TRACE™ GC 2000

Gas Chromatograph

Service Manual

ThermoQuest
CE INSTRUMENTS

ISO 9001 REGISTERED COMPANY

Trace GC 2000 Service Manual
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- installation
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Warranty

Please complete, date and sign the **Quality Form** accompanying the instrument.

Your new instrument is covered against manufacturing defects for the period agreed within the sales terms which is generally a period of 15 months from the invoice date or 12 months from the date of installation, whichever occurs earlier, specific agreements excepted. Warranty does not cover consumables, damage caused by the improper use of the instrument and damage due to transportation.

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CE Instruments Customer Support
Tel. + 39 02 95059 355
Fax. + 39 02 95059 388

The warranty will be invalidated (specific agreements excepted) if the instrument is removed from its original packaging in the absence of an authorized CE Instruments Customer Service Engineer.

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About This Manual

Overview

The TRACE GC 2000 Service Manual provides detailed information for installing, servicing, and repairing the TRACE GC 2000 gas chromatograph. This manual is written primarily for certified service representatives.

This manual is organized as follows:

Section I, *Introduction*, provides an introduction to the basic components and systems of the TRACE GC 2000.

Chapter 1.1, *GC Base Unit*, describes the base unit of the TRACE GC 2000 and its components.

Chapter 1.2, *Pneumatic Systems*, describes the pneumatic systems available for the TRACE GC 2000.

Chapter 1.3, *Injection Systems*, describes the injection systems available for the TRACE GC 2000.

Chapter 1.4, *Detection Systems*, describes the detection systems available for use in the TRACE GC 2000.

Section II, *Specification Summary*, provides a summary of specifications for the TRACE GC 2000.

Chapter 2.1,*Column Oven*, describes the column oven of the TRACE GC 2000.

Chapter 2.2, *Injectors*, describes the injectors available for use with the TRACE GC 2000.

Chapter 2.3, *Detectors*, describes the detectors available for use with the TRACE GC 2000.

Section III, *Functional Tests*, provides information about alarm, diagnostic, and error messages of the TRACE GC 2000.

Chapter 3.1, *Info Messages*, contains information to help identify and troubleshoot info messages on the TRACE GC 2000.

Chapter 3.2, *Error Messages*, contains information to help identify and troubleshoot info, error, and diagnostic messages on the TRACE GC 2000.

Chapter 3.3, *Diagnostic Messages*, contains information to help identify and troubleshoot info, error, and diagnostic messages on the TRACE GC 2000.

Section IV, *Maintenance & Troubleshooting*, provides maintenance and troubleshooting for various components of the TRACE GC 2000.

Chapter 4.1, *GC Base Unit*, contains procedures for replacing the components associated with the frame and oven assembly. It also explains how to remove the Power Control Module, the CPU, and the Temperature Feedback and Digital I/O unit.

Chapter 4.2, *Digital Pressure Flow Control for Carrier Gases*, contains information about the Digital Pressure Flow Control modules of the TRACE GC 2000. It also addresses maintenance and troubleshooting issues.

Chapter 4.3, *Detector Gas Flow Control for Detector Gases*, contains information about the Detector Gas Flow Control modules of the TRACE GC 2000. It also addresses maintenance and troubleshooting issues.

Chapter 4.4, *Hand Shake Cables*, contains information regarding the different types of handshake cables and connections used with the TRACE GC 2000.

Section V, *Electronic Board Description*, provides a description of the electronic boards in the TRACE GC 2000.

Chapter 5.1, *Analytical Unit*, describes the Analytical Unit of the TRACE GC 2000.

Chapter 5.2, *Control Unit*, describes the Control Unit of the TRACE GC 2000.

Chapter 5.3, *Motherboard*, describes the Motherboard of the TRACE GC 2000.

Chapter 5.4, *Central Processing Unit (CPU)*, describes the PCB for the Central Processing Unit (CPU) of the TRACE GC 2000.

Chapter 5.5, *Temperature Feedback and Digital I/O*, chapter describes the Temperature Feedback and Digital I/O (TF & DIO) PCB of the TRACE GC 2000.

Chapter 5.6, *Power Control Module*, describes the PCB for the Power Control Module (PCM) of the TRACE GC 2000.

Chapter 5.7, *Digital Pressure Flow Control*, describes the PCB for the Digital Pressure Flow Control (DPFC) of the TRACE GC 2000.

Chapter 5.8, *Keypad and Display Panel*, describes the PCB for the Keypad and Display Panel of the TRACE GC 2000.

Chapter 5.9, *Theory of Detector Cards*, contains a representative block diagram for the following 6 detector chapters.

Chapter 5.10, *Flame Ionization Detector Controller*, describes the Flame Ionization Detector (FID) controller of the TRACE GC 2000.

Chapter 5.11, *Electron Capture Detector Controller*, describes the Electron Capture Detector (ECD) controller of the TRACE GC 2000.

Chapter 5.12, *Nitrogen Phosphorous Detector Controller*, describes the Nitrogen Phosphorous Detector (NPD) controller of the TRACE GC 2000.

Chapter 5.13, *Flame Photometric Detector Controller (FPD)*, describes the TRACE GC 2000 Flame Photometric Detector (FPD) controller.

Chapter 5.14, *Photoionization Detector Controller (PID)*, This chapter describes the TRACE GC 2000 Photoionization Detector (PID) controller.

Chapter 5.15, *Thermal Conductivity Detector Controller (TCD)*, describes the TRACE GC 2000 Thermal Conductivity Detector (TCD) controller.

Chapter 5.16, *Thermocouple Preamplifiers*, describes the PCB for the thermocouple preamplifiers of the TRACE GC 2000.

Chapter 5.17, *On-Column Semiautomatic Actuator*, describes the PCB for an on-column semiautomatic actuator of the TRACE GC 2000.

Section VI, *Service Equipment*, provides specifications for recommended test equipment used with the TRACE GC 2000. The TRACE GC 2000 Service Kit is also included.

Chapter 6.1, *Recommended Test Equipment*, provides test equipment specifications that should enable isolation of problems, repair, and calibration of the TRACE GC 2000.

Chapter 6.2, *TRACE GC 2000 Service Kit*, provides a list of the parts found in the TRACE GC 2000 Service Kit. Part numbers are included.

Section VII, *Replacement Parts List*, provides a list of replacement parts and component part numbers for the TRACE GC 2000.

Section VIII, *Service Information*, provides service and technical information for the TRACE GC 2000.

Chapter 8.1, *Service Notes (TSB)*, contains service notes and Technical Service Bulletins (TSBs) for the TRACE GC 2000.

Chapter 8.2, *Additional Technical Information*, contains additional technical information for the TRACE GC 2000.

Appendix A, *Flame Ionization Detector*, contains the manual **FID Installation Instructions** (PN M 317 09 327), which provides instructions for installing and configuring the Flame Ionization Detector on your TRACE GC 2000.

Appendix B, *Nitrogen Phosphorus Detector*, contains the manual **NPD Installation Instructions** (PN M 317 09 329) which provides the instructions to install and configure the Nitrogen Phosphorus Detector on your TRACE GC 2000.

Appendix C, *Flame Photometric Detector*, contains the manual **FPD Installation Instructions** (PN M 317 09 331) which provides the instructions to install and configure the Flame Photometric Detector on your TRACE GC 2000.

Appendix D, *Photoionization Detector*, contains the manual **PID Installation Instructions** (PN M 317 09 333) the instructions to install and configure the Photoionization Detector on your TRACE GC 2000.

Appendix E, *Electron Capture Detector*, contains the manual **ECD Installation Instructions** (PN M 317 09 335) which provides the instructions to install and configure the Electron Capture Detector on your TRACE GC 2000.

Appendix F, *Transformer Installation*, contains the manual **Transformer Installation** which provides the instructions to install and configure a transformer on your TRACE ™ GC 2000.

Appendix G, *Reagent Safety Information*, contains the chemical references for the solvents mentioned in this manual.

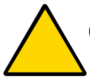
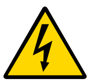
Appendix H, *Customer Communication*, contains contact information for ThermoQuest offices worldwide. Use the *Reader Survey* in this section to give us feedback on this manual and help us improve the quality of our documentation.

The *Glossary* contains definitions of terms used that may be used in this manual. This also includes abbreviations, acronyms, metric prefixes, and symbols.

The *Index* contains an alphabetical list of key terms and topics in this manual, including cross-references and the corresponding page numbers.

Conventions Used in This Manual

The following symbols and typographical conventions are used throughout this manual.

Bold	Bold text indicates names of windows, menus, dialog boxes, buttons, and fields.
Italic	Italic indicates cross references, first references to important terms defined in the glossary, and special emphasis.
`Monospace`	Monospace, or Courier, indicates filenames and filepaths, or to indicate text the user should enter with the keyboard.
`Monospace Bold`	Monospace Bold indicates messages or prompts displayed on the computer screen or on a digital display.
»	This symbol illustrates menu paths to select, such as **File»Open…**.
KEY NAME	Bold, uppercase sans serif font indicates the name of a key on a keyboard or keypad, such as **ENTER**.
 **CAUTION**	This symbol alerts you to an action or procedure that, if performed improperly, could damage the instrument.
 **NOTE**	This symbol alerts you to important information related to the text in the previous paragraph.
 **WARNING!**	This symbol alerts you to an action or procedure that, if performed improperly, could result in damage to the instrument or possible physical harm to the user. This symbol may be followed by icons indicating special precautions that should be taken to avoid injury.
	This symbol indicates electric shock hazard.
	This symbol indicates danger from hazardous chemicals.
	This symbol indicates danger from high temperature surfaces or substances.
	This symbol indicates a fire hazard.
	This symbol indicates an explosion hazard.
	This symbol indicates a toxic hazard.

This symbol indicates the presence of flammable materials.

This symbol indicates the presence of radioactive material.

This symbol indicates an operation or procedure that must NOT be performed by the user. A ThermoQuest authorized Customer Support Engineer must perform this procedure.

This symbol indicates all metal objects, such as watches and jewelry, must be taken off.

This symbol indicates an eye hazard. Eye protection must be worn.

This symbol indicates the user must wear a protective screen when performing the procedure.

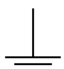
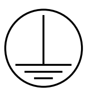
This symbol indicates the user must wear protective shoes when performing the procedure.

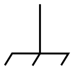
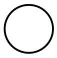
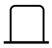
This symbol indicates the user must wear protective clothing when performing the procedure.

This symbol indicates the user must wear gloves when performing the procedure.

Instrument Markings and Symbols

The following table explains the symbols used on ThermoQuest instruments. Only a few of them are used on the TRACE GC 2000 gas chromatograph.

Symbol	Description
	Direct Current
	Alternating Current
	Both direct and alternating current
	Three-phase alternating current
	Earth (ground) terminal
	Protective conductor terminal

Symbol	Description
	Frame or chassis terminal
	Equipotentiality
	On (Supply)
	Off (Supply)
	Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION (Equivalent to Class II of IEC 536)
	Indicates that the user must refer to the manual for specific Warning or Caution information to avoid personal injury or damage to the product.
	Caution, risk of electric shock
	Caution, hot surface
	Caution (refer to accompanying documents)
	In-position of a bistable push control
	Out-position of a bistable push control

Using Hydrogen

The use of hydrogen as a carrier gas or as fuel for certain flame detectors requires the operator’s strict attention and compliance with special precautions due to the hazards involved.

Hydrogen is a dangerous gas, particularly in an enclosed area when it reaches a concentration corresponding to its lower explosion level (4% in volume). When mixed with air it can create an explosive mixture. An explosion hazard could develop in the GC oven when hydrogen is used as a carrier gas if oven elements are not perfectly connected to each other, or if the connection materials are worn out, broken, or otherwise faulty.

Use the following safety precautions when using hydrogen:

- Ensure that all hydrogen cylinders comply with the safety requirements for proper use and storage. All hydrogen cylinders must be equipped with safety valves and automatic safety systems.
- Make sure the gas supply is turned completely off when connecting hydrogen lines.
- Perform a bubble test to ensure that the hydrogen lines are leak-tight before using the instrument.
- Ensure your GC column oven has a ThermoQuest hydrogen sensor. A hydrogen sensor continuously monitors the hydrogen level in the GC column oven.

  If your GC oven does not have a hydrogen sensor already installed, contact your ThermoQuest sales representative. To comply with instrument safety requirements, a ThermoQuest CSE or authorized service technician should install the sensor.

  If you plan to use a sensor other than the recommended ThermoQuest sensor, you must verify its ability to perform the functions listed above before installing it. It must comply with your local safety regulations, or with the IEC 1010[1] regulations if local regulations do not exist.

Using the Hydrogen Sensor

The lower limit of the hydrogen sensor is 0.5% in volume. You should adjust the detection threshold to 1% in volume, which is 25% of the hydrogen lower limit of explosion (4% in volume).

In cases where the connections begin to leak or the column breaks, the sensor alerts the operator. Then it automatically cuts off the gas supply and heating to the active zones, and sweeps the column oven with forced air ventilation.

1. IEC 1010-1, First Edition, September 1990; IEC 1010-1, Amendment 1, September 1992; IEC 1010-1, Amendment 2, June 1995.

If the sensor detects anomalies or leaks during GC operation due to instrument malfunction, the operator must immediately:

- close the hydrogen supply
- switch off the gas chromatograph
- air out the room

The reliability of the sensor depends on careful maintenance. After the sensor is in use, you must periodically check its operating performance and calibration as recommended by the manufacturer. Refer to your hydrogen sensor's instruction manual for maintenance guidelines.

WARNING! **Never use hydrogen in your TRACE GC 2000 system unless your GC oven has a hydrogen sensor installed.**

NOTE ThermoQuest CSEs are not authorized to install or repair any instrument using hydrogen as a carrier gas unless the instrument is equipped with the appropriate sensor.

SECTION I

Introduction

This section provides an introduction to the basic components and systems of the TRACE GC 2000.

Chapter 1.1, *GC Base Unit*, describes the base unit of the TRACE GC 2000 and its components.

Chapter 1.2, *Pneumatic Systems*, describes the pneumatic systems available for the TRACE GC 2000.

Chapter 1.3, *Injection Systems*, describes the injection systems available for the TRACE GC 2000.

Chapter 1.4, *Detection Systems*, describes the detection systems available for use in the TRACE GC 2000.

1.1

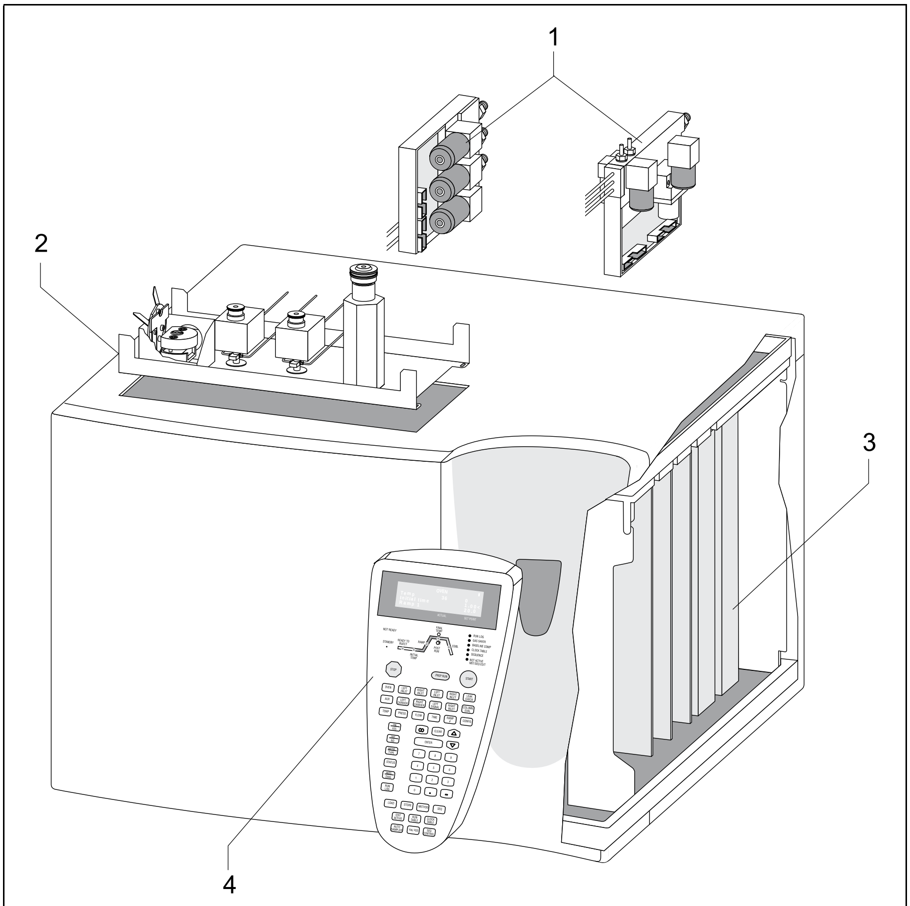
GC Base Unit

This chapter describes the base unit of the TRACE GC 2000 and its components.

Chapter at a Glance…

TRACE GC 2000 System Components

The TRACE GC 2000 consists of four major components, as shown in Figure 1.1-1.



1. Pneumatic Compartment	3. Electronic Compartment
2. Analytical Unit	4. Keypad and Display Panel

Figure 1.1-1. TRACE GC 2000 Compartments

Pneumatic Compartment

The pneumatic compartment contains the pneumatic gas control circuits. The circuits can be completely electronic (digital pneumatics), completely analog, or a combination of analog and digital components (mixed pneumatics).

Analytical Unit

The analytical unit consists of two subcompartments:

- The column oven
- The injector and detector cassette

Electronic Compartment

The electronic compartment consists of two subcompartments:

- The high-voltage compartment
- The motherboard for the detector controller cards

Keypad and Display Panel

The keypad and display panel make up the TRACE GC 2000 user interface.

1.2

Pneumatic Systems

This chapter describes the pneumatic systems available for the TRACE GC 2000.

Chapter at a Glance…

Gas Control

The arrangement of the pneumatic gas control system depends on the detectors configured on the base unit. Three possible configurations of the pneumatic compartment are available:

- Digital pneumatics
- Analog pneumatics
- Mixed pneumatics (analog and digital)

Digital Pneumatics

In GCs equipped with digital pneumatics, carrier and detector gases are controlled electronically through a series of electronic pneumatic control modules mounted in the pneumatic compartment. The Digital Pressure Flow Control (DPFC) modules control the carrier gas flow, and the Detector Gas Flow Control (DGFC) modules control detector gas flow.

A single DPFC module can alternate the flow of one carrier gas supply between a split/splitless injector and another (non-split/splitless) injector.

Analog Pneumatics

In GCs equipped with analog pneumatics, detector gases are controlled by a series of conventional, manually regulated control modules mounted in the pneumatic compartment. Manual control is also referred to as non-DGFC.

Mixed Pneumatics

In GCs equipped with mixed digital and analog pneumatics, DPFC modules control carrier gas flow, while conventional, or non-DGFC, modules control detector gases.

The detector gas pneumatic circuits can be configured for up to three detectors at one time. Each of the three detector gas flows can be regulated separately. You can easily interchange different detectors.

Carrier Gas Control

Carrier gas control is only available in DPFC format. The DPFC module allows the digital control of the inlet pressure and carrier gas flow.

The DPFC module features the following:

- Constant pressure or constant flow operating modes
- Programmed pressure or programmed flow operating modes
- Inlet pressure control (in kPa, psi, or bar) and column flow rate control (in mL/min)
- Split flow control (in mL/min)

Column Evaluation

For *pressure controlled* injectors (split/splitless and on-column), control of the column flow is *indirect*. This means that the GC regulates *pressure* to control the flow of gas through the column. To do this, the GC relies on a *column constant*. The column constant is a measure of the column's pneumatic resistance. You can use the TRACE GC 2000's column evaluation feature to automatically calculate the column constant.

Leak Check

A leak check involves six stages.

1. Leak testing the gas source to the GC
2. Pressurizing the split/splitless inlet system
3. Pressuring the packed injection
4. Pressurizing the detector base body
5. Automatic leak checking

Stage 1. Leak Testing the gas source to the GC

Helpful Materials: Electronic Leak Detector, Cut-Off Valve PN 405 100 23, Pressure Gauge PN 408 500 07, 1/8” Tee PN 403 200 42

The TRACE DPFC gas input contains on and off solenoid valves that are in the off position when the GC power is off. Figure 1.2-1 *Leak Test Parts* provides a detailed description for the following instruction.

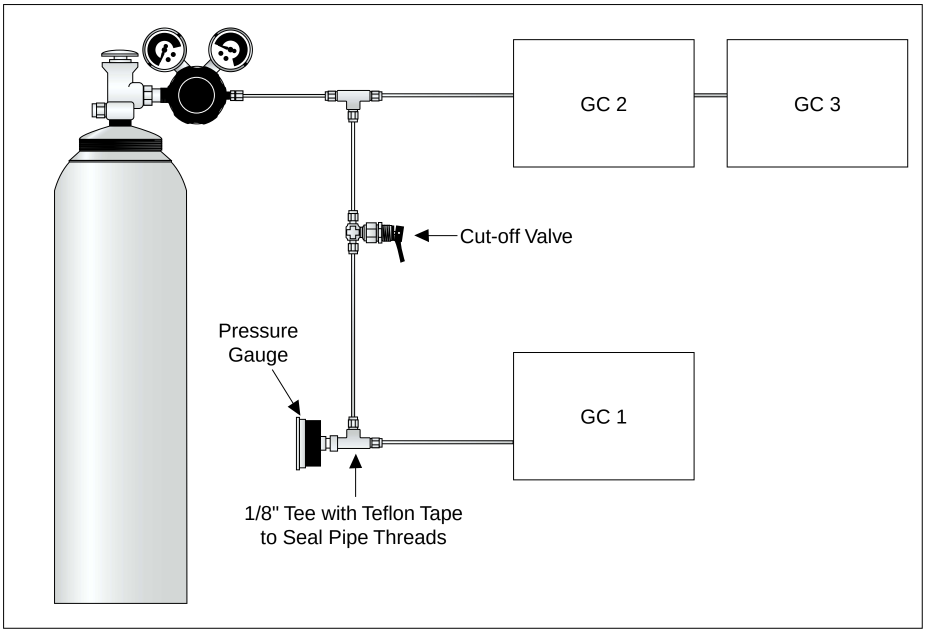


Figure 1.2-1. Leak Test Parts

First, connect the gas lines to the GC as outlined in the Site Prep and Installation manual. While the GC power is still off, turn on all gas supply lines to the GC and set the input pressure to 420 kPa (60 psig). Allow the gas lines to pressurize for several seconds. Turn off the input gas source and allow the system to set for several minutes. The pressure should not decrease. If the pressure drops, locate the leak using an electronic leak detector. If multiple systems are attached to the same gas source, you will need to isolate each GC system. An easy way to isolate the GC is to install an **Cut-Off valve** (PN 405 100 23) and **Pressure Gauge** (PN 408 500 07) with a 1/8” input **Tee** (PN 403 200 42) in the gas line leading to the GC that you are leak testing,

Be sure the pressure gauge is connected in line between the on/off valve and the GC.

Turn on the gas supply and allow the system to pressurize. Turn off the Cut-off valve and verify the pressure holds. Keep in mind, this only leak checks the plumbing from the Cut-off valve to the GC.

Stage 2. Pressurizing the split/splitless inlet system

Helpful Materials: Aluminum Plug PN 290 326 55, M4 Capillary Inlet Nut PN 350 324 23

Turn the GC power on and allow the TRACE GC 2000 to perform its initial self-test. Insert an aluminum plug PN 290 326 55 (pkg. 10 ea.) into the M4 capillary inlet nut PN 350 324 23. Attach the nut to the capillary inlet and tighten. On the GC front panel, press the VALVES button (bottom row). Select Inlet valves. Turn the appropriate injector split valve and the septum purge valve off. Select the appropriate Right or Left Carrier. Set the mode to constant pressure. Turn on the gas pressure and set the inlet pressure to the maximum value. The maximum value can be determined by moving the cursor to the pressure display line and pressing the Info key on the front panel. Allow the inlet several seconds to pressurize. The display should show the selected pressure and the actual pressure. Turn the pressure OFF. The actual pressure should not change more than 14 to 21 kPa (2–3 Psig) in 10 minutes. If the pressure begins to immediately drop, use an electronic leak tester and check the split and septum purge vent, the septum and the fittings on the split vent filter for leaks. Check all fittings around the inlet.

Stage 3. Pressurizing the packed injector

Helpful Materials: Septum PN 313 032 00, Cap PN 350 010 51

Two types of packed injectors exist on the TRACE GC 2000. One is packed with septum purge and the other is packed without septum purge. Determine which packed injector is installed on your GC. Turn the GC power on and allow the TRACE GC 2000 to perform its initial self-test. Seal the inlet using Cap PN 350 010 51. Select the appropriate Right or Left Carrier. If a packed injector with septum purge is being used, it will be necessary to turn the septum purge valve off. To turn the septum purge valve off, press the VALVES button (bottom row) on the front panel. Select Inlet valves. Turn the appropriate injector septum purge valve off. Select the appropriate Left or Right carrier. Set the mode to constant pressure. Turn on the gas pressure and set the inlet pressure to the maximum value. The maximum value can be determined by moving the cursor to the pressure display line and pressing the Info key on the front panel. Allow the inlet several seconds to pressurize. The display should show the selected pressure and the actual pressure. Turn the pressure OFF. The actual pressure should not change more than 14 to 21 kPa (2–3 Psig) in 10 minutes. If the pressure begins to immediately drop, use an electronic leak tester and check the septum purge vent, the septum and all fittings around the inlet for leaks.

Stage 4. Pressurizing the on column injector

The on column injector must be sealed using a short section of capillary column connected to the injector. Insert the column into the injector as described in chapter 13 of the Operating Manual. Insert the other end of the column into a septa. This should seal the other end of the column. After the column is in place, turn the GC power on and allow the TRACE GC 2000 to perform its initial self-test. Select the Left Carrier and set the mode to constant pressure. Turn on the gas pressure and set the inlet pressure to the maximum value. The maximum value can be determined by moving the cursor to the pressure display line and pressing the Info key on the front panel.

Allow the inlet several seconds to pressurize. The display should show the selected pressure and the actual pressure. Turn the pressure OFF. The actual pressure should not change more than 14 to 21 kPa (2–3 Psig) in 10 minutes. If the pressure begins to immediately drop, use an electronic leak tester and check the various parts of the inlet for leaks.

Stage 5. Pressurizing the detector base body

Helpful Materials: Cap PN 350 061 01, M4 Column Nut PN 350 324 23, Aluminum Plug PN 290 326 55, Blank Detector Jet PN 404 019 00

Turn the GC power on and allow the TRACE GC 2000 to perform its initial self-test. Set all detector temperatures to ambient and verify the detector base body has cooled to ambient temperature. Remove the detector from the base body. Seal the top of the detector base body using cap PN 350 061 01. If the detector base body contains an FID or NPD jet, it is not necessary to remove the jet. The seal will fit over the jet. If the base is configured for capillary columns, remove the column and seal the detector base inlet using a M4 column nut PN 350 324 23 and aluminum plug PN 290 326 55 (pkg. 10 ea.). If the base body is configured for packed columns, insert a septum PN 313 032 00 into a septum cap PN 350 010 51 and attach it to the detector inlet to seal the base body input. Turn on one of the detector gases and allow the detector base to pressurize.

NOTE It is not necessary to turn on all the detector gases. With the top and bottom of the base body sealed, all the gas lines will pressurize back to the flow module. The front panel display will show different pressures for the various detector gases event though only one of the detector gases is turned on. Once the base body has pressurized, turn the gas that was used to pressurize the base body off. The actual pressure should not change more than 14 to 21 kPa (2–3 Psig) in 10 minutes.

The capillary column base body standard outfit contains a blank Detector Jet PN 404 019 00. Substituting the existing detector jet with this blank jet will allow the base body column flow path to be sealed. With this blank jet in place and a column connected between the inlet and the base body, the inlet can be pressurized and the complete carrier flow path leak tested. Be sure any H2 and makeup supplies connected to the base body are turned off when this test is made. Allow several minutes for the system to pressurize before turning off the column flow. If the system is pressurized and the split/septum purge vents are off, the actual pressure should not change more than 14 to 21 kPa (2–3 Psig) in 10 minutes.

Stage 6. Automatic leak check

With the TRACE GC 2000 system you can perform an automatic gas *leak check*. When you select the GC leak check function the GC measures the column flow with a true mass flow sensor and compares it to a calculated flow value obtained from the original column constant to see if the numbers match. If there is a significant difference between the two values then the instrument detects a gas leak.

Gas Saver Function

The gas saver function reduces the split flow after an injection to avoid the waste of expensive gases. It is only available on DPFC systems.

Refer to...

Chapter 4.6 *Digital Pressure Flow Control for Carrier Gases*

Detector Gas Control

The DGFC module allows the digital control of all the necessary detector gases. The non-DGFC modules have conventional pneumatic controls which require manual regulation of detector gases. Both DGFC and non-DGFC gas flows can be automatically switched on and off using the TRACE GC 2000 keypad.

Refer to...

Chapter 4.7 *Detector Gas Flow Control for Detector Gases*

1.3

Injection Systems

This chapter describes the injection systems available for the TRACE GC 2000.

Chapter at a Glance…

Injection Systems Overview

The following injection systems are available on the TRACE GC 2000:

- Split/Splitless Injector (S/SL)
- On-Column Injector (OCI)
- HOT Cold On-Column Injector (HOT OC)
- Large Volume On-Column Injector (LVOCI)
- Packed Column Injector (PKD)
- Purged Packed Column Injector (PPKD)

Digital Pressure and Flow Control (DPFC) is available for all injection systems.

Split/Splitless Injector

The Split/Splitless (S/SL) injector minimizes heavy component discrimination with optimized sample transfer to the column. You can use capillary and wide-bore columns with the split/splitless injector. With the appropriate adapter kit, you can also use packed columns.

Refer to...
Chapter 4.2 *Maintaining a Split/Splitless Injector*

On-Column Injector

The On-Column Injector (OCI) allows you to inject a sample directly into a 0.25 or 0.32 mm capillary column or 0.53 mm wide-bore column. Primary and secondary cooling systems keep the injection block at ambient temperature and the injection zone cool to prevent sample vaporization and ensure complete sample transfer from the syringe to the column.

Refer to...
Chapter 4.3 *Maintaining a Cold On-Column Injector*

HOT Cold On-Column Injector

The High Oven Temperature cold On-Column (HOT OC) injector is a special version of the standard on-column injector. It can operate at high oven temperatures. An optional HOT device is required.

Refer to...
Chapter 4.3 *Maintaining a Cold On-Column Injector*

Large Volume On-Column Injector

The Large Volume On-Column Injector (LVOCI) is a special version of the standard on-column injector. It allows the automatic introduction of large volumes of liquid sample through the AS 2000 Autosampler.

Refer to...
Chapter 4.3 *Maintaining a Cold On-Column Injector*

Packed Column Injector

The Packed (PKD) column injector features injection directly into metal or glass packed columns or into metal or glass packed columns with glass liners.

Refer to...
Chapter 4.4 *Maintaining a Packed Column Injector*

Purged Packed Column Injector

The Purged Packed (PPKD) column injector allows sample injection and vaporization into a liner. The sample then transfers to a wide-bore capillary column.

Refer to...
Chapter 4.5 *Maintaining a Purged Packed Column Injector*

1.4

Detection Systems

This chapter describes the detection systems available for use in the TRACE GC 2000.

Chapter at a Glance…

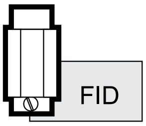
Detectors

The following detection systems are available for the TRACE GC 2000:

- Flame Ionization Detector (FID)
- Electron Capture Detector (ECD)
- Nitrogen Phosphorus Detector (NPD)

All detectors are available with both Digital Gas Flow Control (DGFC) and conventional pressure regulators (non-DGFC).

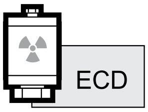
Flame Ionization Detector



The Flame Ionization Detector (FID) provides optimum sensitivity and linearity. The FID ensures stable, reproducible, and long-term trouble-free performance.

Refer to…
Chapter 4.8 *Maintaining an FID*

Electron Capture Detector



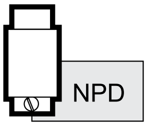
The Electron Capture Detector (ECD) features a very low ionization cell volume and increased resistance to contamination. This ensures high sensitivity and trouble-free operations.

You can easily remove and clean the collecting electrode without disturbing the ^{63}Ni source.

The detector can be heated to 400 °C, extending its application range to higher molecular weight compounds.

Refer to…
Chapter 4.9 *Maintaining an ECD*

Nitrogen Phosphorus Detector



The Nitrogen Phosphorus Detector (NPD), equipped with a ceramic matrix thermionic source, features high sensitivity and long-term stability for analyzing compounds containing nitrogen and phosphorus.

A special thermionic source is also available for Enhanced Nitrogen Selectivity (ENS) mode.

Refer to…
Chapter 4.10 *Maintaining an NPD*

Multidetector System

To analyze complex samples, a significant reduction in analysis time and increase in analytical information may be gained with a multidetector configuration. Detectors may be arranged:

- In series with a non-destructive detector (ECD) followed by a destructive detector (NPD or FID)
- In parallel to provide a number of chromatograms from each single injection

This may be particularly useful for bulk analysis of product formulations, biochemical, and environmental applications.

Detector Base Bodies

The ionization detectors are easily interchangeable. This is made possible by *base bodies* on the analytical unit that provide a connection between the detector head and the analytical column.

Two types of detector base bodies are available. The type you can use depends on the GC base unit configuration.

- Packed column base body
- Capillary column base body

Refer to…

Chapter 2.3 *Detectors*

SECTION II

Specification Summary

This section provides a summary of specifications for the TRACE GC 2000.

Chapter 2.1, *Column Oven*, describes the column oven of the TRACE GC 2000.

Chapter 2.2,*Injectors*, describes the injectors available for use with the TRACE GC 2000.

Chapter 2.3, *Detectors*, describes the detectors available for use with the TRACE GC 2000.

2.1

Column Oven

This chapter describes the column oven of the TRACE GC 2000.

Chapter at a Glance…

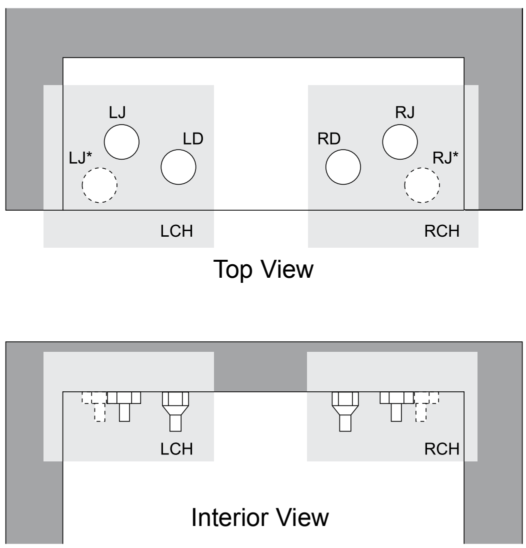
Column Oven Overview

The TRACE GC 2000 column oven provides a stable heating environment for the analytical column. It heats and cools quickly, and efficient air circulation ensures a high degree of thermal stability.

Opening the oven door activates a safety microswitch, which automatically switches off the oven heating and the motor for the air circulation fans. The oven is heated by resistor elements powered by a circuit located within the GC control unit.

The column fittings in the oven depend on whether capillary or packed column injector and detector base bodies are installed. Auxiliary gas lines, if installed, end in M8x1 male fittings between the injector and the detector base bodies. The oven temperature is monitored by a PT 100 platinum wire sensor and controlled by the GC control unit.

Figure 2.1-1 shows the positions of the left and right detectors on top of the oven and the fittings inside the oven.

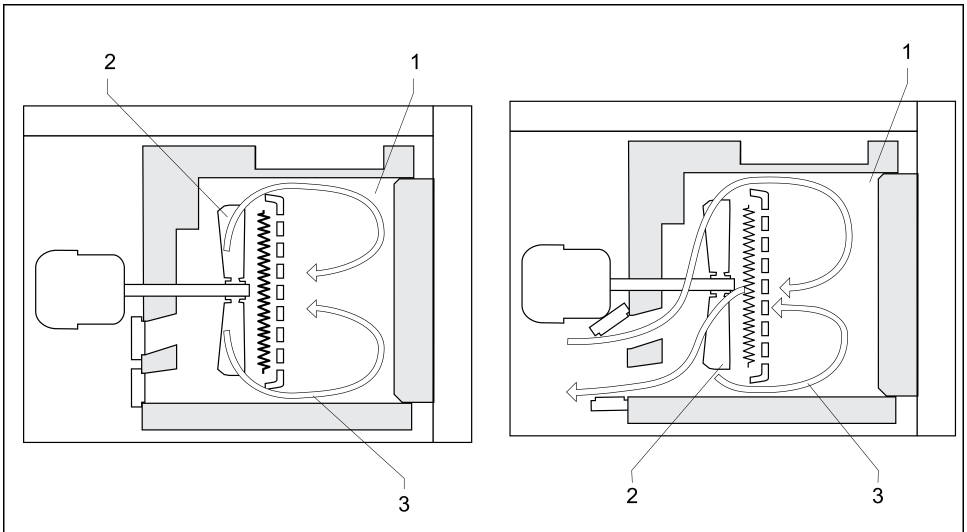


LCH Left Channel	**RCH Right Channel**
LJ Left Injector	RJ Right Injector
LJ* 2nd Left Injector	RJ* 2nd Right Injector
LD Left Detector	RD Right Detector

Figure 2.1-1. Injector/Detector Locations and Fittings

The column oven has the following capabilities:

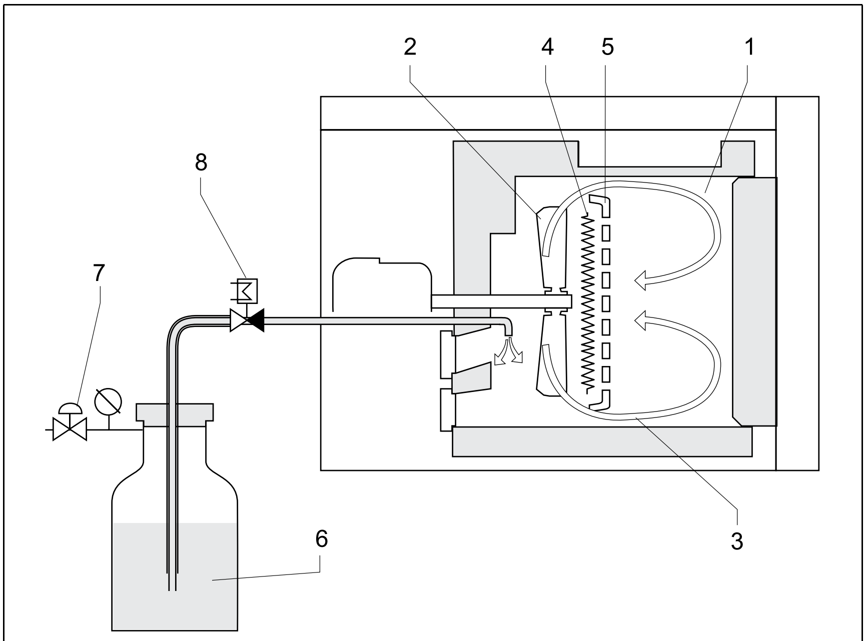
- Seven linear temperature ramps
- A maximum temperature of 450 °C
- A maximum temperature increase rate of 120 °C/min
- A minimum operating temperature a few degrees above ambient obtained by two modulated cooling flaps controlled by the GC, shown in Figure 2.1-2



1. Oven	3. Air
2. Fan	

Figure 2.1-2. Oven Air Circulation

- Temperature control by a combination of heater control and fine control of hot air exhaust and an ambient air intake. The system allows separation of moderately volatile components on thick film capillary columns at near ambient temperatures without the use of a cryogenic system. With a cryogenic option installed, the oven temperatures can reach –55 °C with liquid carbon dioxide or –99 °C with liquid nitrogen. Figure 2.1-3 shows the cryogenic system.



