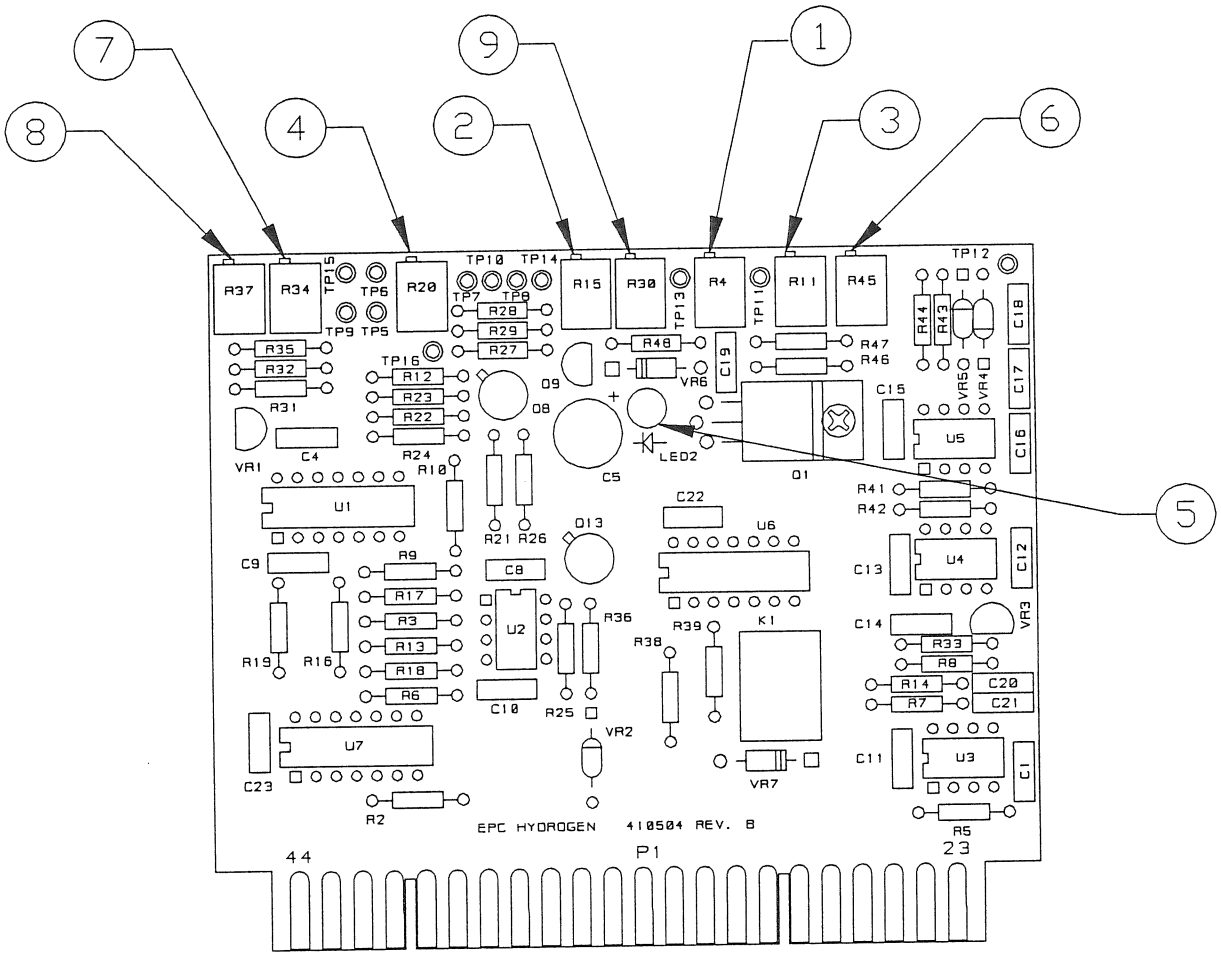


Figure 12 EPC Hydrogen Control Circuit Board Components

1. **Hydrogen Pressure Cal Pot: R4**
2. **Hydrogen Pressure Ignition Pot: R15**
3. **Hydrogen Pressure Gain Pot: R11**
4. **Cutter Temp Adjust: R20**
5. **Cutter Heater Indicator: LED2**
6. **Amplifier Offset Adjust: R45**
7. **Cutter H2 Low Temp Adjust: R34**
8. **Cutter H2 Low Pressure Adjust: R37**
9. **Optional H2 Final Pressure Adjust: R30**

NOTE: The final hydrogen pressure after ignition may be controlled by the front panel potentiometer.

CALIBRATION & OPERATION (Continued)

VALVE DRIVER BOARD COMPONENTS

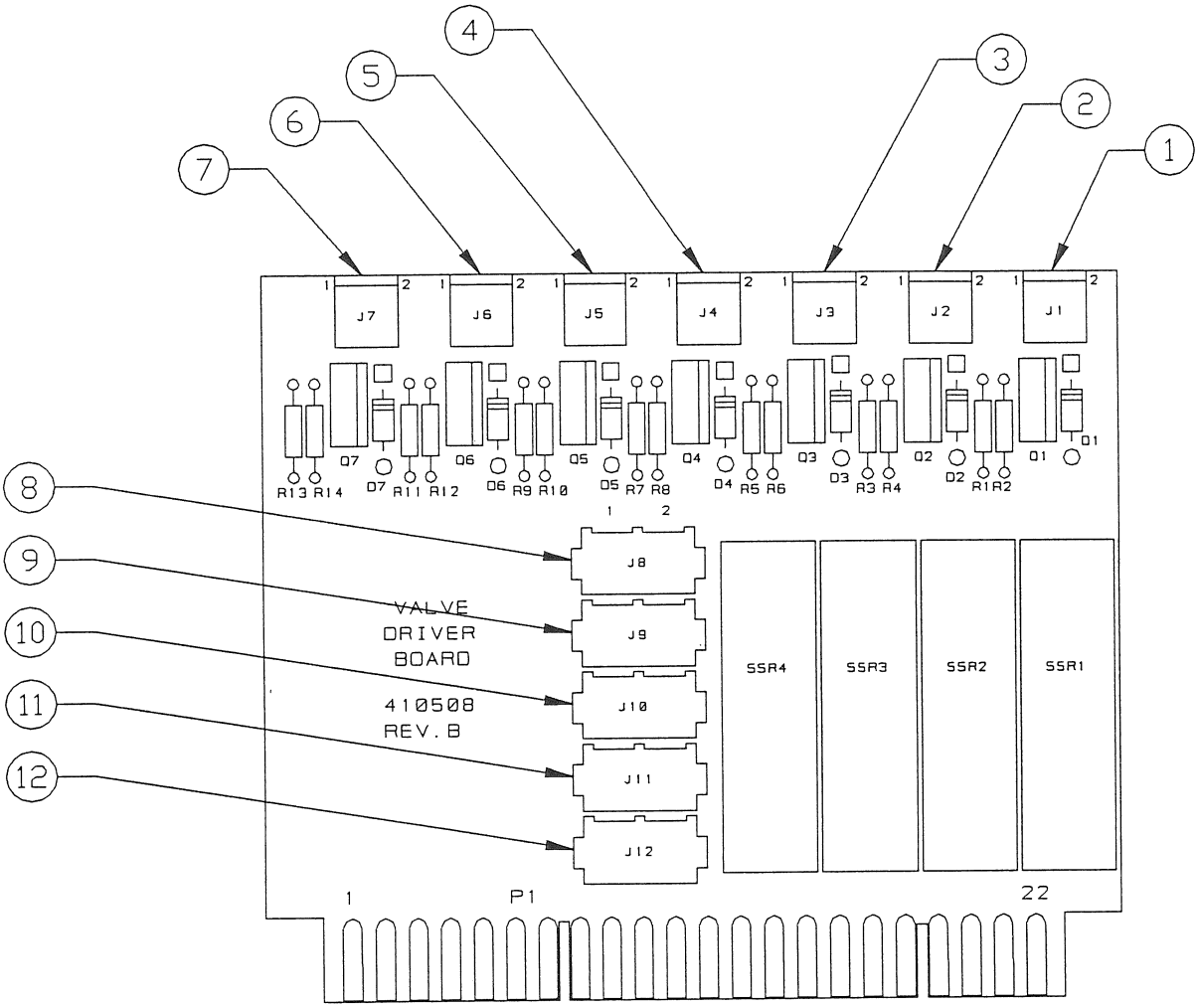


Figure 13 Valve Driver Board Components

1. **Fuel Solenoid Connection: J1**
2. **Burner Air Solenoid Connection: J2**
3. **Zero Air Solenoid Connection: J3**
4. **Span Gas Solenoid Connection: J4**
5. **THC/CH4 Solenoid Connection: J5**
6. **Cutter H2 Solenoid Connection: J6**
7. **Spare: J7**
8. **AC Power Connection: J8**
9. **Pump Heater Connection: J9**
10. **Oven Heater Connection: J10**
11. **Cutter Heater Connection: J11**
12. **Pump On/Off Control: J12**

CALIBRATION & OPERATION (Continued)

PREPARATION FOR OPERATION

1. Check that the external plumbing and wiring have been connected correctly, as described in Section III of this manual.

OPERATION

1. **Power On**: Turn ON the power switch on the rear panel. The digital panel meters should illuminate. The sample pump and burner should remain off until the over reaches at least 100 degree C.

2. **Introduce Fuel & Burner Air**: Adjust the cylinder output pressures to 30 PSIG. Upon initial installation, loosen the fuel inlet connection to allow the air to bleed from the fuel line. This should only take 5 to 10 seconds. Firmly re-connect the fuel line.

3. **Ignition (After Oven at 100 Degrees C)**:: Press the momentary ignite button. This will initiate the automatic ignite sequence. First:: The fuel pressure is controlled by an electronic proportional control valve which opens and flows fuel at an initial, factory set, high flow rate which creates a very rich fuel mixture to allow the burner to be saturated with fuel. Second: After 5 seconds of fuel, the burner air solenoid opens and the ignite glow plug is energized. This cycle repeats for 5 sequences **OR** until the burner lights and the as indicated when the thermocouple reaches a factory set temperature to indicate ignition. After ignition is detected, the burner ON light in the momentary push button is illuminated and a contact closure is completed on the rear connector. The burner fuel flow is then reduced to maintain a more efficient flame. This sequence can be started by a remote (Computer) contact closure. Note: The sequence will not succeed if the ignition control board senses insufficient fuel or air pressure. The fuel valve and air solenoid will shut off if the burner thermocouple senses a flame out OR lack of either fuel or air pressure. To meet the drift and repeatability specifications, allow the instrument to warm up for approximately one hour. It is preferable, but not essential, that zero air flow through the instrument during warm-up.

4. **Fuel and Air Pressure Settings:** The fuel and air pressure pressures may be observed by placing the diagnostic switch in the respective positions. They should agree with the factory set pressure settings indicated on the QA Checkout Sheet, +/- 1.0 PSIG. If necessary, reset the air and fuel pressures by adjusting the front panel potentiometers or regulator.

CALIBRATION & OPERATION (Continued)

PREPARATION FOR OPERATION (Continued)

5. **Flame Optimization:** Since the fuel and air flow rates are controlled using state-of-the-art pressure control and internal critical flow orifices, flame optimization is always maintained if the fuel and air pressures are within +/- 1.0 PSIG of the respective settings, indicated above.