1. Oven	5. Heater Baffle
2. Fan	6. Coolant Reservoir (LCO_2 or LN_2)
3. Air Circulation Path	7. Back Pressure Regulator
4. Heater Coil	8. Coolant Valve (LCO_2 or LN_2)

Figure 2.1-3. Cryogenic Air Circulation

Oven Safety

Opening the oven door cuts off the power to the oven heater, fan, and the cryogenic system (if installed). The setpoints are kept in memory. The display shows the following safety message:

```
              OVEN
Temp            40 Door Open
Initial time            2.00
Ramp 1                   Off
```

To return to normal operation, close the oven door.

WARNING! The oven vents at the rear of the GC discharge hot air during cooling.

WARNING! Hydrogen is a potentially dangerous gas. Refer to *Using Hydrogen* on page xxiv for safety information.

Column Oven Configuration

The **CONFIGURE OVEN** menu contains the control parameters for the column oven.

Press **CONFIG** and **OVEN** to open the menu shown in Table 2.1-1. Refer to Chapter 3, *Configuration*, in the *Operating Manual* for more information about the **CONFIGURE** menu.

Table 2.1-1. Configure Oven Menu

Menu	Range	Comments
CONFIGURE OVEN		The title bar.
Auto Prep Run	Off/On	Press **ON** to enable automatic execution of the **Prep Run** without pressing **PREP RUN**. This feature is useful when you use the autosampler. When this item is set to Off, you must press **PREP RUN** to activate the **Prep Run**.
PR timeout	0–999.99 min, ∞	Enter the duration of the prep run. The injection must occur within this time or the timeout will return the GC to the **Standby** condition.
Equil time	0–999.99 min	This is the time required for equilibrating the oven temperature after the temperature is set or modified.
Ready delay	0–99.9 min	This parameter delays the **Ready to Inject** condition. This function is useful for on-column injectors. It allows the secondary cooling to cool the injector before the injection. This time must not exceed the PR timeout value.
Max temp	0– 450 °C	This parameter defines the maximum allowable oven temperature setpoint to protect the column from unintentional excessively high temperature. This limit must be set to the manufacturer's maximum recommended operating temperature for the column.
Enable cryogenics[1]	Yes/No	This function enables the oven cryogenic system when it is installed and configured (LCO_2 or LN_2 as coolant). Press **YES** to activate the cryogenic system. Press **NO** to deactivate it.
Start cryogen[1]		This parameter defines the temperature at which the oven cryogenic system regulation occurs. This parameter line is displayed if Enable cryogenics has been set to **YES**.

1. If the cryogenic system is installed and configured, its parameters are included in the menu.

OPERATING PROCEDURE

Configure the Column Oven

Use this procedure to configure the column oven.

Configuration Without the Cryogenic System

1. Press **CONFIG**, then press **OVEN** or scroll to `Oven` and press **ENTER**.
2. Scroll to `Auto prep run`. Press **ON** to enable automatic prep run. Press **OFF** if you want prep run to be activated by pressing the **PREP RUN** key.
3. Scroll to `PR timeout` and set the duration of the prep run timeout.
4. Scroll to `Equil time` and set the oven temperature equilibration time.
5. Scroll to `Ready delay` and set the time delay before the GC enters the **Ready to Inject** condition.
6. Scroll to `Max Temp` and set the maximum allowable oven temperature.

Configuration With the Oven Cryogenic System

1. Press **CONFIG**, then press **OVEN** or scroll to `Oven` and press **ENTER**.
2. Scroll to `Auto prep run`. Press **ON** to enable automatic prep run. Press **OFF** if you want prep run to be activated by pressing the **PREP RUN** key.
3. Scroll to `PR timeout` and set the duration of the prep run timeout.
4. Scroll to `Enable cryogenics` and press **YES** to enable the cryogenic system or **NO** to disable it.
5. Scroll to `Equil time` and set the oven temperature equilibration time.
6. Scroll to `Ready delay` and set the time delay before the GC enters the **Ready to Inject** condition.
7. Scroll to `Start cryogen` and set the cryogenic system regulation temperature. The range depends on the coolant used.
8. Scroll to `Max Temp` and set the maximum allowable oven temperature.

Oven Menu

The **OVEN** menu contains the parameters for programming the oven temperature from an initial temperature to a final temperature using up to seven ramps during the analytical run. It is possible to set a single (isothermal) or multiple ramp program.

Press **OVEN** to open the **OVEN** menu, shown in Table 2.1-2.

Table 2.1-2. The Oven Menu

Menu	Range	Comments
`OVEN`		The title bar.
`Temp`	On/Off, 0–450 °C[1]	Press **ON** to display the actual and setpoint values. This value is the *initial temperature*.
`Initial time`	0–999.99 min	This parameter defines the time the oven remains at the starting temperature after a programmed run has begun.
`Ramp 1`	0.0–120 °C/min, On/Off	This is the temperature ramp rate in °C/minute to reach the *final temperature.* Press **ON** to enable a temperature ramp.
`Final temp 1`	0–450 °C[1]	This parameter defines the temperature the column oven will reach at the end of the heating or cooling ramp. This line only appears if `Ramp 1` is `On`.
`Final time 1`	0.00–999.99 min, ∞	This parameter defines how long (in minutes) the oven will maintain the *final temperature* of the ramp.
`Ramp 2-7`	On/Off, 0.0–120 °C/min	After you program the first ramp, the menu adds the `Ramp 2` parameter lines. If you do not want an additional ramp, leave this parameter set to `Off`. To program the ramp, press **ON**. The `Final temp` and `Final time` lines for the ramp will be added to the menu. You can repeat this process to program up to seven temperature ramps.
`Final temp 2-7`	0–450 °C[1]	This parameter defines the temperature the column oven will reach at the end of the relevant ramp.
`Final time 2-7`	0.00–999.99 min, ∞	This parameter defines how long (in minutes) the oven will maintain the *final temperature* of the ramp.
`Post run temp`	0–450 °C[1]	This parameter defines a temperature the oven will reach after the end of the analytical run. Press **OFF** if you do not want a post run temperature. Press **ON** to display the setpoint value and the `Post run temp`, `Post run time`, `L Post pres`, and `R post pres` parameters.

Table 2.1-2. The Oven Menu (Continued)

Menu	Range	Comments
`Post run time`	0.00–999.99 min	This is the time the oven maintains the post run temperature.
`L/R Post pres`	0–700 kPa	This parameter defines the pressure for the Left or Right carrier during the `Post run time` when the system operates in Constant Pressure or Programmed Pressure mode.

1. With a cryogenic system, the ranges are –99–450 °C (with liquid N_2), –55–450 °C (with liquid CO_2). The range is 0–500 °C if the oven is configured for high oven temperatures.

OPERATING PROCEDURE

Set Up a Single Ramp Temperature Program

This program raises the initial oven temperature to a specified final temperature at a specified rate and maintains the final temperature for a specified time.

1. Press **OVEN** to access the `Oven` menu.
2. Scroll to `Temp` and enter the initial temperature.
3. Scroll to `Initial time` and enter the time you want the oven to maintain the initial temperature.
4. Scroll to `Ramp 1` and press **ON**. Enter the ramp rate in °C/minute for the oven to reach the ramp's `Final temp`.
5. Scroll to `Final temp 1` and enter the final temperature for the ramp.
6. Scroll to `Final time 1` and enter the time the oven will maintain the `Final temp`.
7. To end the single ramp program, `Ramp 2` must be `Off`.

OPERATING PROCEDURE

Set Up a Multiple Ramp Temperature Program

This program raises the initial oven temperature to a specified final temperature through up to seven ramps, each having a specified ramp rate, time and temperature.

1. Press **OVEN** to access the `Oven` menu.
2. Scroll to `Temp` and enter the initial temperature.
3. Scroll to `Initial time` and enter the time you want the oven to maintain the initial temperature.
4. Scroll to `Ramp 1` and press **ON**. Enter the ramp rate in °C/minute for the oven to reach the ramp's `Final temp`.
5. Scroll to `Final temp 1` and enter the final temperature for the ramp.
6. Scroll to `Final time 1` and enter the time the oven will maintain the `Final temp`.
7. Scroll to `Ramp 2` and press **ON**. Enter the ramp rate for the second temperature ramp.

8. Scroll to `Final temp 2` and enter the final temperature for the ramp.
9. Scroll to `Final time 2` and enter the time the oven will maintain the `Final temp`.
10. To end the multiple ramp temperature program, leave `Ramp 3` set to `Off`. To add additional oven ramps, repeat the steps 7 through 9.

2.2

Injectors

This chapter describes the injectors available for use with the TRACE GC 2000.

Chapter at a Glance…

Split/Splitless Injector Overview

The Split/Splitless (S/SL) injector, shown in Figure 2.2-1, is optimized for either *split* or *splitless* applications to ensure effective sample transfer into the column, minimizing heavy component discrimination.

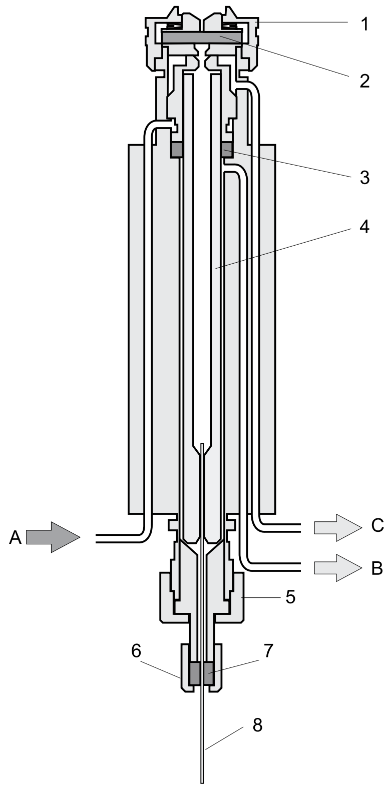
For both split and splitless applications, the sample is injected through a septum into a glass liner in the vaporization chamber.

The technique used, split or splitless, determines the choice of the glass liner and the length of the syringe needle employed. You can control the injector temperature from ambient to 450 °C, although the actual injector temperature you use depends on solvent choice and thermal stability of the samples.

In GCs with Digital Pressure Flow Control (DPFC), an electronic device controls the split flow, while the septum purge flow is kept constant by a calibrated flow regulator.

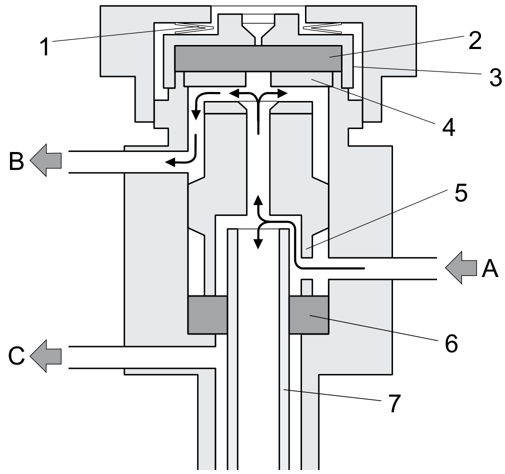
The S/SL injector is also equipped with electronically actuated On/Off valves for split and septum purge lines.

Volatile components given off by the hot septum can produce ghost peaks in a chromatogram. The septum purge system can continually purge the septum with a flow of gas. This prevents the volatile components from the septum from entering the column. Figure 2.2-2 shows the septum purge system. Figure 2.2-3 shows the S/SL injector components.



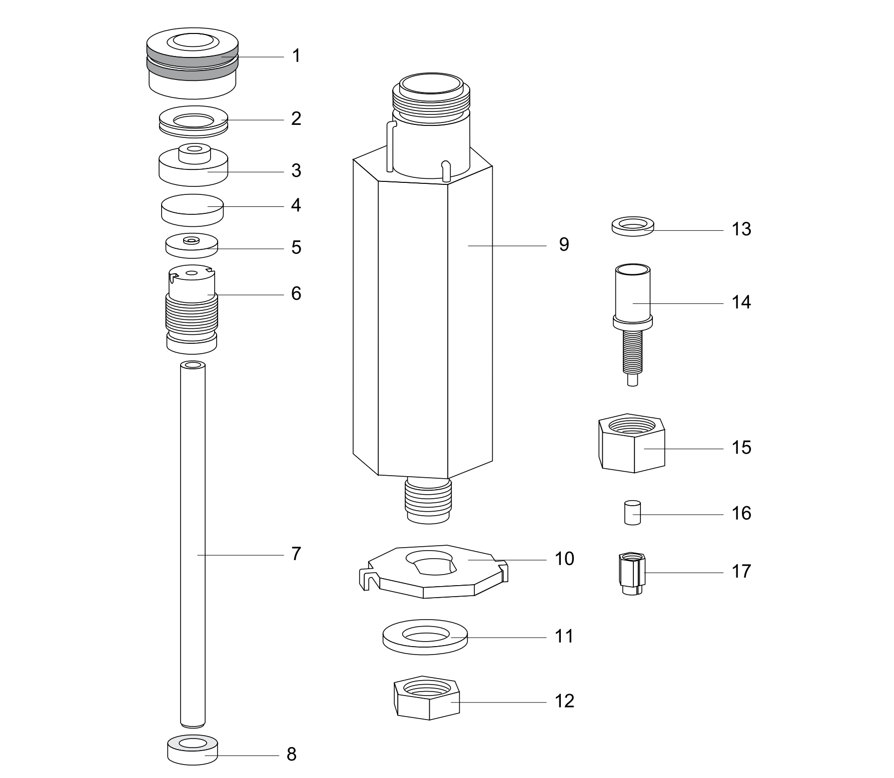
1. Septum Cap	7. Graphite Ferrule for Column
2. Septum	8. Capillary Gas Column
3. Liner Graphite Seal	A. Carrier Gas Inlet
4. Glass Liner	B. Split Line
5. Fixing Nut	C. Septum Purge Line
6. M4 Retaining Nut	

Figure 2.2-1. Split/Splitless Injector



1. Spring	6. Liner Graphite Seal
2. Septum	7. Glass Liner
3. Septum Holder	A. Carrier Gas Inlet
4. Septum Support	B. Septum Purge Line
5. Liner Cap	C. Split Line

Figure 2.2-2. Septum Purge System



1. Septum Cap	10. Securing Bracket
2. Spring	11. Metal Ring
3. Septum Holder	12. Fixing Nut
4. Septum	13. Silver Seal
5. Septum Support	14. Terminal Fitting
6. Liner Cap	15. Fixing Nut
7. Liner	16. Graphite Ferrule for Column
8. Liner Graphite Seal	17. M4 Retaining Nut
9. Injector Body	

Figure 2.2-3. Split/Splitless Injector Components

Septum

You should always use good quality septa, such as the BTO septa supplied with the TRACE GC 2000. Such septa resist deformation, have longer life expectancy, and have a low bleed level, even at high temperatures.

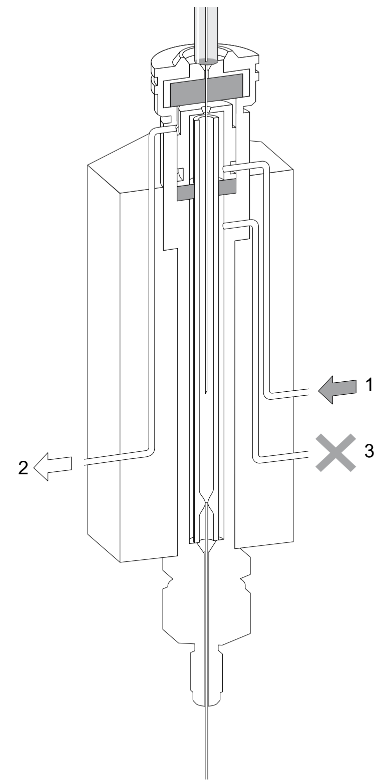
Liners

Different types of glass liners may be installed depending on the injection mode used. Table 2.2-1 shows the liner options currently available.

Table 2.2-1. Liners Sizes and Applications

ID mm	OD mm	Application
5	8	Split Injection
3	8	Split Injection
3	8	Splitless Injection
5	8	Splitless Injection
5	8	Direct injection into wide-bore column
5	8	Split injection at high flow rates or for the most polar solvents

The glass liner used for direct splitless injection into a *wide-bore column* is tapered at the bottom. It is used with 0.53-mm ID columns. Figure 2.2-4 shows the tapered glass liner.



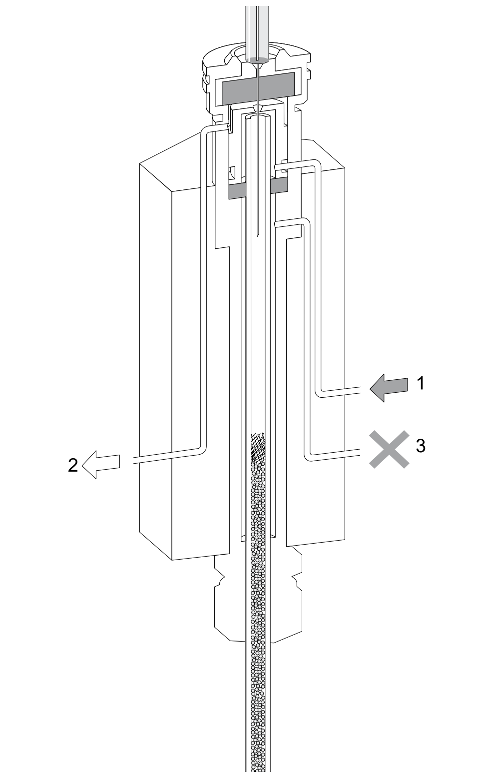
1. Carrier Gas Inlet
2. Septum Purge Line
3. Split Line

Figure 2.2-4. S/SL Wide-Bore Injection Tapered Liner

A laminar cup liner is used for split injections at high split flow rates or for the more polar solvents. This glass liner has a mixing chamber with an extended flow path that allows complete sample vaporization before the sample reaches the split point.

Packed Columns

With a special conversion kit, you can install packed columns in the S/SL injector, as shown in Figure 2.2-5.



1. Carrier Gas Inlet	3. Split Line
2. Septum Purge Line	

Figure 2.2-5. S/SL With a Packed Column

Split/Splitless Injector Menus

The **`INLET (S/SL)`** menu includes the operating parameters for the split/splitless injector. The parameters you can edit depend on the operating mode chosen: split, splitless, or splitless with surge.

Press **LEFT INLET** or **RIGHT INLET** to display the **`LEFT`** or **`RIGHT INLET`** menu for the split/splitless injector.

```
     LEFT INLET (S/SL)
Temp              250  250
Pressure       10.6   10.6
Mode:                split<
```

The `Mode:` menu item displays the current operating mode.

Press **MODE/TYPE** to open the **`INLET MODE`** submenu.

```
      XX INLET MODE
* Split                   <
  Splitless
  Splitless w/surge
```

Scroll to the mode you want to use and press **ENTER** to confirm the selection. An asterisk appears on the left of the operating mode selected.

Tables 2.2-2 through 2.2-4 explain the ranges and functions of the parameters in the **`LEFT`** and **`RIGHT INLET`** menus for each of the four operating modes.

NOTE The injector and carrier gas menus are related. If you set a pressure at the carrier gas menu, that same pressure setting is reflected in the injector menu and vice versa.

The items in the inlet menu vary depending on the operating mode you select in the **LEFT** or **RIGHT INLET MODE** menu. Tables 2.2-2 through 2.2-4 show the split/splitless inlet menu for the four operating modes.

Table 2.2-2. Inlet Menu in Split Mode

Menu	Range	Comments
`RIGHT INLET (S/SL)`		Title bar.
`Temp`	On/Off, 30°–400 °C	This line shows the base injector temperature. Press **ON** to enable the heater and to display the actual and setpoint values. Press **OFF** to disable the heater and to display the actual value.
`Pressure`	On/Off, 2–250 kPa or 3–700 kPa[1]	This line shows the pressure. Press **ON** to display the actual and setpoint values. Press **OFF** or **0** to display the actual value and to turn off all inlet flows.
`Mode: Split`		This line displays the inlet operating mode selected.
`Total flow`	Not editable	This line shows the total gas flow consumption, which is the sum of the column flow, split flow (or gas saver flow), and septum purge flow.
`Split flow`	On/Off, 0, 10–500 mL/min	This line shows the split flow. Press **ON** to enable the split flow and to display the actual and setpoint values. Press **OFF** or **0** to close the split valve and to disable the split flow.
`Split ratio`	1–5000	This line displays the actual value of the split ratio. This value is the ratio between the split flow and the column flow.

1. 0.05–100 psi, 0.03–7.00 bar.

Table 2.2-3. Inlet Menu in Splitless Mode

Menu	Range	Comments
`RIGHT INLET (S/SL)`		Title bar.
`Temp`	On/Off, 0°–400 °C	This line shows the base injector temperature. Press **ON** to enable the heater and to display the actual and setpoint values. Press **OFF** to disable the heater and to display the actual value.
`Pressure`	On/Off, 2–250 kPa or 3–700 kPa[1]	This line shows the pressure. Press **ON** to display the actual and setpoint values. Press **OFF** or **0** to display the actual value and to turn off inlet pressure, thereby turning off the flow.
`Mode: Splitless`		This line displays the operating mode selected. Press **ENTER** or **MODE/TYPE** to change the operating mode.
`Total flow`	Not editable	This line shows the total gas flow consumption, which is the sum of the column flow, split flow (or gas saver flow), and septum purge flow.

Table 2.2-3. Inlet Menu in Splitless Mode (Continued)

Menu	Range	Comments
`Split flow`	On/Off, 0, 10–500 mL/min	This line shows the split flow. Press **ON** to enable the split flow and to display the actual and setpoint values. Press **OFF** or **0** to close the split valve and to disable the split flow.
`Splitless time`	0–999.99 min	This line shows the splitless time, which is the duration of split valve closure.
`Const sept purge?`	Yes/No	Press **YES** to activate a constant septum purge to continuously flush the septum with a purge flow of 5 mL/min when using helium or nitrogen as a carrier gas, or 10 mL/min when using hydrogen as a carrier gas.
`Stop purge for:`	0–999.99 min, ∞	This line appears only when `Constant septum purge` is set to `No`.

1. 0.05–100 psi, 0.03–7.00 bar.

Table 2.2-4. Inlet Menu in Surge Splitless Mode

Menu	Range	Comments
`RIGHT INLET (S/SL)`		Title bar.
`Temp`	On/Off, 0°–400 °C	This line shows the base injector temperature. Press **ON** to enable the heater and to display the actual and setpoint values. Press **OFF** to disable the heater and to display the actual value.
`Pressure`	On/Off, 2–250 kPa, 3–700 kPa[1]	This line shows the pressure. Press **ON** to display the actual and setpoint values. Press **OFF** or **0** to display the actual value and to turn off inlet pressure, thereby turning off the flow.
`Mode:    Surge SL`		This line displays the operating mode selected. Press **ENTER** or **MODE/TYPE** to change the operating mode.
`Total flow`	Not editable	This line shows the total gas flow consumption, which is the sum of the column flow, split flow (or gas saver flow), and septum purge flow.
`Split flow`	On/Off, 0, 10–500 mL/min	This line shows the split flow. Press **ON** to enable the split flow and display the actual and setpoint values. Press **OFF** or **0** to close the split valve and to disable the split flow.
`Splitless time`	0–999.99 min	This line shows the splitless time, which is the duration of split valve closure.
`Surge pressure`	2–250 kPa or 3–700 kPa[1]	This line indicates the surge pressure. Surge pressure is activated at **Prep Run**.
`Surge duration`	0–999.99 min	This line indicates the duration of the surge pressure.

Table 2.2-4. Inlet Menu in Surge Splitless Mode (Continued)

Menu	Range	Comments
`Const sept purge?`	Yes/No	Press **YES** to activate a constant septum purge to continuously flush the septum with a purge flow of 5 mL/min when using helium or nitrogen as a carrier gas, or 10 mL/min when using hydrogen as a carrier gas.
`Stop purge for:`	0–999.99 min, ∞	This line appears only when `Constant septum purge` is set to `No`.

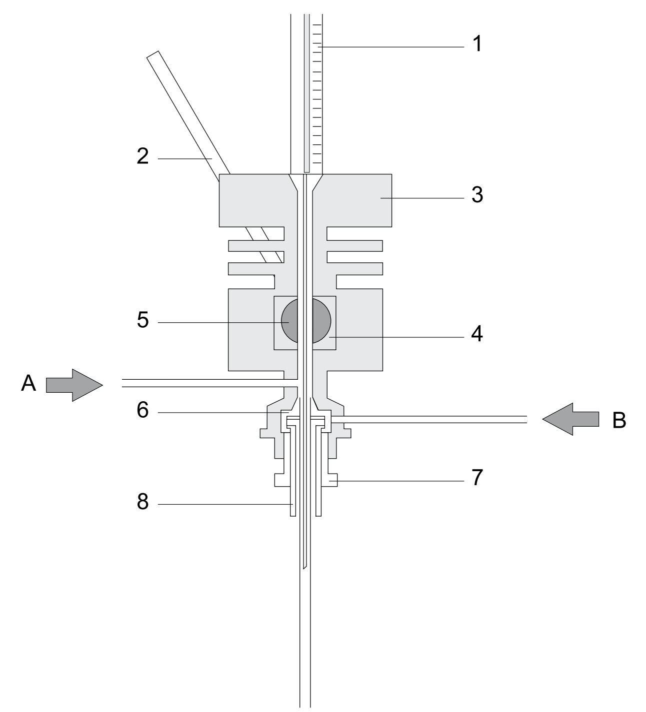
1. 0.05–100 psi, 0.03–7.00 bar.

On-Column Injector Overview

With On-Column Injectors (OCI), you use a syringe to inject a liquid sample directly into the capillary column.

The upper part of the injector has a needle guide and a rotary valve. The lower part attaches to the top of the column oven. The standard on-column injector does not have a septum.

The on-column injector is shown in Figure 2.2-6.



1. Syringe	6. Seal
2. Valve Lever	7. M8x1 Fixing Nut
3. Upper Block	8. Cooling Sleeve
4. PTFE Valve Seal	A. Carrier Gas Inlet
5. Stainless Steel Rotary Valve	B. Secondary Cooling Inlet

Figure 2.2-6. On-Column Injector

Primary Cooling System

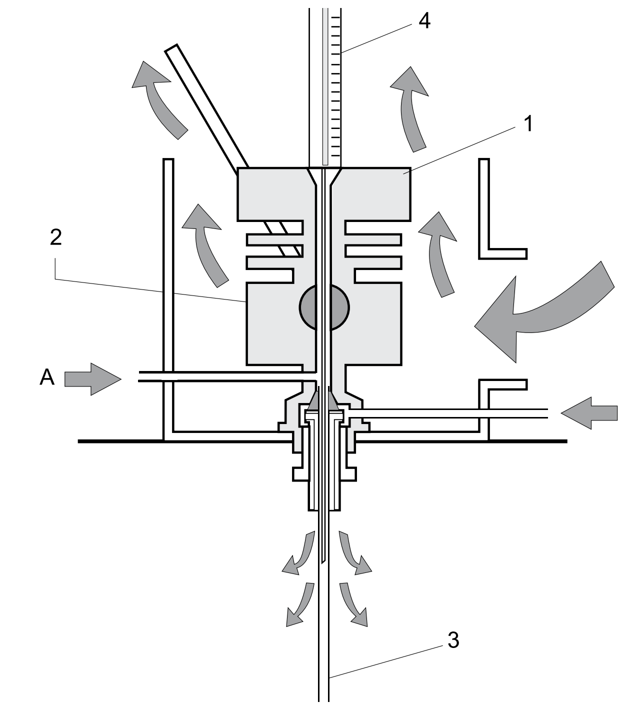
The injection block is kept at ambient temperature by the primary cooling system, which maintains a permanent flow of air across the injector body through a special cooling fan.

Secondary Cooling System

A stream of gas surrounds the area around the column at the point of injection. This gas is normally compressed air, but for special applications CO_2 can be used. The *secondary cooling* flow keeps the injection zone at a temperature below the solvent boiling point, even when the oven runs at a higher temperature. Elevated oven temperature helps eliminate peak distortion in the chromatogram caused by *flooding effects*.[1]

The secondary cooling system ensures complete and effective sample transfer from the syringe to the column and improves reproducibility. Secondary cooling activates only immediately before an injection and remains on after the injection until all of the injected solvent has vaporized. The *secondary cooling time*, which is the duration of secondary cooling during a run, depends on the oven temperature, the volatility of the solvent, and the amount injected, but is normally in the range of 3–10 seconds. You program the parameters for secondary cooling in the **INLET** menu when an on-column injector is configured.

Primary and secondary cooling systems are shown in Figure 2.2-7.



1. Injector Upper Block	A. Carrier Gas Inlet
2. Injector Lower Block	B. Secondary Cooling
3. Capillary Column	C. Primary Cooling
4. Syringe	

Figure 2.2-7. Primary and Secondary Cooling Systems

1. Journal of Chromatography, 279 (1983) 241–250.

Optional Devices

Several optional devices and special on-column injectors can be used for special applications or to help automate certain functions.

Auxiliary Purge Line

The optional auxiliary purge line allows the elimination of excess of solvent that could accumulate due to incorrect injection conditions. It purges the excess solvent to keep it from entering other parts of the GC system.

Automatic Actuator

The automatic actuator can semi-automate manual injections by automatically opening the rotary valve when the syringe needle is inserted. When the needle is removed, the automatic actuator closes the valve and starts the GC.

High Oven Temperature (HOT OC) Device

The HOT OC device allows on-column operation at high initial oven temperatures, eliminating the need to cool the oven to a lower temperature for the injection. Chapter 8, *High Oven Temperature Cold On-Column Injector*, in the TRACE GC 2000 *Operating Manual*, describes this device in detail.

Large Volume On-Column Injector (LVOCI)

The LVOCI is a special version of the standard on-column injector that allows large volume liquid sample analysis with an AS 2000 autosampler. Special software is required for this injector. Chapter 11, *Large Volume On-Column Injector*, in the TRACE GC 2000 *Operating Manual*, describes the principles and hardware for this injection technique.

On-Column Injector Menu

The **INLET** menu contains the parameters for on-column injector operations if you have configured an on-column injector.

Press **LEFT INLET** or **RIGHT INLET** to display the menu, depending on the injector position.

NOTE The injector and carrier gas menus are related. If you set a pressure at the carrier gas menu, that same pressure setting is reflected in the injector menu, and vice-versa.

Table 2.2-5. Inlet Menu in Split Mode

Menu	Range	Comments
RIGHT INLET (OCI)		Title bar.
Pressure	On/Off, 2–250 kPa or 3–700 kPa[1]	This line shows the pressure. Press **ON** to display the actual and setpoint values. Press **OFF** or **0** to display the actual value and turn off inlet pressure, thereby turning off the flow.
Sec. Cool Time	0–999.99 min, ∞	This line shows the secondary cooling time, which is the duration of the secondary cooling. If programmed, the valve opens in the **Prep Run** stage.
Const Aux Purge?[2]	Yes/No	Press **YES** to enable a constant auxiliary purge to continuously flush the septum with a fixed purge flow.
Stop purge for[2]	0–999.99 min, ∞	This line only appears when Const Aux Purge? is set to No. Enter the time the purge flow should be interrupted.

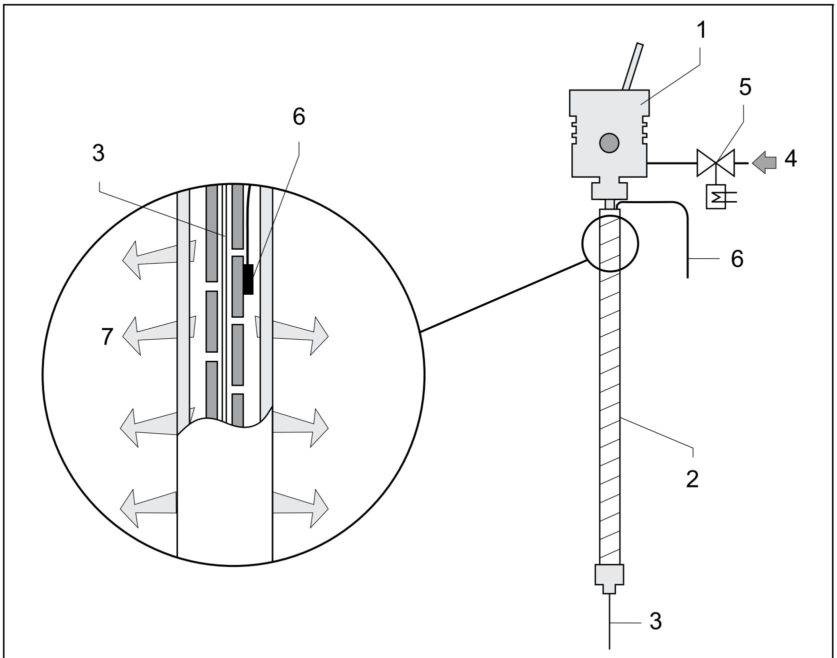
1. 0.05–100 psi, 0.03–7.00 bar.
2. This menu item appears only if the auxiliary purge option is installed and configured.

NOTE When you press either **COLUMN EVAL** or **LEAK CHECK** while the **INLET** menu in **S/SL** mode is displayed, the GC immediately performs the selected function if the instrument is in the **Standby** status.

HOT Cold On-Column Injector Overview

The On-Column Injector (OCI) requires an optional device for injection at oven temperatures at or above 200 °C, regardless of the solvent used. This High Oven Temperature (HOT) device must be attached below the on-column injector and configured in **CONFIG** menu.

As with the standard on-column injector, you can manually inject samples into the HOT OC injector with or without an automatic valve actuator. Refer to *Optional Devices* in Chapter 7 of the TRACE GC 2000 *Operating Manual* for more information about the automatic actuator. Figure 2.2-8 shows the HOT OC injector.



1. Cold On-Column Injector	4. Cooling Fluid Inlet
2. HOT Device	5. Solenoid Valve
3. Capillary Column	6. Thermocouple

Figure 2.2-8. HOT Cold On-Column Injector

Optional Devices

In addition to the automatic actuator, the OCI with the HOT device can be modified with an auxiliary purge line or solvent vapor exit valve.

Auxiliary Purge Line

The optional auxiliary purge line allows the elimination of excess of solvent that could accumulate due to incorrect injection conditions. It purges the excess solvent to keep it from entering other parts of the GC system.

Solvent Vapor Exit Valve

Large volume injection with the HOT OC technique requires an optional Solvent Vapor Exit (SVE) valve. This valve allows the venting of the solvent vapors formed during the sample injection. The SVE valve consists of a specially designed, electronically activated, heated three-way valve.

The valve inlet is connected to a tee-shaped piece that links the desolvation pre-column to the analytical column. The solvent vapors are vented through the main outlet which is connected to a solvent reservoir. The SVE valve has a high flow restrictor. This restrictor, a fine capillary tube, is placed in a special support heated by the valve. This configuration ensures a very small purge rate (around 0.01 mL/min) when the SVE valve is closed. This prevents back-diffusion of solvent vapors into the analytical system.

HOT Cold On-Column Injector Menu

The **INLET (HOT OC)** menu contains the parameters for the HOT OC injector when one has been configured on the GC.

Press **LEFT INLET** or **RIGHT INLET** to display the menu shown in Table 2.2-6.

NOTE The injector and carrier gas menus are related. If you set a pressure at the carrier gas menu, that same pressure setting is reflected in the injector menu and vice versa.