6. **Zero Adjustment**: After the one-hour warm-up period, flow zero gas through the instrument sample inlet. Adjust the zero control on the front panel until the digital panel meter or recorder reading reads exactly zero.

7. **Span Adjustment**: Flow span gas through the instrument sample inlet. Adjust the span control on the front panel until the digital panel meter, or recorder, reading is at the value specified for the span gas concentration.

8. **Sample Pressure Check**: With sample or span gas flowing through the instrument, place the diagnostic switch in sample position. The inlet sample pressure **must** be above 6 PSIG for the meter to read original factory setting (+/- 1.0) PSIG, unless the instrument has an internal sample pump, then pressure is automatically controlled.

9. **Methane ONLY Operation**: Switch the CH4 cutter in and out of the sample stream to measure total hydrocarbons or methane only.

CALIBRATION & OPERATION (Continued)

START-UP & ROUTINE MAINTENANCE

1. **Sampling System**: Prepare and check the sample system. Check the sample pressure and by-pass flow and verify agreement with the factory QA Checkout sheet, (+/- 1.0 PSIG).. Failure to meet the sample presure may be due to a dirty filter. See Page 30 for replacement procedure.

2. **Air & Fuel Pressure:** Check the fuel and air pressures for agreement with the factory QA Checkout sheet, (+/- 1.0 PSIG). Readjust pressures as required. Note: Cylinder pressures should be set at 30 PSIG.

3. **Zero & Span Calibration**: Zero and span adjustment should be checked daily.

   a. Check the zero reading while flowing zero gas, and readjust, if necessary, using the front panel zero control.

   b. Check the span reading while flowing span gas, and readjust, if necessary, using the front panel zero control.

SECTION V

FUNCTIONAL DESCRIPTION

OPERATING PRINCIPLE

The California Analytical Model 300 HFID Heated Total Hydrocarbon Analyzer utilizes the flame ionization detection method of determination of total carbon (C) in a sample gas. The detector is a burner in which a regulated flow of sample gas passes through a flame sustained by a regulated flow of hydrocarbon free air and fuel gas 40% H_2/60% He or 100% H_2, as specified. Within the flame, the hydrocarbon components of the sample undergo an ionization process that produces electrons and positive ions. A 250 volt (-250 VDC) polarized electrode ring collects these ions, causing a very low current to flow. This low current is amplified by a precision electrometer amplifier. This current flow is directly proportional to the carbon content of the sample. Since the instrument includes a temperature controlled sample oven, all material in contact with the sample is maintained at an elevated temperature. This temperature is adjustable from ambient to 200 °C.

BURNER ASSEMBLY (Figure 8.)

The sample, burner air and fuel are delivered to the burner via the unique regulated flow systems described below. The sample and fuel are mixed together and passed through the burner tip. Air is then added to present the proper air/fuel mixture to sustain ignition. Ignition is accomplished by energizing a standard glow plug. The burner jet and electrode ring function as electrodes and are connected to a precision high voltage regulated 250 volt DC power supply. The collector is connected to a precision low current electrometer. The two polarized electrodes establish an electrostatic field near the flame. Electrons migrate to the burner jet while the positive ions migrate to the collector ring. The small ionization current flowing between electrodes is directly proportional to the carbon atoms in the sample stream.

METHANE CUTTER (NON-METHANE HYDROCARBONS)

The cutter utilizes a temperature controlled metal oxide catalyst to oxidize all hydrocarbons in the sample except methane. The cutter catalyst assembly contains a cartridge heater and an RTD that is used by the electronic proportional circuitry to maintain the catalyst converter at the factory value of approximately 250°C. The operator can first elect to measure the total hydrocarbons in the sample by by-passing the cutter. The cutter may be switched in and out of the sample stream with the front panel switch or remotely via a contact closure. The cutter can then be

FUNCTIONAL DESCRIPTION (Continued)

switched into the sample stream to read only the methane content of the sample. Simple subtraction will yield the non-methane hydrocarbon content of the sample.

FLOW SYSTEM (See Drawing 210002)

The basic function is to deliver highly regulated flows of sample, fuel and air to the burner assembly. The air pressure regulator delivers the appropriate pressure to critical flow orifice. The fuel is presented via a precision, electronically controlled proportional flow controller through a critical orifice and consequently accurately pre-determine the flame characteristics without the need of flame optimization adjustments. The supply cylinders should be set to 30 PSIG. The sample is presented to the burner via a precision, electronically controlled proportional flow controller through a critical orifice. This pressure is factory set at approximately 2 PSIG. A close coupled by-pass capillary minimizes "dead volume" and improves response time. This by-pass

flow is factory set by the capillary and flows approximately 4 liters/Min. Sample inlet pressure, regulated fuel and air pressures are monitored by internal pressure transducers and presented in PSIG via the diagnostics meter.

ELECTRONICS

Main Circuit Board (Figure 6.)

The main circuit board contains the instrument power supplies and edge connectors for the required control boards. A single transformer is used to allow operation form 110/220 VAC at 50/60 Hz. The power entry is used to convert from 110 to 220 VAC by changing a small circuit board from the back panel of the instrument. This main board also contains the plug in connectors for all the additional electronic circuitry in the instrument, providing ease of maintenance. The board also contains clearly marked test points for diagnostic purposes, including +15, -15, + 24 and –250 VDC, etc.

Main Electrometer Amplifier Board (Figure 7.)

The main electrometer amplifier board contains the low noise low transimpedance amplifier used to amplify the ionization current produced in the burner. The amplifier changes to current to a representative voltage and scales the output. This board contains a coarse zero and span potentiometers which work in conjunction with the front panel controls. This amplifier also contains the 9 range electronic components which sets the instrument's 8 operating ranges.

Automatic Ignite Board (Figure 9.)

The automatic ignite circuit board contains the logic circuitry required to perform an automatic ignite function. The front panel momentary ignite switch is depressed and the logic follows the block diagram contained in Section VIII. LED's on the board give visual indication of the operation of the air solenoid, fuel solenoid and glow plug.

Diagnostic Board (Figure 10.)

The diagnostic circuit board contains the logic circuitry required to convert the instrument transducers output signals for presentation via a 7 position switch to the diagnostic digital panel meter.

EPC/Dual Temperature Control Board (Figure 11.)

This board, when fully populated, contains the circuitry required to temperature control the oven and pump temperature and contains the logic circuitry required for precision control of the sample proportional flow controller. A single potentiometer controls the temperature of both the pump and oven. A pressure transducer is used to measure the sample pressure directly at the entrance of the burner capillary. The electronically controlled proportional control valve is then automatically adjusted to maintain this pressure at the factory setting.

EPC Hydrogen/Cutter Temperature Control Board (Figure 12.)

This board, when fully populated, contains the circuitry required to temperature control the THC cutter, control the hydrogen solenoid and provide pressure control for the hydrogen electronic control valve. To assure proper cutter operation, a small amount of burner fuel is introduced to the cutter and the solenoid is activated only when proper temperature and pressures are satisfied. As with the EPC/Dual Temperature Control Board, an EPC valve is used to accurately control the burner fuel pressure. During the ignition process, the fuel pressure is increased to facilitate ignition. After ignition, this pressure is reduced to factory setting to optimize the burner.

Valve Driver Control Board (Figure 13.)

This board, when fully populated, contains the seven amplifiers and four solid state relays necessary to electrically control the instrument solenoid valves and AC devices. **EXTREME CAUTION** should be taken, as instrument supply voltages are located on both sides of this board. Either 112 or 220 VAC.

SECTION VI

DISASSEMBLY PROCEDURES

BURNER ASSEMBLY

1. **Removal** (Refer to Figure 12)

   a. Shut off ALL gas flow. CAUTION: Burner may be hot if recently operational.

   b. Remove power from the instrument.

   c. Remove the top cover retaining screws

   d. Remove the burner air, fuel and sample supply lines. Remove the sample by-pass line.

   e. Remove the SMA connector connecting the burner output to the main amplifier.

   f. Remove the high voltage connector connecting the collector.

   g. Remove the burner thermocouple.

   h. Remove the glow plug connection wires.

   i. The burner may now be removed by loosening the retaining screws on the rear panel. Slowly pull the burner forward (toward the front panel).

   j. Unscrew the burner inlet "T" fitting (containing the critical orifice).

BURNER CLEANING INSTRUCTIONS

   a. Remove the glow plug.

   b. Wash the complete burner assembly in detergent using a test tube brush. Rinse with clean water.

   c. Dry the burner assembly by blowing clean using dry nitrogen.

   d. Reassemble the burner in reverse order per the above.

DISASSEMBLY PROCEDURES (Continued)

ELECTRONIC BOARDS

1. **Removal** (Refer to Figure 12)

   a. Shut off ALL gas flow.

   b. Remove power from the instrument.

   c. Remove the top cover retaining screws.

   d. Slowly remove the individual plug in circuit boards.

SECTION VII

TROUBLESHOOTING - GENERAL INFORMATION

ELECTRONICS

For ease of service, **ALL** electrical connections terminate on the main circuit board using plug-in connectors. The following information may be of use to the electronic technician:

a) The digital panel meters are powered by 5 VDC from the main circuit board. If the instrument seems to operate properly, output analog voltage, etc., except the meter display, refer to the main circuit board schematic and check the 5 volt section, 3 terminal regulators, capacitors, etc.

b) The +/- 15 VDC supplies from the main circuit board must be operating properly. If any of these are not operational, refer to the main circuit board schematic and check the 15 volt section, 3 terminal rectifiers, capacitors, etc.

c) The 250 VDC burner collector voltage supply from the main circuit board is operating properly as indicated by the diagnostic meter. If this voltage is not between 200 and 300 VDC, refer to the main circuit board schematic and check the 300 volt section, 3 terminal regulators, capacitors, transistors, op amps, etc.

d) The 4 VAC burner glow plug voltage supply from the main circuit board is operating properly as indicated by the sequencing LED on the ignite board, during the ignite cycle. If this LED not illuminating, refer to the main circuit board schematic and check the 4 VAC section, transformer, etc.

FLOW SYSTEM

Fuel & Burner Air Supply

a) Capillary protection sintered metal filters are contained in the respective regulators output fittings. These filters are located down stream of the diagnostic pressure point. If difficulty occurs during the lighting sequence, it is suggested to **TEMPORARILY** remove these filters when proceeding with diagnostic activity. Should the filters be contaminated, replacement is necessary.

Fuel & Burner Air Supply (Continued)

b) These flows are controlled by adjustable forward pressure devices which require 30 PSIG cylinder supply pressure and are factory set at the pressures indicated on the QA Check Sheet plate +/- 1.0 PSIG. These pressures may be monitored by the diagnostics meter during the ignite sequence or after the flame is ignited. The burner flow rate from the orifices is very low and will require a bubble flow meter to determine proper flow rates. If the pressures are properly set, it is suggested to replace the delivery lines containing the orifices if clogged lines are suspected.

Sample Supply

a) An inline SMALL filter is contained in the heated oven, however an external sample orifice protection sintered metal filter is highly recommended for trouble-free operation. An optional remote in-line filter assembly is available from CAI. If difficulty occurs with erratic sample flow, it is suggested to **TEMPORARILY** remove this filter when proceeding with diagnostic activity. Should the filter be contaminated, replacement is necessary.

b) The sample flow is controlled by an adjustable electronic proportional pressure valve. This pressure may be monitored by the diagnostics meter at any time. The instrument has an internal sample pump and is factory set per the QA Check Sheet.

TROUBLESHOOTING GUIDE 1.

SYMPTOM	CAUSE	REMEDY
1. Downscale indication with flame out.	Electrical leakage in burner.	Clean Burner as explained in Section VI.
2. Burner will not ignite.	Air and/or Fuel Pressures improperly adjusted.	Depress Ignite button, and with diagnostic switch verify all pressures per manual. Adjust regulators as required.
		(IF OK)
	Improper operation of glow plug.	Depress Ignite button, and from rear of instrument, check for red glow from plug at burner vent.
		(IF OK)
		If plug glows, bleed off fuel line to instrument for 5 seconds.
		(IF OK)
		Check glow plug connections.
		(IF OK)
		Check for 3 VAC at plug connections. If OK, replace plug.
		(IF OK)
		View ignite board LED's for proper sequence. Replace board if necessary.
		(IF OK)
		Check for 3 VAC at plug connections. If no voltage, replace transformer.
		(IF OK)
		Check switch continuity. Replace if necessary.
		(IF OK)
		Replace fuel and/or air critical orifices.
3. Noisy Signal.	Sample pressure under regulator control limit of 6 PSIG.	Check and adjust as required.
		Change fuel and/or air supply. Replace external tubing.

TROUBLESHOOTING GUIDE 2.

SYMPTOM	CAUSE	REMEDY
3. Noisy Signal.	Water or contamination in burner.	Clean Burner as explained in Section VI.
4. Loss of Sensitivity. (Not enough gain)	Contamination in fuel/air or sample flow system.	Verify air & fuel pressures to be set per calibration sheet. (IF OK) Verify sample pressure to be set per calibration sheet. (IF OK) Verify by-pass flow to be at 4 Liters/Min. +/- 1.5. (IF OK) Verify 250 volt DC collector voltage. (=/- 15 Volts) (IF OK) Carefully remove burner signal co-ax cable. Touch center conductor and watch for up scale reading. (IF OK) Remove and clean sample critical orifice. (IF OK) Check Co-Ax cable for continuity.