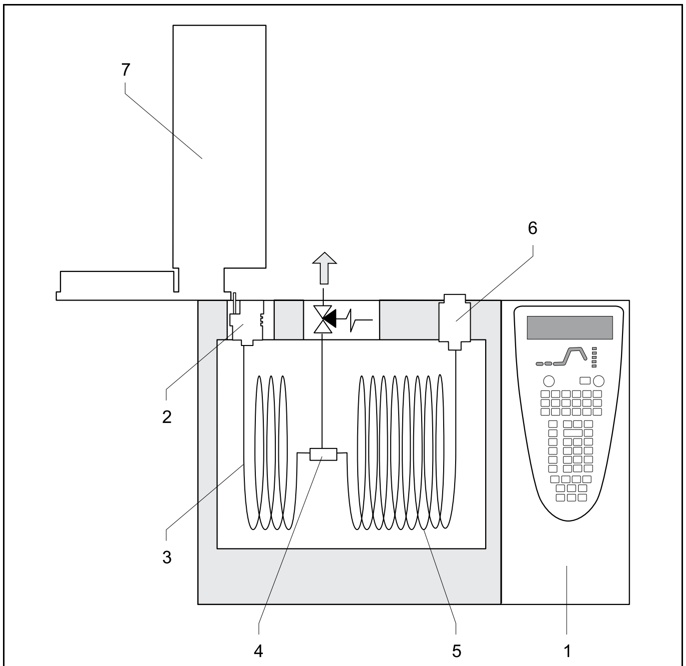
Table 2.2-6. Inlet Menu for On-Column Injectors With the HOT Device

Menu	Range	Comments
RIGHT INLET (HOT OC)		Title bar.
HOT OC Temp	25 °C–initial oven temp	This parameter defines the injector temperature.
HOT OC duration	0.00–999.99 min, ∞	This parameter defines the duration of the secondary cooling. When programmed, the secondary cooling valve is opened during **Prep Run**. If set to zero, the valve remains in the default condition.
Pressure	On/Off, 2–250 kPa or 3–700 kPa[1]	This line shows the carrier gas inlet pressure. Press **ON** to display the actual and setpoint values. Press **OFF** or **0** to display the actual value turn off the inlet pressure, thereby turning off the flow.
Const Aux Purge?[2]	Yes/No	Press **YES** to enable a constant auxiliary purge to continuously flush the septum with a fixed purge flow.
Stop purge for[2]		This line only appears when Const Aux Purge? is set to No. Set the time the purge flow should be interrupted.
SVE temp[3]	On/Off, 0–250 °C	(Only for large volume injections) This parameter defines the solvent vapor exit valve temperature.
SVE duration[3]	0.00–999.99 min, ∞	(Only for large volume injections) This parameter defines the duration of the solvent vapor exit event. When the duration is set to zero, the SVE valve remains in the default condition.

1. 0.05–100 psi, 0.03–7.00 bar.
2. This menu item appears only if the auxiliary purge option is installed and configured.
3. This menu item appears only if the Solvent vapor exit valve option is installed and configured (for large volume injections).

Large Volume On-Column Injector Overview

The Large Volume On-Column Injector (LVOCI) is a special version of the standard on-column injector. It allows the automatic introduction of large volume liquid samples with the AS 2000 autosampler. The autosampler injects the samples directly into a fused silica capillary column system as shown in Figure 2.2-9.



1. TRACE GC 2000	5. Analytical Column
2. On-Column Injector	6. Detector
3. Desolvation Pre-Column	7. AS 2000 Autosampler
4. Tee connection	8. SVE Solvent Vapor Exit

Figure 2.2-9. TRACE GC 2000 Configuration for Large Volume On-Column Injection

This injector is equipped with a Solvent Vapor Exit (SVE) valve to allow venting of the solvent vapor formed during the sample injection.

The SVE valve is an electronically activated, heated three-way valve. The valve inlet is connected to a tee piece linking the desolvation pre-column to the analytical column.

The solvent vapors vent through the main outlet, which is connected to a vapor condenser receptacle provided with a filter to the atmosphere. The outlet is connected with a high flow restrictor. The restrictor is placed in a special support heated by the valve. This configuration ensures a very small purge rate (around 0.01 mL/min) when the SVE is closed. This prevents the back diffusion of solvent inside the system.

Auxiliary Purge Line

The optional auxiliary purge line allows the elimination of excess solvent that could accumulate due to incorrect injection conditions. It purges the excess solvent to keep it from entering other parts of the GC system.

Large Volume On-Column Injector Menu

The **INLET (LVOCI)** menu contains the parameters for large volume on-column injectors if the GC has been configured for an LVOCI.

Press **LEFT INLET** or **RIGHT INLET** to display the menu, depending on the injector position.

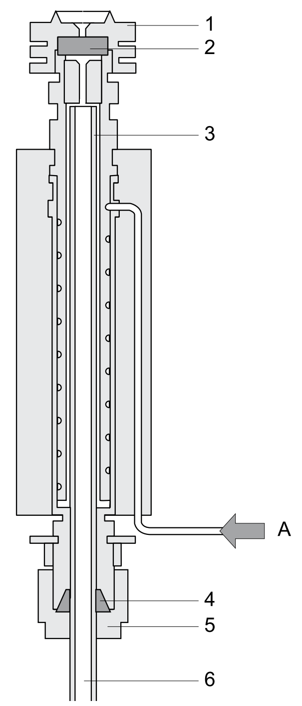
Table 2.2-7. Inlet Menu for Large Volume On-Column Injectors

Menu	Range	Comments
`RIGHT INLET (LVOCI)`		Title bar.
`Pressure`	On/Off, 2–250 kPa or 3–700 kPa[1]	This line shows the carrier gas inlet pressure. Press **ON** to display the actual and setpoint values. Press **OFF** or **0** to display the actual value and to turn off the inlet flow.
`Sec. Cool Time`	0–999.99 min, ∞	This line shows the secondary cooling time. This parameter controls the duration of the secondary cooling event. If set to ∞, the solenoid valve remains in default condition. The valve opens at the beginning of the standby mode when programmed.
`SVE temp`[2]	On/Off, 0–250 °C	This line only appears when the optional solvent vapor valve is installed in the system. This parameter defines the solvent vapor exit valve temperature.
`SVE duration`[3]	0–999.99 min, ∞	This parameter defines the duration of the solvent vapor exit event. When the duration is set to zero, the SVE valve remains in the default condition.
`Const. Aux Purge?`[3]	Yes/No	Press **YES** to enable a constant auxiliary purge to continuously flush the injector with a fixed purge flow.
`Stop purge for`[3]		This line only appears when `Const Aux Purge?` is set to `No`. Set the time the purge flow should be interrupted.

1. 0.05–100 psi, 0.03–7.00 bar.
2. This menu item appears only if the Solvent vapor exit valve option is installed and configured.
3. This menu item appears only if the auxiliary purge option is installed and configured.

Packed Column Injector Overview

The Packed (PKD) column injector, shown in Figure 2.2-10, is used for injections with the sample vaporizing directly in the column or in a liner. The PKD standard injector accepts metal or glass packed columns. The injector temperature may range from ambient to 400 °C. Injector temperature is regulated by a temperature controller in the GC CPU board and monitored by a platinum wire sensor.



1. Septum Cap
2. Septum
3. Insert for .04-mm OD Column
4. Column Ferrule
5. Column Retaining Nut
6. Column
A. Carrier In

Figure 2.2-10. Packed Column Injector

Septa

You should use a high-temperature septum with a long life expectancy, good resistance to deformation, and a low bleed level, even with high temperatures. Use high-temperature septa for both manual and automatic injections.

Liners and Adapters

You can install different glass liners depending on the type of column used. Table 2.2-8 shows the liner options currently available. To install an Imperial-size packed column, you need a liner equipped with a metric/imperial adapter.

Table 2.2-8. Liners and Adapters for Packed Column Injectors

Liner/Adapter	Type of Column
Glass Liner 4-mm OD	Glass Packed Column 6-mm OD (4-mm ID)
Glass Liner 4-mm OD	Metal Packed Column 4-mm OD (2-mm ID)
	Metal Packed Column 6-mm OD (4-mm ID)
Metric-Imperial Adapter	1/8-in. Metal Packed Column
Metric-Imperial Adapter	1/4-in. Metal Packed Column

Packed Column Injector Menu

The **INLET (PKD)** menu contains the parameters for packed columns if the GC has been configured for a PKD injector.

Press **LEFT INLET** or **RIGHT INLET** to display the menu, depending on the injector position.

NOTE The injector and carrier gas menus are related. If you set a pressure at the carrier gas menu, that same pressure setting is reflected in the injector menu, and vice-versa.

Table 2.2-9. Inlet Menu for Packed Column Injectors

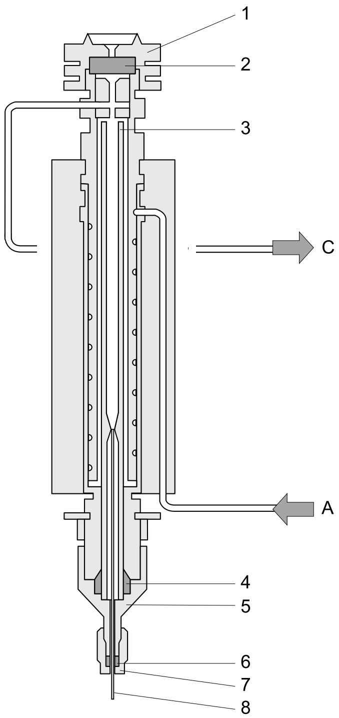
Menu	Range	Comments
XXXX INLET (PKD)		Title bar.
Temp	On/Off, 50–450 °C	This line shows the base injector temperature. Press **ON** to enable the heater and display the actual and setpoint values. Press **OFF** to disable the heater and to display the actual value.
Pressure	On/Off, 3–700 kPa[1]	This line shows the carrier gas inlet pressure. Press **ON** to display the actual and setpoint values. Press **OFF** or zero to display the actual value and to turn off the inlet flow.

1. 0.05–100 psi, 0.03–7.00 bar.

NOTE When you press either **COLUMN EVAL** or **LEAK CHECK** while the **INLET** menu in **S/SL** mode is displayed, the GC immediately performs the selected function if the instrument is in the **Standby** status.

Purged Packed Column Injector Overview

The Purged Packed (PPKD) column injector is a packed column injector with a septum purge. The PPKD standard injector accepts wide-bore capillary columns. The sample vaporizes in a liner and enters the wide-bore capillary column. The injector temperature is controllable from 50 °C to 450 °C. Figure 2.2-11 shows the PPKD injector.



1. Septum Cap
2. Septum
3. Liner
4. Liner Seal
5. Adapter for Wide-Bore Columns
6. Column Ferrule
7. Column Fixing Nut
8. Column

A. Carrier Input

C. Septum Purge

Figure 2.2-11. Purged Packed Column Injector

Septa

You should use high temperature septa with a longer life expectancy, good resistance to deformation, and a low bleed level, even with high temperatures. Use high-temperature septa for both manual and automatic injections.

Liners

Two different glass liners can be used for wide-bore capillary columns:

- 2-mm ID
- 4-mm ID

Purged Packed Column Injector Menu

The **INLET (PPKD)** menu contains the parameters for the purged packed injector if the GC has been configured for a PPKD.

Press **LEFT INLET** or **RIGHT INLET** to display the menu, depending on the injector position.

NOTE The injector and carrier gas menus are related. If you set a pressure at the carrier gas menu, that same pressure setting is reflected in the injector menu, and vice versa.

Table 2.2-10. Inlet Menu for Purged Packed Column Injectors

Menu	Range	Comments
`XXXX INLET (PKD)`		Title bar.
`Temp`	On/Off, 50–450 °C	This line shows the base injector temperature. Press **ON** to enable the heater and display the actual and setpoint values. Press **OFF** to disable the heater and display the actual value.
`Pressure`	On/Off, 3–700 kPa[1]	This line shows the carrier gas inlet pressure. Press **ON** to display the actual and setpoint values. Press **OFF** or zero to turn off the inlet flow.
`Total Flow`	Not editable	This line shows the total gas flow consumption. The total gas flow consists of the sum of the column flow and septum purge flow rates.
`Surge pressure`	On/Off, 3–700 kPa[1]	This line indicates surge pressure.
`Surge duration`	0–99.99 s	This line displays the duration of surge pressure after run start.
`Const sept purge?`	Yes/No	Press **YES** to activate a constant septum purge to continuously flush the injector with a purge flow of 5 mL/min for helium and nitrogen or 10 mL/min for hydrogen.
`Stop purge for`	0–99.99 min, ∞	This line appears only when `Constant septum purge` is set to `No`.

1. 0.05–100 psi, 0.03–7.00 bar.

2.3

Detectors

This chapter describes the detectors available for use with the TRACE GC 2000.

Chapter at a Glance…

Flame Ionization Detector Overview

In the FID, the effluent from the column is mixed with hydrogen and burned in a stream of air as it emerges from the jet. The jet acts as polarizing electrode while the metal collar surrounding the flame forms the collecting electrode.

A polarizing voltage is applied across the electrodes from the electrometer unit to accelerate and collect the ions that are generated during the combustion process of organic compounds. The resulting ionization current is sensed by an electrometer amplifier and converted to a suitable output signal.

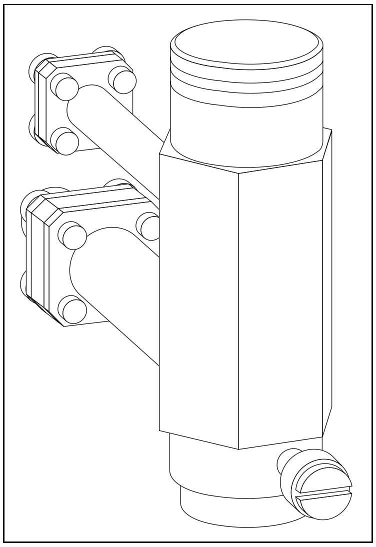


Figure 2.3-1. Flame Ionization Detector

Jet

The flame jet, mounted on the detector base body for capillary, wide-bore, or packed columns is suitable for operating temperatures up to 450 °C. It has ceramic insulation.

Selectivity

The FID responds to almost all organic compounds containing a carbon-hydrogen bond. The detector does not respond, or responds minimally, to a number of compounds such as permanent gases, oxides of nitrogen, sulfur compounds, ammonia and water.

Temperature

The FID is heated from the detector base body. It’s exact temperature is not critical. It only has to be sufficiently high to prevent condensation of the water vapor formed as a result of the hydrogen combustion of the flame. It cannot be used with a detector base body temperature of less than 150 °C. The TRACE GC 2000 will not allow flame ignition to proceed at temperatures less than 150 °C. The base body temperature is normally set to the upper temperature limit of the column in use.

Carrier and Detector Gases

The stability and analytical performance of the Flame Ionization Detector are greatly affected by the flow of the various gases through the detector.

The gases normally used with FID are shown in Table 2.3-1.

Table 2.3-1. FID Carrier Gases.

Carrier Gas	Capillary Columns	Packed Column
Helium	X	X
Nitrogen	X	X
Hydrogen	X	
Argon		X

The carrier gas flow range depends on the type of the gas used and on the type and diameter of the capillary or packed column installed.

The fuel and make-up gases used for the FID are:

- Fuel Gas: Hydrogen or Air
- Make-up Gas: Nitrogen (recommended) or Helium

NOTE Make-up gas is not required when a packed column is used.

The recommended ranges of detector gas flow rates tolerated by the FID are:

- Hydrogen: 30–50 mL/min.
- Air: 300–600 mL/min.
- Make-up gas: 10–60 mL/min.

NOTE Usually the air flow is about 10 times the hydrogen flow to keep the flame lit.

To gain optimum performance from the FID, you should experiment with the hydrogen flow rate, keeping the carrier and air flows constant, to obtain the maximum signal intensity for the components of interest.

Table 2.3-2 shows typical FID operating conditions.

For high-sensitivity applications, it is essential to exclude all traces of organic contamination from the chromatographic system and/or detector gas lines. Such contamination may create ghost peaks in the chromatogram or, more often, an unstable baseline.

Table 2.3-2. Typical Operating Conditions

Parameter	Capillary Columns	Packed Column
Oven Temperature	200 °C	200 °C
Carrier	2 mL/min	40 mL/min
Hydrogen	35 mL/min	40 mL/min

Table 2.3-2. Typical Operating Conditions (Continued)

Parameter	Capillary Columns	Packed Column
Air	350 mL/min	500 mL/min
Make-up gas (Nitrogen)	50 mL/min	Not used

FID Menu

The **DETECTOR (FID)** menu contains the detector control parameters if the GC has been configured for an FID. Press **LEFT DETECT** or **RIGHT DETECT** to open the menu shown in Table 2.3-3.

Table 2.3-3. FID Menu

Menu	Range	Comments
RIGHT DET (FID)		Title bar.
Flame	On/Off	This indicates the flame status: On, Off, Igniting, or Out. Hydrogen and air flow rates are required to light the flame. Press **ON** to turn on the hydrogen and air flows. This happens only if the Base temp is ≥ 150°C. If not, an error messages is displayed. The IGNITION message is displayed during the flame ignition sequence. The Out message is displayed when the flame is inadvertently extinguished. The **Error** LED will blink, and the hydrogen and air supplies will automatically turn off. Refer to *Flame Out Conditions* for more information. Press **OFF** to turn off the hydrogen and air flows.
Base temp	On/Off, 50–450 °C	This indicates the detector base body temperature. Press **ON** to enable the heater and display the actual and setpoint values. Press **OFF** to disable the heater and display the actual value.
Signal pA	Not editable	This parameter shows the collector current in picoamperes (standing current level). The value displayed is also used to indicate the flame status. If the value is very low (such as 0.3 pA) the flame is off. When the value displayed is greater than Ignition threshold, the flame is on.
Ignition thresh	0.0–9.9 pA	The FID produces a small signal current when lit. This parameter defines the flame ON condition. The TRACE GC 2000 uses this value to determine flame status (on or off) and control automatic re-ignition. If Flameout retry is On, the flame will re-ignite if the signal drops below this value.
Flameout retry	On/Off	This indicates re-ignition status. Press **ON** to program flame re-ignition is attempted. Refer to *Flame Out Conditions* for more information.

Table 2.3-3. FID Menu (Continued)

Menu	Range	Comments
`H2`[1] `Air`[1]	On/Off, 0–200 mL/min for H_2, On/Off, 0–600 mL/min for Air	These indicate the hydrogen and air flow supplied to the detector. Press **ON** to turn on the gas flows and to display the actual and setpoint values. Press **OFF** or **0** to turn off the flows and to display the actual value. These flows can be turned on independently when the FID is off, but they are cut off when the FID is turned off, or when the FID fails the ignition sequence. When you have a non-DGFC module, the actual values are not displayed, and you can only turn the flows on and off.
`Mkup`[1] `(XX)`	On/Off, 0–100 mL/min	This indicates the make-up gas used with the FID. The type of gas is displayed in parentheses (for example, `N2`). Press **ON** to turn on the make-up gas flow and to display the actual and setpoint values. Press **OFF** or **0** to turn off the flow and to display the actual value. The flow turns off during the flame ignition sequence, then it turns back on before the ignition threshold test. The flow remains turned on when the FID is turned off. When you have a non-DGFC module, the actual value is not displayed and the setpoint allows only On and Off conditions.

1. If you have a non-DGFC module, the detector gases H_2, air, and make-up, must be measured and adjusted manually from a pressure regulator located in the pneumatics. The range with the non-DGFC module is On/Off.

Flame Out Conditions

When the flame is accidentally extinguished, either permanently because of exhausted fuel gas supplies, or temporarily, due to the elution of water, the `Flame Out` message is displayed in the menu, and a message is recorded in the **Run Log**.

If the `Retry` function is turned `On`, the system will attempt to re-ignite the flame up to three times.

Electron Capture Detector Overview

The ECD has a low-volume ionization chamber and increased contamination resistance which ensure high sensitivity and reliability. The detector consists mainly of a stainless steel cylinder housing a ^{63}Ni radioactive source.

The source acts as cathode in the ionization cell while another cylindrical coaxial electrode acts as an anode (collecting electrode). High temperature resistant insulating material ensures effective insulation between the two electrodes and the detector body

The detector is heated by a low-voltage resistor controlled by an electronic thermoregulator.

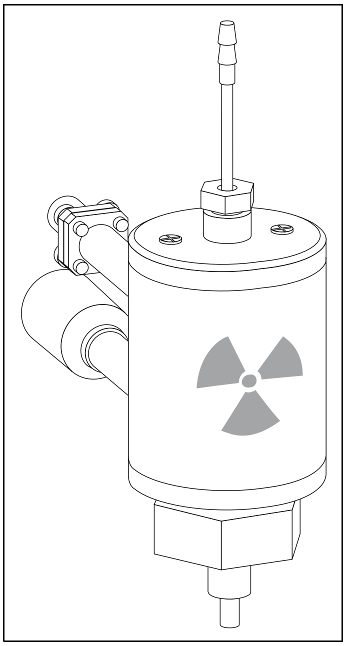


Figure 2.3-2. Electron Capture Detector

WARNING! The Electron Capture Detector (ECD) contains a ^{63}Ni beta-emitting radioactive source of 370 MBq (10 mCi).

The ^{63}Ni radioisotope, electrically deposited as metal on a nickel foil, is in a cylindrical source holder made of 6-mm stainless steel. This holder is fixed to the detector body, also made of stainless steel, to protect it and make it inaccessible from the outside.

The radioisotope is not released by its support at temperatures lower than 450 °C.

This temperature can never be reached by the detector, whose maximum operating temperature is 400 °C and is protected by a safety device (thermo-resistor regulator complying with standard DIN 43760) that does not allow overheating to occur.

The normal operation of the detector does not involve any dispersion of solid or gaseous radioactive material, and therefore the risk of direct or secondary radiation (Bremsstrahlung) coming from the detector is practically nil.

For no reason should the detector be opened or handled by the operator. Any maintenance or service operations involving even partial disassembling of the instrument must be performed ONLY by qualified personnel at the laboratory expressly authorized by ThermoQuest and specifically licensed to handle radioactive material.

Wipe Test

The ECD, before leaving the factory, is tested for surface contamination by means of a *wipe test* (leak test) method. Each detector is provided with a certificate reporting the results of the values found and the procedure followed.

NOTE The users of this detector in the United States are required to perform a wipe test on their ECD at intervals not to exceed 3 years (36 months) following the reported procedure. For other countries, please refer to the appropriate agency for equivalent requirements.

Carrier and Detector Gases

In the ECD cell, the ^{63}Ni sources releases β particles that collide with the molecules at an easily ionizable carrier gas (or make-up gas) to produce low energy electrons.

Nitrogen or argon/5–10% methane are the gases generally used.

Argon/methane is recommended when a higher linear range is required or when contaminants in the carrier gas make a high mobility of electrons necessary to restore correct operating values. Both gases should be of high purity and must not contain more than 1–2 ppm of oxygen or water vapor, since their presence would reduce the concentration of free electrons and, therefore, the probability of capturing them.

The gases normally used with ECD are shown in Table 2.3-4.

Table 2.3-4. ECD Carrier Gases.

Carrier Gas	Capillary Columns	Packed Column
Helium	X	
Nitrogen	X	X
Hydrogen	X	
Argon		X

When using helium or hydrogen as a carrier gas with capillary or wide-bore columns, the detector should be fed with nitrogen or argon/methane through the make-up gas line.

WARNING! **Hydrogen is a potentially dangerous gas. Refer to *Using Hydrogen* on page xxiv for safety information.**

Operating Principle

The ECD operates according to the principle of gas phase absorption by electron capturing molecules.

The primary electrons emitted by the radioactive source (beta emission) collide with the molecules of carrier or make-up gas (such as nitrogen) and give rise to an ionization process with the formation of secondary electrons and positive ions (Equation 2.3-1).

$$\beta * + N_2 \qquad \beta + N_2^{+} + e^{-} \tag{2.3-1}$$

By the application of a weak electrical field between the electrodes, the electrons are rapidly collected at the anode generating a small current (standing current), while the possibility for *heavy* positive ions to recombine with electrons is negligible.

When an electron capturing substance passes through the detector cell, the current is reduced because of the absorption of electrons by this substance according to one of the following reactions (Equations 2.3-2 and 2.3-3).

$$e^{-} + AB \qquad AB^{-} + h\nu \tag{2.3-2}$$

$$e^{-} + AB \qquad A\cdot \ + B^{-} \tag{2.3-3}$$

In Equation 2.3-2, an energized negative molecular ion forms, while in Equation 2.3-3, after the electron capture, the molecule dissociates (dissociative capture) generating a free radical A· and a negative ion B^{-}.

The energy freed during the capture in Equation 2.3-2 is the measure of the electron affinity of the molecule.

The succession of phenomena determining the detector response ends by the neutralization of the negative ions formed by *capture*. The detector response is therefore related to the loss of electrons that occurs by capture in the system in equilibrium.

The decrease in the electron concentration is converted into an electric signal proportional to the concentration of solute present.

Molecular Structure and Detector Response

The sensitivity and selectivity of the ECD response are determined by the electron affinity of the substances entering the detection cell and are affected by the operating parameters and analytical conditions.

In the case of organic compounds, the electron affinity mainly depends on the presence of electrophores in the molecular structure, such as halogens, nitro groups, organometals or diketons.

For halogens the ECD response decreases in the following order:

$$I > Br > Cl > F$$

The response factor, and therefore selectivity, can vary between 1 and 10^6 as a function of the degree of the electron affinity of molecules, as shown in Table 2.3-5. These values are also affected by temperature that enhances the detector response for those compounds capturing electrons dissociatively.

Considering the differences in response, you must calibrate the detector before performing quantitative determinations. To calibrate the detector, you inject standard mixtures under the same operating conditions used for the samples to be tested. The detector sensitivity is also affected by carrier and make-up gas flow rates, since the detector response is related to the solute concentration of the gaseous mixture.

Table 2.3-5. Relative Response to Some Organic Compounds

Substance	Relative Sensitivity
Ethane Benzene Butanol	1
Acetone Chlorobutane Chlorobenzene 1,2 Dichloroethane	$1–10^2$
Anthracene Keto-steroids Tetraethyl lead Benzyl chloride Chloroform Nitrobenzene	$10^2–10^4$
Carbon disulphide Cinnamaldehyde Carbon tetrachloride Dinitrophenol	$10^4–10^5$
Diethyl fumarate Dinotrobenzene Hexachlorobenzene Hexachlorocyclohexane	$10^5–10^6$

Constant Current Operating Mode

The detector control module operates in a constant current pulse-modulated mode. During pulse application, electrons migrate to the anode, and therefore their concentration in the cell rapidly drops to zero.

During the interval between pulses, electrons gradually return to their original concentration and to thermal equilibrium in which the capturing process is favorable.

In the relatively long interval between two short pulses, all electrons not consumed by capture are collected at the anode that measures the electron flow (cell current) present at that moment.

In Equation 2.3-4, the average cell current I is proportional to the concentration of electrons $[e^-]$ collected at each pulse, and to the frequency f of the applied pulses:

$$I = K[e^-]f \tag{2.3-4}$$

In constant current operating mode, the cell current is forced to be constant, at a preset reference value, through an electric feedback loop circuit that compares the cell current to the reference current at any time.

When an electron capturing compound enters the detector cell, the electron concentration $[e^-]$ decreases and, according to Equation 2.3-4, the pulse frequency, required to collect the remaining free electrons, rises to maintain a constant cell current.

The difference in the frequency when an electron capturing compound enters the cell and the base frequency, when no sample is present, is converted into an electric signal which is proportional to the concentration of the compound in the detector.

Base Frequency

Base frequency is an important parameter in evaluating the operating status of the ECD system.

For a constant concentration of thermal electrons inside the detector cell, the base frequency is a function of the reference current, pulse amplitude and pulse width selected. The frequency increases when the reference current is increased, or when the pulse duration or pulse amplitude are reduced.

For a given reference current, pulse duration, and amplitude, the base frequency remains constant when only carrier gas and make-up gas flow through the cell. The frequency generally increases, under the same operating conditions, because of decreased electron population inside the cell or reduced electron collecting efficiency. In the latter case, the collecting efficiency can be restored by cleaning or replacing the collecting electrode (anode).

If the electron concentration has decreased due to contaminants entering the detector cell, you must remove the source of contamination.

With a high base frequency, probability of electron capture tends to decrease, and therefore the signal to noise ratio generally decreases.

You must select the appropriate reference current values to maintain the base frequency at acceptable levels in the **DETECTOR (ECD)** menu.

ECD Menu

The **DETECTOR (ECD)** menu contains the detector control parameters if the GC has been configured for an ECD. Press **LEFT DETECT** or **RIGHT DETECT** to open the menu shown in Table 2.3-6.

Table 2.3-6. ECD Menu

Menu	Range	Comments
RIGHT DET (ECD)		Title bar.
Base temp	On/Off, 30–400 °C[1]	This indicates the detector base body temperature. Press **ON** to enable the heater and to display the actual and setpoint values. Press **OFF** to disable the heater and to display the actual value.
ECD temp	On/Off, 20–400 °C	This indicates the detector temperature. Press **ON** to turn on the heater and to display the actual and setpoint values. Press **OFF** to turn off the heater and to display the actual value.
Ref current nA	0.0–3.0 nA in steps of 0.1 nA	This indicates the cell reference current expressed in nanoamperes.
Freq kHz	0–999.99 kHz	This indicates the actual value of the pulse frequency rate. Refer to *Base Frequency* on page 73 for more information.
Pulse amp V	5–50 V in a continuous mode	This indicates the pulse amplitude expressed in volts.
Pulse width us	0.1, 0.5, or 1.0 µs	This indicates the pulse width expressed in microseconds. Press **ENTER** to open the submenu. An asterisk appears on the left of the pulse width selected.
Mkup[2] (XX)	On/Off, 0–100 mL/min	This indicates the make-up gas used with ECD. The type of the gas is displayed in parentheses (for example, N2). Press **ON** to turn on the flow and display the actual and setpoint values. Press **OFF** the turn the flow off and display the actual value.

1. Up to 500 °C if the GC is configured for high temperature operation.
2. If you have a non-DGFC module, the make-up gas must be measured and adjusted manually from a pressure regulator located in the pneumatics. The menu only displays the flow mode On/Off.

Nitrogen Phosphorous Detector Overview

The NPD provides selective detection of nitrogen or phosphorous organic compounds.

A ceramic matrix thermionic source, positioned above the jet, is electrically heated in a dilute hydrogen/air environment to create a hot, chemically reactive gas layer around the source.

When compounds containing nitrogen or phosphorus atoms impact this hot source, electronegative decomposition products are formed and ionized by extraction of electrons from the thermionic source. The negative ions are then collected and detected through the electrometric amplifier.

A thermionic source with a different surface coating is also available. This source provides high specificity and sensitivity to certain electronegative molecules when operating in an inert nitrogen gas environment. This is the Enhanced Nitrogen Selectivity (ENS) operating mode.

The jet, mounted on the detector base body is suitable for operating temperature up to 450 °C. Figure 2.3-3 shows the NPD.

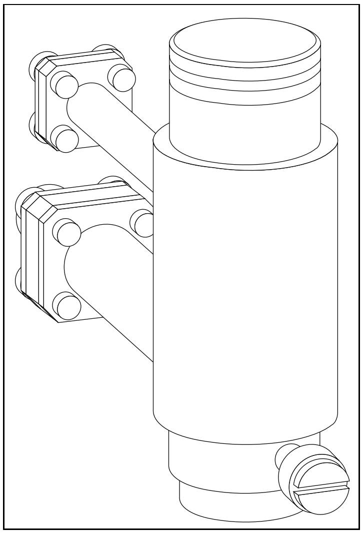


Figure 2.3-3. Nitrogen Phosphorus Detector

Thermionic Source Lifetime

Source lifetime can vary depending on the individual source, the operating temperature, and the analytical conditions. The source heating current needs to be just high enough to produce an active layer around the source itself.

When a readjustment of the source heating current is necessary, the magnitude of the detector standing current or the response to a standard sample can serve as a guide to the correct adjustment.

To prolong the source lifetime, we recommend you turn off the heating current and the hydrogen flow when the detector is not being used for a prolonged period of time (for example, overnight or on weekends), or when the carrier gas flow is interrupted.

Bleed from silicone-based stationary phases or residual silanizing reagents (from derivatization procedures) may contaminate the source surface with silicone dioxide and reduce the operative lifetime. Also the extended use of halogenated solvents can adversely affect the source lifetime by the formation of reaction by-products on the source coating.

Carrier and Detector Gases

The gases normally used with the NPD are shown in Table 2.3-7.

Table 2.3-7. NPD Carrier Gases

Carrier Gas	Capillary Columns	Packed Column
Helium	X	X
Nitrogen	X	X
Hydrogen	X (only with DPFC)	

WARNING! **Hydrogen is a potentially dangerous gas. Refer to *Using Hydrogen* on page xxiv for safety information.**

The carrier gas flow range depends on the type of the gas used and on the type and diameter of the capillary or packed column installed.

The fuel and make-up gases for the NPD are:

- Fuel Gas: Hydrogen, Air
- Make-up Gas: Nitrogen, Helium

Nitrogen is preferred over helium because it has a much lower thermal conductivity, and a lower heating current is required for the source.

NOTE When a packed column is used, a make-up gas is not necessary.

The detector gas flow rates generally used are:

- Hydrogen: 2–4 mL/min
- Air: 40–80 mL/min
- Make-up: 10–20 mL/min

NPD Menu

The `DETECTOR (NPD)` menu contains the NPD control parameters.

Press **LEFT DETECT** or **RIGHT DETECT** to open the `DET (NPD)` menu. The parameters are explained in Table 2.3-8.

Table 2.3-8. NPD Menu

Menu	Range	Comments
`RIGHT DET (NPD)`		Title bar.
`Source curr. A`	On/Off, 1.000–3.500 A in steps of 0.01 A	This is the current applied to heat the thermionic source. It is expressed in amperes. Press **ON** to enable the current and to display the actual and setpoint values. Press **OFF** to disable the current and to display the actual value.
`Base temp`	On/Off, 30–450 °C	This the detector base body temperature. Press **ON** to enable the heater and to display the actual and setpoint values. Press **OFF** to disable the heater and to display the actual value.
`Signal pA`	Not editable	This parameter shows the collector current in picoamperes (standing current level).
`Target level`	0.0–99.9 (for input range of 0), 0–999 (for input range of 1–3)	This is the target level, expressed in pA, to be used as a reference value.
`Auto adjust`	Yes/No, 0–999 pA	This line indicates the automatic adjustment of the `Signal pA` to reach the given `Target level`. Press **YES** to enable auto adjust. The autoadjust range is limited to 0 to 999 pA.
`Polarizer V`	1.0–99.0 in steps of 0.1 V	This indicates the source polarizing voltage in volts.
`H2`	On/Off, 0–10.0 mL/min in steps of 0.1 mL/min	This indicates the hydrogen flow supplied to the detector. Press **ON** to enable the gas flow and to display the actual and setpoint values. Press **OFF** to disable the flow and to display the actual value. When you have a non-DPFC module, the actual values are not displayed and you can select only `On` or `Off`.
`H2 delay time`	On/Off, 0.00–999.9 min	This parameter may be set to interrupt the hydrogen flow during the solvent elution to protect the source. After this time, the hydrogen flow is automatically restored. Press **ON** to enable the delay and to display the actual and setpoint values.

Table 2.3-8. NPD Menu (Continued)

Menu	Range	Comments
`Air`	On/Off, 0–600 mL/min	This indicates the air flow supplied to the detector. Press **ON** to enable the gas flow and to display the actual and setpoint values. Press **OFF** to disable the flow and to display the actual value. When you have a non-DPFC module, the actual values are not displayed and you can select only `On` or `Off`.
Mkup (N2)[1]	On/Off, 0–100 mL/min	This indicates the make-up gas used with NPD. The type of the gas is displayed in parentheses. Press **ON** to enable the gas flow and to display the actual and setpoint values. Press **OFF** or **0** to disable the flow and to display the actual value. The flow cuts off during the source ignition sequence. It turns back on before the ignition threshold test. The flow remains on when the NPD is off. When you have a non-DGFC module, the actual values are not displayed and you can select only `On` or `Off`.

1. If you have non-DGFC module, the detector gases (H_2, air, and make-up) must be measured and adjusted manually from a pressure regulator located in the pneumatics. The menu only displays the flow mode and `On/Off`.

SECTION III

Functional Tests

This section provides information about alarm, diagnostic, and error messages of the TRACE GC 2000.

Chapter 3.1, *Info Messages*, contains information to help identify and troubleshoot info messages on the TRACE GC 2000.

Chapter 3.2, *Error Messages*, contains information to help identify and troubleshoot info, error, and diagnostic messages on the TRACE GC 2000.

Chapter 3.3, *Diagnostic Messages*, contains information to help identify and troubleshoot info, error, and diagnostic messages on the TRACE GC 2000.

3.1

Info Messages

This chapter contains information to help identify and troubleshoot info messages on the TRACE GC 2000.

Chapter at a Glance…

Info Messages

Table 3.1-1 lists the TRACE GC 2000 info messages, which act as an internal help system. Each info message is accessed by pressing the **INFO** key. The info message displayed corresponds to the position of the cursor on a specific line of the display panel.

NOTE Messages with AS denote autosampler.