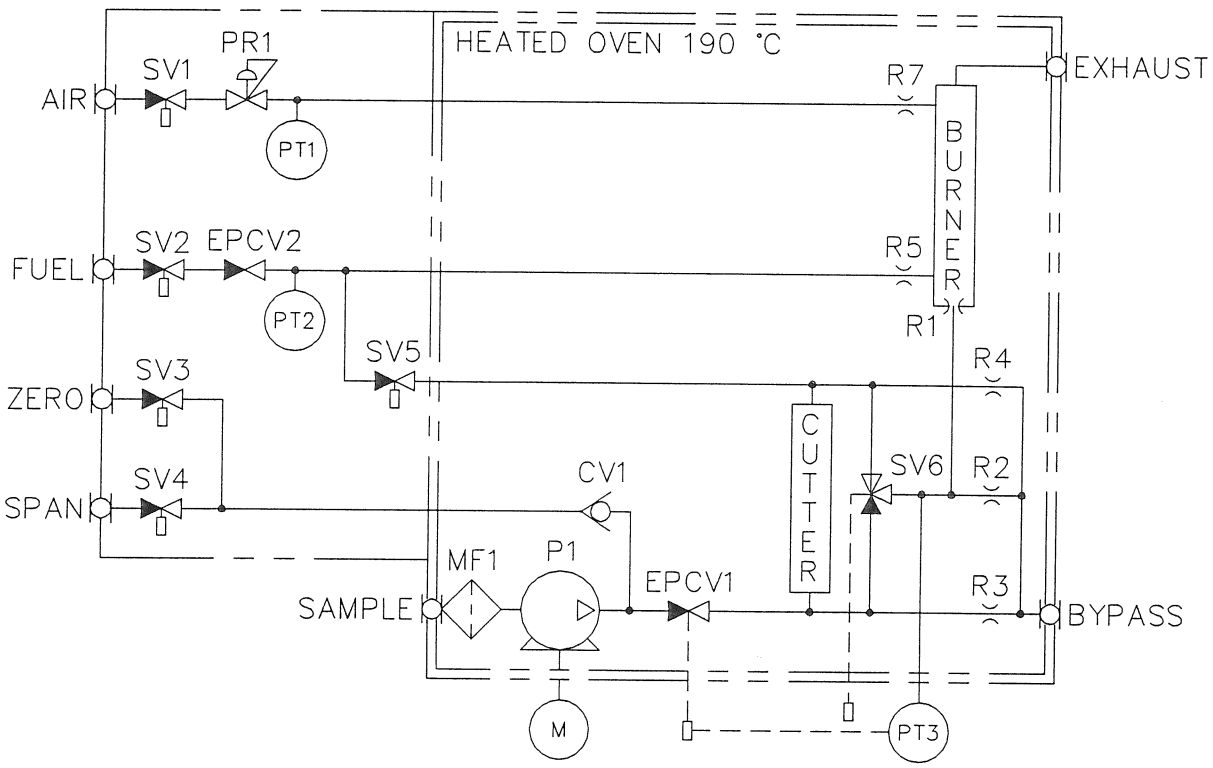
SECTION VIII

FLOW DIAGRAMS

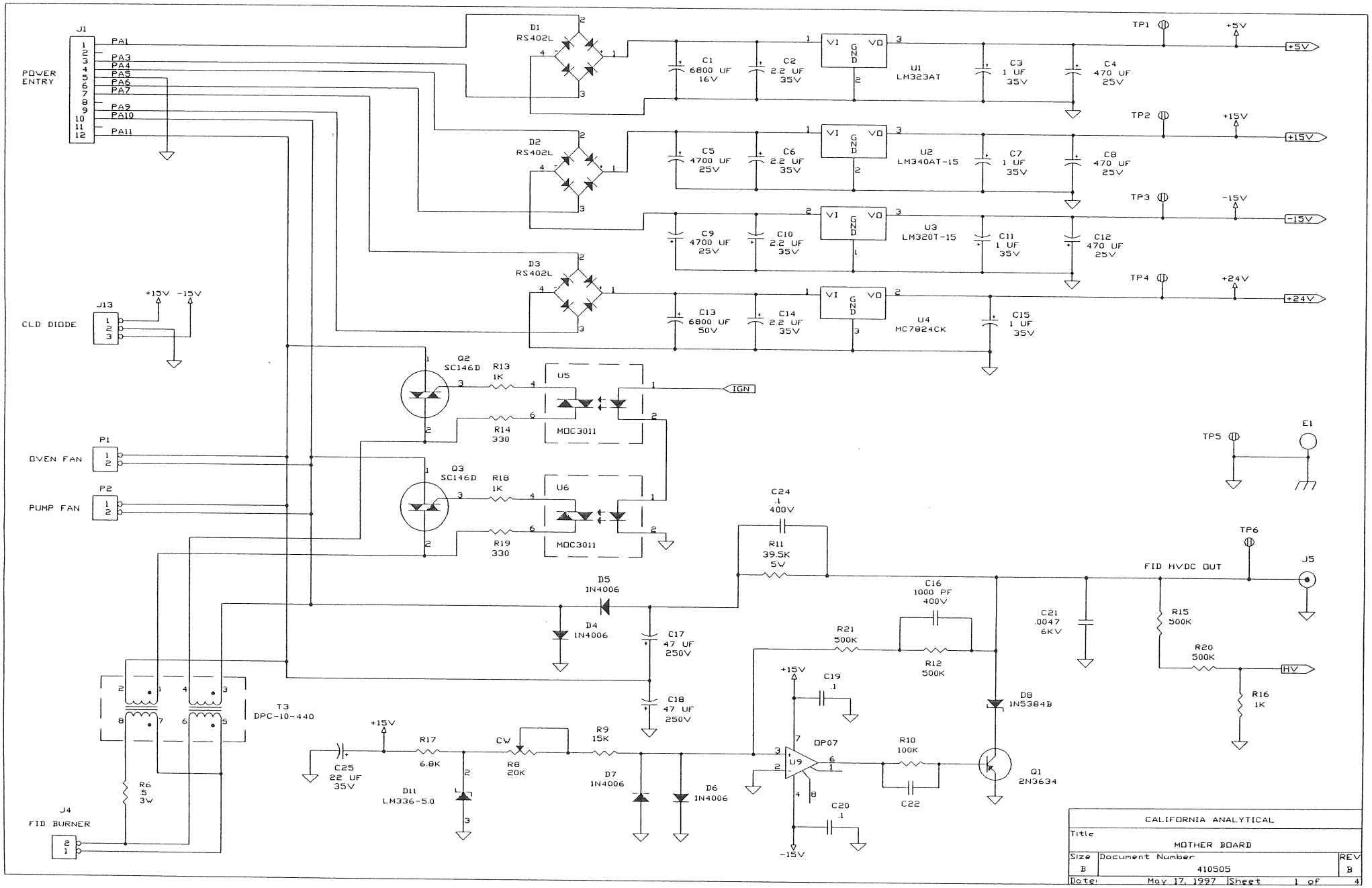
SCHEMATIC & ASSEMBLY DIAGRAMS

SEE ATTACHED

FLOW DIAGRAM



Model 300M-HFID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PA4
PA5
PA6
PA7
PA9
PA10
PA11
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D2 RS402L
D3 RS402L
C1 6800 UF 16V
C2 2.2 UF 35V
U1 LM323AT
C3 1 UF 35V
C4 470 UF 25V
TP1
+5V
C5 4700 UF 25V
C6 2.2 UF 35V
U2 LM340AT-15
C7 1 UF 35V
C8 470 UF 25V
TP2
+15V
C9 4700 UF 25V
C10 2.2 UF 35V
U3 LM320T-15
C11 1 UF 35V
C12 470 UF 25V
TP3
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C13 6800 UF 50V
C14 2.2 UF 35V
U4 MC7824CK
C15 1 UF 35V
TP4
+24V
J13
CLD DIODE
Q2 SC146D
R13 1K
R14 330
U5 MOC3011
IGN
P1
OVEN FAN
Q3 SC146D
R18 1K
R19 330
U6 MOC3011
P2
PUMP FAN
TP5
E1
C24 .1 400V
R11 39.5K 5W
TP6
J5
FID HVDC OUT
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D4 1N4006
C16 1000 PF 400V
C21 .0047 6KV
R15 500K
R21 500K
R12 500K
R20 500K
HV
C17 47 UF 250V
C18 47 UF 250V
T3 DPC-10-440
+15V
C19 .1
D8 1N5384B
R16 1K
R17 6.8K
CW
R8 20K
R9 15K
C25 22 UF 35V
D11 LM336-5.0
D7 1N4006
D6 1N4006
DP07
U9
R10 100K
C22
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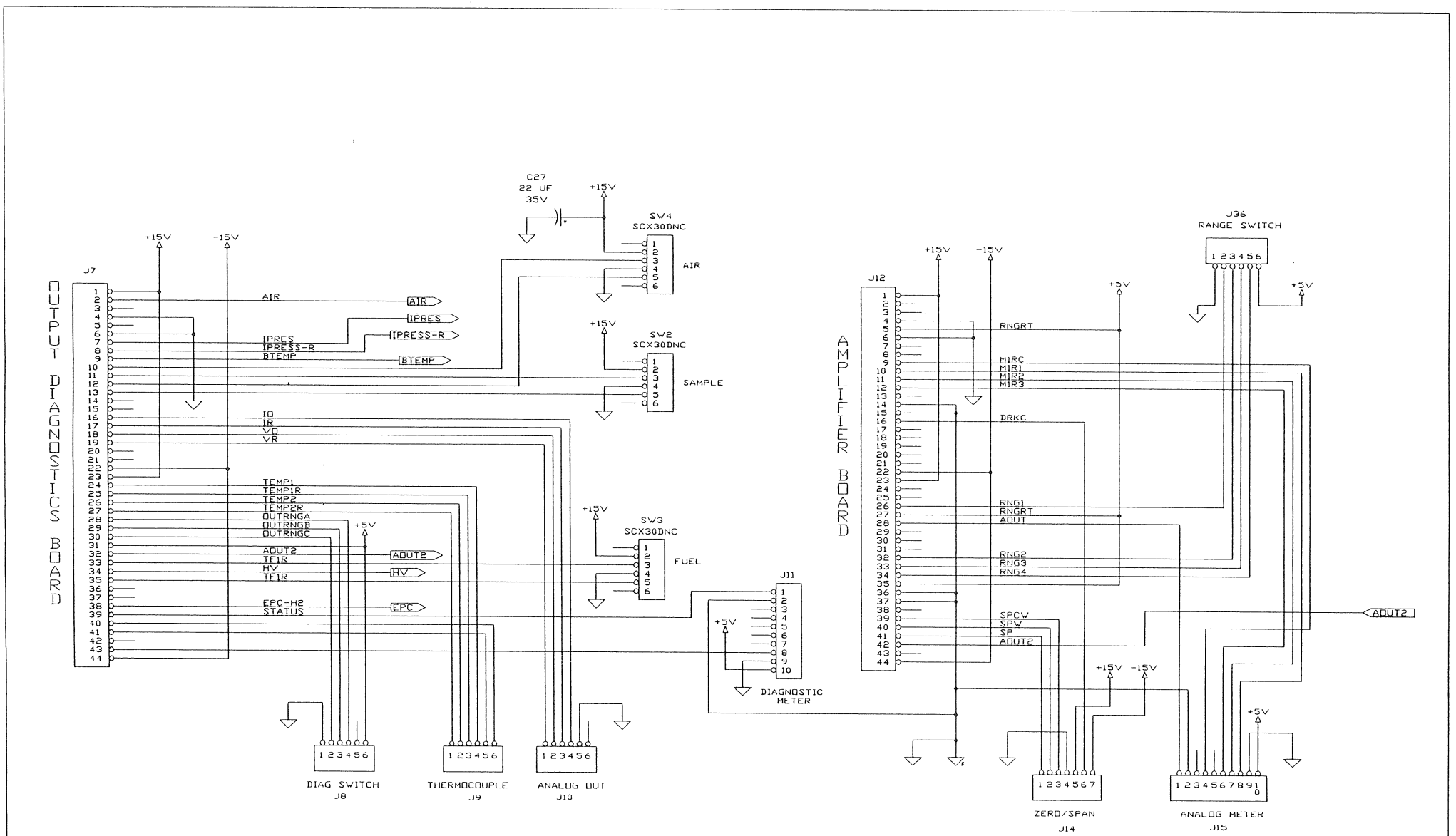
Sheet 1 of 4



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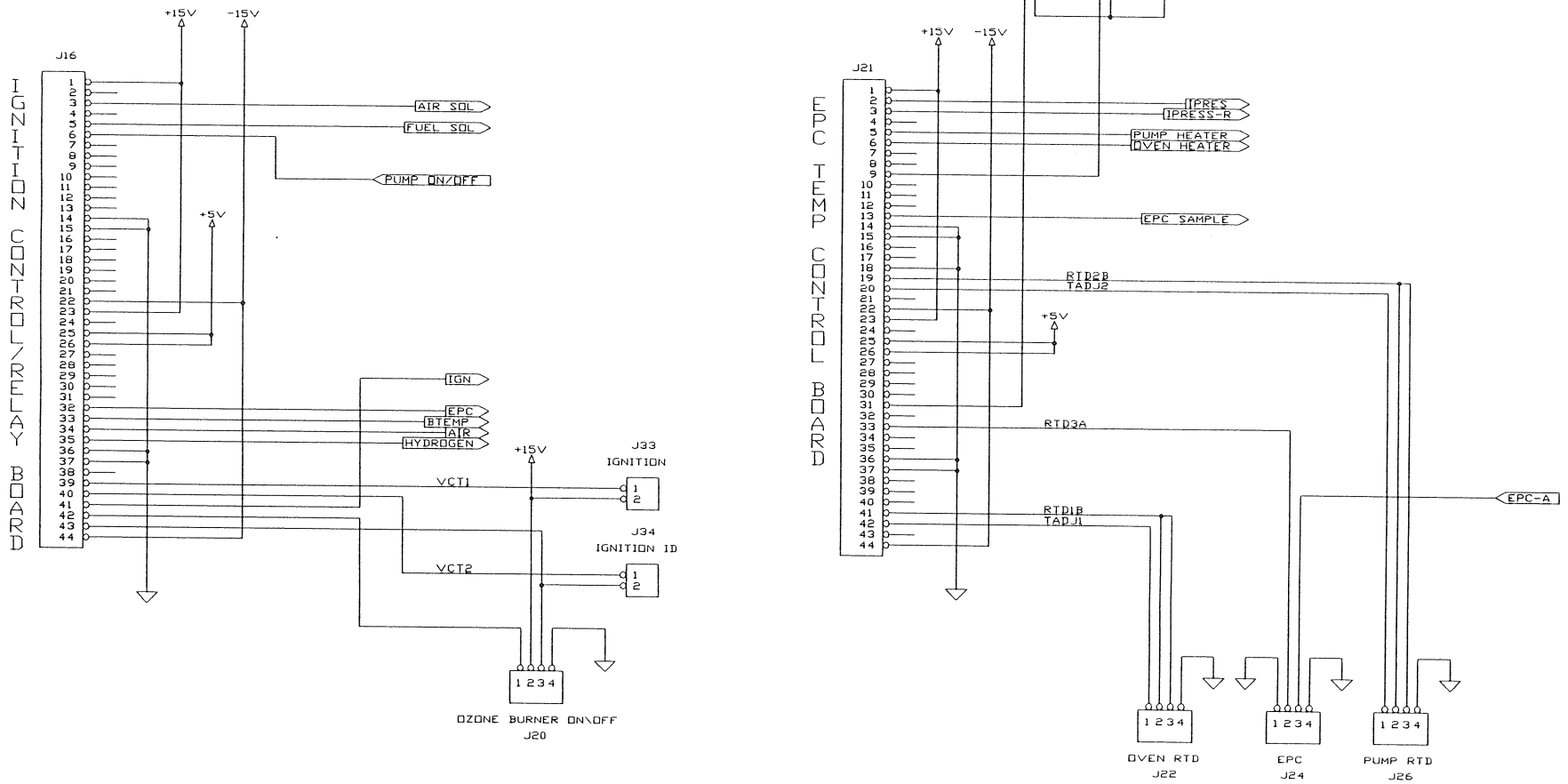

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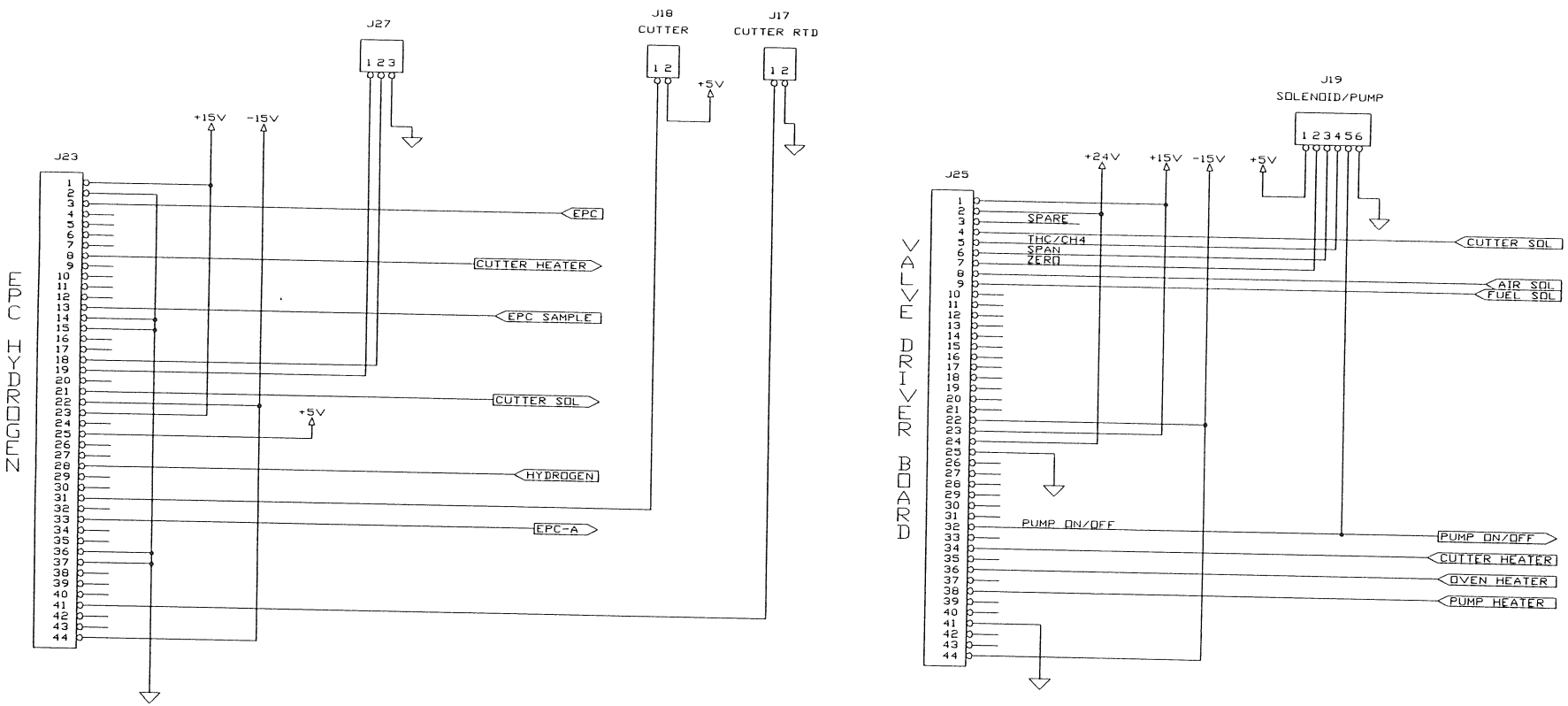

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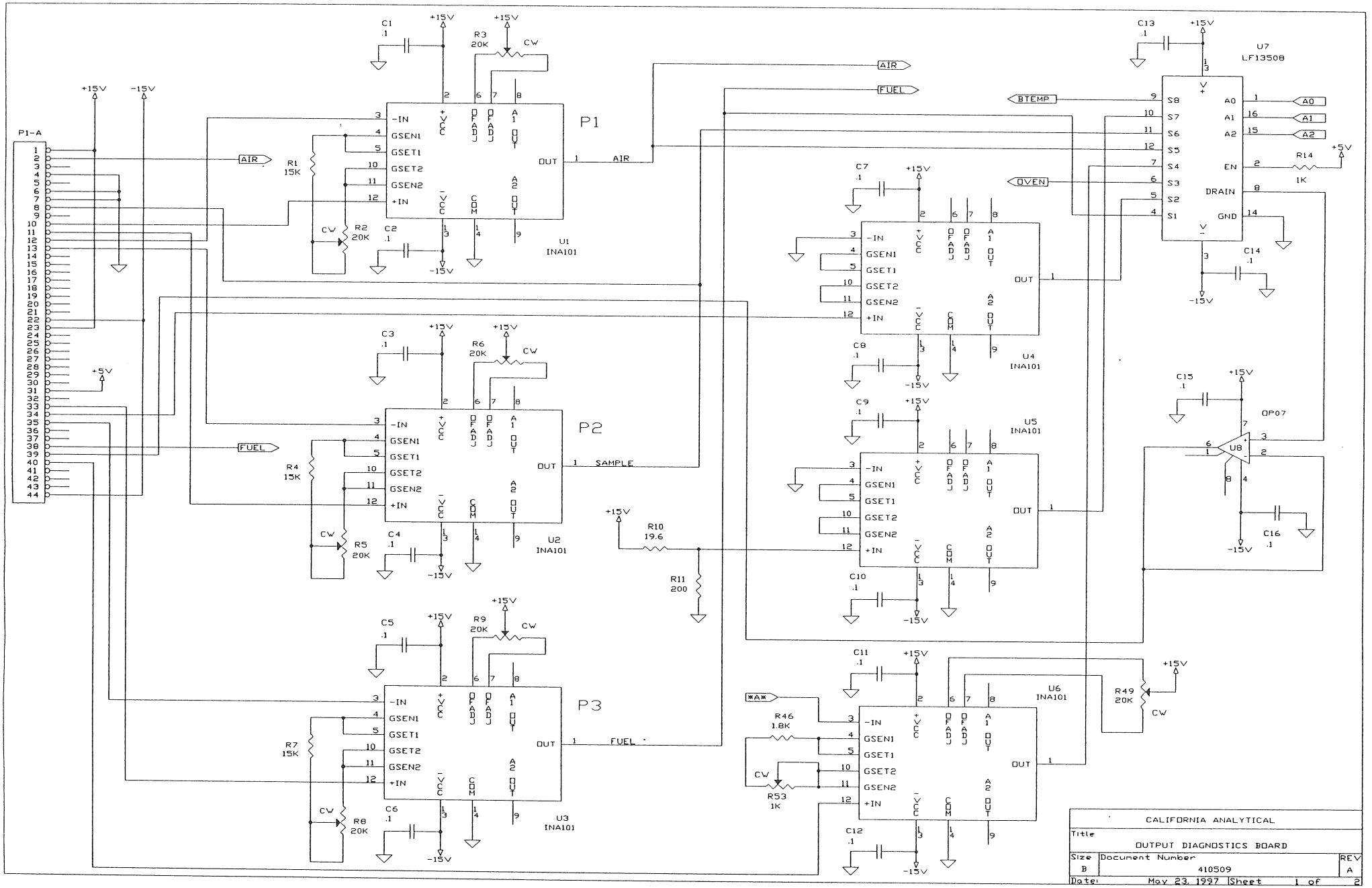
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MAX
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+5V
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R3 20K
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R6 20K
R7 15K
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R11 200
R14 1K
R46 1.8K
R49 20K
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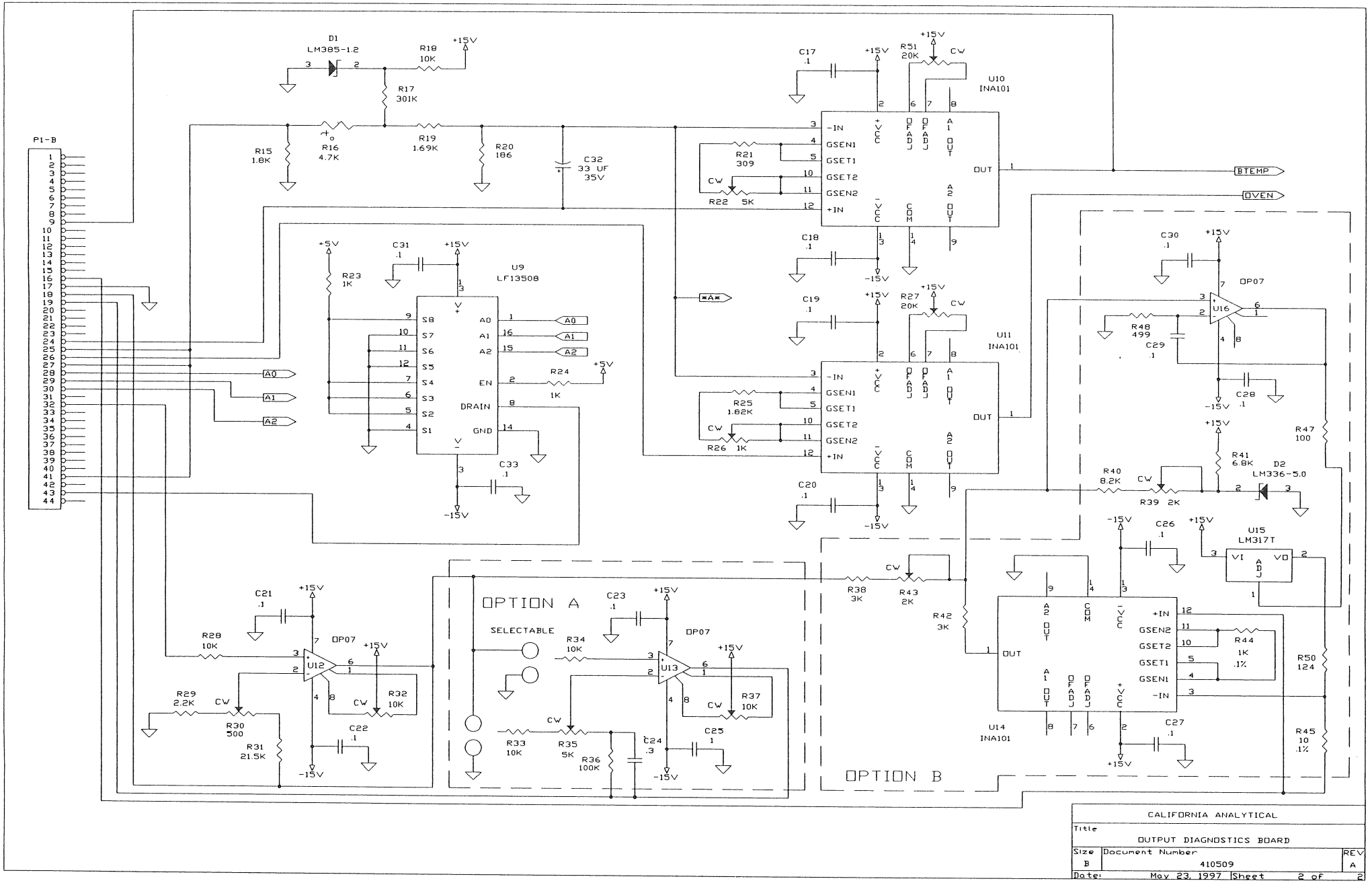
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C17
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20K
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U10
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GSET2
GSEN2
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R22
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BTEMP
OVEN
C31
.1
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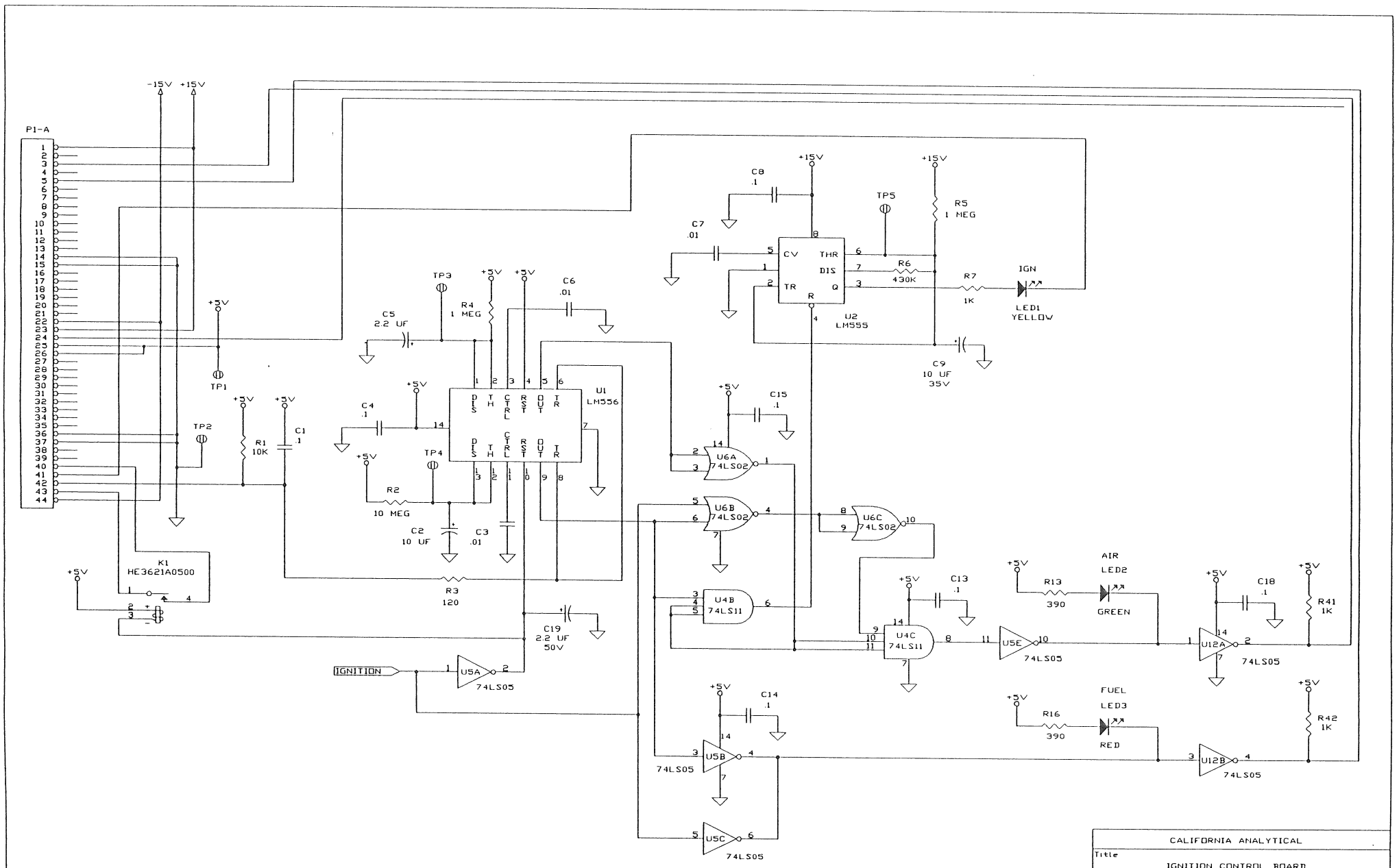
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R3 120
C4 .1
C5 2.2 UF
R4 1 MEG
C6 .01
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K1 HE3621A0500
C7 .01
C8 .1
R5 1 MEG
R6 430K
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U4B 74LS11
U4C 74LS11
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LED2
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U12A 74LS05
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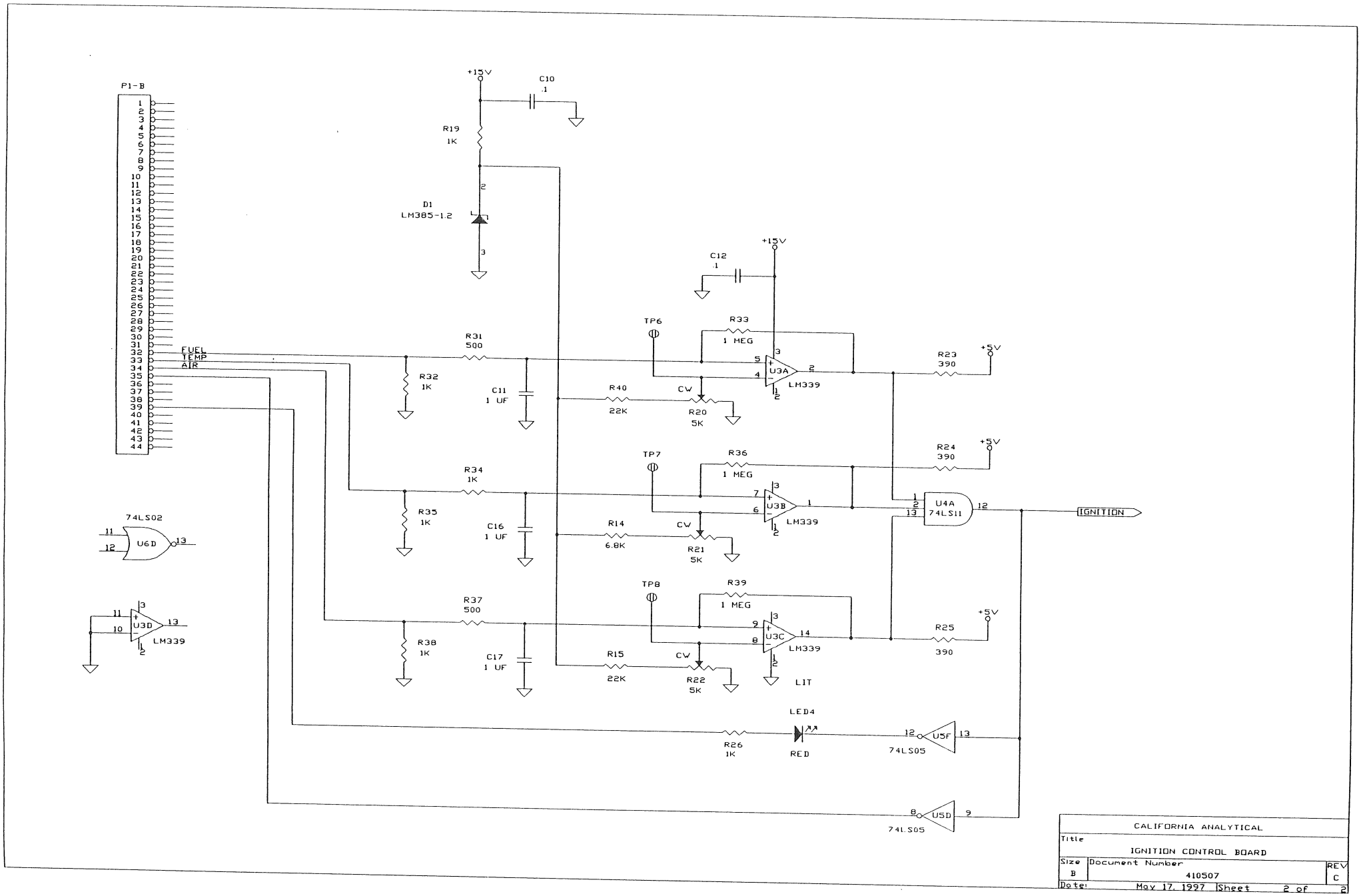
Size B
Document Number 410507
REV C
Date: May 17, 1997
Sheet 1 of 2