Table 3.1-1. Info Messages

Info Message	Info Message	Info Message
GCInfo GC UNIT INFO Displays information unique to this unit SN #runs mfg. date	**OKFailInfo** DIAGNOSTIC INFO Displays powersupply Status as OK or Failed.	**ChanFailInfo** DIAGNOSTIC INFO Temp Channel Status OK OPEN SHORTED NOT USED etc.
MethNoInfo METHOD NUMBER INFO Enter the saved method number to be loaded (1 to 10).	**SpecCycInfo** SPECIFIC CYCLE INFO Press ENTER to see how to set the specific cycle.	**SlctDayInfo** SELECT DAY INFO Pick the day of the week that the event should occur on.
ClkEvValveInfo VALVE EVENT INFO Press ENTER to see how to set up a valve event.	**DiagInfo** DIAGNOSTIC INFO Enter an integer value for debugging the heater controls.	**DetTypeInfo** DETECTOR TYPE INFO Pick the detector type and location (a=lft b=ctr c=rght)
MakeupGasInfo MAKEUP GAS INFO Pick the makeup gas desired from the list of choices.	**DetectorInfo** DETECTOR INFO Enter the submenu to be able to select the desired detector	**ListInfo** LIST INFO Choose an item from the list. Current pick has a * by it.
DblInletInfo DblPro INLET INFO Choose Yes if this GC has double SSL inlets for DblPro.	**DateTimeInfo** DATE & TIME INFO Displays the current date and time as set in CONFIG.	**ConfigTimeInfo** ENTER TIME INFO Enter the time of day as hhmm with all 4 numbers required.
ConfigDateInfo ENTER DATE INFO Enter the date as mmddyy with all six digits required.	**TEVeditInfo** TIMED EVENT INFO Choose an item from the list to be the event to occur.	**ExtEVeditInfo** EXTERNAL EVENT INFO Press ENTER to setup the external timed event to occur.
TEVInfo TIMED EVENT INFO Shows a timed event. Press CLEAR to be able to delete it.	**StoreMethodInfo** STORE METHOD INFO Indicate the entry (1-10) to store the current method in.	**LoadMethodInfo** LOAD METHOD INFO Indicate the entry (1-10 or default) to load the method from

Table 3.1-1. Info Messages (Continued)

Info Message	Info Message	Info Message
LSMethodInfo METHOD LD/STR INFO Indicate the method to be loaded from or to be stored into.	**DoLSMethodInfo** LOAD/STORE INFO Indicate whether to Load from or Store to the chosen method	**SaveDefaultInfo** SAVE AS DEFAULT INFO Will save this mthd as the default and saves into EEPROM.
StoreSeqInfo STORE SEQUENCE INFO Indicate the entry (1-5) to store the current sequence in.	**LoadSeqInfo** LOAD SEQUENCE INFO Indicate the entry (1-5) to load the sequence from.	**LeftInlInfo** LEFT INLET INFO Enter inlet submenu to choose the inlet desired on the left.
RightInlInfo RIGHT INLET INFO Enter inlet submenu to choose the inlet desired on the right	**ValveInfo** SAMPLE/SWITCH VALVE Use ON/OFF in order to OPEN/CLOSE the valve.	**MultiValveInfo** MULTIPOSITION VALVE Enter the valve position# or ON/OFF to go up/down by one
InletValveInfo INLET VALVE INFO Use ON/OFF in order to OPEN/CLOSE the valve.	**EPCTypeInfo** MODULE INFO Gives the type of gas control module in use for channel.	**EPCPresInfo** AMBIENT PRESS INFO Displays ambient pressure sensed by the DPFC controller.
ASInjectInfo SEQ CONTROL INFO Shows how many of the injections have been done.	**ASPauseInfo** SEQ CONTROL INFO Press ENTER to pause the sequence at the end of the run.	**ASPriVialInfo** SEQ CONTROL INFO Shows which vial is being used for this priority run.
ASResumeInfo SEQ CONTROL INFO Press ENTER to start the sequence back up from where it was.	**ASRunPriInfo** SEQ CONTROL INFO Press ENTER to start a priority sequence as the next run.	**ASStartInfo** SEQ CONTROL INFO Press ENTER to start a regular sequence.
ASStopInfo SEQ CONTROL INFO Press ENTER to stop the sequence after the current run.	**ASSubseqInfo** SEQ CONTROL INFO Shows which vial is being used for which subsequence now.	**ASRegStatusInfo** SEQ CONTROL INFO Indicates that a sequence is active.
ASWaitStatusInfo SEQ CONTROL INFO Indicates that an active sequence is waiting for the GC.	**ASPauseStatusInfo** SEQ CONTROL INFO Indicates the seq is on hold. Hit Resume to reactivate.	**ASStopStatusInfo** SEQ CONTROL INFO Indicates that no sequence is active.
ASAbortStatusInfo SEQ CONTROL INFO A sequence error was detected. Fix and Resume to reactivate	**ASNoSeqStatusInfo** SEQ CONTROL INFO Indicates that no sequence is defined so it cant be run.	**ASPriStatusInfo** SEQ CONTROL INFO Shows the state of the head space autosampler

Table 3.1-1. Info Messages (Continued)

Info Message	Info Message	Info Message
ASRepInfo SEQ CONTROL INFO Shows the repitition of this sample that is currently in use.	**GenericStatusInfo** STATUS INFO Shows the status of the GC usually what it expects next.	**TempStatusInfo** STATUS INFO Temp out of range. It currently is but is expecting
OvenTempStatusInfo STATUS INFO Fatal temp in heated zone. Correct and cycle power on/off.	**ErrorStatusInfo** ERROR STATUS INFO GC in error state. Contact Finnigan customer service.	**RunStatusInfo** STATUS INFO This indicates where the system is in the oven profile.
ISVialInfo INT STD VIAL INFO Enter vial# 1-90 for int std or 100-103 (a-d) for solv SLV.	**QuestionClear** You have requested clearing the RUNLOG. Press <YES> to clear another key to exit.	**RunlogInfo** RUN LOG INFO Shows the deviations during the run. Use arrows to see all.
ShowOnlyInfo DIAGNOSTIC INFO Displays diagnostic results and internal calculated values.	**InletInfo** INLET INFO Enter the submenu to be able to select the desired inlet.	**HeaderInfo** INFO LINE INFO This line is for information only usually a comment.
SplitRatioInfo SPLIT RATIO INFO Displays the split ratio = split flow/ column flow.	**TotalFlowInfo** TOTAL FLOW INFO Displays total flow= split flow+col flow+ septum purge.	**PressureInfo** PRESSURE INFO Displays pressure in psi kPa or Bar as configured.
StopWatchInfo STOPWATCH INFO Displays flow and time elapsed in the stopwatch.	**DetOutInfo** OUTPUT INFO Displays detector output from the V/F at a 10HZ rate.	**SignalpAInfo** SIGNAL pA INFO Displays the offset adjusted signal value in picoamps.
RunPresInfo PRESSURE INFO Displays the actual pressure during the run.	**DblProDlyInfo** DOUBLEPRO DELAY INFO Displays injection delay between inlets using doublepro mode	**RunTimeInfo** RUN TIME INFO Displays a run time in minutes to two decimal places.
StartCompInfo START COMP INFO Will start the base- line compensation process.	**LoadBasicInfo** LOAD BASIC MTHD INFO Loads a basic method in to clear out the current method.	**ColFlowInfo** COLUMN FLOW INFO Displays the actual flow on the column in cc/min.
CARInfo ONE MOMENT Setting Carrier Gas Type	**DETInfo** ONE MOMENT Setting Detector Gas Type	

3.2

Error Messages

This chapter contains information to help identify and troubleshoot info, error, and diagnostic messages on the TRACE GC 2000.

Chapter at a Glance…

Error Messages

Table 3.2-1 lists the TRACE GC 2000 error messages, a brief description, and troubleshooting options that may appear on the display panel. Errors must be corrected before proceeding further.

Table 3.2-1. Error Messages

Error Message	Error Message	Error Message
CONSTANT	**CONSTANT**	**CONSTANT**
OrderViolation These entries must be sequential. Veri-fy adjacent values & re-enter.	**MissingInletJumper** Configuration Error You have selected Configure Inlet but Hdwre shows NO inlet	**MethodNum2big** When saving/loading a Method you re-quested method # >10 Try with number <=10
ClockError Error Setting/Read-ing Clock. Proceed with CAUTION. Press Any Key to Proceed.	**NoDetTimeParams** XXX Detector has no time parameters. Any Key to Proceed.	**OvenMaxViolation** New Oven Max Temp is below a SetPoint(s). SetPoint(s) will be reset to new maximum
DetConfError The DPFC module is not compatible with the detector cards.	**LeakCheckinProcess** LEAK CHK IN PROCESS No editing allowed while leak check is in process.	**ColumnEvalinProcess** COL EVAL IN PROCESS No editing allowed while column evalu-ation is in process.
TempOFFError Flame ignition can not be done with Det base temperature OFF or set below 150C.	**SplitRatioViolation** Error: Calculated total flow exceeds max of 500 cc/min. Press any key.	**SplitFlowViolation** Error: Calc'd total flow exceeds 500 cc/ min. Splt ratio will be reduced. Any key.
MethodNotSavedorBad A good copy of the requested method does not exist. Try another or create it	**LoadMethodError** LOAD METHOD Load method not allowed while GC is running.	**LoadSequenceError** LOAD SEQUENCE Load sequence not allowed while GC is running.
ConfigChecksum Config saved check-sum is bad. Default is being loaded. Edit Meth and Cfg!	**MethodChecksum** Method saved check-sum is bad. Default is being loaded. Edit Meth and Cfg!	**NoHydrogenSensor** Hydrogen sensor not available or not configured. Any Key to Proceed.
ConfigHasChanged The GC Configuration has changed since Method saved. AnyKey to Proceed w/Care.	**MultipositionValveError** Invalid valve # Must be 4 6 8 10 12 or 16.	**TimeFormatError** Invalid Input. Input must be 4 digits.
ClockTimeError Invalid Input. Must be hhmm where hh = (0-23) and mm = (0-59).	**DateFormatError** Invalid Input. Input must be 6 digits.	**InActiveEditMode** Can not alter GC run state while in NON-ACTIVE EDIT MODE.

Table 3.2-1. Error Messages (Continued)

Error Message	Error Message	Error Message
NOInlets ERROR: No Inlets have been installed.	**OnlyPKDInlet** ERROR: Only Packed Inlet(s) installed. Col. Eval. or leak check not allowed.	**NoSampler** SAMPLER ERROR No autosampler installed.
EvalRColPresOFFmsg R COLUMN EVALUATION Column must be pressurized for evaluation.	**EvalLColPresOFFmsg** L COLUMN EVALUATION Column must be pressurized for evaluation.	**FaultMsg7** Report to ThermoQuest Ph: (512)251-1571 Fax: (512)251-1547 Fault 7. Press a key
FaultMsg8 Report to ThermoQuest Ph: (512)251-1571 Fax: (512)251-1547 Fault 8. Press a key	**DPFCPreprunError** DPFC failure during preprun. Press any key to resume.	**DPFC_OCHOTError** HOTOC failure during preprun. Press any key to resume.
DPFC_GasOutError Loss of carrier. Oven will shutdown In 60 seconds.	**OvenShutDownError** Oven shutdown Loss of carrier Press any key to Resume.	**DSHasAS** Data system has the autosampler function locked out.
ASOffline SAMPLER ERROR Sequence aborted: Sampler off-line	**ASBadMethod** SAMPLER ERROR Sequence aborted: Method download failure	**ASNoStart** SAMPLER ERROR Autosampler stopped with no remote start.
OvenTempError TEMPERATURE SHUTDOWN Oven temperature exceeded the allowed temperature limit(s)	**OverTempError** TEMPERATURE SHUTDOWN temperature zone(s) exceeded the allowed temperature limit(s)	**ShortedRTDError** TEMPERATURE SHUTDOWN Shorted Temp sensor Run Temperature Diagnostics
ShortedRTDOvenError TEMPERATURE SHUTDOWN Shorted Oven sensor Run Temperature Diagnostics	**OVENError** TEMPERATURE SHUTDOWN OVEN is Over Heating out of Control Check Sensor	**OVENbusted** TEMPERATURE SHUTDOWN OVEN Not Controlling and Not Heating Check Sensor
PTVError TEMPERATURE SHUTDOWN PTV is Over Heating out of Control Check Sensor	**PTVbusted** TEMPERATURE SHUTDOWN PTV not Controlling and not Heating Check Sensor	**ISOError** TEMPERATURE SHUTDOWN Isothermal Zone is Over Heating out of control
ISObusted TEMPERATURE SHUTDOWN Isothermal Zone is not Controlling or Heating	**TCDError** TEMPERATURE SHUTDOWN TCD is Over Heating out of Control Check Sensor	**TCDbusted** TEMPERATURE SHUTDOWN TCD not Controlling and not Heating Check Sensor

Table 3.2-1. Error Messages (Continued)

Error Message	Error Message	Error Message
OverHardwareError HARDWARE SHUTDOWN temperature zone(s) exceeded the allowed HARDWARE limit(s)		
VARIABLE	**VARIABLE**	**VARIABLE**
TempViolation Maximum Temp is To enter a larger value you must chg configuration!.	**TempViolation** Minimum Temp is This value will be entered.	**Violation** Mxx. Entry is for this field.
LimitViolation ERROR: The range for the value is between	**OffsetViolation** The present signal can be subtracted by up to	**SplitRatioInformation** Split ratio limited by max total flow of 500 cc/min. Split ratio max is

3.3

Diagnostic Messages

This chapter contains information to help identify and troubleshoot info, error, and diagnostic messages on the TRACE GC 2000.

Chapter at a Glance…

Diagnostic Messages

Table 3.3-1 lists the TRACE GC 2000 diagnostic messages, a brief description, and troubleshooting options.

Table 3.3-1. Diagnostic Messages

Diagnostic Message	Description	Troubleshooting
Software Info	Press **ENTER** to display software information.	
Serial #	The GC serial number is factory coded.	
Ver:	Displays GC firmware version and year created.	
DPFC ROM Ver:	Displays DPFC firmware version. DPFC firmware EPROM is located on the DPFC processor PCB.	
Manufactured:	Factory coded with month/day/year. Displays when the unit is initially powered up.	
Total Runs	Keeps a running total of the number of times the GC start run was initiated.	This total is reset when the GC firmware is replaced or reloaded.
Temp Diagnostic	Allows the operator to scroll all GC temperature zones and view the status. Note: All temperature controlled zones are disabled while this menu is on the GC screen. The Temp Diagnostics menu line will not appear when the GC is in a run.	The status for each zone will indicate OK, NOT USED, OPEN, SHORTED, or NOT CONTROLLING.
HARDWARE CONFIG	Press **ENTER** to display hardware configuration.	
DPFC ROM Ver:	Displays the DPFC firmware version.	

Table 3.3-1. Diagnostic Messages (Continued)

Diagnostic Message	Description	Troubleshooting
`L inlet module` `R inlet module`	Identifies the type of carrier flow module that is installed in this location (not the inlet type). Possibilities include OCI, S/SL, and PKD.	Identification of the carrier flow module occurs when the GC power is cycled or turned on. If the module is unplugged or defective, it will read `None`. Selecting the left or right inlet identifies the pressure range of this module. Scroll to pressure and press the **INFO/DIAG** key. The display will identify the usable range of the module.

Table 3.3-1. Diagnostic Messages (Continued)

Diagnostic Message	Description	Troubleshooting
L DET MODULE R DET MODULE AUX DET MODULE	Identifies the type of detector gas flow module in this location. Possibilities include AA, AB, AC, AD, AE1, AE2, AE3. All gas modules have the capability for three gas paths: H2, Air, and Makeup. The module type will determine which gas paths are present. Gas path 1 is the H2 gas path. Gas path 2 is the Air gas path. Gas path 3 is the Makeup gas path.	If the module is unplugged or defective it will read None. Module coding is as follows: AA = Option 401. Uses gas module, path 3 only. AB = Option 402. Uses gas paths 1 and 2 without the make-up gas path. The ECD make-up will use gas path 1. The FPD/FID use gas path 1 for H2, and path 2 for Air. The PID uses gas path 2 for sheath gas, and path 1 for Makeup. AC = Option 403. Uses gas paths 1, 2, and 3. The ECD uses Makeup gas path 3 only. The FID/FPD use gas path 1 for H2, and path 2 for Air. The FPD can not be configured for make-up. The FID uses gas path 3 for Makeup. The PID uses gas path 2 for sheath gas, and path 3 for Makeup. AD = Option 404. Uses gas path 1, 2, and 3. The ECD uses gas path 3 only. The FID/FPD uses gas path 2 for Air, and path 3 for H2. The NPD uses gas path 1 for low flow H2, path 2 for Air, and path 3 for Makeup. The AE gas module is used for auxiliary gases. This module may be configured with gas paths 1, 2, or 3. This module uses a proportional electronically controlled valve and pressure sensor. It is designed to furnish flow to a flow path containing a fixed or variable restrictor.

Table 3.3-1. Diagnostic Messages (Continued)

Diagnostic Message	Description	Troubleshooting
`DPFC Temp`	Temperature sensor on the DPFC processor PCB supplies ambient temperature information to the GC processor for front panel display. This value is updated continuously every two to three seconds.	The temperature sensor is located on the DPFC processor PCs. Temperature sensor calibration is performed in the factory. Gross errors in displayed ambient temperature require the DPFC processor board to be recalibrated or replaced.
`Ambient Press`	Displays atmospheric pressure. The displayed pressure unit is in KPA or PSIG, depending on the configuration that was selected as part of the display pressure unit configuration page. This value is updated only when the `Ambient Pres` display line is scrolled out of view then back into view on the display.	The ambient pressure sensor is located on the DPFC processor PCB. Pressure sensor calibration is performed in the factory. Gross errors in displayed ambient pressure require the DPFC processor board TO be recalibrated or replaced.
`FID Transformer`	This line displays the type of detector transformer present in the power module when an FID is to be used on the GC. One transformer will support two FIDs.	The transformer is supplied with a jumper that will connect to J6. This identifies which transformer is installed. J6 is a three-pin connector. Pins 1 and 3 are jumpered to designate an FID transformer has been installed.
`NPD Transformer`	This line displays the type of detector transformer present in the power module when an NPD is to be used on the GC. The NPD transformer is an additional transformer that supports only the NPD. One transformer will support dual NPDs.	The transformer is supplied with a jumper that will connect to J5. This identifies which transformer is installed. J5 is a three-pin connector. Pins 2 and 3 are jumpered to designate an NPD transformer has been installed.
`STD Transformer`	This line displays the type of detector transformer present in the power module when an ECD or FPD is to be used on the GC. The STD transformer replaces any existing FID transformer. The standard transformer supports the FID, ECD, and FPD single or dual configuration.	The transformer is supplied with a jumper that will connect to J6. This identifies which transformer is installed. J6 is a three-pin connector. Pins 2 and 3 are jumpered to designate an STD transformer has been installed.

Table 3.3-1. Diagnostic Messages (Continued)

Diagnostic Message	Description	Troubleshooting
`No DET Transformer`	Indicates no detector transformer is installed in the power module.	A jumper is not correctly installed on J5 or J6 or the jumpered pins are incorrect. Rework as required.
`Power Info`	Press **ENTER** to display power information.	
`Wired for _____ Volts`	Designates if the unit is configured as a 115 V ac or 220 V ac unit.	
`AC Voltage:`	Continually monitors the ac line voltage. The display is updated every 2 to 3 seconds.	Accuracy of this display is calibrated in the hidden configuration. To calibrate, press **CONFIG** and enter `2000`. Once in hidden configuration, scroll down to `AC`. Read the actual line voltage with a calibrated DVM and enter this value in volts ac.
`Max AC Amps`	Limits the GC line current to this value.	Changes in this value will effect maximum heating rates. This value is set as part of the hidden configuration. To change this value, press **CONFIG** and enter `2000`. Once in hidden configuration, scroll down to `Max GC Amps`. Enter the desired value in Amps in the range of 10 to 20.
`AC Limit %`	Limits the maximum percentage of power that can be applied to the oven heater.	
`+24 Volts:`	`OK` indicates the presence of the 24-volt power supply.	An `OK` only indicates the +24-volt supply exists. It does not indicate the actual voltage.
`+15 Volts:`	`OK` indicates the presence of the +15-volt power supply.	An `OK` only indicates the +15-volt supply exists. It does not indicate the actual voltage.
`+5   Volts:`	`OK` indicates the presence of the +5-volt power supply.	An `OK` only indicates the +5-volt supply exists. It does not indicate the actual voltage.
`-15 Volts:`	`OK` indicates the presence of the –15-volt power supply.	An `OK` only indicates the –15-volt supply exists. It does not indicate the actual voltage.
`-5   Volts:`	`OK` indicates the presence of the –5-volt power supply.	An `OK` only indicates the –5-volt supply exists. It does not indicate the actual voltage.

Table 3.3-1. Diagnostic Messages (Continued)

Diagnostic Message	Description	Troubleshooting
`Oven Info`		
`Chassis Temp`	Monitors the temperature around the analog PCB. U12 on the analog board is used as a 2.5V reference device. This device also has an ambient temperature output. This output is used in some of the temperature calculating algorithms.	
`Oven Offset`	This value is usually set to zero. Any entry offsets the oven actual temperature without changing the oven readout value.	
`Oven Temp`	Monitors the actual oven temperature.	Differences in the actual temperature in the oven (as measured by an external calibrated temperature measuring device) and the displayed oven temperature can be adjusted using the Oven Offset above.
`Oven Power %`	Displays the actual percentage of power that is being applied to the oven heater. Full on equals 100%.	
`Oven Predict %`	As the oven is heating toward an entered set point, the microprocessor calculates the power required for the oven to hold the specified set point. When the oven is equilibrated at a setpoint temperature, the `Oven Power %` and the `Oven Predict %` should be nearly the same value.	
`Exhaust Doors %`	Indicates at what percentage the oven flapper door is open at the current oven temperature.	

`P1`
`K1`
`DER`
`INTSUM0`
`INTSUM1`
`INTSUM2`
`INTSLOPE`
	These are displayed values only, and can be changed only by factory programmer engineers.	

Table 3.3-1. Diagnostic Messages (Continued)

Diagnostic Message	Description	Troubleshooting
Injector Info		
Lt Injector	Reads the actual temperature.	A value of 0 indicates a detector is not present.
Rt Injector	Reads the actual temperature.	A value of 0 indicates a detector is not present.
P1 K1 DER INTSUM0 INTSUM1 INTSUM2 INTSLOPE	These are displayed values only, and can be changed only by factory programmer engineers.	
Detector Info		
Lt Detector	Reads the actual temperature.	A value of 0 indicates an injector is not present.
Rt Detector	Reads the actual temperature.	A value of 0 indicates an injector is not present.
P1 K1 DER INTSUM0 INTSUM1 INTSUM2 INTSLOPE	These are displayed values only, and can be changed only by factory programmer engineers.	

SECTION IV

Maintenance & Troubleshooting

This section provides maintenance and troubleshooting for the GCQ Plus base unit and flow control for carrier and detector gases.

NOTE For maintenance information regarding ***injectors*** and ***detectors*** refer to the *Maintenance and Troubleshooting Manual*, **PN 31709180**.

Chapter 4.1, *GC Base Unit*, contains procedures for replacing the components associated with the frame and oven assembly. It also explains how to remove the Power Control Module, the CPU, and the Temperature Feedback and Digital I/O unit.

Chapter 4.2, *Digital Pressure Flow Control for Carrier Gases*, provides maintenance and troubleshooting for a Split/Splitless injector.

Chapter 4.3, *Detector Gas Flow Control for Detector Gases*, provides maintenance and troubleshooting for a Cold On-Column injector.

4.1

GC Base Unit

This chapter contains procedures for replacing the components associated with the frame and oven assembly. It also explains how to remove the Power Control Module, the CPU, and the Temperature Feedback and Digital I/O unit.

Chapter at a Glance...

Operating Procedures

Overview

The TRACE central base unit consists of the following:

- Frame and oven assembly
- Power Control Module
- Electronic compartment

The frame and oven assembly consists of the following:

- Oven blower motor
- Oven cooling flapper assembly
- Oven heater baffle

The electronic compartment contains the following:

- Motherboard
- Central Processing Unit (CPU)
- Temperature Feedback and Digital I/O unit

NOTE Since the TRACE GC 2000 is a modular design, the frame and oven assembly and its affiliated components are the only items requiring detailed maintenance instructions.

Replace the Oven Motor

Required Tools

You will need the following tools:

- 3-mm Allen wrench
- 4-mm Allen wrench
- 7-mm nut driver
- 10-mm x 8-mm open-ended wrench
- Appropriate column wrench for removal of the gas chromatograph columns
- Flat-tip screwdriver
- Phillips screwdriver

Required Parts

You will need the following parts:

- Replacement blower motor—includes mounting plate and grommets (PN 155 990 00)
- Silver seal M8 x 1 for column adapter fitting (PN 290 071 00)
- Tube of anti-seize compound (PN 76460-0014)

Introduction

Removing the blower motor will require the removal of several GC parts and assemblies.

To access the oven baffle, the following items will be removed:

- GC top cover
- Rear panel
- Analytical column(s)
- Detector capillary column adapter(s)

To access the blower motor, the following items will be partially removed or disassembled:

- Pneumatic flow module (partial)
- Oven heater baffle
- Oven fan

Read the entire procedure completely to familiarize yourself with the disassembly process before you proceed.

OPERATING PROCEDURE

Replace the Oven Motor

1. Reduce the oven temperature to 25 °C. Turn off all temperature zones. Allow the oven to cool.

CAUTION **Be sure that the oven has cooled to room temperature.**

2. Turn off all carrier gas pneumatic flow to the columns.

WARNING! **Always turn the GC off before removing or replacing any parts.**

3. Turn off the main power on the rear panel of the GC. Disconnect the main power cable from the rear of the GC. This may require loosening the clamp that secures the power cable to the rear panel.
4. Open the oven door.
5. Remove the columns.
6. Remove the detector capillary adapters from each detector using the 10-mm open-ended wrench. A flat silver-coated washer inside this fitting seals the fitting to the detector base.
7. Remove the autosampler if present.
8. Remove the detector inlet cover.

NOTE If an autosampler mounting bracket is installed, it may be necessary to remove it. The mounting screw that secures the autosampler bracket and GC top to a standoff is located under the top cover.

Figure 4.1-1 shows the retaining screws on the GC top cover.

Figure 4.1-1. Retaining Screws on the GC Top Cover

9. Remove the GC top cover by loosening the two retaining screws (Figure 4.1-1). Push the cover back approximately 3 cm. Lift the cover off the GC.
10. Locate the six Allen screws that secure the rear panel to the GC. Remove these screws using the 3.0-mm Allen wrench.
11. Carefully remove the rear panel of the GC. Notice that the cooling fan is attached to the rear panel.

NOTE Pay attention to the orientation of the cooling fan plug, so it can be reconnected in the same way that it was removed.

12. Unplug the power cord to the rear panel cooling fan. Set the rear panel off to the side of the GC.

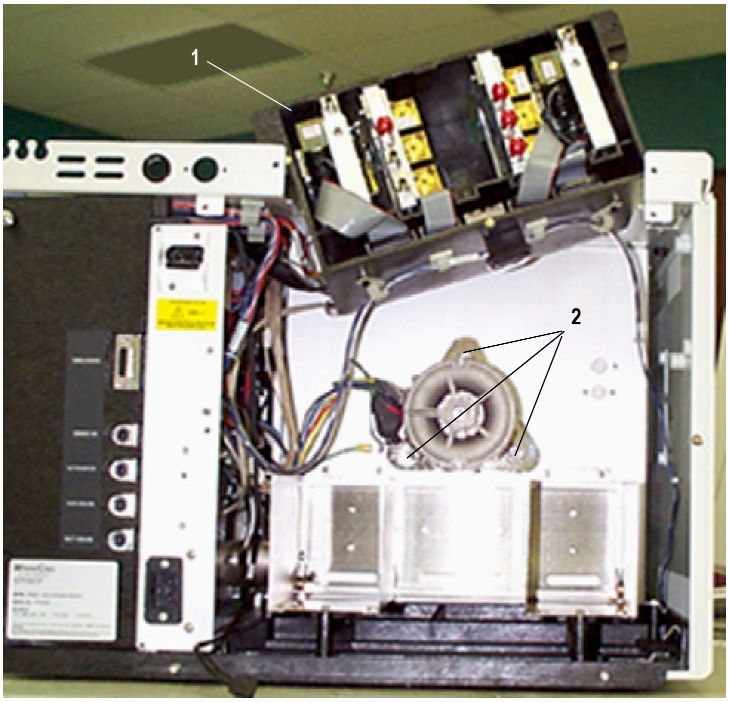
Remove the Pneumatic Flow Module

The pneumatic flow module should be partially lifted from the GC. This will allow access to the blower motor. It is not necessary to remove the plumbing or the electrical connections. The pneumatic flow module is attached with six screws. Four screws mount to the GC upper deck. Two screws secure it to the rear of the GC upper deck.

NOTE The four screws securing the pneumatic flow module to the GC upper deck are different than the two screws securing the pneumatic flow module to the rear of the GC upper deck. Keep these screws separate for correct reassembly.

1. Remove the six screws securing the pneumatic flow module to the GC.
2. Lift the pneumatic flow module (with cables intact) high enough to expose the blower motor.
3. Prop the pneumatic flow module out of the way on the GC upper deck as illustrated in Figure 4.1-2.

Figure 4.1-2 shows the pneumatic flow module propped on the GC upper deck. Note the blower motor screws.



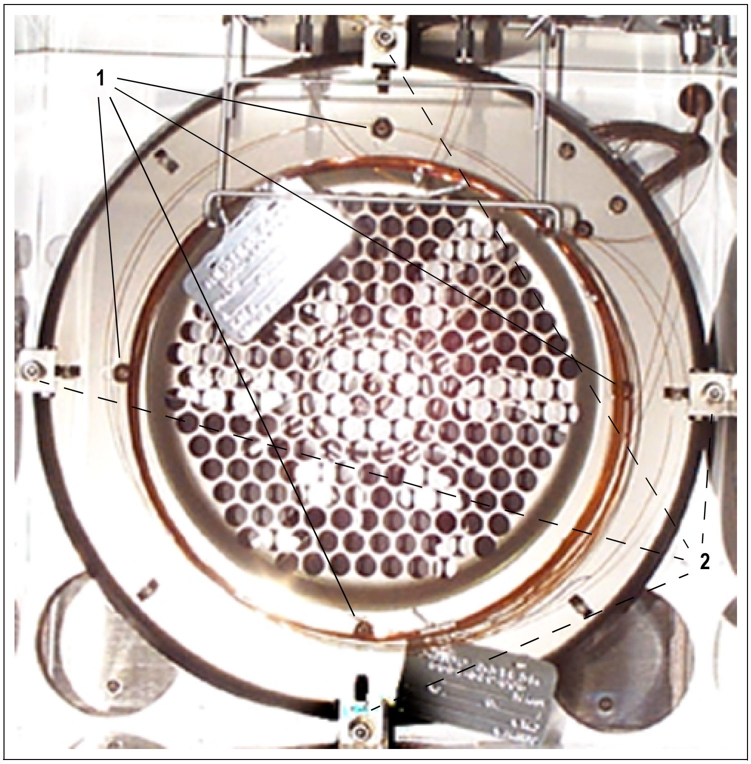
1. Pneumatic Flow Module	2.Blower Motor Screws

Figure 4.1-2. Pneumatic Flow Module Propped on the GC Upper Deck

Remove the Oven Heater Baffle and Oven Fan

The oven heater baffle is attached to the oven wall by four adjustable tabs. These tabs are attached to the oven heater baffle with four Allen screws. The four tab adjustment screws are located on the inside edge of the oven heater baffle (Figure 4.1-3). The tabs are adjusted by loosening these four Allen screws.

Figure 4.1-3 shows the tab adjustment screws and the tab screws for the four adjustable tabs on the oven heater baffle.



1. Tab Adjustment Screws	2.Tab Screws

Figure 4.1-3. Tab Adjustment Screws and Tab Screws on the Oven Heater Baffle

NOTE Anti-seize compound is applied to all screws removed from inside the oven.

1. Loosen the four tab adjustment screws.
2. Remove the four Allen screws that secure the tabs to the oven heater baffle.
3. Slide each of the four tabs inward to allow each tab to clear the oven wall.
4. Rotate the oven heater baffle counterclockwise approximately 2 cm.
5. Push in on the right-hand side of the oven heater baffle, while pulling out on the left-hand side of the oven heater baffle. Swing the oven heater baffle so that it parallels the right oven wall. This will expose the oven blower fan.
6. The oven blower fan is attached to the shaft of the oven blower motor with a setscrew. This setscrew can be loosened with a 4-mm Allen wrench.
7. Loosen the setscrew. Carefully remove the oven fan from the blower motor shaft.

Remove the Blower Motor

1. The blower motor plugs into J17 on the power control PCB (PN 236 995 00). Unplug the blower motor electrical plug by pushing down on the plug tab and pulling out.
2. The ground strap from the motor is secured to chassis ground on a terminal just below the starting capacitor. Locate this terminal.
3. Remove the terminal nut using a 4-mm nut driver; or, unplug the connector. Remove the ground wire.
4. The blower motor is secured to the rear of the oven wall with three #4 self-locking nuts. Using the same 4-mm nut driver, remove these nuts.
5. Locate and note the orientation of the six shoulder washers on each side of the three grommets, before removing the blower motor.
6. Locate the three flat washers between the locking nut and the shoulder washers. Remove and retain these washers for reassembly.
7. Remove the blower motor from the oven by pulling outward.

Assemble the Oven Motor

The replacement blower motor will contain the mounting brackets with the three grommets in place. The existing blower motor will have a total of six shoulder washers. Three shoulder washers are installed on each side of the grommets.

1. Remove the all of the shoulder washers from the old blower motor.
2. Place three of the shoulder washers over the mounting studs located on the rear oven wall.
3. Install the motor on the studs.
4. Place the remaining three shoulder washers over the studs, mating them with the grommets and the blower motor mounting bracket.
5. Place the three flat washers over the studs and against the shoulder washers.
6. Carefully screw the locking nuts back onto the studs, after all of the washers are in place.
7. Tighten the locking nuts until the grommets are flat. Loosen each locking nut by one complete turn.
8. Attach the ground wire to the grounding terminal on the rear oven wall. Secure it with the locking nut.
9. Connect the blower motor electrical plug to J17.
10. Reassemble the remaining components on the rear of the GC in the reverse order in which they were removed.

11. Plug in the rear panel cooling motor.
12. Carefully apply a small amount of anti-seize compound on the end of the blower motor shaft inside the GC oven.
13. Remove the setscrew from the fan. Apply a small amount of anti-seize compound to the setscrew. Replace the setscrew in the blower.
14. Apply a small amount of anti-seize compound to each one of the four Allen screws that hold the oven heater baffle to the tabs.
15. Reinstall the oven blower fan onto the shaft. The fan should be even with the beveled edge on the motor shaft. The motor shaft should not extend more than 1 mm beyond the blower fan.
16. Secure the fan to the motor shaft using the number M4 Allen wrench. Be sure that the setscrew is in place on the flat side of the blower motor shaft.
17. Replace the oven heater baffle in the reverse order in which it was removed.
18. Secure the oven heater baffle to the oven wall with the four Allen screws in the tabs.
19. The tab adjustment screws should be loose. Carefully center the oven heater baffle inside of the oven. Be sure that the center hole in the oven heater baffle screen is centered over the blower motor shaft. The tolerance is very small. The oven heater baffle will not move left or right, nor up or down more than a couple of millimeters. However, be sure that it is centered in the oven over the blower wheel. This will ensure that whenever the GC is turned on, the blower wheel will not be touching the heater coils mounted to the oven heater baffle.
20. Turn the GC on.
21. Close the oven door. Be sure that the oven blower is running.
22. Verify that the heater heats, and the fan rotates without contacting the heater coils.
23. Open the oven door.
24. Reinstall the capillary adapter to the detectors using new silver seals #290 07100.
25. Reinstall the column.
26. Reestablish all flows and temperatures.
27. Perform a column leak check and continue.

Replace the Oven Heater Baffle

Required Tools

You will need the following tools:

- 3-mm Allen wrench
- 4-mm Allen wrench
- 10-mm x 8-mm open-ended wrench
- Appropriate column wrench for removal of the gas chromatograph columns
- Flat-tip screwdriver
- Phillips screwdriver

Required Parts

You will need the following parts:

- Silver seal M8 x 1 for column adapter fitting (PN 290 071 00)
- Tube of anti-seize compound (PN 76460-0014)

Introduction

To remove and replace the oven heater baffle, the following items will be partially or completely removed:

- Top cover
- Rear panel
- Right side panel
- Power supply module (partial)

OPERATING PROCEDURE

Replace the Oven Heater Baffle

1. Reduce the oven temperature to 25 °C. Turn off all temperature zones. Allow the oven to cool.

CAUTION **Be sure that the oven has cooled to room temperature.**

2. Turn off all carrier gas pneumatic flow to the columns.

WARNING! **Always turn the GC off before removing or replacing any parts.**

3. Turn off the main power on the rear panel of the GC. Disconnect the main power cable from the rear of the GC. This may require loosening the clamp that secures the power cable to the rear panel.

4. Open the oven door.

5. Remove the columns.

6. Remove the detector capillary adapters from each detector using the 10-mm open-ended wrench. A flat silver-coated washer inside this fitting seals the fitting to the detector base.

7. Remove the autosampler if present.

8. Remove the detector inlet cover.

NOTE If an autosampler mounting bracket is installed, it may be necessary to remove it. The mounting screw that secures the autosampler bracket and GC top to a standoff is located under the top cover.

9. Remove the GC top cover by loosening the two retaining screws (Figure 4.1-1). Push the cover back approximately 3 cm. Lift the cover off the GC.

Figure 4.1-4 shows the retaining screws on the GC top cover.

Figure 4.1-4. Retaining Screws on the GC Top Cover

10. Locate the six Allen screws that secure the rear panel to the GC. Remove these screws using the 3-mm Allen wrench.

11. Carefully remove the rear panel of the GC. Notice that the cooling fan is attached to the rear panel.

NOTE Pay attention to the orientation of the cooling fan plug, so it can be reconnected in the same way that it was removed.

12. Unplug the power cord to the rear panel cooling fan. Set the rear panel off to the side of the GC.

Remove the GC Right Side Panel

The power control module is attached with five Phillips screws. Access to these screws requires removal of the right side panel of the GC. To remove the right side panel, proceed as follows:

1. Locate the large screw that secures the right side panel on the right upper rear corner of the GC. Unscrew this screw at least 1 cm.

2. Slide the side panel back until the panel contacts the thumbscrew.

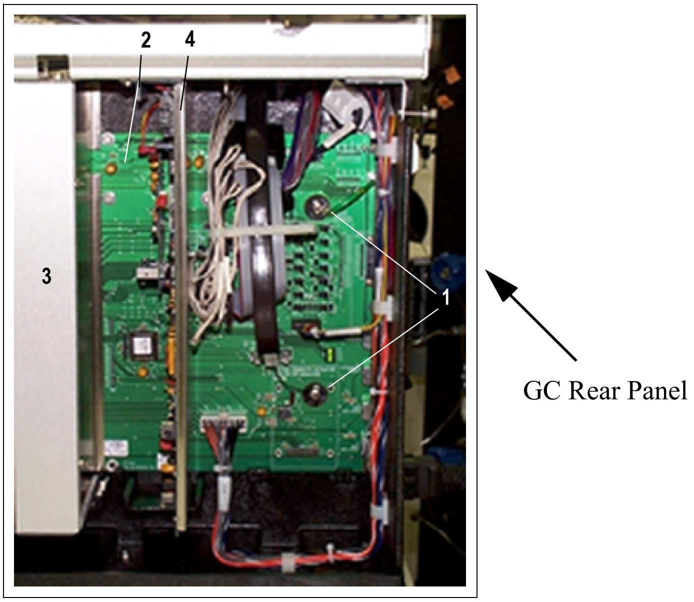
3. Tilt the top of the side panel outward. Continue to slide the side panel toward the rear.

4. Hold the side panel parallel to the GC and pull the lower edge of the panel away from the GC.

Remove the Power Control Module

Six screws attach the Power Control Module. Two large Phillips screws are located in the rear of the right side of the GC (see Figure 4.1-5. Right Side View of GC Rear Panel). While the remaining four large Phillips screws are located just behind the front panel of the GC (Figure 4.1-6. Right Side View of GC Front Panel).

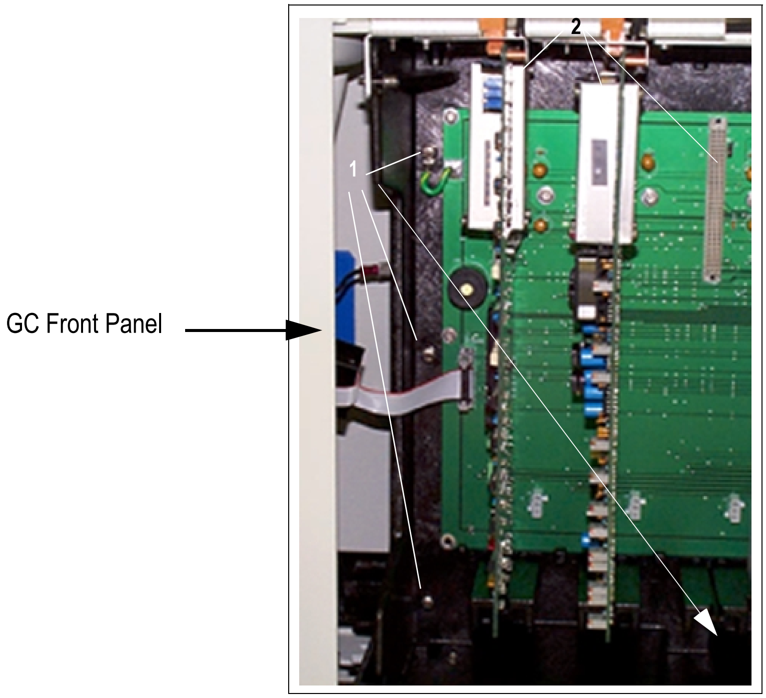
Figure 4.1-5 shows the two large Phillips screws located towards the rear of the GC. Note the Motherboard, Microprocessor PCB, and Temperature Feedback and Digital I/O PCB.



1. Two Large Phillips Screws
2. Motherboard
3. Microprocessor PCB
4. Temperature Feedback and Digital I/O PCB

Figure 4.1-5. Right Side View of GC Rear Panel

Figure 4.1-6 shows three large Phillips screws behind the GC front panel and one large Phillips screw located above the third expansion slot guide. Note the detector controllers plugged into expansion slots 1 and 2. In this illustration the third expansion slot is empty.



1. Four Large Phillips Screws
2. Detector Controller Expansion Slots

Figure 4.1-6. Right Side View of GC Front Panel

1. Remove all of the screws.

NOTE It is only necessary to slide the power control module out a few centimeters to gain access to the heater wire terminals. It may be necessary to remove a number of the connectors, so the power control module can be slid out far enough to gain access to the heater wire connections. Be sure to identify the location of these heater wire connections for reassembling purposes.

2. Slide the power control module outward toward the rear of the GC.

Remove the Temperature Sensor

CAUTION **The temperature sensor wires are small and delicate, so care should be taken when disconnecting the sensor.**

The temperature sensors used for the various heating zones in the TRACE GC 2000 are located on the rear portion of the motherboard.

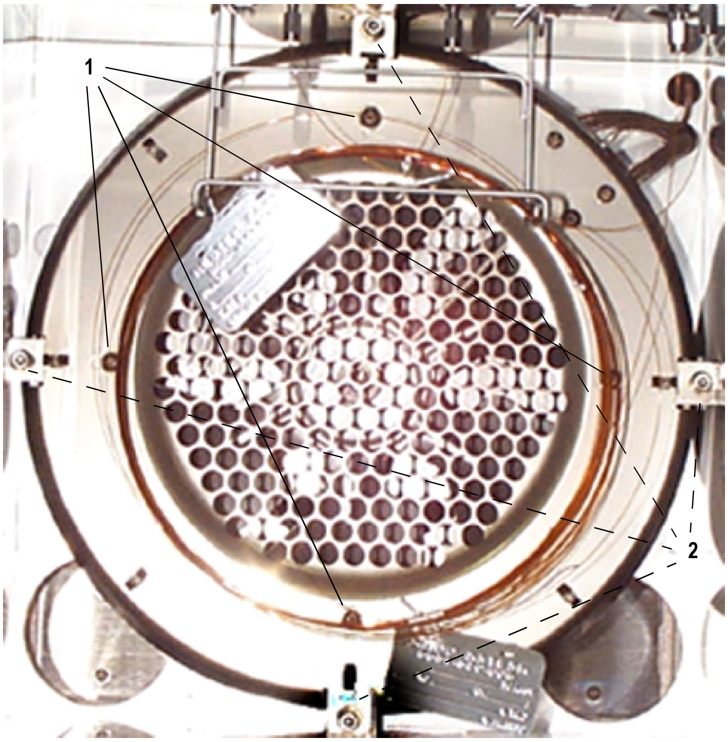
1. The oven temperature sensor is connected to J41. Disconnect the oven temperature sensor.

2. Feed the wires for the oven temperature sensor over the motherboard and into the rear of the oven. The oven heater is connected directly to the power control module board.

Remove the Oven Heater Baffle

The oven heater baffle is attached to the oven wall by four adjustable tabs. These tabs are attached to the oven heater baffle with four Allen screws. The four tab adjustment screws are located on the inside edge of the oven heater baffle (Figure 4.1-7). The tabs are adjusted by loosening these four Allen screws.

Figure 4.1-7 shows the tab adjustment screws and the tab screws for the four adjustable tabs on the oven heater baffle.



1. Tab Adjustment Screws 2.Tab Screws

Figure 4.1-7. Tab Adjustment Screws and Tab Screws on the Oven Heater Baffle

NOTE Anti-seize compound is applied to all screws that you have removed from inside the oven.

1. Loosen the four tab adjustment screws.

2. Remove the four Allen screws that secure the tabs to the oven heater baffle.

3. Slide each of the four tabs inward to allow each tab to clear the oven wall.

4. Rotate the oven heater baffle counterclockwise approximately 2 cm.

NOTE Before proceeding, it may be necessary to remove the capillary column adapters from the detector bases.

5. Pull the heater and temperature sensor wires through the holes located in the top right-hand corner of the rear oven wall.

6. Remove the baffle.

Replace the Oven Heater

Replacement of the oven heater requires replacing the complete oven heater baffle. This includes the plate, heaters, and temperature sensor.

1. Remove the oven heater baffle.

2. A single clamp attaches the oven heater temperature sensor. This clamp is located on the back of the oven heater baffle (Figure 4.1-8). Loosen the clamp.

Figure 4.1-8 shows the clamp that attaches the oven heater temperature sensor to the oven heater baffle.

Figure 4.1-8. Clamp for Oven Heater Temperature Sensor

3. Remove the oven heater temperature sensor.

4. Replace the oven heater temperature sensor in the reverse order in which it was removed.

Reassemble the Oven Heater Baffle

1. Replace the oven heater baffle in the reverse order in which it was removed.
2. Apply a small amount of anti-seize compound to each one of the four Allen screws that hold the oven heater baffle to the tabs.
3. Secure the oven heater baffle to the oven wall with the four Allen screws in the tabs.
4. The tab adjustment screws should be loose. Carefully center the oven heater baffle inside of the oven. Be sure that the center hole in the oven heater baffle screen is centered over the blower motor shaft. The tolerance is very small. The oven heater baffle will not move left or right, nor up or down more than a couple of millimeters. However, be sure that it is centered in the oven over the blower wheel. This will ensure that whenever the GC is turned on, the blower wheel will not be touching the heater coils mounted to the oven heater baffle.
5. Connect the oven heater wires to the power control module terminals.
6. Plug the oven heater temperature sensor into J41 on the motherboard.
7. Reconnect the remaining wires previously disconnected from the power control module.
8. Slide the power control module in place and resecure it.
9. Replace the GC rear panel and side panel.
10. Turn the GC on.
11. Confirm that all circuits are functioning correctly.
12. Verify that the oven fan does not touch any part of the oven heater baffle.

Replace the Flapper Motor

Required Tools

You will need the following tools:

- 3-mm Allen wrench
- Phillips screwdriver

Required Parts

You will need the following parts:

- Stepper motor (PN 318 070 46)
- Self-locking Allen screws M4 x 10 (PN 76909-L410)

Introduction

To replace the oven flapper motor, you must remove the complete motor flapper and cooling duct assembly. The flapper motor plugs into the motherboard on the GC. Therefore, you must remove the right side panel of the GC.

OPERATING PROCEDURE

Replace the Flapper Motor

1. Cool all temperature zones to room temperature.

WARNING! Always turn the GC off before removing or replacing any parts.

2. Turn off the main power on the rear panel of the GC. Disconnect the main power cable from the rear of the GC. This may require loosening the clamp that secures the power cable to the rear panel.
3. Locate the six Allen screws that secure the rear panel to the GC. Remove these screws using the 3-mm Allen wrench.
4. Carefully remove the rear panel of the GC. Notice that the cooling fan is attached to the rear panel.

NOTE Pay attention to the orientation of the cooling fan plug, so it can be reconnected in the same way that it was removed.

5. Unplug the power cord to the rear panel cooling fan. Set the rear panel beside the GC.
6. Locate the six Allen screws that secure the cooling ducts to the oven wall. Remove these screws.

Each cooling duct has a self-tapping screw on the outer edge nearest the rear panel. These screws are accessible from a hole in the top of the cooling duct.

7. Locate the self-tapping screw that secures each cooling duct to the lower GC base. Remove the screw from each cooling duct. This will allow the complete motor flapper and cooling duct assembly to be removed from the rear of the GC.

Disconnect the Flapper Motor Electrical Plug

1. Remove the right side cover of the GC.
2. Locate connector J12 in the rear upper corner of the motherboard. Disconnect the oven flapper motor electrical plug from J12.

CAUTION **Be very careful not to cut any wires in the harness.**

3. Use a pair of side-cutters to cut and remove the tie wraps that secure this cable to the main harness leading into the rear of the GC.

4. Feed the flapper motor cable through the rear of the GC. Remove the complete flapper motor cable.

Remove and Replace the Flapper Motor

The flapper motor is secured to the left-hand cooling duct with two Phillips screws. The flapper motor shaft is secured to the flapper with an M4 Allen screw. This Allen screw is accessible through a small hole located on the top portion of the left-hand cooling duct.

CAUTION **Be very careful not to rotate the flapper motor by applying pressure to the flappers. Rotate the flapper motor by gripping the lower portion of the railing that attaches to the flappers.**

1. Loosen the M4 Allen screw.

2. Remove the flapper motor.

3. Reinstall the new motor. Align the flat side of the motor shaft with the Allen screw.

Reassemble the Flapper Motor

1. Reassemble the flapper motor and cooling duct assembly in the reverse order in which it was removed.

2. Reconnect the power plug to connector J12.

3. Turn the GC on.

4. Turn on all zones, including the oven.

5. Confirm that all heated zones are functioning correctly.

6. Reestablish flows.

7. Perform a column leak check.

Remove the Power Control Module

Required Tools

You will need the following tools:

- 3-mm Allen wrench
- Phillips screwdriver

Required Parts

In this procedure, you may require any of the items listed in the section below. Their part numbers have been included.

Introduction

The Power Control Module contains the following:

- Main power input filter (PN 24128-0085)
- Circuit breaker 115 V (PN 237 099 15)
  Circuit breaker 230 V (PN 237 099 16)
- Varistor—attaches to circuit breaker (PN 119949-0001)
- Main power thermal shutdown relay 20 A (PN 76269-0120)
- Power supply module (PN 76330-0031)
- Power Control Module PCB with fuses (PN 236 995 00)
- ECD/FID detector transformer (PN 119917)
- NPD detector transformer (PN 119918)
- FID detector transformer (PN 119916)
- Oven heater triac (PN 76379-0025)

To remove the Power Control Module, it is necessary to remove the following:

- Power cord
- GC rear panel
- GC right side panel

OPERATING PROCEDURE

Remove the Power Control Module

Remove the GC Rear Panel

WARNING! Always turn the GC off before removing or replacing any parts.

1. Turn off the main power on the rear panel of the GC. Disconnect the main power cable from the rear of the GC. This may require loosening the clamp that secures the power cable to the rear panel.

NOTE If an autosampler mounting bracket is installed, it may be necessary to remove it. The mounting screw that secures the autosampler bracket and GC top to a standoff is located under the top cover.

2. Remove the GC top cover by loosening the two retaining screws (Figure 4.1-1). Push the cover back approximately 3 cm. Lift the cover off the GC.

Figure 4.1-9 shows the retaining screws on the GC top cover.

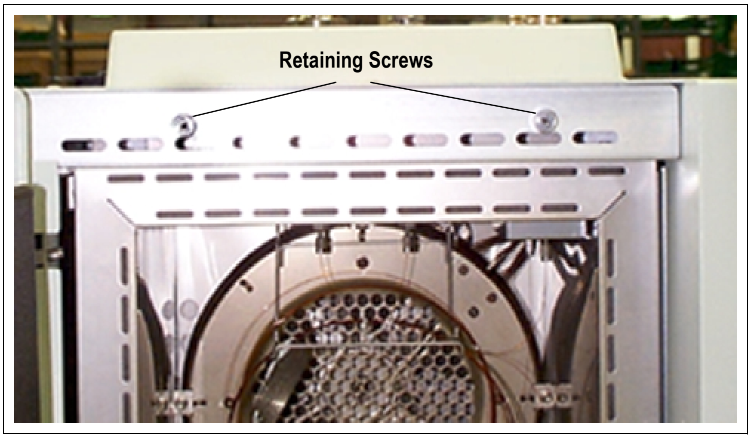


Figure 4.1-9. Retaining Screws on the GC Top Cover

3. Locate the six Allen screws that secure the rear panel to the GC. Remove these screws using the 3-mm Allen wrench.

4. Carefully remove the rear panel of the GC. Notice that the cooling fan is attached to the rear panel.

NOTE Pay attention to the orientation of the cooling fan plug, so it can be reconnected in the same way that it was removed.

5. Unplug the power cord to the rear panel cooling fan. Set the rear panel off to the side of the GC.

Remove the GC Right Side Panel

The Power Control Module is attached with five Phillips screws. Access to these screws requires removal of the right side panel of the GC. To remove the right side panel, proceed as follows:

1. Locate the large thumbscrew that secures the right side panel on the right upper rear corner of the GC. Unscrew the thumbscrew at least 1 cm.

2. Slide the side panel back until the panel contacts the thumbscrew.

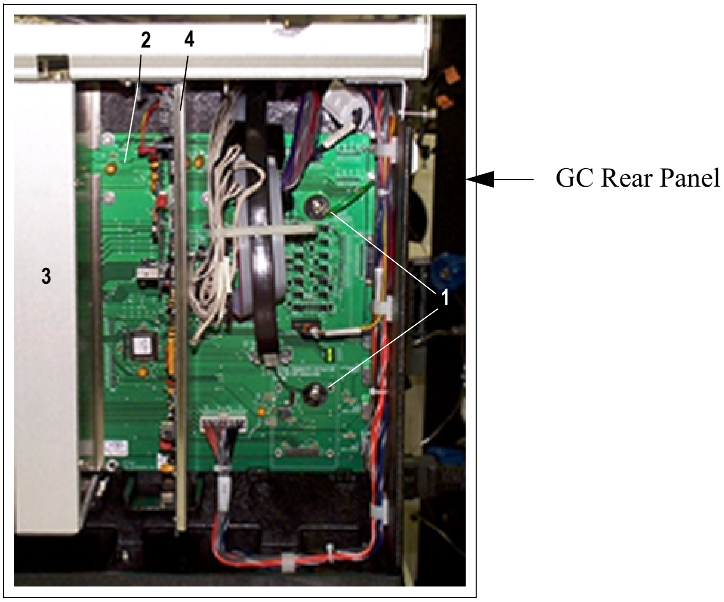
3. Tilt the top of the side panel outward. Continue to slide the side panel toward the rear.

4. Hold the side panel parallel to the GC, and pull the lower edge of the panel away from the GC.

Remove the Power Control Module

Six screws attach the Power Control Module. Two large Phillips screws are located in the rear of the right side of the GC (see Figure 4.1-10. Right Side View of GC Rear Panel). While the remaining four large Phillips screws are located just behind the front panel of the GC (Figure 4.1-11. Right Side View of GC Front Panel).

Figure 4.1-10 shows the two large Phillips screws located in the rear of the GC. Note the Motherboard, Microprocessor PCB, and Temperature Feedback and Digital I/O PCB.

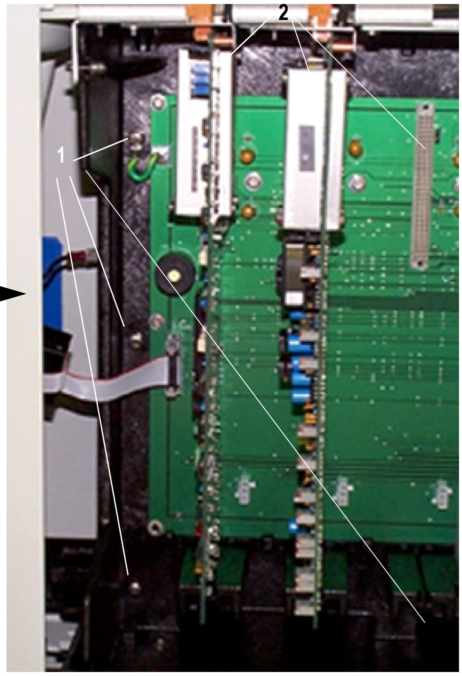


1. Two Large Phillips Screws
2. Motherboard
3. Microprocessor PCB
4. Temperature Feedback and Digital I/O PCB

Figure 4.1-10. Right Side View of GC Rear Panel

Figure 4.1-11 shows three large Phillips screws behind the GC front panel and one large Phillips screw located above the third expansion slot guide. Note the detector controllers plugged into expansion slots 1 and 2. In this illustration the third expansion slot is empty.

GC Front Panel



1. Four Large Phillips Screws
2. Detector Controller Expansion Slots

Figure 4.1-11. Right Side View of GC Front Panel

1. Remove the screws.
2. Slide the Power Control Module outward toward the rear of the GC.
3. As the Power Control Module is being removed, disconnect the following in the order listed below:
    - J1, 16-pin white connector
    - J8, 2-pin connector
    - J11, 16-pin white connector located in the upper rear quadrant of the chassis
    - J13, ribbon cable
    - Oven heater wire connected to the oven heater triac
    - TB1 and TB2, orange terminal strips for the heater wire connections

- J17, oven blower motor
- J18, second oven heater wire
- Chassis ground wire from the GC rear oven terminal

NOTE It may be necessary to remove or unclip tie wraps that may bind some of the disconnected harnesses to the Power Control Module internal harnesses.

CAUTION **Be very careful not to cut any wires in the harness.**

Reinstall the Power Control Module

1. Reconnect the previously disconnected connections in the reverse order of their removal.
2. Reconnect the chassis ground wire to the GC rear oven terminal.
3. Secure the five Phillips screws that hold the Power Control Module in place.
4. Replace the GC rear panel. Be sure to reconnect the rear panel cooling fan.
5. Reconnect the main power.
6. Turn on main power.
7. Verify all keypad functions.

Remove the CPU and Temperature Feedback and Digital I/O Unit

Required Tools

You will need the following tools:

- 3-mm Allen wrench
- Phillips screwdriver

Required Parts

You may need the following replacement assemblies:

- Central Processing Unit (CPU) (PN 236 483 45)
- Temperature Feedback and Digital I/O unit (PN 236 483 40)

Introduction

It may be necessary to replace the CPU or the Temperature Feedback and Digital I/O unit. This section describes how to remove and replace both of these units.

OPERATING PROCEDURE

Remove the CPU and Temperature Feedback and Digital I/O Unit

WARNING! **Always turn the GC off before removing or replacing any parts.**

1. Turn off the main power on the rear panel of the GC.

NOTE If an autosampler mounting bracket is installed, it may be necessary to remove it. The mounting screw that secures the autosampler bracket and GC top to a standoff is located under the top cover.

2. Remove the GC top cover by loosening the two retaining screws (Figure 4.1-1). Push the cover back approximately 3 cm. Lift the cover off the GC.

Figure 4.1-12 shows the retaining screws on the GC top cover.

Figure 4.1-12. Retaining Screws on the GC Top Cover

Remove the GC Right Side Panel

After removing the GC right side panel you will have access to the CPU and temperature feedback and digital I/O unit.

1. Locate the large screw that secures the right side panel on the right upper rear corner of the GC. Unscrew this screw at least 1 cm.
2. Slide the side panel back until the panel contacts the thumbscrew.
3. Tilt the top of the side panel outward. Continue to slide the side panel toward the rear.
4. Hold the side panel parallel to the GC and pull the lower edge of the panel away from the GC.

Remove the CPU

The CPU is located in the fifth slot behind the keypad and display panel. The CPU is held in place with one 3-mm Allen screw that is located on the top of the GC under the top cover.

1. Remove the RS232 cables connected to the computer and the autosampler.
2. Remove the Allen screw.
3. Grasp the CPU.
4. Slide the unit outward away from the electronic compartment.

Reinstall the CPU

1. Reinstall the CPU in the reverse order in which it was removed.
2. Turn the GC on.
3. Verify that the system completes the initial startup test.
4. Replace all covers.
5. Resume normal operation.

Remove the Temperature Feedback and Digital I/O unit

The Temperature Feedback and Digital I/O unit is located in the fourth slot behind the keypad and display panel. The Temperature Feedback and Digital I/O unit is held in place with one 3-mm Allen screw that is located on the top of the GC under the top cover.

1. Remove the Allen screw.
2. Grasp the Temperature Feedback and Digital I/O unit.
3. Slide the unit outward away from the electronic compartment.

Reinstall the Temperature Feedback and Digital I/O unit

1. Reinstall the Temperature Feedback and Digital I/O unit in the reverse order in which it was removed.
2. Turn the GC on.
3. Verify that the system completes the initial startup test.
4. Verify all temperature zones read and control correctly.
5. Replace all covers.
6. Resume normal operation.

4.2

Digital Pressure Flow Control for Carrier Gases

This chapter contains information about the Digital Pressure Flow Control modules of the TRACE GC 2000. It also addresses maintenance and troubleshooting issues.

Chapter at a Glance...

Digital Pressure Flow Control Modules

Digital Pressure Flow Control (DPFC) modules refer to the TRACE GC 2000 inlet flow modules. These modules are specifically designed to control carrier gas, either by means of pressure sensing or actual flow sensing.

DPFC flow modules are available in two pressure ranges:

- 0–250 kPa (0–35 psig)
- 0–700 kPa (0–100 psig)

DPFC Purged Packed Carrier Pneumatic Module

The DPFC purged packed carrier module is identified on the module as PKD-1100-250 or PKD-1100-700. The GC diagnostics identify this module as PKD.

This configuration supplies carrier gas to the GC inlet and offers septum purge vent control. It is most commonly used with packed columns, wide-bore (megabore) columns, and the purged packed injector. For wide-bore columns, it operates in *constant flow through calculated pressure*. For packed columns, it operates in true *closed loop flow control*. The packed flow module uses a high and low auto range flow sensor, which sets to the high flow range for closed loop flow control. In inlets for packed column with septum purge operation, the flow control module supplies the requested column flow plus 5 cc/min for the septum purge.

Figure 4.2-1 shows the DPFC purged packed carrier pneumatic module.

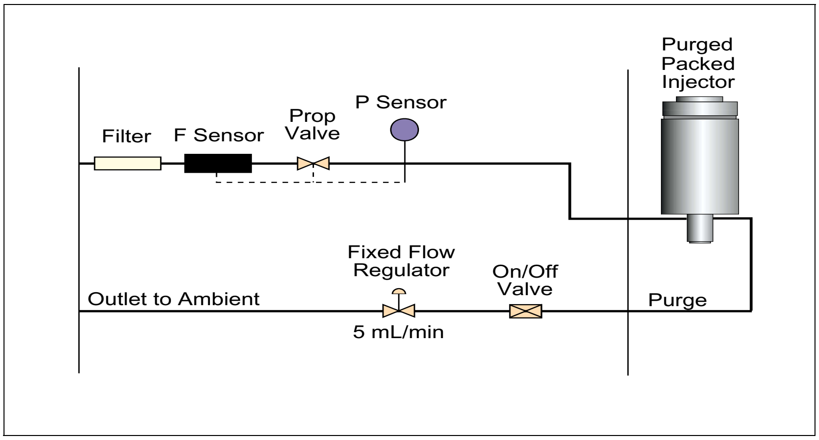


Figure 4.2-1. DPFC Purged Packed Carrier Pneumatic Module

DPFC Packed Carrier Pneumatic Module

The DPFC purged packed carrier module is identified on the module as PKD-1100-250 or PKD-1100-700. The GC diagnostics identify this module as PKD.

The packed column module is the simplest in operation. This type of system is used for packed columns only, which operate in true constant flow mode. The packed column module is *closed loop flow control* design. This means that the module contains a flow sensor, and directly measures the flow being supplied to the column. The packed flow module uses a high and low auto range flow sensor, which sets to the high flow range for closed loop flow control. The packed column module does not require the column evaluation calculation to adjust column pressures during an analytical run. The packed column module operates from direct flow sensor readings in flow-controlled mode.

Figure 4.2-1 shows the DPFC packed carrier pneumatic module.

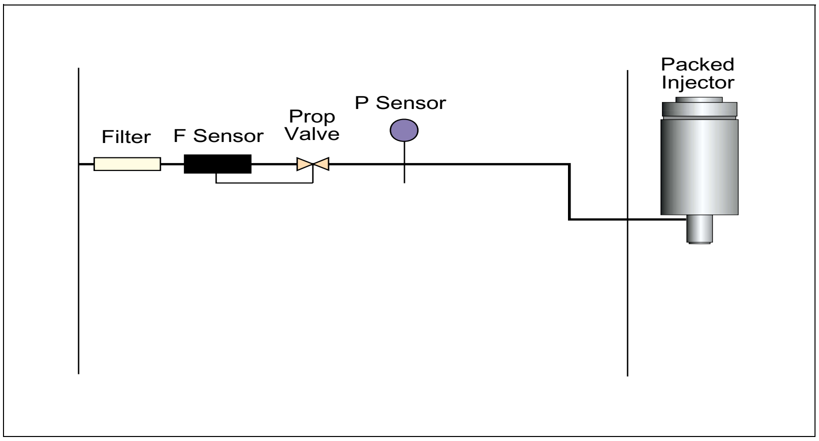


Figure 4.2-2. DPFC Packed Carrier Pneumatic Module

Calibration: The packed carrier pneumatic module is calibrated at 50 mL/min ± 5 mL and 250 mL/min ± 12 mL/min.

DPFC On-Column Carrier Pneumatic Module

This DPFC on-column carrier module is identified on the module as OC-1100-250 or OC-1100-700. The GC diagnostics identify this module as OC.

This configuration is most commonly used with cold on-column injectors. This module controls column flow by means of pressure feedback. The flow sensor is only used during column characterization. Column characterization is necessary when used in this configuration.

DPFC flow modules are available in two pressure ranges:

- 0–250 kPa (0–35 psig)
- 0–700 kPa (0–100 psig)

This module has no septum purge or split vent flow control.

Figure 4.2-3 shows the DPFC on-column carrier pneumatic module.

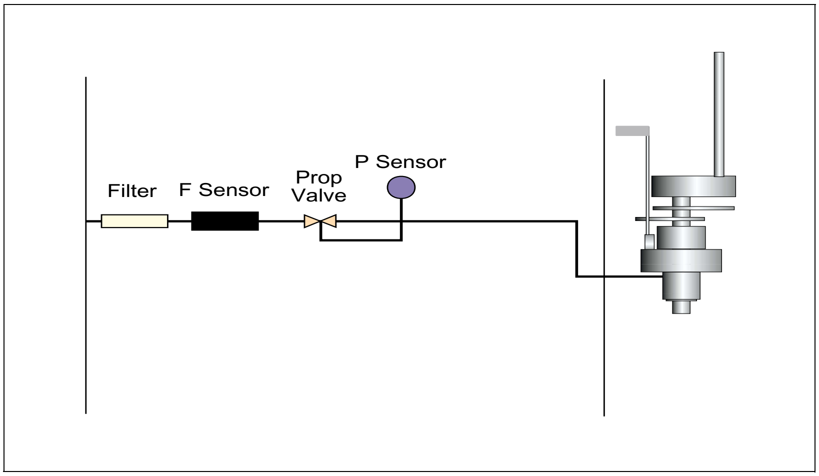


Figure 4.2-3. DPFC On-Column Carrier Pneumatic Module

Calibration: The On-Column carrier pneumatics module is calibrated to deliver 2.5 mL of flow ± 2 mL at the column exit.

DPFC for S/SL and PTV Carrier Pneumatic Module

This DPFC module is identified as option on the module as SSL-1100-250 or SSL-1100-700. The GC diagnostics identify this module as SSL. This configuration is used with the split/splitless injector and the PTV split/splitless injector. This module controls column flow by means of pressure feedback. Carrier flow range is 0–10 cc/min.

DPFC flow modules are available in two pressure ranges:

- 0–250 kPa (0–35 psig)
- 0–700 kPa (0–100 psig)

This module has septum purge and split vent flow control.

Figure 4.2-4 shows the DPFC for S/SL and PTV carrier pneumatic module.

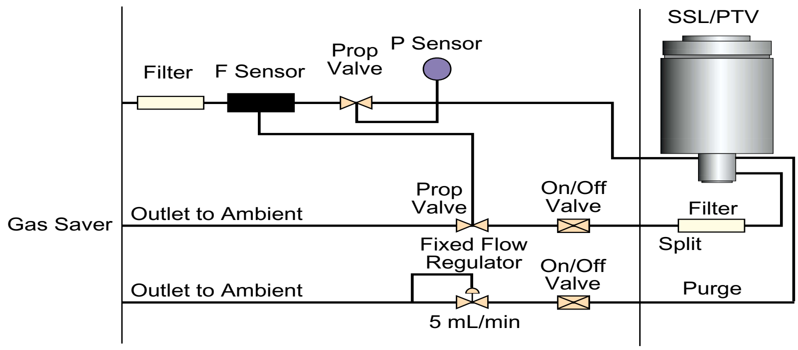


Figure 4.2-4. DPFC for S/SL and PTV Carrier Pneumatic Module

The module used for split/splitless or PTV inlets is equipped with a dual range flow sensor and a pressure sensor. It also has a proportioning valve for split flow, and ON/OFF valves for split and purge flows. The mass flow sensor measures all flow moving into the inlet.

Since capillary column flows are traditionally low (0.5–3 mL/min), flow through the capillary column is controlled by means of pressure. The mass flow sensor feedback is used to control split flow. Septum purge is maintained at a constant by means of a fixed flow regulator.

The lowest column pressure that must be maintained to control flow is:

- 0–250 kPa module—5 kPa (0.7 psig)
- 0–700 kPa module—14 kPa (14 psig)

Maintenance

Calibration

NOTE The DPFC electronic control module is trimless. All components are solid-state. Calibration of the A/D and D/A is a factory-performed operation requiring specialized test equipment. Any errors in calibration require the replacement of the DPFC module.

Factory calibration is accomplished by measuring the appropriate parameter with a reference fixture. Then, the actual result is entered in the software. The module is calibrated for both pressure and flow.

Figure 4.2-5 shows the DPFC electronic diagram of the carrier pneumatic module.

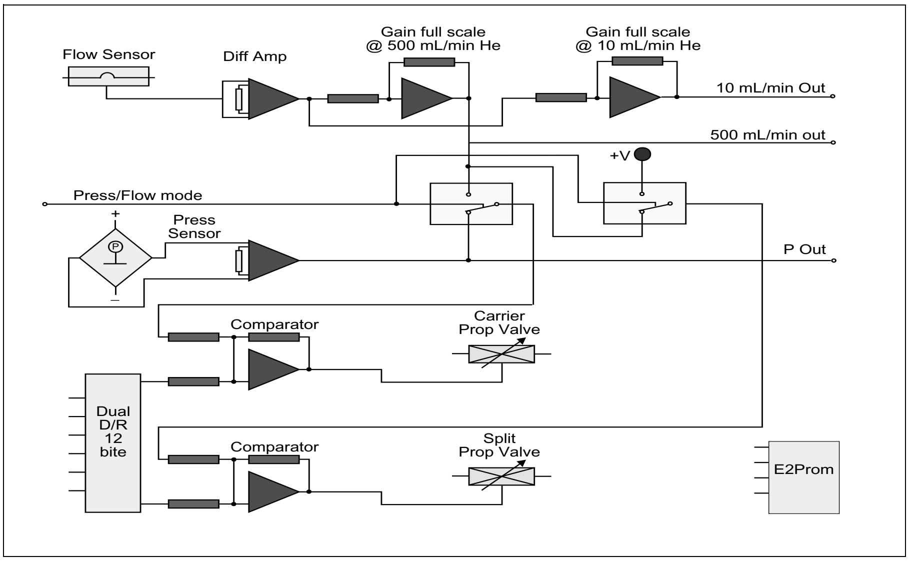


Figure 4.2-5. DPFC Electronic Diagram of the Carrier Pneumatic Module

Troubleshooting

The DPFC module is not designed for component level troubleshooting. Table 4.2-1 shows the input and output voltages that may assist in isolating problems with the DPFC module.

Table 4.2-1. DPFC Input and Output Voltages

Pin	Voltage
Pin 1	+15 V Analog
Pin 2	–15 V Analog
Pin 3	Analog GND
Pin 9	Digital GND
Pin 10	+5 V Digital
Pin 19	+15 V Valve Power
Pin 20	+15 V Valve Power
Pin 21	Return Ground of Proportional Valves
Pin 22	Return Ground of Proportional Valves
Pin 23	Split Valve +24 V
Pin 24	Split Valve Return
Pin 25	Purge Valve +24 V
Pin 26	Purge Valve Return

CAUTION **Valve power must be closed on the return ground of the valves.**

4.3

Detector Gas Flow Control for Detector Gases

This chapter contains information about the Detector Gas Flow Control modules of the TRACE GC 2000. It also addresses maintenance and troubleshooting issues.

Chapter at a Glance…

Detector Gas Flow Control Modules

Detector Gas Flow Control (DGFC) modules are used primarily to control detector gas flow. Flow control is accomplished by applying pressure to a fixed restrictor. The GC microprocessor provides pressure control. The flow range of the module is determined by the fixed restrictor. The pressure sensor gage is accurate to 700 kPa (100 psig). Recommended inlet pressure is 480 kPa (60 psig). Each module is capable of controlling three independent gases.

Hardware Configuration AA, Option 401

Figure 4.3-1 shows hardware configuration AA, option 401 for ECD only.

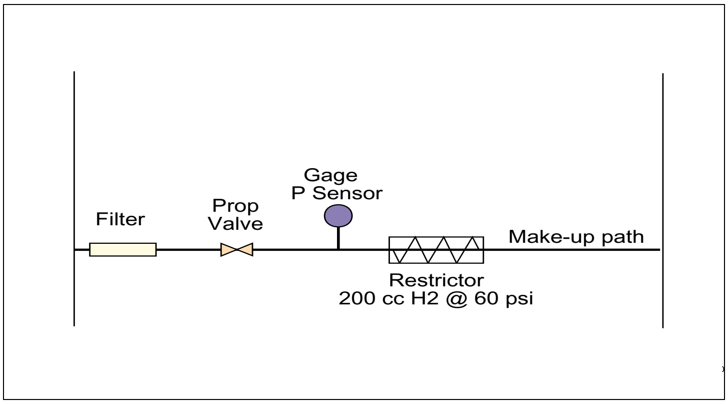


Figure 4.3-1. Hardware AA, Option 401 for ECD Only

The make-up gas used for the ECD is either N_2 (highest sensitivity) or 5% CH_4/Ar (greater dynamic range).

Calibration

The AA module is calibrated with N_2 at 13.5 mL/min and 45 mL/min. The tolerance is <2%.

Hardware Configuration AB, Option 402

Figure 4.3-2 shows hardware configuration AB, option 402 for ECD, PID, FPD, and FID without make-up.

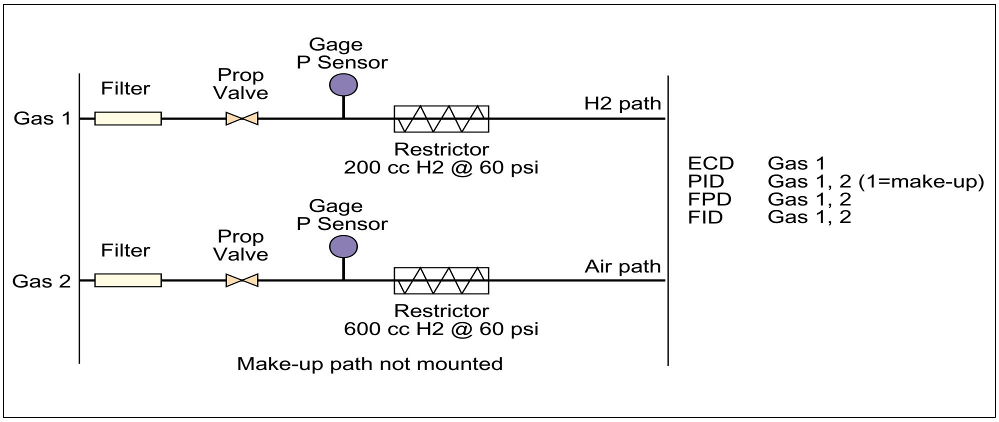


Figure 4.3-2. Hardware AB, Option 402 for ECD, PID, FPD, and FID Without Make-Up

This module can be configured with a gas # 2 restrictor for delivering reference gas to the TCD (HWD). He, H_2, N_2, or Ar can be used for this purpose.

For ECD operation, N_2 or 5% CH_4/Ar is plumbed to the Gas 1 input. The Air path is not used.

For PID operation, He or N_2 can be used as make-up, and is plumbed to the Gas 1 input. He or N_2 is also used for the sheath gas, and is plumbed to the Gas 2 input.

Calibration

The AB module is calibrated using H_2 for Gas 1. Gas 1 is calibrated at 20 mL/min and 100 mL/min. The tolerance is <2%.

Gas 2 is calibrated using air. Gas 2 is calibrated at 90 mL/min and 300 mL/min. The tolerance is <2%.

Hardware Configuration AC, Option 403

Figure 4.3-3 shows hardware configuration AC, option 403 for ECD, PID, FPD, and FID with make-up.