5.7.0 ll
5/31/97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TP6
R33
1 MEG
R31
500
R32
1K
C11
1 UF
R40
22K
CW
R20
5K
U3A
LM339
R23
390
+5V
TP7
R36
1 MEG
R34
1K
R35
1K
C16
1 UF
R14
6.8K
CW
R21
5K
U3B
LM339
R24
390
U4A
74LS11
IGNITION
74LS02
U6D
TP8
R39
1 MEG
R37
500
R38
1K
C17
1 UF
R15
22K
CW
R22
5K
U3C
LM339
LIT
R25
390
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LM339
LED4
R26
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RED
U5F
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U5D
74LS05
CALIFORNIA ANALYTICAL
Title
IGNITION CONTROL BOARD
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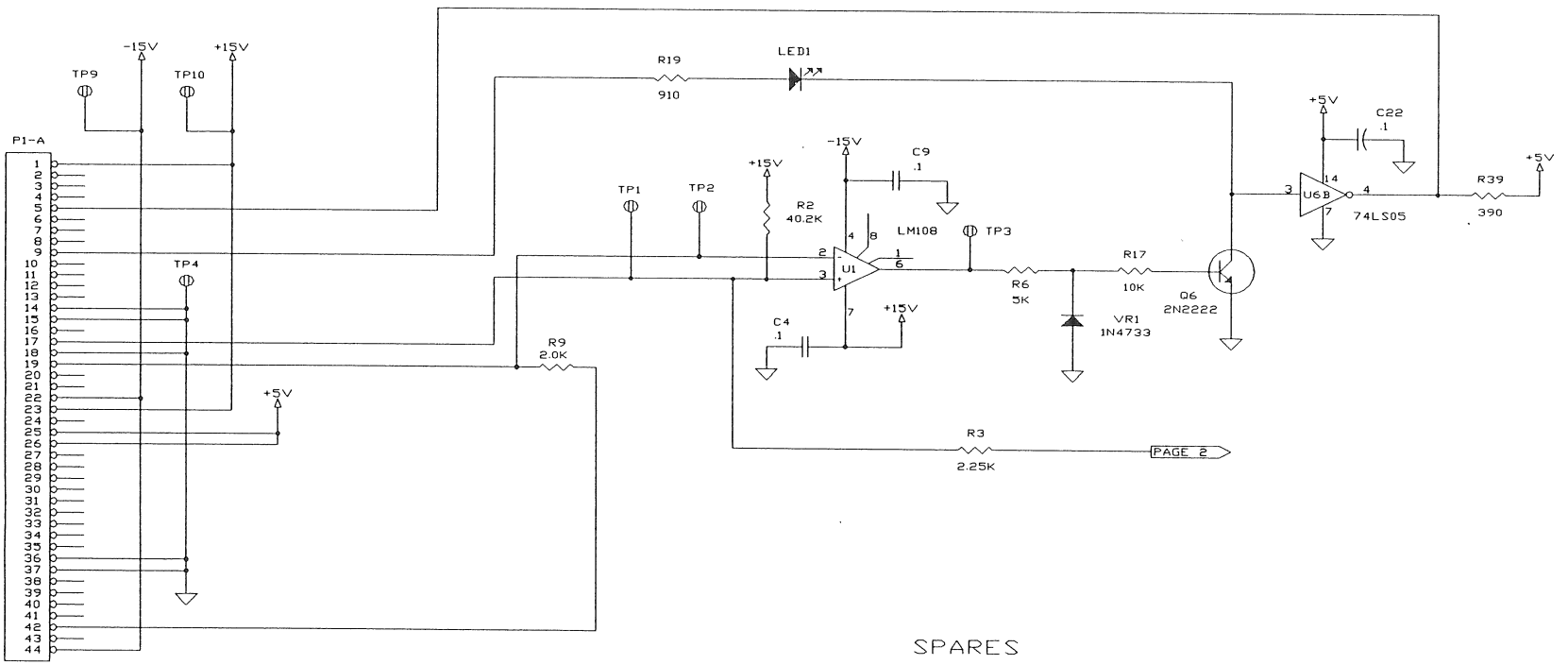

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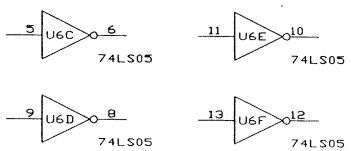