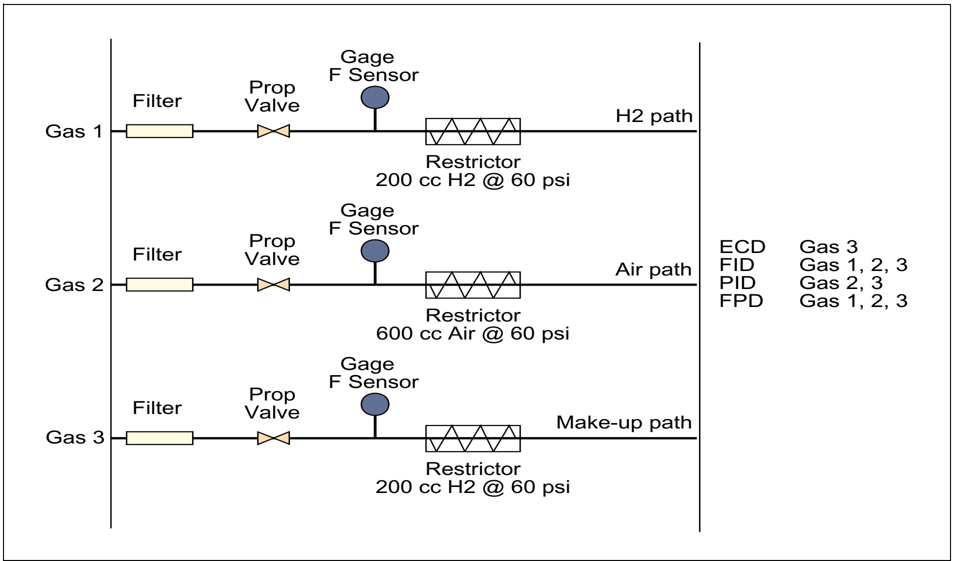


Figure 4.3-3. Hardware AC, Option 403 for ECD, PID, FPD, and FID With Make-Up

For PID operation, He or N_2 can be used as make-up, and is plumbed to the Gas 3 input. Sheath gas is connected to the Gas 2 input. The H_2 path is not used.

Calibration

The AC module uses H_2 as Gas 1. Gas 1 is calibrated at 30 mL/min and 100 mL/min. The tolerance is <2%.

Gas 2 is calibrated using air. Gas 2 is calibrated at 90 mL/min and 300 mL/min. The tolerance is <2%.

Gas 3 is calibrated using N_2. Gas 3 is calibrated at 13.5 mL/min and 45 mL/min. The tolerance is <2%.

Hardware Configuration AD, Option 404

Figure 4.3-4 shows hardware configuration AD, option 404 for NPD, ECD, PID, FPD, and FID without make-up.

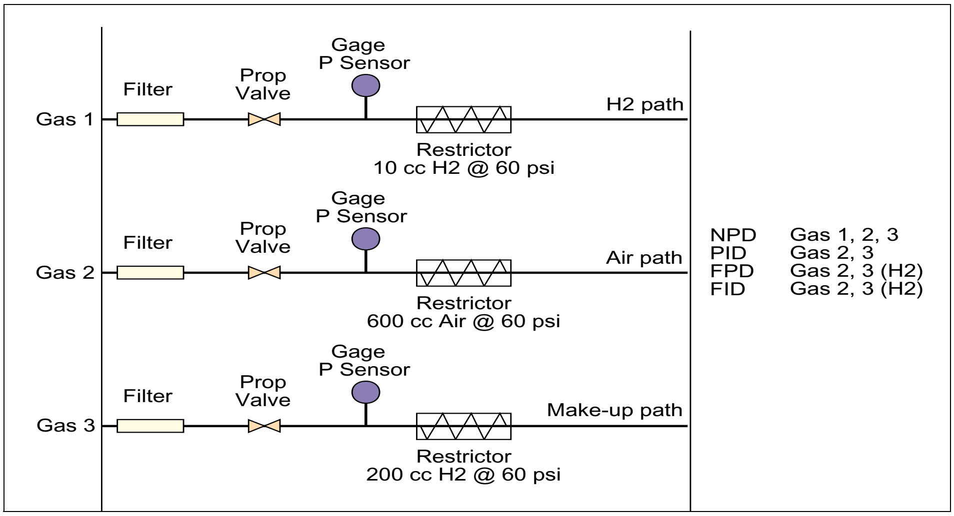


Figure 4.3-4. Hardware AD, Option 404 for NPD, ECD, PID, FPD, and FID Without Make-Up

For PID operation, He or N_2 may be used as make-up, and is plumbed to the Gas 3 input. He or N_2 may also be used as sheath gas, and is plumbed to the Gas 2 input. The H_2 path is not used.

For FPD and FID operation, the H_2 path is not used. Instead, H_2 is plumbed to the Gas 3 path.

Calibration

The AD module is calibrated using H_2 as Gas 1. Gas 1 is calibrated at 1.5 mL/min and 5 mL/min. The tolerance is <2%.

Gas 2 is calibrated using air. Gas 2 is calibrated at 90 mL/min and 300 mL/min. The tolerance is <2%.

Gas 3 is calibrated using N_2. Gas 3 is calibrated at 13.5 mL/min and 45 mL/min. The tolerance is <2%.

Hardware Configuration AE

Figure 4.3-5 shows hardware configuration AE, which is used for auxiliary gas control.

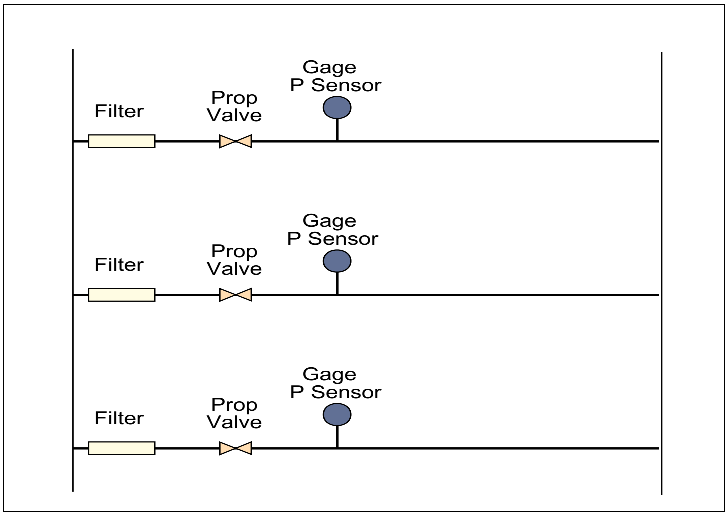


Figure 4.3-5. Hardware AE for Auxiliary Gas Control

This module is used for auxiliary gas control. This module is recognized by the GC controller when mounted in detector position three. It includes up to three electronically controlled pressure regulators on a single module. It is necessary to supply this gas to an external restrictor to achieve flow control.

Detector Gas Connections

The following table simplifies the versatility of the different gas modules. The left column describes the information supplied in the column or row to the right of the first column. When the GC is configured for a specific detector/gas module, the microprocessor will automatically turn of the appropriate gas flow path to the detector.

For example, an FID used with an AD module would require that H_2 be connected to the input fitting labeled **Mkup**. Or, an ECD used with an AB module would require that the make-up/detector gas be connected to the input fitting labeled $\mathbf{H_2}$.

Table 4.3-1. Detector Gas Connections

Detector Type:	**FID**			**ECD**				**NPD**
Installed Module:	**AB**	**AC**	**AD**	**AA**	**AB**	**AC**	**AD**	**AD**
Connect Hydrogen to fitting labeled:	H_2	H_2	**Mkup**	—	—	—	—	H_2
Connect Air to fitting labeled:	Air	Air	Air	—	—	—	—	Air
Connect Make-up gas to[1] fitting labeled:	—	Mkup	—	Mkup	$\mathbf{H_2}$	Mkup	Mkup	Mkup
Detector Type:	**FPD**			**PID**				**TCD**
Installed Module:	**AB**	**AC**	**AD**	**AA**	**AB**	**AC**	**AD**	**AB**
Connect Hydrogen to fitting labeled:	H_2	H_2	**Mkup**	—	—	—	—	—
Connect Air to fitting labeled:	Air	Air	Air	—	—	Air	—	—
Connect Make-up gas to fitting labeled:	—	—	—	—	Mkup	Mkup	Mkup	Mkup
Connect Sheath gas to[2] fitting labeled:	—	—	—	—	**Air**	—	**Air**	—

1. For ECD detectors, the make-up gas is N_2 or 5% CH_4/Ar.
2. For PID detectors, the sheath gas is N_2 or He.

WARNING! **Hydrogen is a potentially dangerous gas. Refer to *Using Hydrogen* on page xxiv for safety information.**

4.4

Handshake Cables

This chapter contains information regarding the different types of handshake cables and connections used with the TRACE GC 2000.

Chapter at a Glance...

TRACE to TEKMAR 2000/3000 Handshake Cable

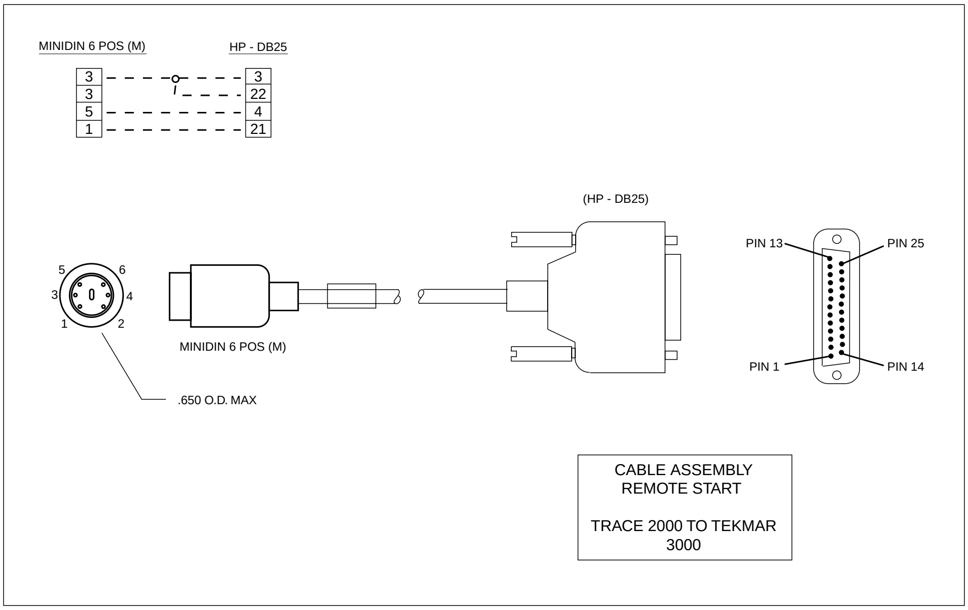
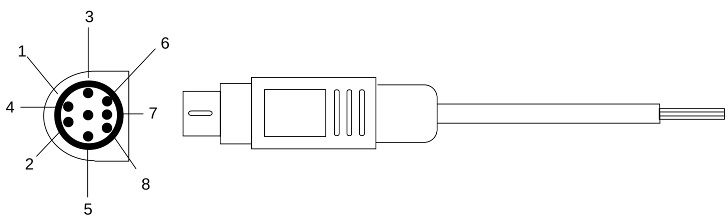


Figure 4.4-1. TRACE to TEKMAR 2000/3000 handshake cable, # b119521-0002

TRACE to TSQ Handshake Cable



COLOR CODE :

MD-8P

Signal	Pin	Color
REMOTE START IN	1	PURPLE
INHIBIT READY	2	BLACK
GROUND	3	YELLOW
START RUN	4	ORANGE
READY OUT	5	BLUE
END RUN	6	GREEN
	7	BROWN
N/A	8	RED
SHELL		DRAIN

TRACE - TSQ
INTERFACE

3801 - 4004

Figure 4.4-2. TRACE to TSQ handshake cable, #3801-4004

TRACE to Generic Data System Remote Start

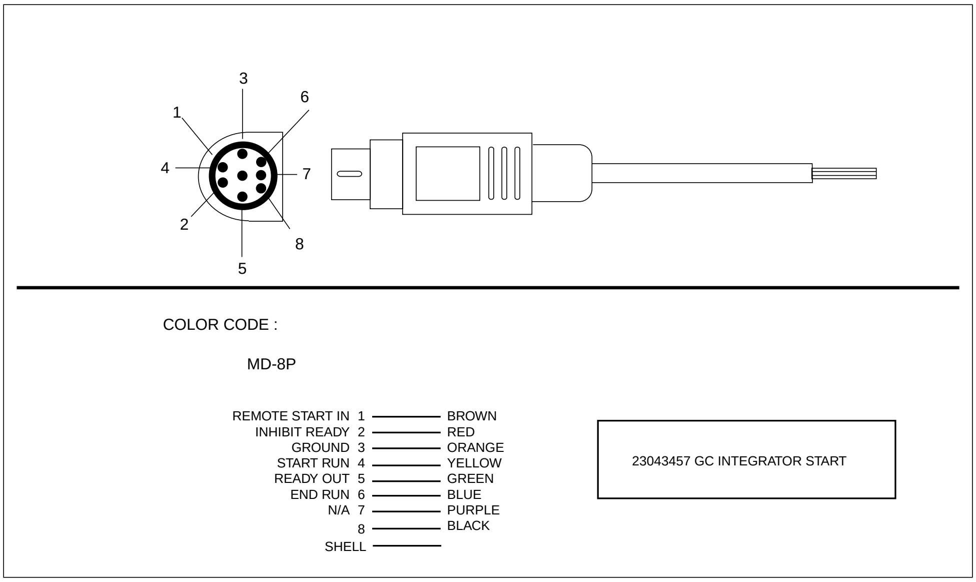
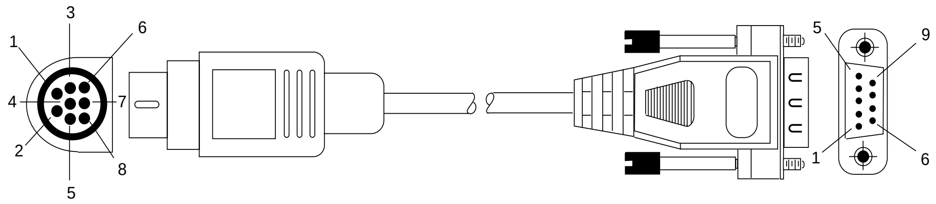


Figure 4.4-3. TRACE to generic data system remote start, #23043457

TRACE to GCQ



PIN OUT :

MD-8, MALE		DE-9, MALE
		3
2ND	3	6
INH_READY	2	4
ST_RUN	4	5
SHELL		SHELL

TRACE GENERIC TO GCQ REMOTE

3801 - 4003

Figure 4.4-4. TRACE to GCQ, # 3801-4003

Autosampler Handshake Cables

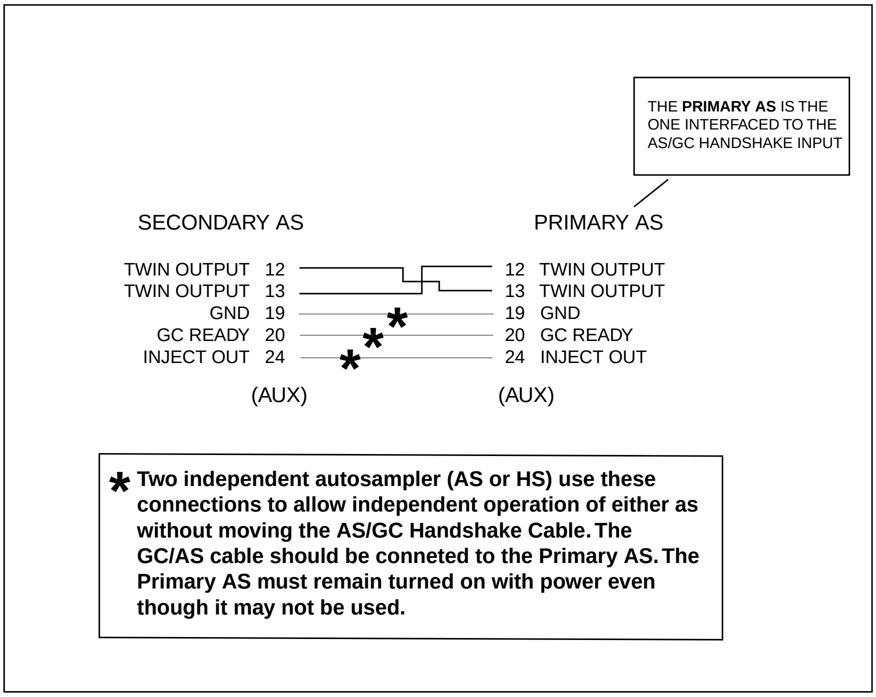


Figure 4.4-5. Connections for AS2000 Gemini Interconnect Cable and Dual Autosampler Start Cable

SECTION V

Electronic Board Description

This section provides a description of the electronic boards in the TRACE GC 2000.

Chapter 5.1, *Analytical Unit*, describes the Analytical Unit of the TRACE GC 2000.

Chapter 5.2, *Control Unit*, describes the Control Unit of the TRACE GC 2000.

Chapter 5.3, *Motherboard*, describes the Motherboard of the TRACE GC 2000.

Chapter 5.4, *Central Processing Unit (CPU)*, describes the PCB for the Central Processing Unit (CPU) of the TRACE GC 2000.

Chapter 5.5, *Temperature Feedback and Digital I/O*, chapter describes the Temperature Feedback and Digital I/O (TF & DIO) PCB of the TRACE GC 2000.

Chapter 5.6, *Power Control Module*, describes the PCB for the Power Control Module (PCM) of the TRACE GC 2000.

Chapter 5.7, *Digital Pressure Flow Control*, describes the PCB for the Digital Pressure Flow Control (DPFC) of the TRACE GC 2000.

Chapter 5.8, *Keypad and Display Panel*, describes the PCB for the Keypad and Display Panel of the TRACE GC 2000.

Chapter 5.9, *Theory of Detector Cards*, describes the Flame Ionization Detector (FID) controller of the TRACE GC 2000.

Chapter 5.10, *Flame Ionization Detector Controller*, describes the Electron Capture Detector (ECD) controller of the TRACE GC 2000.

Chapter 5.11, *Electron Capture Detector Controller*, describes the Nitrogen Phosphorous Detector (NPD) controller of the TRACE GC 2000.

Chapter 5.12, *Nitrogen Phosphorous Detector Controller*, contains a representative block diagram for the following 3 detectors (FPD, PID, and TCD).

Chapter 5.13, *Flame Photometric Detector Controller (FPD)*, describes the Flame Photometric Detector (FPD) controller of the TRACE GC 2000.

Chapter 5.14, *Photoionization Detector Controller (PID)*, describes the Photoionization Detector (PID) controller of the TRACE GC 2000.

Chapter 5.15, *Thermal Conductivity Detector Controller (TCD)*, describes the Thermal Conductivity Detector (TCD) controller of the TRACE GC 2000.

Chapter 5.16, *Thermocouple Preamplifiers*, describes the PCB for the thermocouple preamplifiers of the TRACE GC 2000.

Chapter 5.17, *On-Column Semiautomatic Actuator*, describes the PCB for an on-column semiautomatic actuator of the TRACE GC 2000.

Special Printing Instructions:

All schematics in *Section 5* (**Electronic Board Description**) *must* be printed on *Tabloid* size paper in order to be viewed correctly. This applies only to the *schematics* sections of *Section 5*. The *Section 5 chapters* themselves can be printed on normal Letter or A4 Letter size paper.

Schematic Drawings List

Use this table for a listing of all schematics and component layouts in each chapter of Section V. The drawing and layout numbers have been included and chapter numbers are noted for easy reference.

PCB	Description	Drawing	Layout	Chapter
	Analytical Unit Wiring Diagram	SC750	—	5.1
	Control Unit Wiring Diagram	SC751	—	5.2
BKPLN-Standard	Motherboard	119828E	119826	5.3
BKPLN-Right	Motherboard (alternate)	119828E	119991	5.3
CPU	Central Processor Unit	119825B	119823	5.4
TF & DIO	Temperature Feedback & Digital I/O	119822E	119820	5.5
	Thermocouple Amplifier	119834	119832	5.5
	RN4 Temperature Stabilizer	119978	119976	5.5
PCM	Power Control Module	119837D	119835	5.6
DPFC	Digital Pressure Flow Control	SE 1391 sh.2	PC 1111	5.7
KYPD & DISP	Keypad and Display Panel	119841B		5.8
FID	Flame Ionization Detector	SE 1388 sh.4	PC 1105	5.9
ECD	Electron Capture Detector	SE 1389 sh.5	PC 1106	5.10
NPD	Nitrogen Phosphorus Detector	SE 1424 sh.5	PC 1107	5.11
FPD	Flame Photometric Detector	SE 1436 sh.4	PC 1109	5.12
PID	Photoionization Detector	SE 1437 sh.5	PC 1437	5.13
TCD	Thermal Conductivity Detector	SE 1390 sh.3	PC 1113	5.14
	Thermocouple Preamplifiers	119834E	119832	5.15
	On-Column Semiautomatic Actuator	119947B	119945	5.16

NOTE Schematics and component layouts are located in the *Schematics and Component Layout* section of the chapters listed in the table above.

5.1

Analytical Unit

This chapter describes the Analytical Unit of the TRACE GC 2000.

Chapter at a Glance…

General Description

The TRACE GC 2000 Analytical Unit is divided in four main compartments:

- Oven compartment
- Injector/Detector (INJ/DET) cassette
- Digital Pressure Flow Control/Detector Gas Flow Control (DPFC/DGFC) compartment
- Power Control Module (PCM) compartment

The following parts are located in the Oven compartment:

- Oven fan
- Oven motor
- Oven heater
- Oven temperature sensor

The following parts are located in the INJ/DET cassette:

- Two injectors
- Two base bodies for detectors
- Heaters
- Temperature sensors

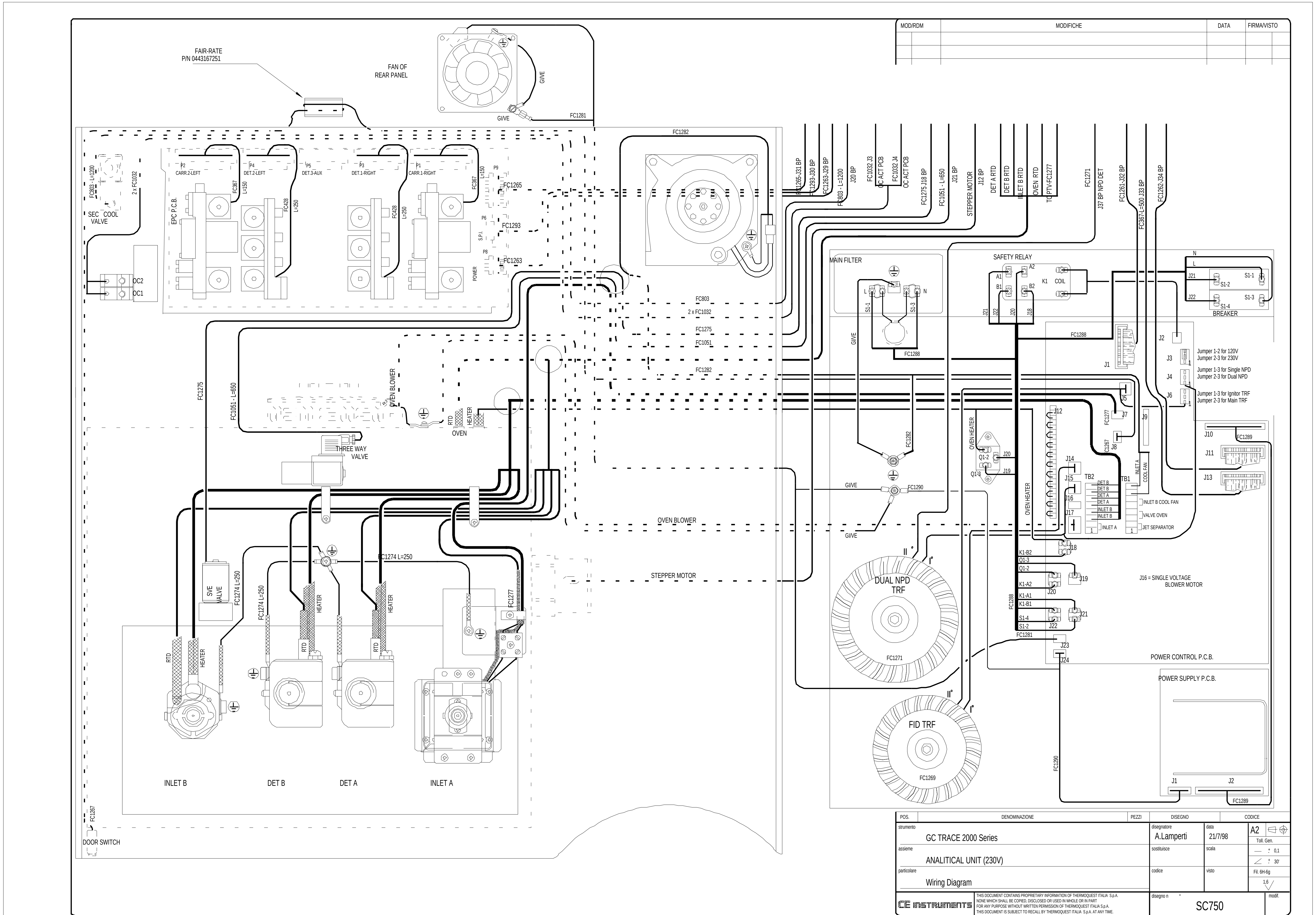
The following parts are located in the DPFC/DGFC compartment:

- Main DPFC PCB
- Two DPFC modules (carrier gases)
- Three DGFC modules (detector gases)

The following parts are located in the Power Control Module compartment:

- Main input voltage components (breaker, filter, and others)
- Power supply
- SSR devices

The TRACE GC 2000 Wiring Diagram (see next page) illustrates internal cables and connectors used to connect all heaters, temperature sensors, boards, fans and transformers.



MOD/RDM
MODIFICHE
DATA
FIRMA/VISTO
FAIR-RATE
P/N 0443167251
FAN OF
REAR PANEL
G/VE
FC1281
FC1282
FC803 - L=1200
2 x FC1032
SEC COOL
VALVE
OC2
OC1
EPC P.C.B.
P2
CARR.2-LEFT
P4
DET.2-LEFT
P5
DET.3-AUX
P3
DET.1-RIGHT
P1
CARR.1-RIGHT
FC367
L=150
FC428
L=250
P9
FC1265
P6
FC1293
P8
FC1263
POWER
FC1265-J31 BP
FC1293-J30 BP
FC1263-J29 BP
FC803 - L=1200
J20 BP
FC1032 J3
OC ACT PCB
FC1032 J4
OC ACT PCB
FC1275 J18 BP
FC1051 - L=650
J21 BP
STEPPER MOTOR
J12 BP
DET A RTD
DET B RTD
INLET B RTD
OVEN RTD
TO PTV-FC1277
FC1271
J37 BP NPD DET
FC1261-J32 BP
FC3674 =500 J33 BP
FC1262-J34 BP
FC803
2 x FC1032
FC1275
FC1051
FC1282
FC1275
FC1051 - L=650
OVEN BLOWER
RTD
HEATER
OVEN
THREE WAY
VALVE
OVEN BLOWER
STEPPER MOTOR
FC1274 L=250
SVE
VALVE
FC1274 L=250
FC1274 L=250
FC1277
HEATER
RTD
INLET B
DET B
DET A
INLET A
FC1267
DOOR SWITCH
MAIN FILTER
S1-1
S1-3
L
N
G/VE
FC1288
SAFETY RELAY
A1
A2
B1
B2
K1
COIL
J21
J22
J20
J18
N
L
S1-1
S1-2
S1-3
S1-4
BREAKER
J2
J3
J4
J6
J1
Jumper 1-2 for 120V
Jumper 2-3 for 230V
Jumper 1-3 for Single NPD
Jumper 2-3 for Dual NPD
Jumper 1-3 for Ignitor TRF
Jumper 2-3 for Main TRF
J5
J7
J9
J8
J10
FC1289
J11
J13
J12
OVEN HEATER
Q1-2
Q1-3
J20
J19
J14
J15
J16
J17
TB2
TB1
DET B
DET A
INLET B
INLET A
INLET B COOL FAN
VALVE OVEN
JET SEPARATOR
INLET A
COOL FAN
FC1267
FC1277
FC1282
FC1290
G/VE
DUAL NPD
TRF
FC1271
K1-B2
Q1-3
Q1-2
K1-A2
K1-A1
K1-B1
S1-4
S1-2
J18
J19
J20
J21
J22
J23
J24
FC1281
FC1288
J16 = SINGLE VOLTAGE
BLOWER MOTOR
POWER CONTROL P.C.B.
POWER SUPPLY P.C.B.
FID TRF
FC1269
FC1290
J1
J2
FC1289
POS.
DENOMINAZIONE
PEZZI
DISEGNO
CODICE
strumento
GC TRACE 2000 Series
assieme
ANALITICAL UNIT (230V)
particolare
Wiring Diagram
disegnatore
A.Lamperti
data
21/7/98
sostituisce
scala
codice
visto
A2
Toll. Gen.
0,1
30'
Fil. 6H-6g
1,6
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SC750
modif.

5.2

Control Unit

This chapter describes the Control Unit of the TRACE GC 2000.

Chapter at a Glance...

General Description

The primary requirement for any GC is multiple independent temperature controlled zones. A GC also needs various input and output signals to synchronize and control peripheral devices. In the TRACE GC 2000, a Motorola 68332 microprocessor controls all functions.

NOTE Throughout this manual, the term microprocessor pertains to the Motorola 68332, unless otherwise specified.

Figure 5.2-1 shows a generalized block diagram of the TRACE GC 2000 base unit.

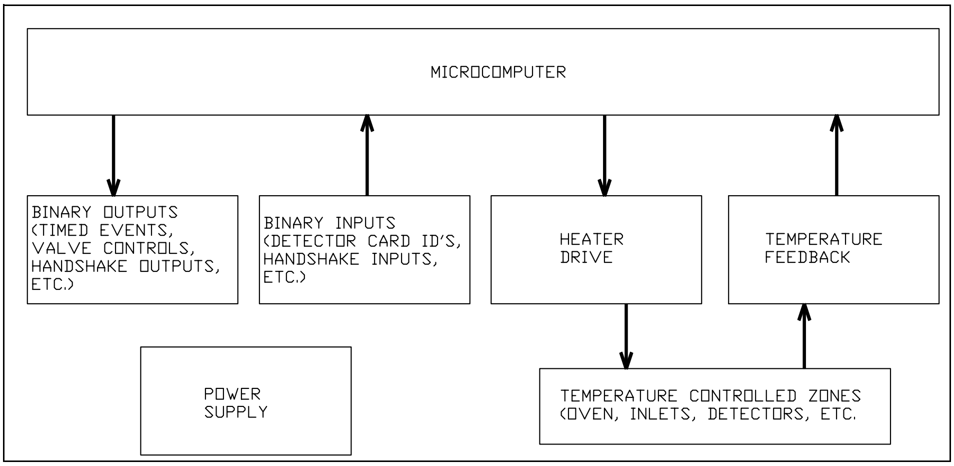


Figure 5.2-1. Block Diagram of Base Unit

The base unit contains six PCBs in the main electronic chassis, plus the Power Control Module (PCM). The main electronic chassis contains the following PCBs:

- Motherboard
- Central processing unit
- Temperature feedback and digital I/0
- Detector controllers (three boards)

The Power Control Module (PCM) contains an additional PCB. The functional blocks shown in Figure 5.2-1 are distributed among the PCBs.

Figure 5.2-2 illustrates the circuit functions in greater detail.

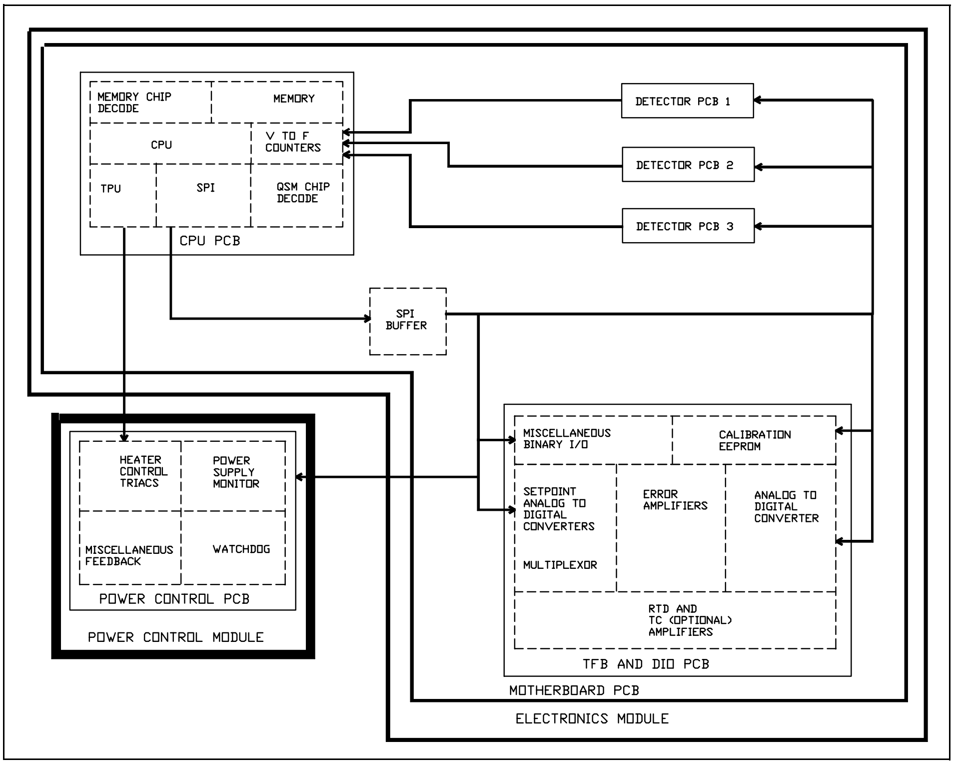
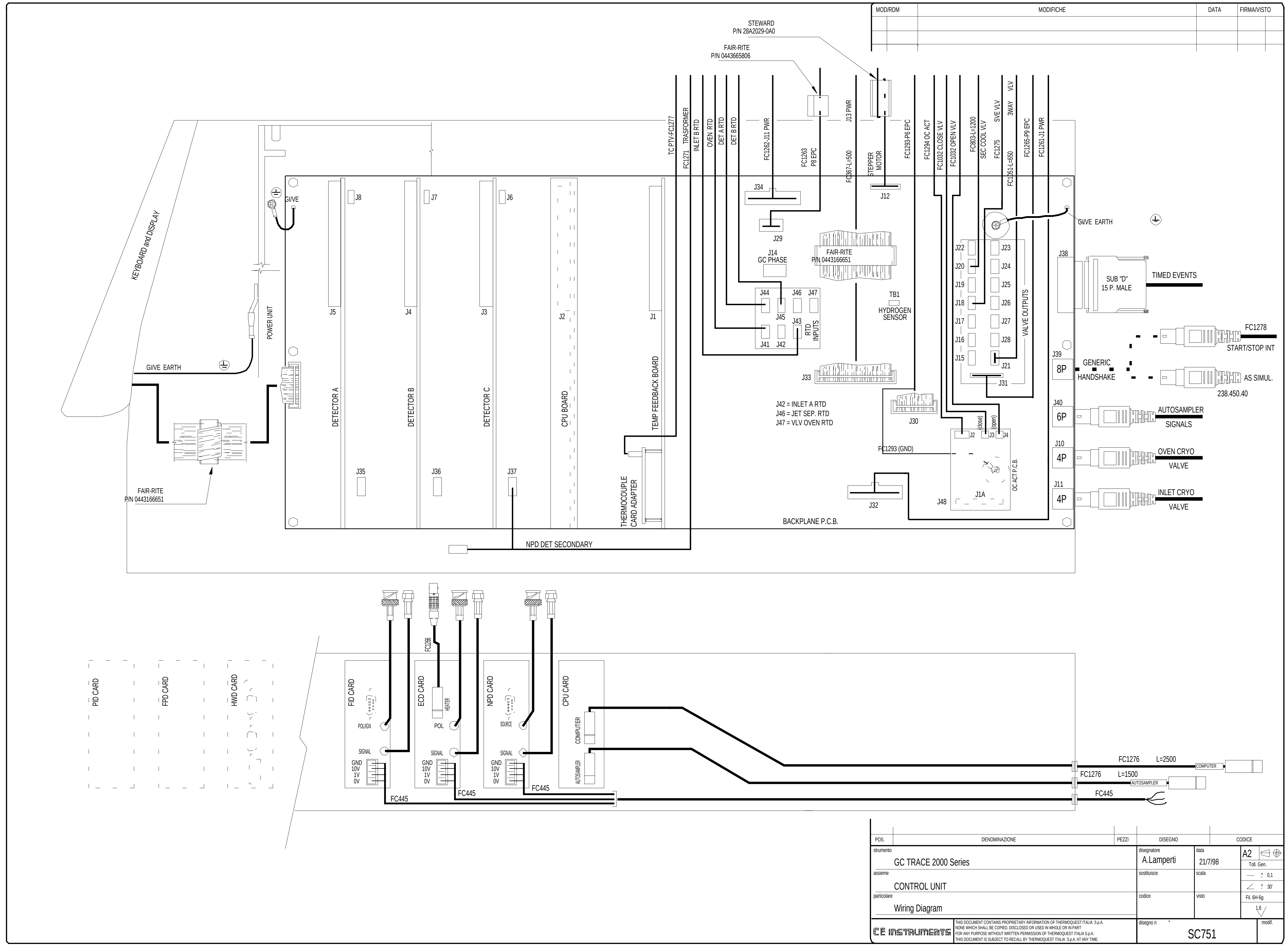


Figure 5.2-2. Expanded Block Diagram of Circuit Functions

The TRACE GC 2000 Block Diagram and the wiring drawing SC751 (see next two pages) show all internal cables and connectors used to connect all boards.


MOD/RDM
MODIFICHE
DATA
FIRMA/VISTO
STEWARD
P/N 28A2029-0A0
FAIR-RITE
P/N 0443665806
KEYBOARD and DISPLAY
POWER UNIT
G/VE EARTH
FAIR-RITE
P/N 0443166651
DETECTOR A
DETECTOR B
DETECTOR C
CPU BOARD
TEMP FEEDBACK BOARD
THERMOCOUPLE CARD ADAPTER
NPD DET SECONDARY
BACKPLANE P.C.B.
TC PTV-FC1277
FC1271 TRASFORMER
INLET B RTD
OVEN RTD
DET A RTD
DET B RTD
FC1262-J11 PWR
FC1263 P8 EPC
J13 PWR
FC967-L=500
STEPPER MOTOR
FC1293-P6 EPC
FC1294 OC ACT
FC1032 CLOSE VLV
FC1032 OPEN VLV
FC803-L=1200
SEC COOL VLV
S/VE VLV
FC1275
3WAY VLV
FC1251-L=650
FC1265-P9 EPC
FC1261-J1 PWR
J14
GC PHASE
FAIR-RITE
P/N 0443166651
TB1
HYDROGEN SENSOR
RTD INPUTS
J42 = INLET A RTD
J46 = JET SEP. RTD
J47 = VLV OVEN RTD
FC1293 (GND)
OC ACT P.C.B.
VALVE OUTPUTS
G/VE EARTH
SUB "D"
15 P. MALE
TIMED EVENTS
FC1278
START/STOP INT
GENERIC
HANDSHAKE
AS SIMUL.
238.450.40
AUTOSAMPLER
SIGNALS
OVEN CRYO
VALVE
INLET CRYO
VALVE
PID CARD
FPD CARD
HWD CARD
FID CARD
ECD CARD
NPD CARD
CPU CARD
FC1266
POL/IGN
SIGNAL
HEATER
POL
SOURCE
COMPUTER
AUTOSAMPLER
GND
10V
1V
0V
FC445
FC1276 L=2500
FC1276 L=1500
POS.
DENOMINAZIONE
PEZZI
DISEGNO
CODICE
strumento
GC TRACE 2000 Series
assieme
CONTROL UNIT
particolare
Wiring Diagram
disegnatore
A.Lamperti
data
21/7/98
A2
Toll. Gen.
sostituisce
scala
codice
visto
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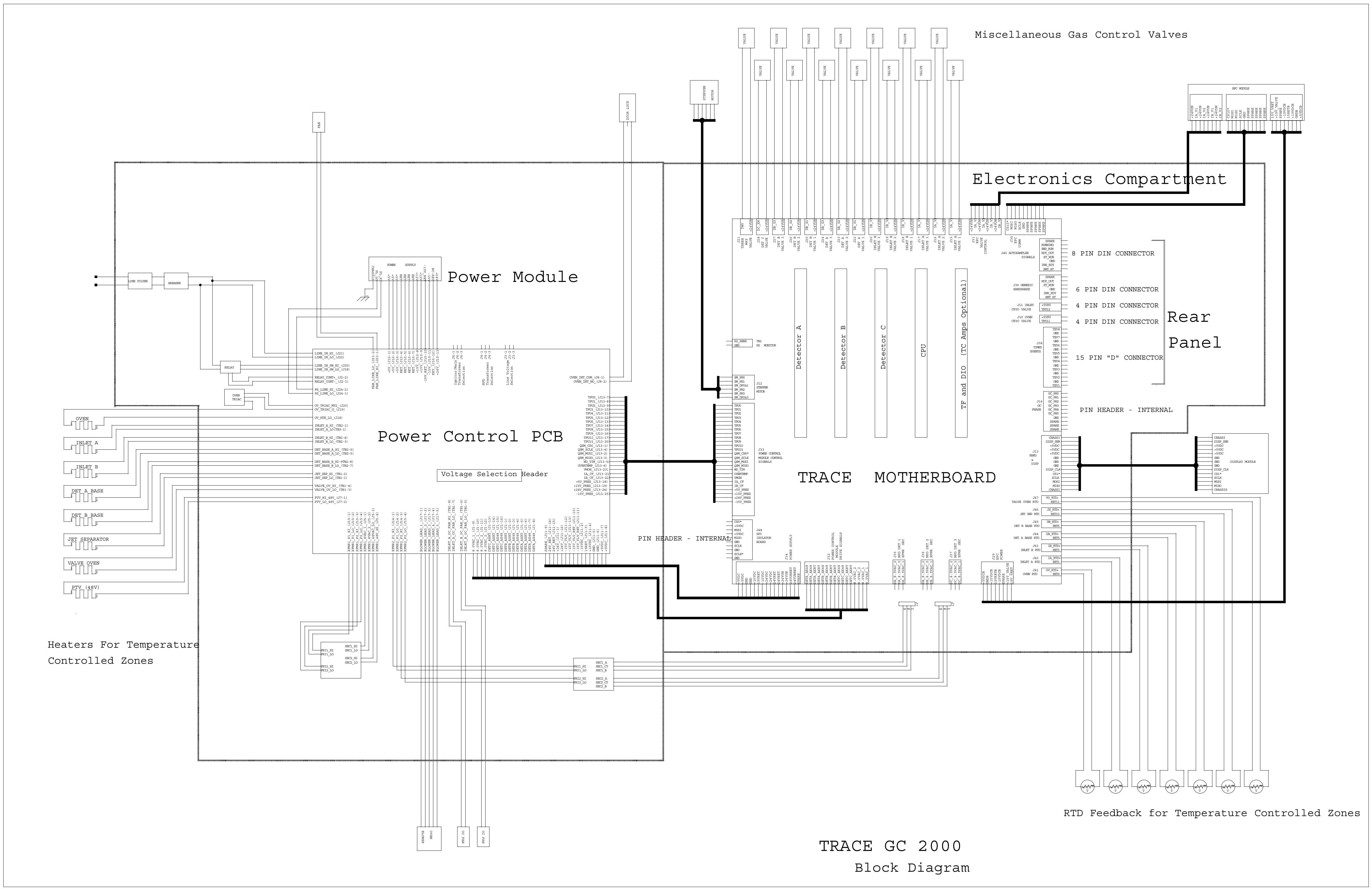
disegno n°
SC751
modif.



Miscellaneous Gas Control Valves
Electronics Compartment
Power Module
Power Control PCB
Voltage Selection Header
TRACE MOTHERBOARD
Detector A
Detector B
Detector C
CPU
TF and DIO (TC Amps Optional)
8 PIN DIN CONNECTOR
6 PIN DIN CONNECTOR
4 PIN DIN CONNECTOR
4 PIN DIN CONNECTOR
15 PIN "D" CONNECTOR
Rear
Panel
PIN HEADER - INTERNAL
PIN HEADER - INTERNAL
OVEN
INLET A
INLET B
DET A BASE
DET B BASE
JET SEPARATOR
VALVE OVEN
PTV (48V)
Heaters For Temperature
Controlled Zones
RTD Feedback for Temperature Controlled Zones
TRACE GC 2000
Block Diagram

5.3

Motherboard

This chapter describes the Motherboard of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

The Motherboard provides communication between the TRACE GC 2000 PCBs and external devices.

NOTE The schematic for the motherboard is labeled *backplane*. Throughout this manual, the term motherboard will be used instead of backplane; however, the two terms refer to the same thing.

Most of the temperature control channels use RTDs (PT100) as feedback elements. All of these signals are routed through the motherboard. Most are connected to the motherboard in an area near PCB connector J1. Certain detectors require an additional temperature control channel. These detectors route the signals through the detector PCB and onto the motherboard. Any time that a temperature channel does not have an RTD connected, the RTD signal must be shorted to ground. In the connector area near J1, shorted connectors are installed wherever an open RTD connector exists. For the detectors, there are jumpers (J6-J8) located adjacent to each of the detector card connectors (J3–J5). When a detector is installed that requires an additional heater, the jumper should be positioned on the top two pins. When a detector is installed that does not require an additional heater, the jumper should be positioned on the bottom two pins.

Three connectors (J3–J5) on the motherboard are dedicated to detector PCBs. Any detector card can be installed in any of these three locations. If the detector card is for a Nitrogen Phosphorous Detector (NPD), then a cable from the optional nitrogen phosphorous (NP) transformer must be plugged into the appropriate NP power connector (J35-J37). There are three NP power connectors on the motherboard, one for each detector card location. These are located at the bottom of the motherboard adjacent to each detector card location.

One connector (J2) is dedicated to the CPU PCB. One connector (J1) is dedicated to the Temperature Feedback and Digital I/O (TF & DIO) PCB. See *Schematics and Component Layout*.

A set of connectors is provided for ON/OFF control of the various gases when the DPFC option is not installed. These are located on the right end of the motherboard in an area labeled VALVE OVEN FTD. Table 5.3-1 indicates the function of each non-DPFC gas ON/OFF control connector.

Table 5.3-1. Non-DPFC Gas ON/OFF Control Connectors

Connector / Description	Valve Voltage
J15 / Inlet A Valve 1	24 Volt
J16 / Inlet A Valve 2	24 Volt
J17 / Inlet A Valve 3	24 Volt
J18 / Inlet B Valve 1	24 Volt
J19 / Inlet B Valve 2	24 Volt
J20 / Inlet B Valve 3	24 Volt
J22 / Detector A Valve 1	12 Volt
J23 / Detector A Valve 2	12 Volt
J24 / Detector A Valve 3	12 Volt
J25 / Detector B Valve 1	12 Volt
J26 / Detector B Valve 2	12 Volt
J27 / Detector B Valve 3	12 Volt
J28 / Detector C	12 Volt
J21 / Three Way Valve	24 Volt

In the lower right corner of the motherboard is a connection (See the PCB Motherboard/Backplane Standard [119826] Layout for J48 in the section labeled *On_Col Semi Auto Actuator and/or SPI Isolator Board*), for a *piggy-back* PCB, which controls the semiautomatic on-column actuator. Two *piggy-back* boards may be stacked if the TRACE GC 2000 has two semiautomatic on-column actuators.

Five connectors are positioned on the motherboard to provide control signals to peripheral devices from the rear panel of the TRACE GC 2000. These connectors are:

- Timed Event
- Generic Handshake
- Autosampler
- Oven Cryo Valve
- Inlet Cryo Valve

Figure 5.3-1 shows the Timed Event connector, which provides generically timed control signals.

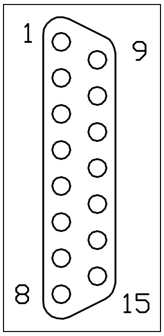


Figure 5.3-1. Front View of Timed Event Connector (J38, 15-Pin Female)

Individual pin assignments for the Timed Event connector, and associated control signals and electrical characteristics, are indicated in Table 5.3-2.

Table 5.3-2. Timed Event Connector

Pin Number	Signal	Electrical Characteristics
1	TEV 1	Open Collector, 25 V Max, 250 mA Current Sink
3	TEV 2	Open Collector, 25 V Max, 250 mA Current Sink
5	TEV 3	Open Collector, 25 V Max, 250 mA Current Sink
7	TEV 4	Open Collector, 25 V Max, 250 mA Current Sink
9	TEV 5	Open Collector, 25 V Max, 250 mA Current Sink
11	TEV 6	Open Collector, 25 V Max, 250 mA Current Sink
13	TEV 7	Open Collector, 25 V Max, 250 mA Current Sink
15	TEV 8	Open Collector, 25 V Max, 250 mA Current Sink
2,4,6,8,10,12,14	GND	

Figure 5.3-2 shows the Generic Handshake connector (J39, MINIDIN 8-Pin Female Circular), which provides generic handshake input/output control signals.

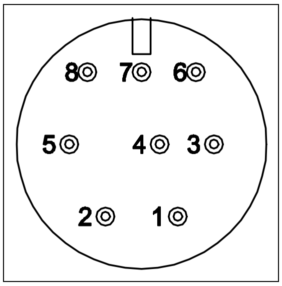


Figure 5.3-2. Front View of Generic Handshake Connector

NOTE Signals on the Generic Handshake connector and the Autosampler connector are electrically parallel.

Individual pin assignments for the Generic Handshake connector, and associated control signals and electrical characteristics, are indicated Table 5.3-3.

Table 5.3-3. Generic Handshake Connector

Pin Number	Signal	Electrical Characteristics
1	Remote Start—This signal is an input to the GC to signal that the run should start. Polarity is software selectable.	TTL Input
2	Inhibit Ready—This signal is an input to the GC to indicate that the GC is not ready to start a run. Polarity is software selectable.	TTL Input
3	Ground	
4	Start Run—This signal is an output from the GC to signal external devices that a run has started. Polarity is software selectable.	Open Collector, 20 V Max, 150 mA Current Sink
5	Ready Out—This signal is an output from the GC to signal external devices that the GC is ready to start a run. Polarity is software selectable.	Open Collector, 20 V Max, 150 mA Current Sink
6	End Run—This signal is an output from the GC to signal external devices that the GC run has ended. Polarity is software selectable.	Open Collector, 20 V Max, 150 mA Current Sink
7	Prep Run—This signal is an output from the GC to signal external devices that the GC is in the **Prep Run** condition. Polarity is software selectable.	Open Collector, 20 V Max, 150 mA Current Sink
8	Not Used	N/A

Figure 5.3-3 shows the Autosampler connector (J40, MINIDIN 6-Pin Female Circular), which provides autosampler input/output control signals.

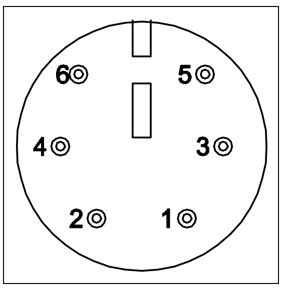


Figure 5.3-3. Front View of Autosampler Connector

NOTE Signals on the Autosampler connector and the Generic Handshake connector are electrically parallel.

Individual pin assignments for the Autosampler connector, and associated control signals and electrical drive capabilities, are indicated in Table 5.3-4.

Table 5.3-4. Autosampler Connector

Pin Number	Signal	Electrical Drive Capability
1	Remote Start—This signal is an input to the GC to signal that the run should start. Polarity is software selectable.	TTL Input
2	Inhibit Ready—This signal is an input to the GC to indicate that the GC should not go **Ready**. Polarity is software selectable.	TTL Input
3	Ground	
4	Start Run—This signal is an output from the GC to signal external devices that a run has started. Polarity is software selectable.	Open Collector, 20 V Max, 150 mA Current Sink
5	Ready Out—This signal is an output from the GC to signal external devices that the GC is **Ready** to start a run. Polarity is software selectable.	Open Collector, 20 V Max, 150 mA Current Sink
6	Not Used	N/A

Figure 5.3-4 shows the Oven Cryo Valve (J10, MINIDIN 4-Pin Female Circular) and Inlet Cryo Valve connector (J11, MINIDIN 4-Pin Female Circular), which provide all input/output control signals to control an external cryo valve module.

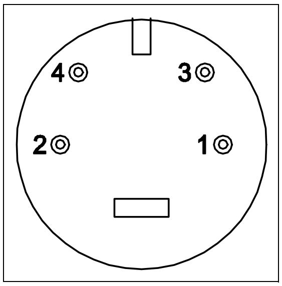


Figure 5.3-4. Front View of Oven Cryo Valve and Inlet Cryo Valve Connector

Pin assignments for both the Oven Cryo Valve and the Inlet Cryo Valve connectors are indicated in Table 5.3-5.

Table 5.3-5. Oven Cryo Valve and Inlet Cryo Valve Connectors

Pin Number	Signal	Electrical Drive Capability
1	Current Drive	~10 mA drive for LED in Optoisolator
2,3	No Connect	
4	Cryo Control Signal	

Other connectors provide interchassis power distribution and communication. These connectors are itemized in Table 5.3-6.

Table 5.3-6. Other Connectors

Connector	Function
J13	Communication with Keypad and Display Panel
J34	System Power Distribution to Motherboard
J29	Power to DPFC Module
J30	Communication with the DPFC
J31	Valve Control (ON/OFF) in the DPFC
J33	Communication with the Power Control Module
J12	Oven Stepper Motor Control

Adjustment Procedures

No field adjustments are necessary.

Schematics and Component Layout

The schematics and component layout information for the motherboard (backplane) is listed below in Table 5.3-7. The number of drawings has been included for each schematic and its corresponding layout. There are nine drawings for reference in this section.

Table 5.3-7. Motherboard Schematics

Board	PN	Drawing	Layout
BKPLN-Standard	23648350	119828E, 1–7	119826, 1
BKPLN-Right	119996-0001	119828E, 1–7	119991, 1

NOTE The last two drawings in this section are the layout of the motherboard. One drawing is for the standard version, and the other is for the right version.

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REV	ECO NO.	DATE	BY	CHK
1	Initial Proto	04-18-97		
2	Alpha Hwr	05-29-97		
A	DRN 4183	01-19-98		
B	ECO 31529	2-1-98	M GARRETT	J COTTRELL
C	ECO 31549	4-8-98	L BALDWIN	
D	ECO 31552	4-8-98	L BALDWIN	

	BY	Date
DRN	M. GARRETT	01-19-98
CHK		
ENGR	M. GARRETT	04-10-97
APPD		

Thermo Quest

2215 Grand Avenue Parkway
Austin, TX 78728

Title: TRACE, BACKPLANE

Document Number: 119828

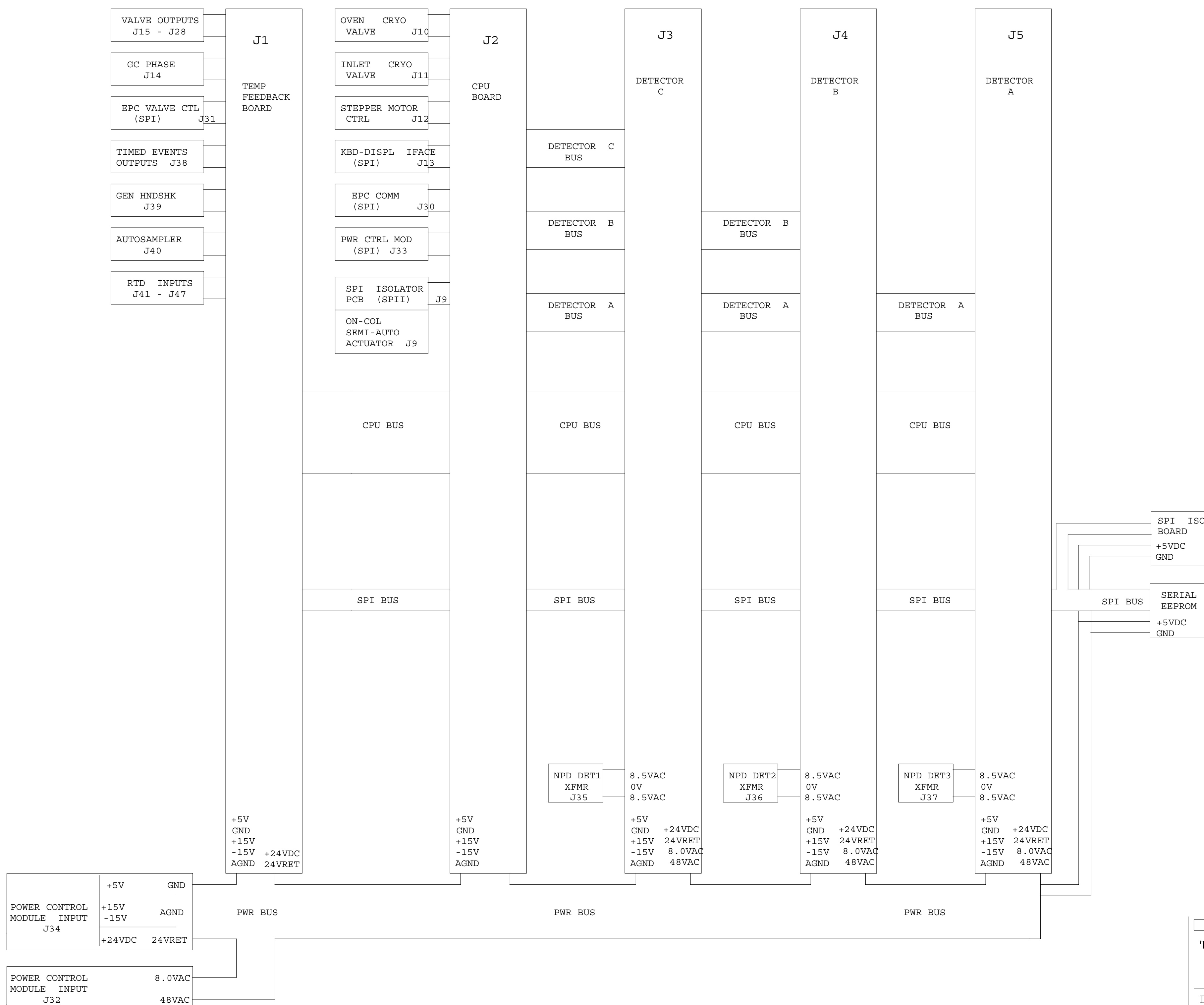
Rev: E

Date: 01-19-98

Size: B

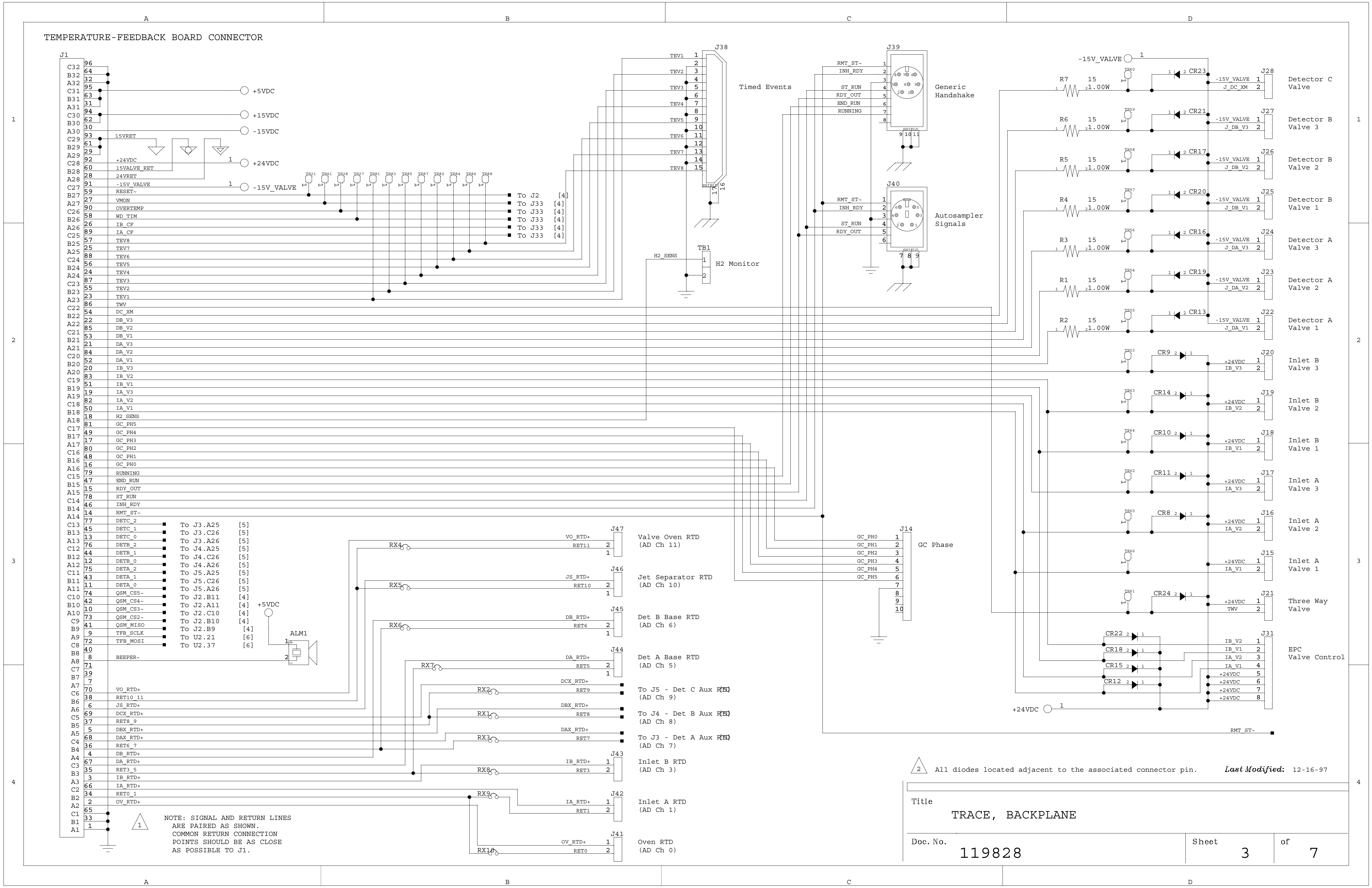
Sheet 1 of 7

BLOCK DIAGRAM, MOTHERBOARD



Last Modified: 12-15-97

Title: TRACE, BACKPLANE		
Doc. No. 119828	Sheet 2	of 7


TEMPERATURE-FEEDBACK BOARD CONNECTOR
J1
+5VDC
+15VDC
-15VDC
+24VDC
-15V_VALVE
Timed Events
J38
J39
Generic Handshake
J40
Autosampler Signals
TB1
H2 Monitor
J14
GC Phase
J47
Valve Oven RTD (AD Ch 11)
J46
Jet Separator RTD (AD Ch 10)
J45
Det B Base RTD (AD Ch 6)
J44
Det A Base RTD (AD Ch 5)
To J5 - Det C Aux R(5) (AD Ch 9)
To J4 - Det B Aux R(5) (AD Ch 8)
To J3 - Det A Aux R(5) (AD Ch 7)
J43
Inlet B RTD (AD Ch 3)
J42
Inlet A RTD (AD Ch 1)
J41
Oven RTD (AD Ch 0)
ALM1
J28 Detector C Valve
J27 Detector B Valve 3
J26 Detector B Valve 2
J25 Detector B Valve 1
J24 Detector A Valve 3
J23 Detector A Valve 2
J22 Detector A Valve 1
J20 Inlet B Valve 3
J19 Inlet B Valve 2
J18 Inlet B Valve 1
J17 Inlet A Valve 3
J16 Inlet A Valve 2
J15 Inlet A Valve 1
J21 Three Way Valve
J31 EPC Valve Control
NOTE: SIGNAL AND RETURN LINES ARE PAIRED AS SHOWN. COMMON RETURN CONNECTION POINTS SHOULD BE AS CLOSE AS POSSIBLE TO J1.
All diodes located adjacent to the associated connector pin.
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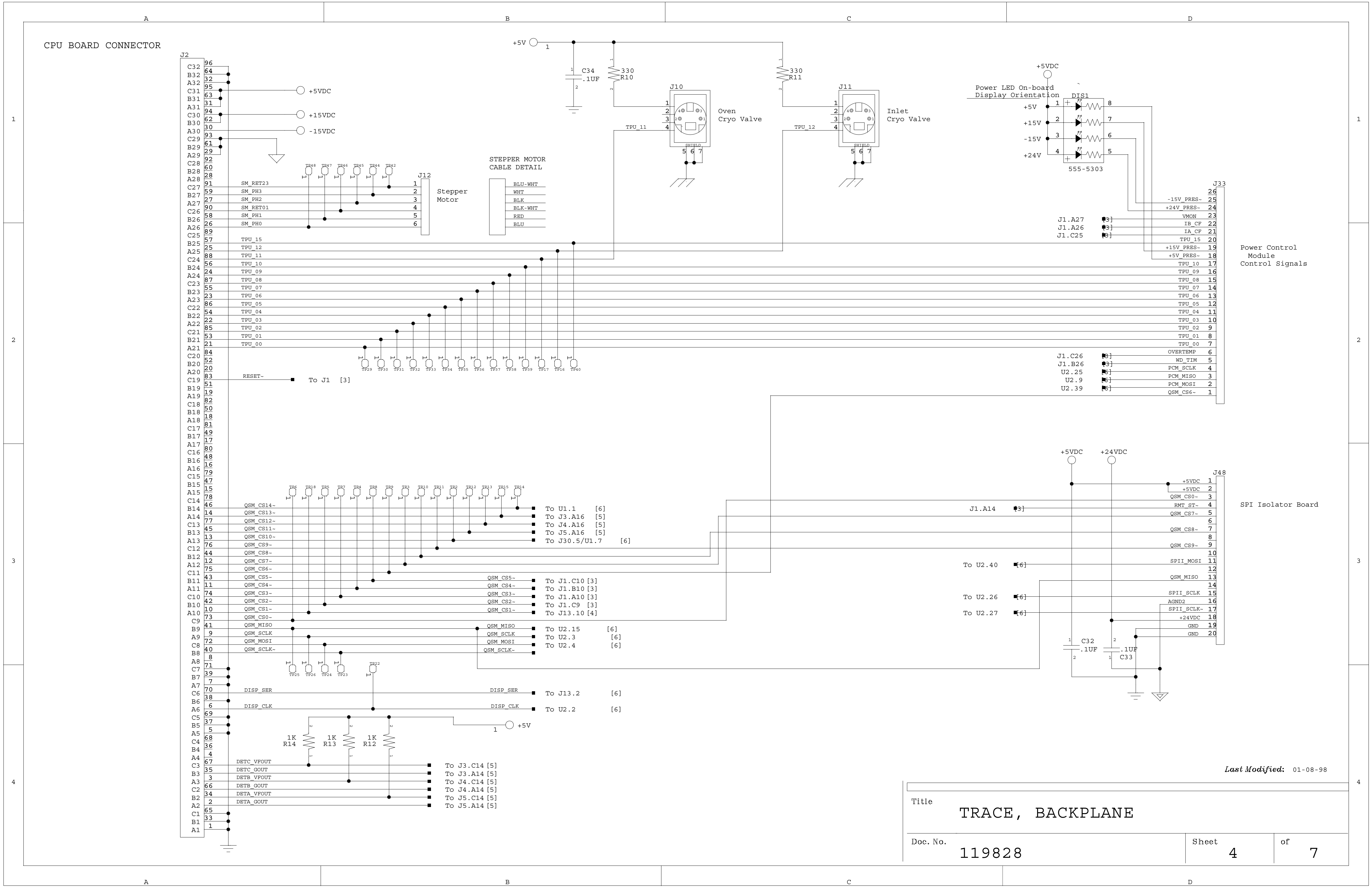
CPU BOARD CONNECTOR
J2
+5VDC
+15VDC
-15VDC
+5V
C34 .1UF
330 R10
330 R11
J10
Oven Cryo Valve
J11
Inlet Cryo Valve
TPU_11
TPU_12
SHIELD
STEPPER MOTOR CABLE DETAIL
BLU-WHT
WHT
BLK
BLK-WHT
RED
BLU
J12
Stepper Motor
SM_RET23
SM_PH3
SM_PH2
SM_RET01
SM_PH1
SM_PH0
Power LED On-board Display Orientation
DIS1
555-5303
+5V
+15V
-15V
+24V
J33
Power Control Module Control Signals
-15V_PRES~
+24V_PRES~
VMON
IB_CF
IA_CF
TPU_15
+15V_PRES~
+5V_PRES~
TPU_10
TPU_09
TPU_08
TPU_07
TPU_06
TPU_05
TPU_04
TPU_03
TPU_02
TPU_01
TPU_00
OVERTEMP
WD_TIM
PCM_SCLK
PCM_MISO
PCM_MOSI
QSM_CS6~
J1.A27 [3]
J1.A26 [3]
J1.C25 [3]
J1.C26 [3]
J1.B26 [3]
U2.25 [6]
U2.9 [6]
U2.39 [6]
RESET~
To J1 [3]
+5VDC
+24VDC
J48
SPI Isolator Board
+5VDC
QSM_CS0~
RMT_ST~
QSM_CS7~
QSM_CS8~
QSM_CS9~
SPII_MOSI
QSM_MISO
SPII_SCLK
AGND2
SPII_SCLK~
+24VDC
GND
J1.A14 [3]
To U2.40 [6]
To U2.26 [6]
To U2.27 [6]
C32 .1UF
C33 .1UF
QSM_CS14~
QSM_CS13~
QSM_CS12~
QSM_CS11~
QSM_CS10~
QSM_CS9~
QSM_CS8~
QSM_CS7~
QSM_CS6~
QSM_CS5~
QSM_CS4~
QSM_CS3~
QSM_CS2~
QSM_CS1~
QSM_CS0~
QSM_MISO
QSM_SCLK
QSM_MOSI
QSM_SCLK~
To U1.1 [6]
To J3.A16 [5]
To J4.A16 [5]
To J5.A16 [5]
To J30.5/U1.7 [6]
To J1.C10 [3]
To J1.B10 [3]
To J1.A10 [3]
To J1.C9 [3]
To J13.10 [4]
To U2.15 [6]
To U2.3 [6]
To U2.4 [6]
DISP_SER
DISP_CLK
To J13.2 [6]
To U2.2 [6]
1K R14
1K R13
1K R12
DETC_VFOUT
DETC_GOUT
DETB_VFOUT
DETB_GOUT
DETA_VFOUT
DETA_GOUT
To J3.C14 [5]
To J3.A14 [5]
To J4.C14 [5]
To J4.A14 [5]
To J5.C14 [5]
To J5.A14 [5]
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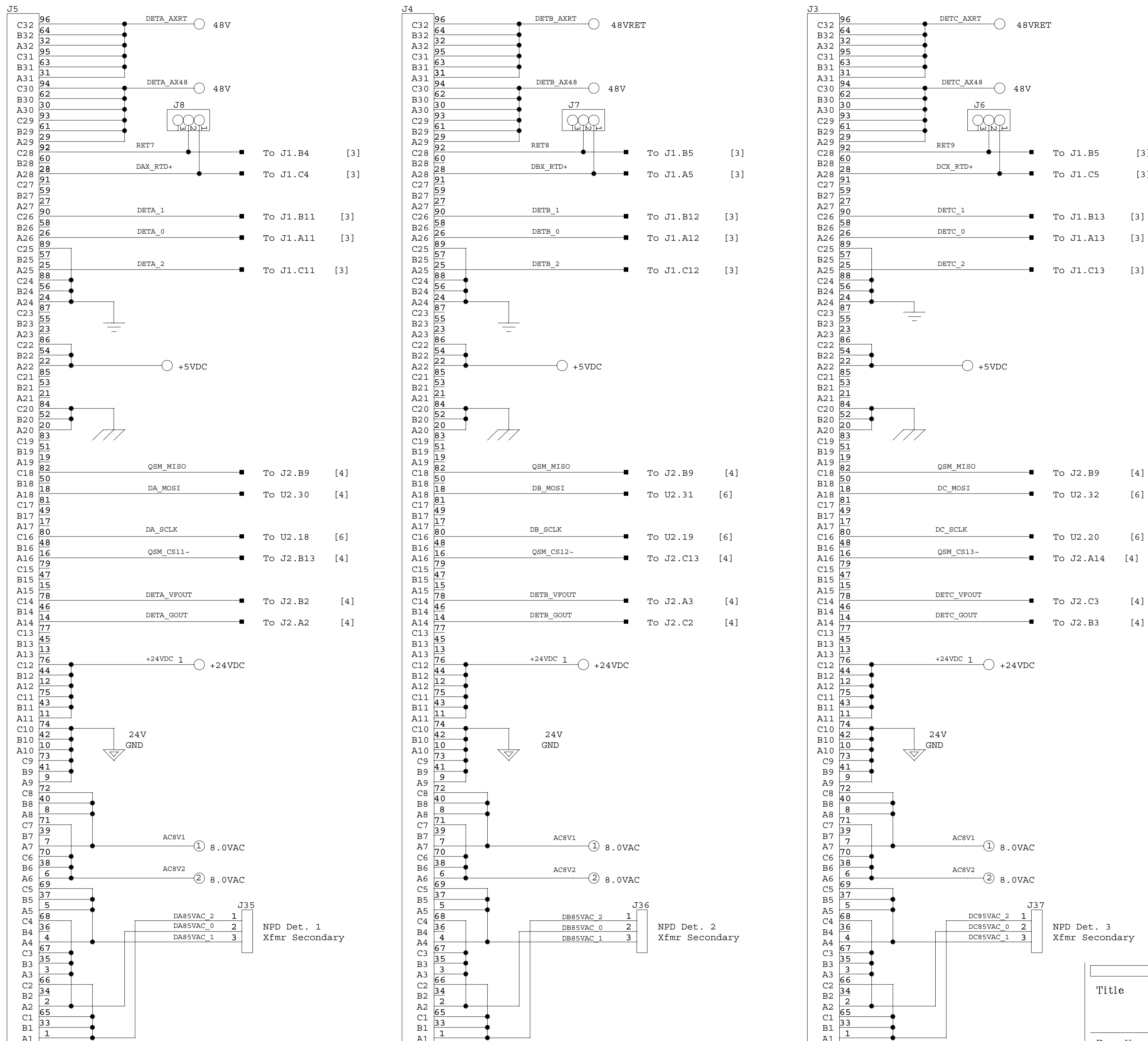
DETECTOR BOARD CONNECTORS



NOTES

1. Jumpers E1, E2, and E3 are RTD shunts. These must be installed when a detecto present for the system to operate properly.