CALIFORNIA ANALYTICAL		
Title: EPC DUAL RANGE TEMPERATURE BOARD		
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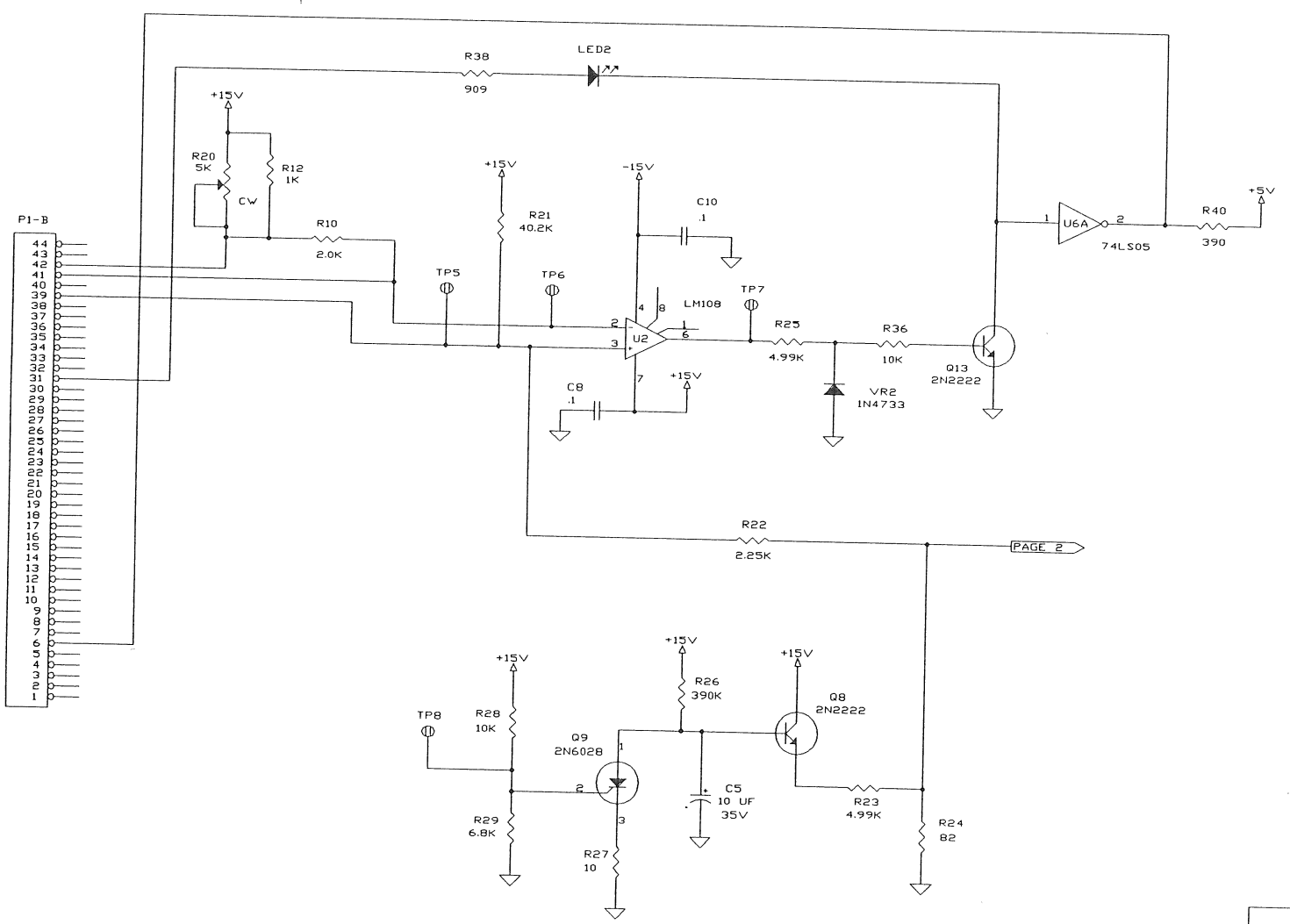
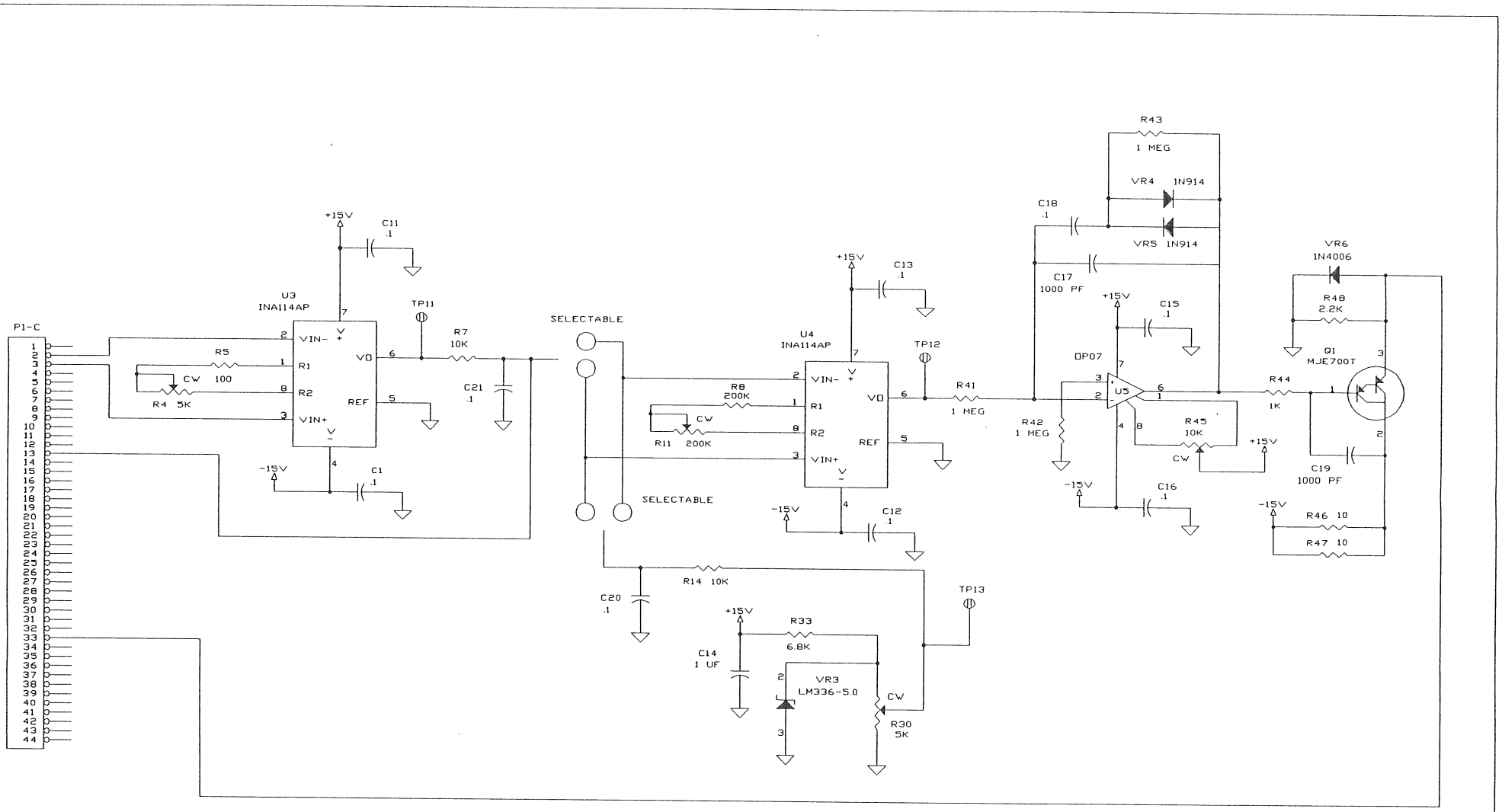
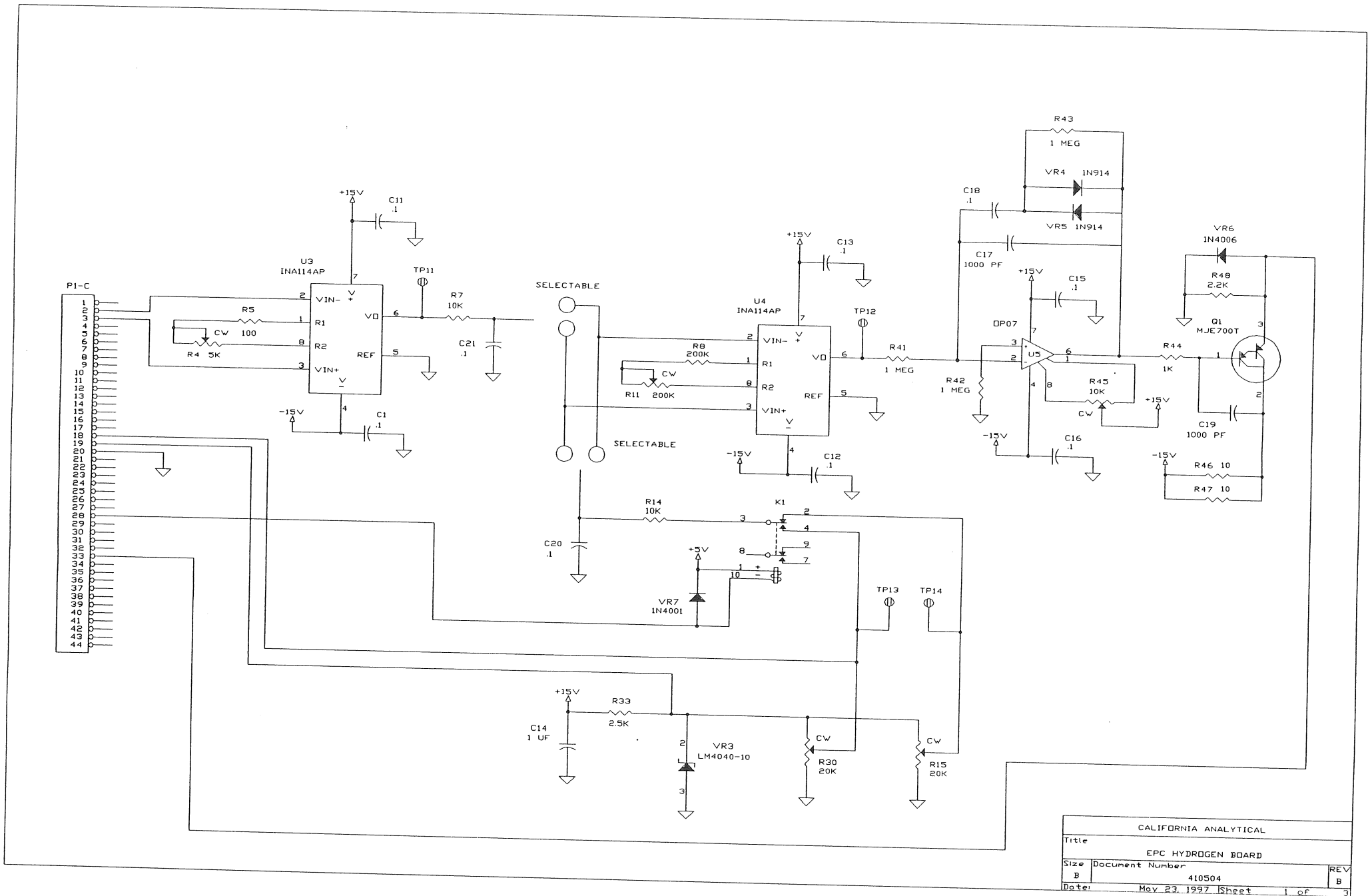


CALIFORNIA ANALYTICAL		
Title: EPC DUAL RANGE TEMPERATURE BOARD		
Size: B	Document Number: 410506	REV: B
Date: May 23, 1997	Sheet 2 of 3	



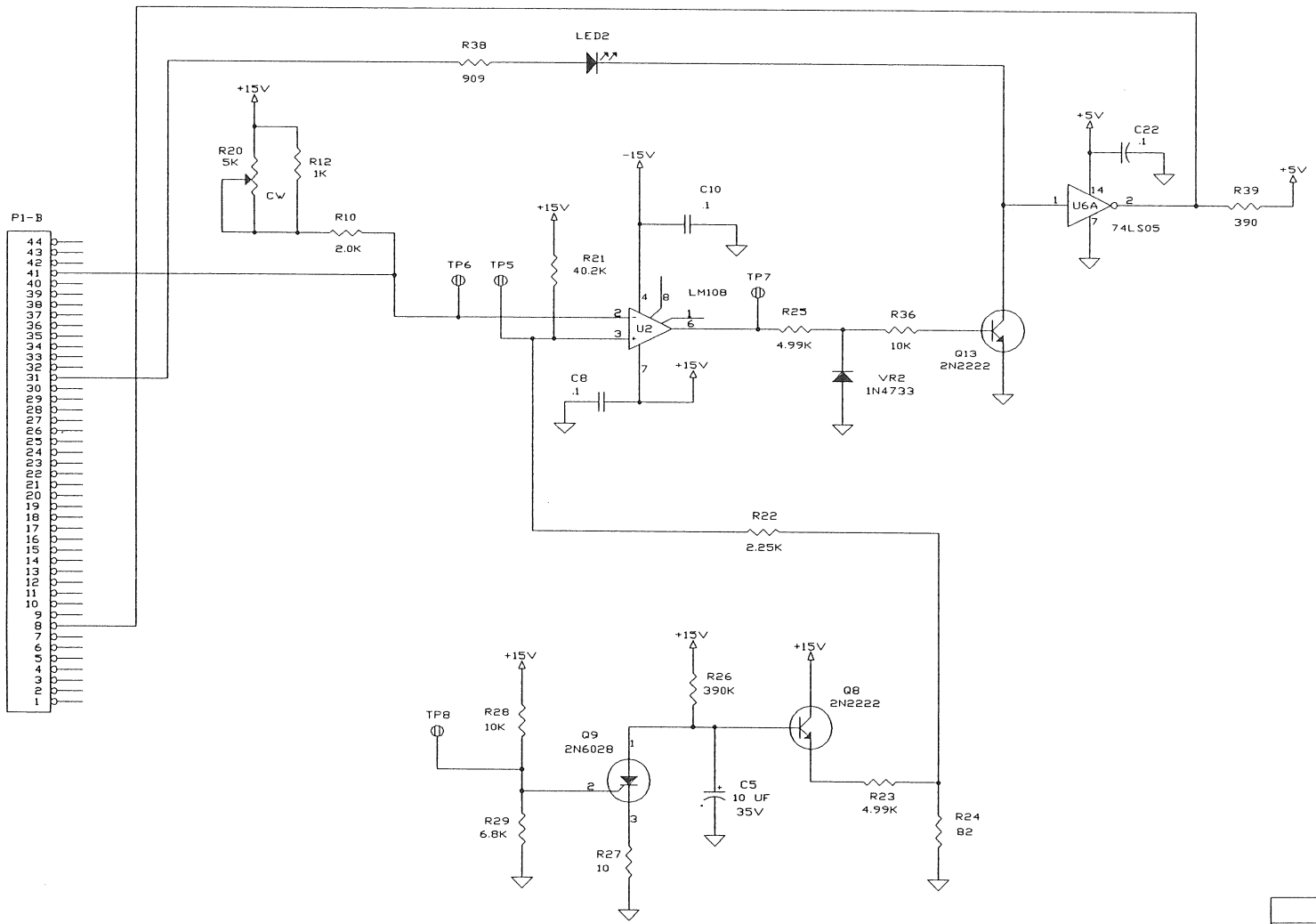
CALIFORNIA ANALYTICAL		
Title: EPC DUAL RANGE TEMPERATURE BOARD		
Size: B	Document Number: 410506	REV: B
Date: May 23, 1997	Sheet 3 of 3	

R. L. Carroll
5/27/97



CALIFORNIA ANALYTICAL		
Title: EPC HYDROGEN BOARD		
Size: B	Document Number: 410504	REV: B
Date: May 23, 1997	Sheet 1 of 3	

E. J. Carroll
5/22/97



CALIFORNIA ANALYTICAL		
Title: EPC HYDROGEN BOARD		
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Date: May 23, 1997	Sheet: 2 of 3	

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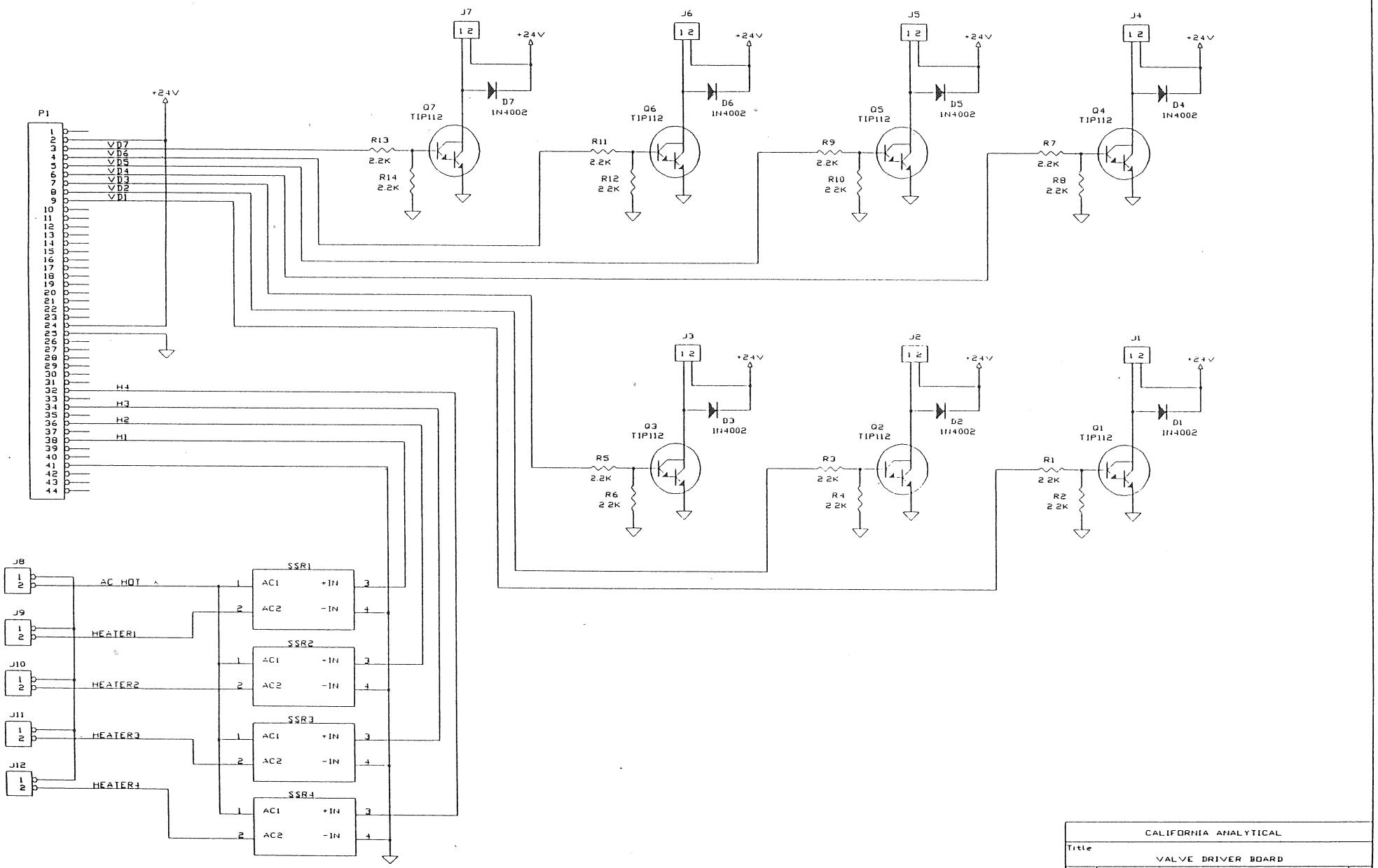
5/15/97



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Size: B	Document Number: 410508	REV: A
Date: February 18, 1997	Sheet 1 of 1	

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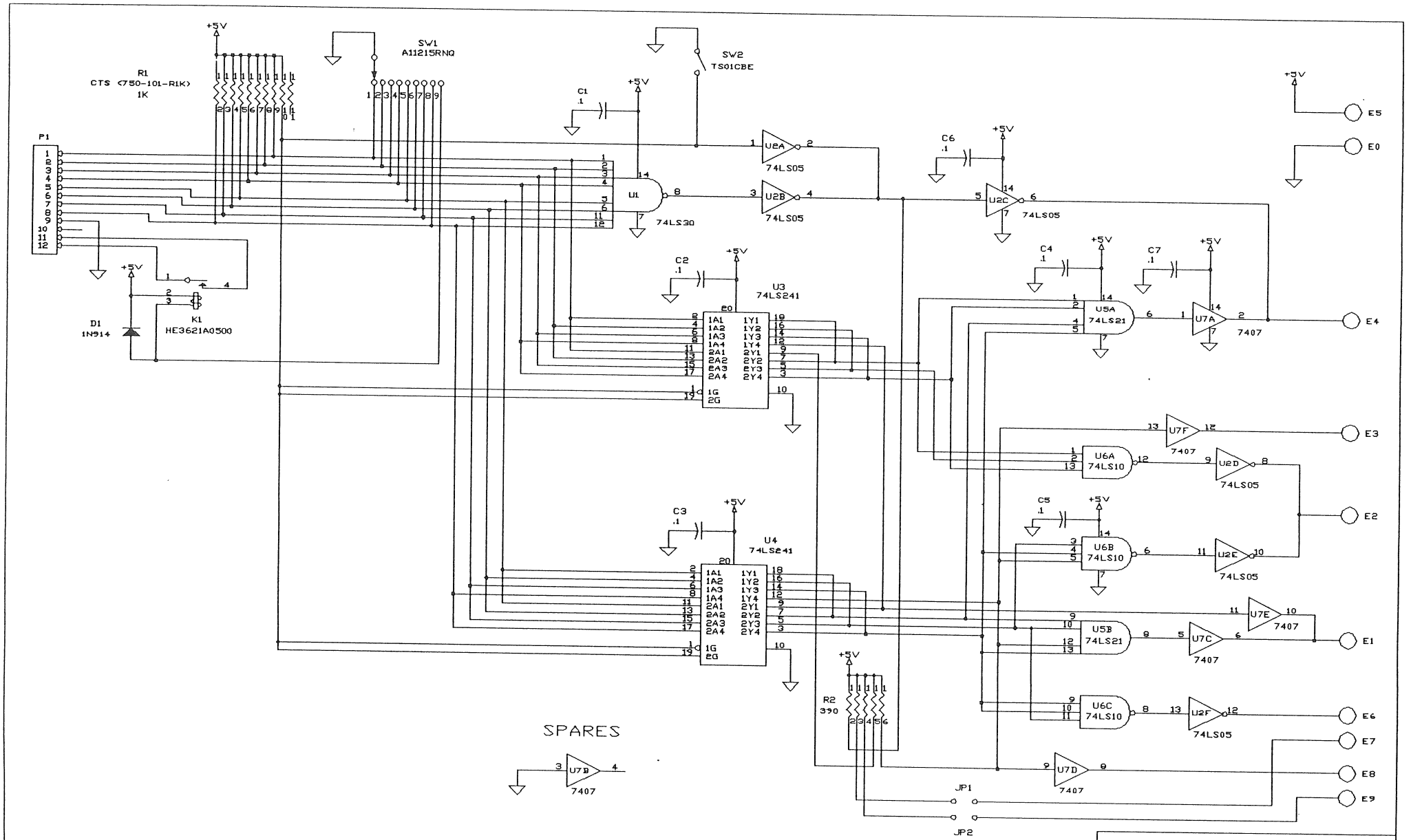

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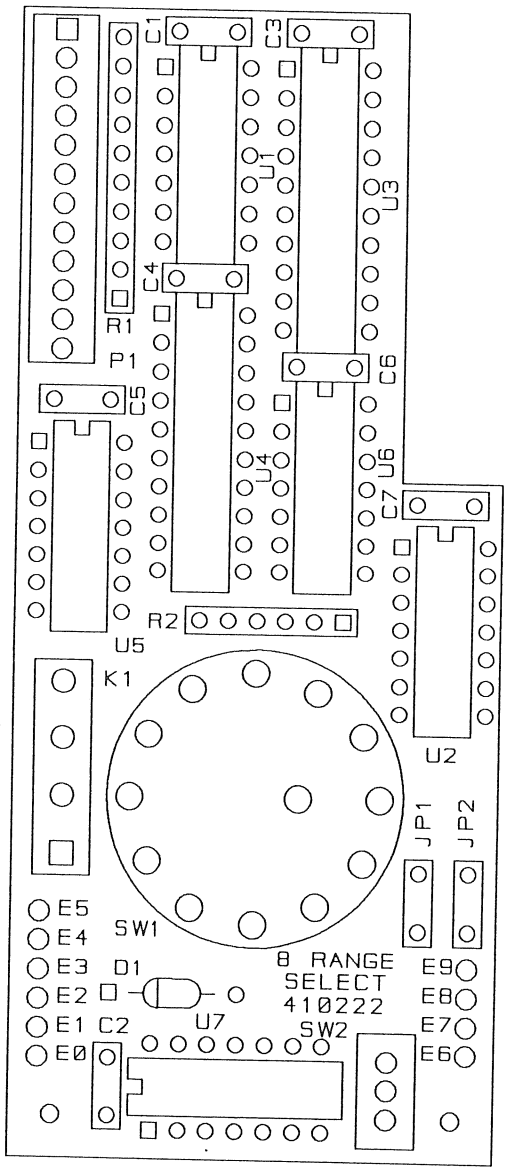
Date: October 23, 1996	Sheet 1 of 1	



8 RANGE SELECT
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410222