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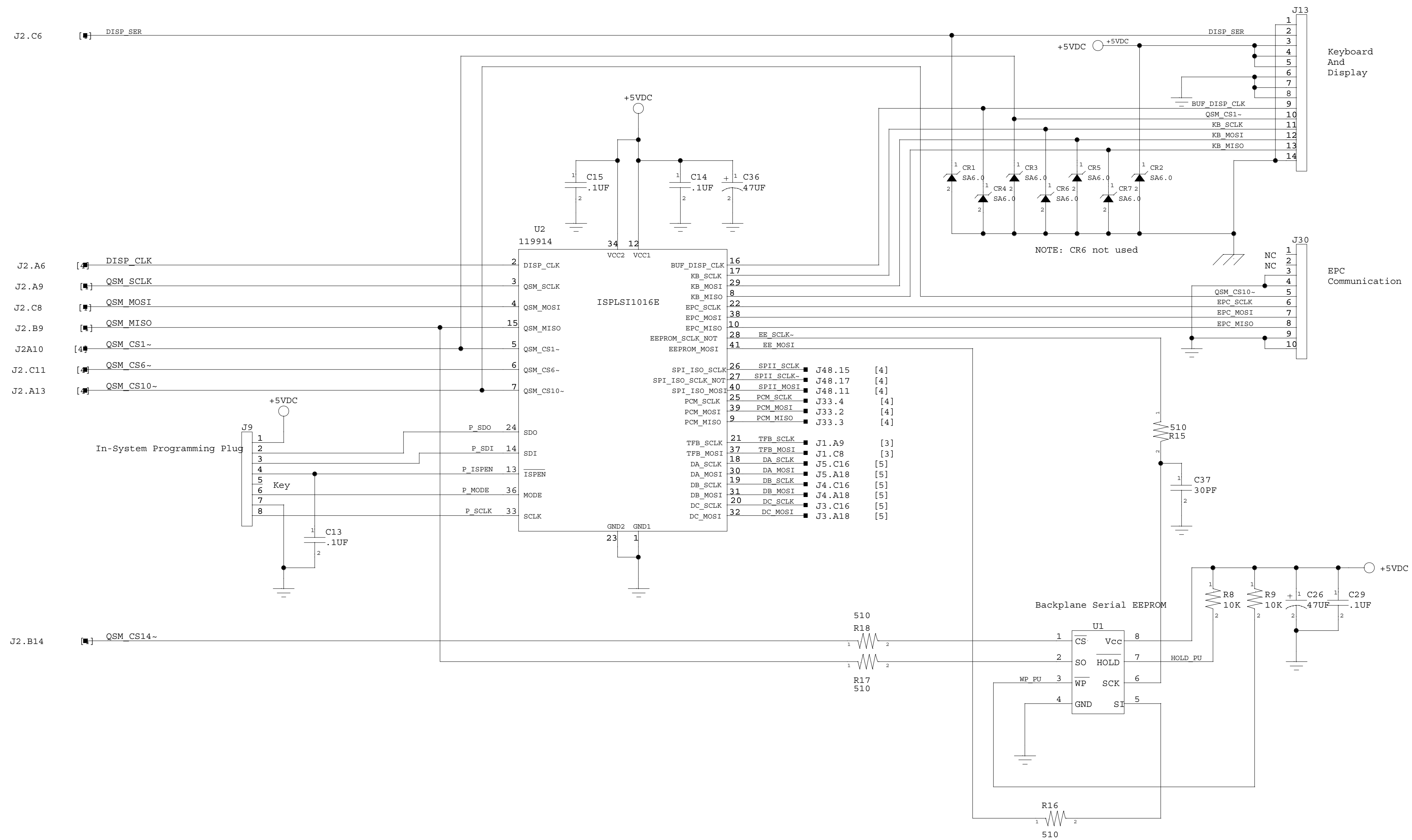
SIGNAL BUFFER CIRCUIT



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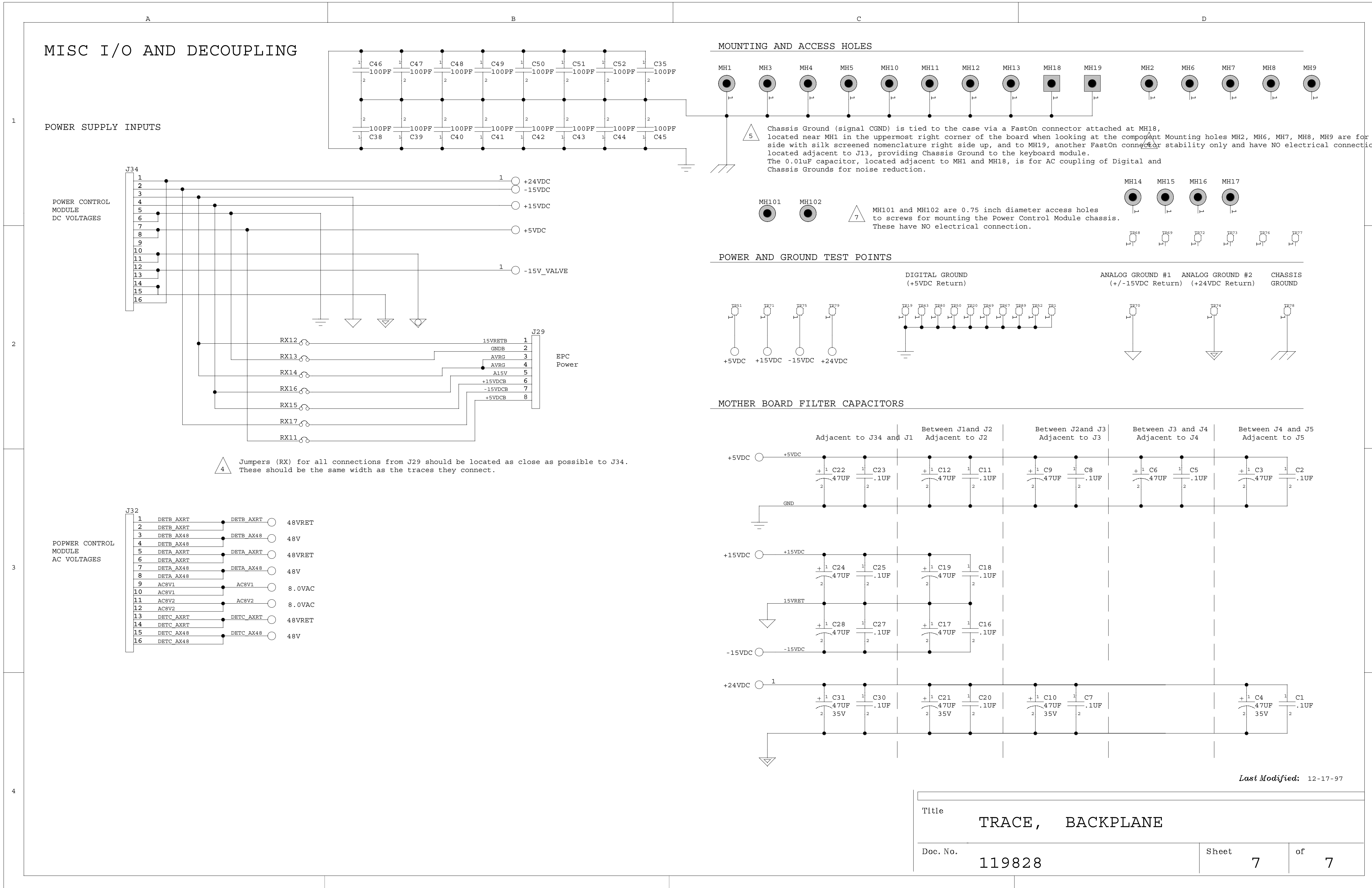
MISC I/O AND DECOUPLING
POWER SUPPLY INPUTS
MOUNTING AND ACCESS HOLES
C46 C47 C48 C49 C50 C51 C52 C35
100PF
C38 C39 C40 C41 C42 C43 C44 C45
MH1 MH3 MH4 MH5 MH10 MH11 MH12 MH13 MH18 MH19 MH2 MH6 MH7 MH8 MH9
Chassis Ground (signal CGND) is tied to the case via a FastOn connector attached at MH18,
located near MH1 in the uppermost right corner of the board when looking at the component
side with silk screened nomenclature right side up, and to MH19, another FastOn connector
located adjacent to J13, providing Chassis Ground to the keyboard module.
The 0.01uF capacitor, located adjacent to MH1 and MH18, is for AC coupling of Digital and
Chassis Grounds for noise reduction.
Mounting holes MH2, MH6, MH7, MH8, MH9 are for mec
stability only and have NO electrical connection.
J34
POWER CONTROL
MODULE
DC VOLTAGES
+24VDC
-15VDC
+15VDC
+5VDC
-15V_VALVE
MH14 MH15 MH16 MH17
MH101 MH102
MH101 and MH102 are 0.75 inch diameter access holes
to screws for mounting the Power Control Module chassis.
These have NO electrical connection.
POWER AND GROUND TEST POINTS
DIGITAL GROUND
(+5VDC Return)
ANALOG GROUND #1
(+/-15VDC Return)
ANALOG GROUND #2
(+24VDC Return)
CHASSIS
GROUND
+5VDC +15VDC -15VDC +24VDC
RX12 RX13 RX14 RX16 RX15 RX17 RX11
J29
15VRETB GNDB AVRG AVRG A15V +15VDCB -15VDCB +5VDCB
EPC
Power
Jumpers (RX) for all connections from J29 should be located as close as possible to J34.
These should be the same width as the traces they connect.
MOTHER BOARD FILTER CAPACITORS
Adjacent to J34 and J1
Between J1and J2
Adjacent to J2
Between J2and J3
Adjacent to J3
Between J3 and J4
Adjacent to J4
Between J4 and J5
Adjacent to J5
+5VDC
C22 47UF C23 .1UF C12 47UF C11 .1UF C9 47UF C8 .1UF C6 47UF C5 .1UF C3 47UF C2 .1UF
GND
+15VDC
C24 47UF C25 .1UF C19 47UF C18 .1UF
15VRET
C28 47UF C27 .1UF C17 47UF C16 .1UF
-15VDC
+24VDC
C31 47UF 35V C30 .1UF C21 47UF 35V C20 .1UF C10 47UF 35V C7 .1UF C4 47UF 35V C1 .1UF
J32
POPWER CONTROL
MODULE
AC VOLTAGES
DETB_AXRT DETB_AXRT DETB_AX48 DETB_AX48 DETA_AXRT DETA_AXRT DETA_AX48 DETA_AX48 AC8V1 AC8V1 AC8V2 AC8V2 DETC_AXRT DETC_AXRT DETC_AX48 DETC_AX48
48VRET
48V
48VRET
48V
8.0VAC
8.0VAC
48VRET
48V
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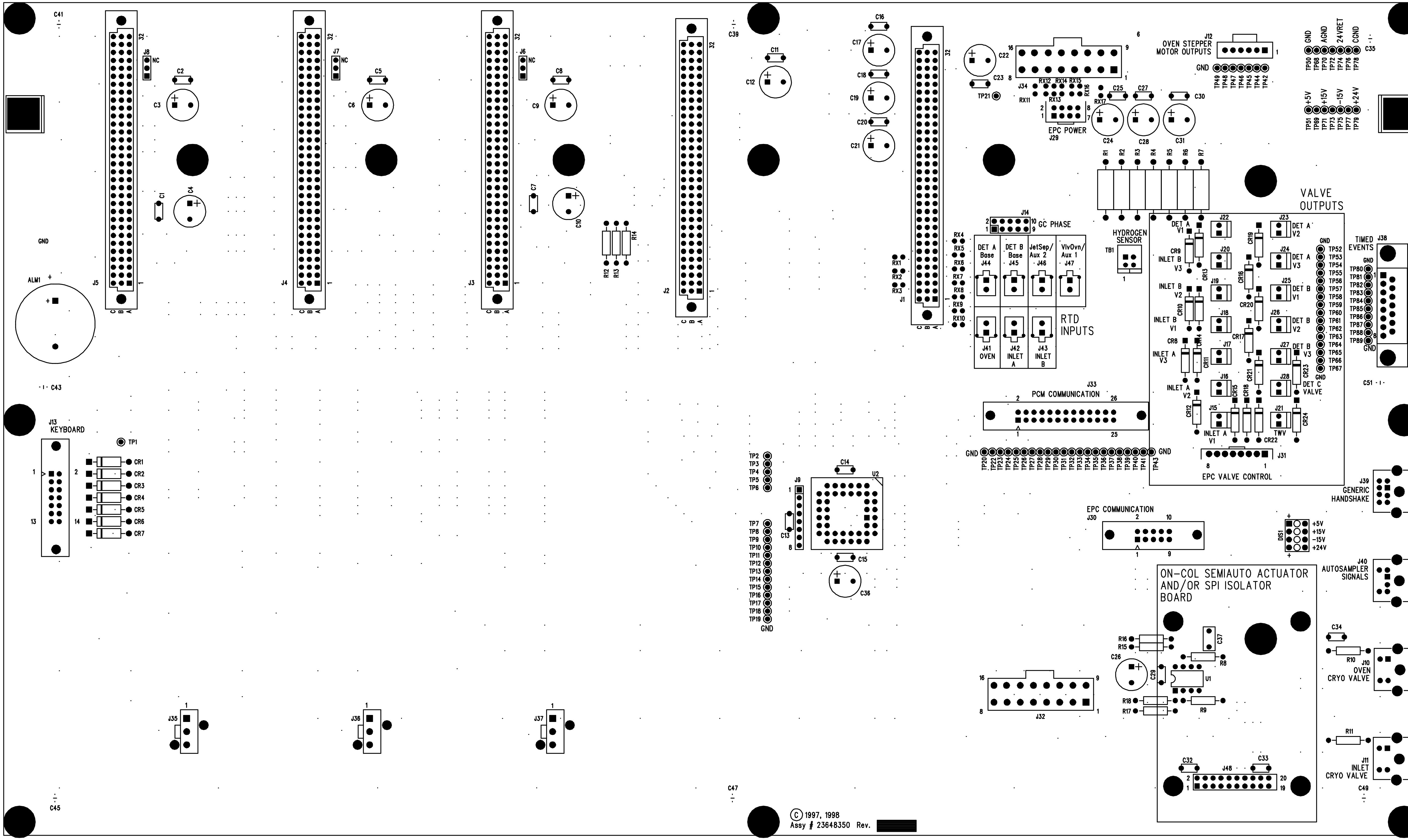

PCB Layout for Motherboard/Backplane Standard (119826)

5.4

Central Processing Unit (CPU)

This chapter describes the PCB for the Central Processing Unit (CPU) of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

The Central Processing Unit (CPU) PCB provides the control for all TRACE GC 2000 functions.

Inside the main microcontroller resides:

- A Motorola 68332 microprocessor
- 2MB of flash memory
- 750KB of static RAM

If the PCB is not fully populated, the memory amounts will be less.

NOTE Throughout this manual, the term microprocessor pertains to the Motorola 68332, unless otherwise specified.

Three programmable logic devices (PLDs) provide most of the miscellaneous logic required. The decode required for the memory chip-selects is generated in PLD U17. The decode required for the on-board peripherals is generated by PLD U19.

One 256KB bank of RAM has its power supplied from a battery circuit, so that it will retain its data when system power is off. The chip-selects for these two ICs are buffered by U10 and U11.

The microprocessor incorporates a variety of subsystems that enhance its usefulness. These include the Queued Serial Module (QSM) and the Time Processor Unit (TPU).

The QSM provides up to 16 channels of synchronous serial communication with peripheral devices. Motorola calls this communication type Serial Peripheral Interface (SPI). SPI communication is always between a master and a slave. In the TRACE GC 2000 the microprocessor is always the master.

The SPI requires four signals:

- Serial clock (SCLK)
- Device select (CS)
- Two serial data lines

The serial data line carrying data from the master to the slave is labeled Master Out Slave In (MOSI). The data line for communication in the other direction is Master In Slave Out (MISO).

In the TRACE GC 2000, SPI communication is used with all peripheral devices not located on the CPU PCB. Since there are multiple devices to be serviced, multiple device select (CS) signals are needed. The microprocessor provides four select lines (PCS0–PCS3). These four lines are decoded in PLD U19 to provide 16 device select lines (QSM_CS*0–QSM_CS*15). Table 5.4-1 identifies the device serviced by each select line.

Table 5.4-1. Select Lines and Devices

Select Line	Device
QSM_CS*0	Not Used—Future Expansion
QSM_CS*1	MMI—Keyboard
QSM_CS*2	A/D Converter TFB PCB
QSM_CS*3	D/A Converter TFB PCB
QSM_CS*4	PCB Digital Input/Output TFB PCB
QSM_CS*5	Serial EPROM on TFB PCB
QSM_CS*6	Power Control Module
QSM_CS*7	Not Used—Future Expansion
QSM_CS*8	Not Used—Future Expansion
QSM_CS*9	Not Used—Future Expansion
QSM_CS*10	DPFC
QSM_CS*11	Detector PCB A
QSM_CS*12	Detector PCB B
QSM_CS*13	Detector PCB C
QSM_CS*14	Serial EPROM on Motherboard
QSM_CS*15	Not Used—Idle State

The TRACE GC 2000 has three serial channels. The first of these is the Serial Communication Interface (SCI), which is part of the microprocessor. This channel is used for driving the display panel. The other two channels are supplied by U22. These two channels are used for communication with the computer and the autosampler. The device that provides these two serial channels also provides a parallel port which is not used in the TRACE GC 2000.

Time information for the TRACE GC 2000 is maintained by a Real Time Clock (U15). The power for this device is supplied by a battery circuit. Its chip-select is buffered by U12.

The TRACE GC 2000 uses the TPU functions for most of the controls required for temperature control. TPU Channel 15 is an input that receives a clock signal, which is twice the power line frequency, and is synchronized with the zero crossing of the power line. The functions of the other 15 TPU channels are listed in Table 5.4-2.

Table 5.4-2. TPU Channels and Functions

TPU Channel	Function
0	Inlet A (Right Inlet) Heater
1	Inlet B (Left Inlet) Heater
2	PTV Heater
3	Detector A (Right Detector) Base Heater
4	Detector B (Left Detector) Base Heater
5	Detector A Auxiliary Heater
6	Detector B Auxiliary Heater
7	Detector C Auxiliary Heater
8	Aux (Jet Separator) Heater
9	Aux (Valve oven) Heater
10	Oven Heater
11	Oven Cryo Valve
12	Inlet Cryo Valve
13	Oven Door Stepper—Step
14	Oven Door Stepper—Direction

The oven door stepper motor is driven by U21, which receives step and direction signals from the microprocessor through TPU channels.

In order to minimize RF emissions, the CPU is enclosed in a metal shield. An auxiliary connector on the PCB will allow future expansion of devices that may require access to the data and address buses.

Each detector card generates a frequency proportional to the analog voltage output. This frequency must be counted with a consistent sampling gate time. U19 controls the sample gate. Its time duration is managed by the software. U20 contains counters for all three detectors.

Adjustment Procedures

No field adjustments are necessary.

Schematics and Component Layout

The schematics and component layout information for the CPU PCB is listed below in Table 5.4-3. The number of drawings has been included for each schematic and its corresponding layout. There are eight drawings for reference in this section.

Table 5.4-3. CPU Schematics

Board	PN	Drawing	Layout
CPU	23648345	119825B, 1–7	119823, 1

The last drawing in this section is the layout of the board.

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B	ECO 61510	1/5/98	L. Baldwin	L. Baldwin
C	ECO 31693	7/6/98	L. Baldwin	
D	ECO 31702	7/6/98	L. Baldwin	

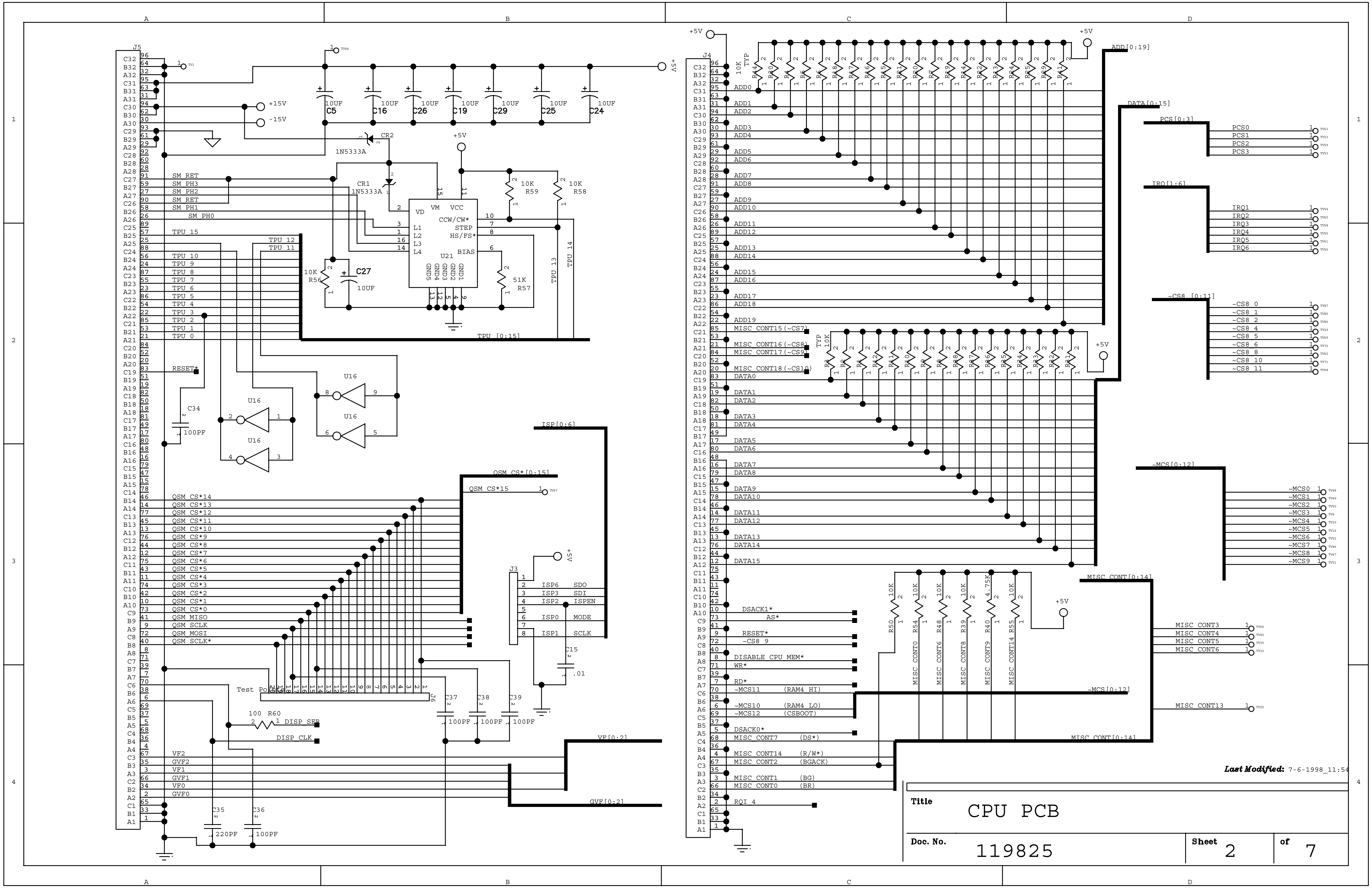
	BY	Date
DRN	L. Baldwin	12/8/97
CHK	L. Baldwin	12/8/97
ENGR	L. Baldwin	12/8/97
APPD		

Thermo Quest
2215 Grand Avenue Parkway
Austin, TX 78728

Title: CPU PCB

Document Number: 119825 | Rev: D

Date: 12/8/97 | Size: B | Sheet 1 of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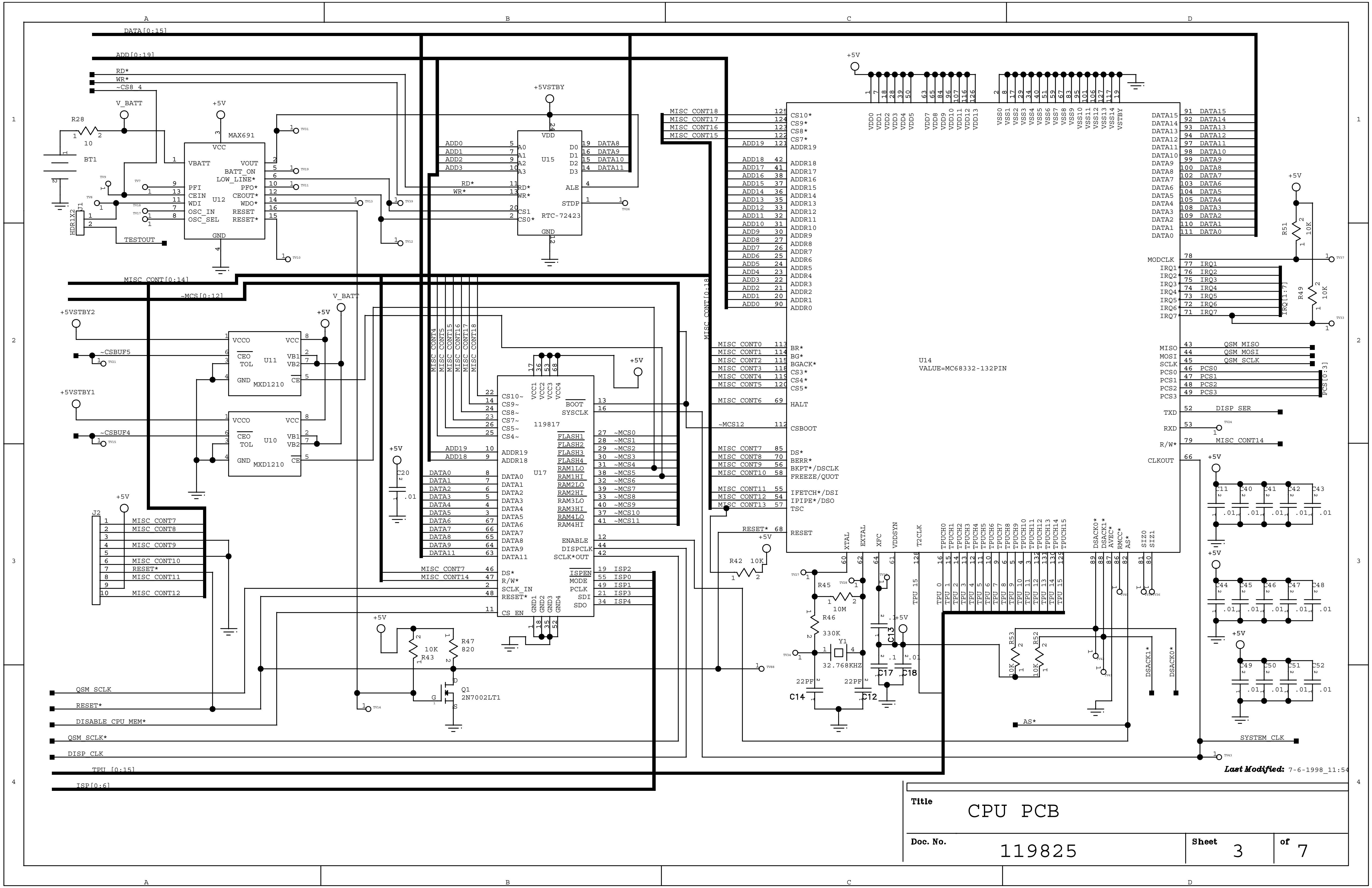

DATA[0:15]
ADD[0:19]
RD*
WR*
~CS8_4
V_BATT
+5V
MAX691
U12
R28
10
BT1
J1
HDR1X2
TESTOUT
+5VSTBY
U15
RTC-72423
MISC_CONT[0:14]
~MCS[0:12]
+5VSTBY2
+5VSTBY1
~CSBUF5
~CSBUF4
U11
U10
MXD1210
V_BATT
U17
119817
C20
.01
J2
MISC_CONT7
MISC_CONT8
MISC_CONT9
MISC_CONT10
RESET*
MISC_CONT11
MISC_CONT12
R47
820
R43
10K
Q1
2N7002LT1
QSM_SCLK
RESET*
DISABLE_CPU_MEM*
QSM_SCLK*
DISP_CLK
TPU_[0:15]
ISP[0:6]
U14
VALUE=MC68332-132PIN
R42
10K
R45
10M
R46
330K
Y1
32.768KHZ
22PF
C14
C12
C13
C17
C18
R53
R52
DSACK1*
DSACK0*
AS*
R51
R49
10K
IRQ[1:7]
QSM_MISO
QSM_MOSI
QSM_SCLK
PCS[0:3]
DISP_SER
MISC_CONT14
SYSTEM_CLK
C11
C40
C41
C42
C43
C44
C45
C46
C47
C48
C49
C50
C51
C52
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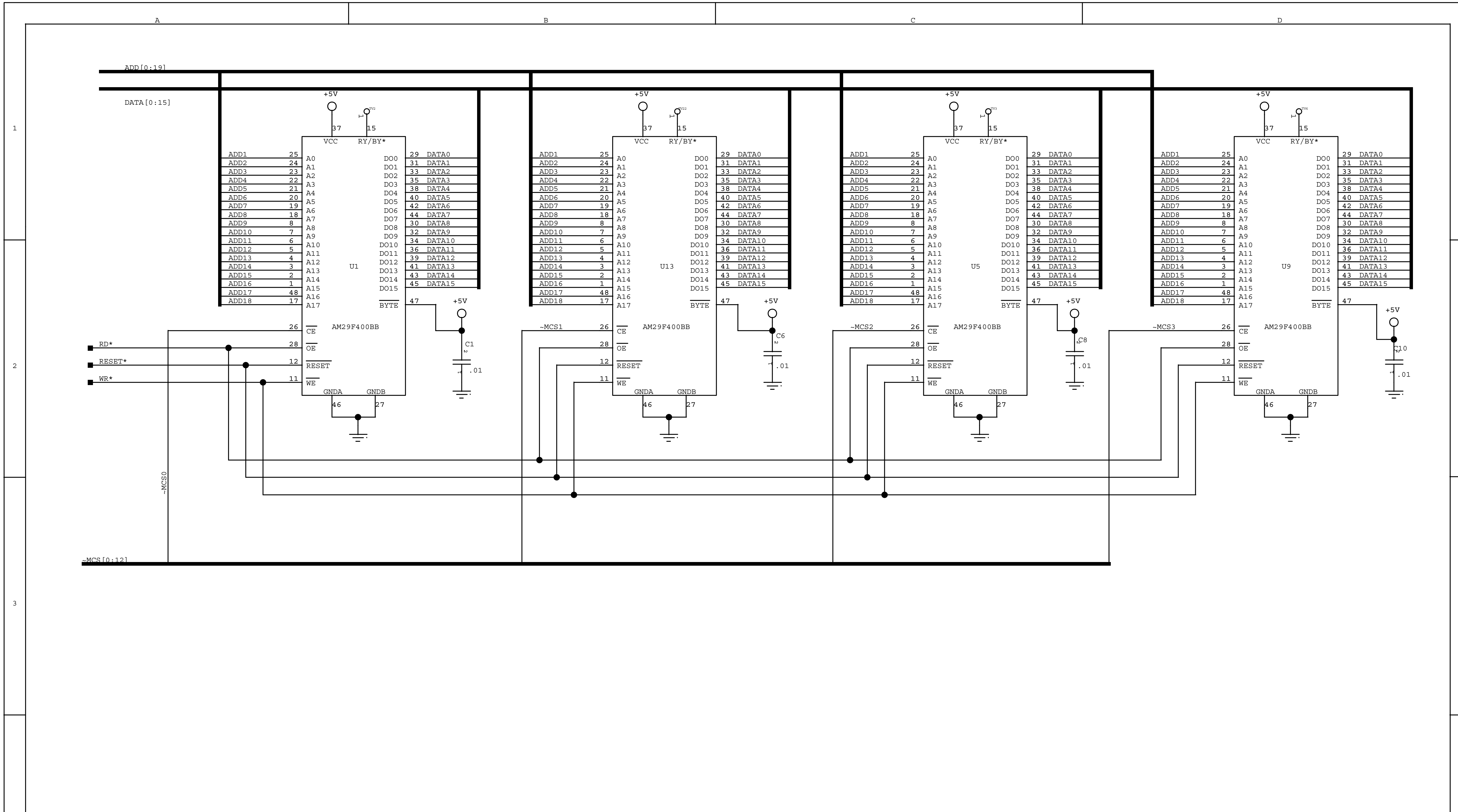

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Title CPU PCB

Doc. No. 119825

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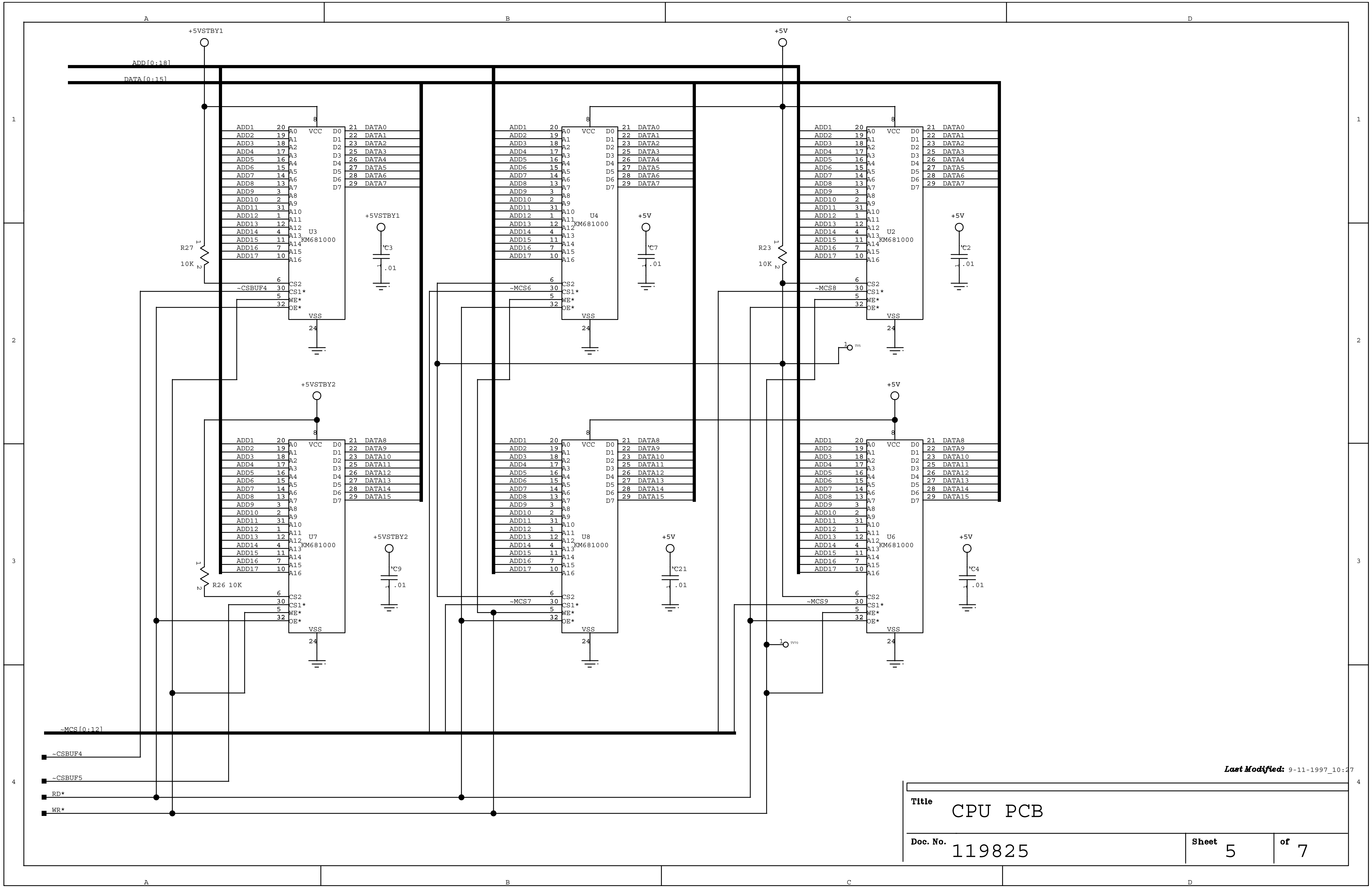

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Title CPU PCB

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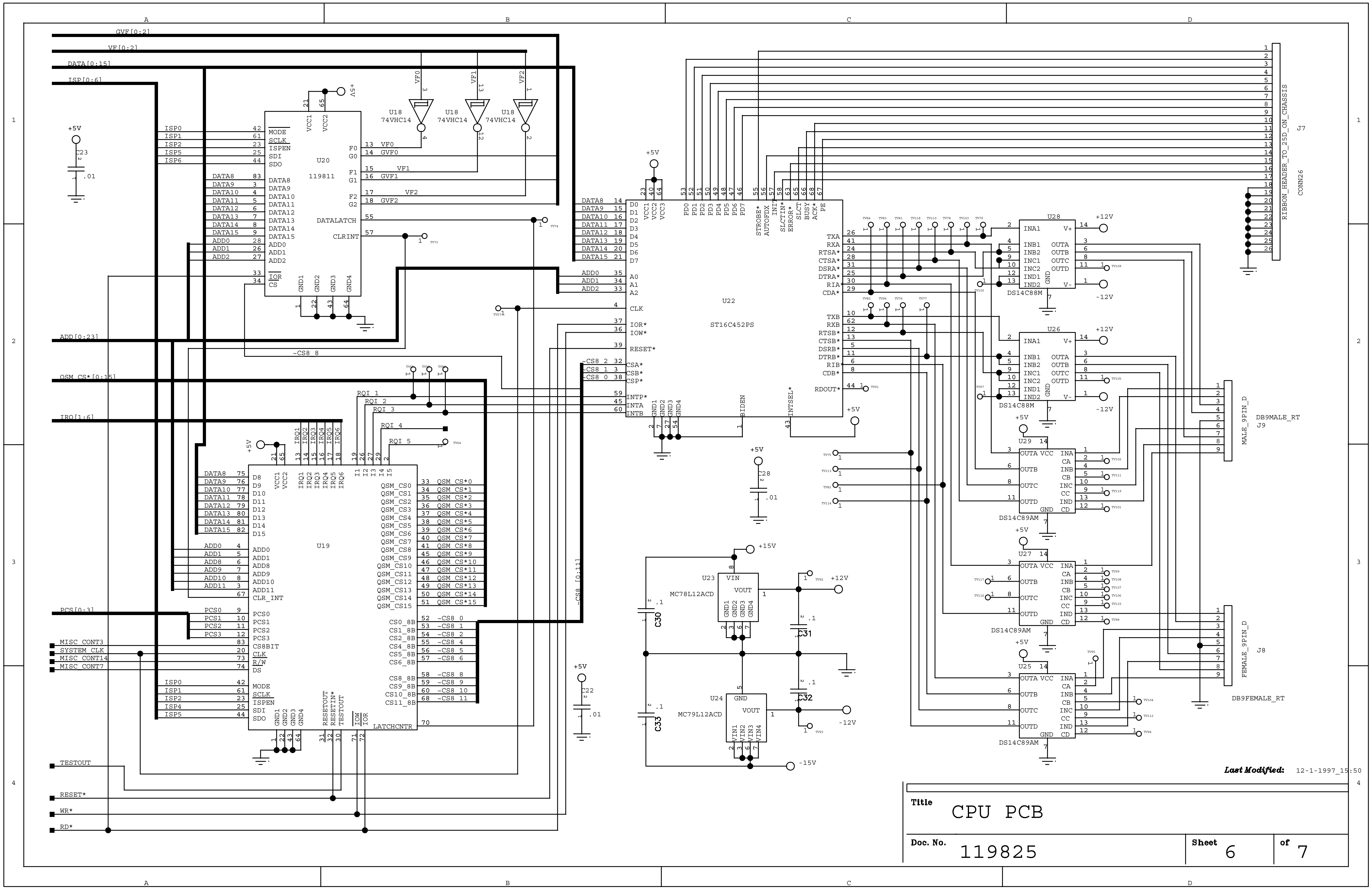
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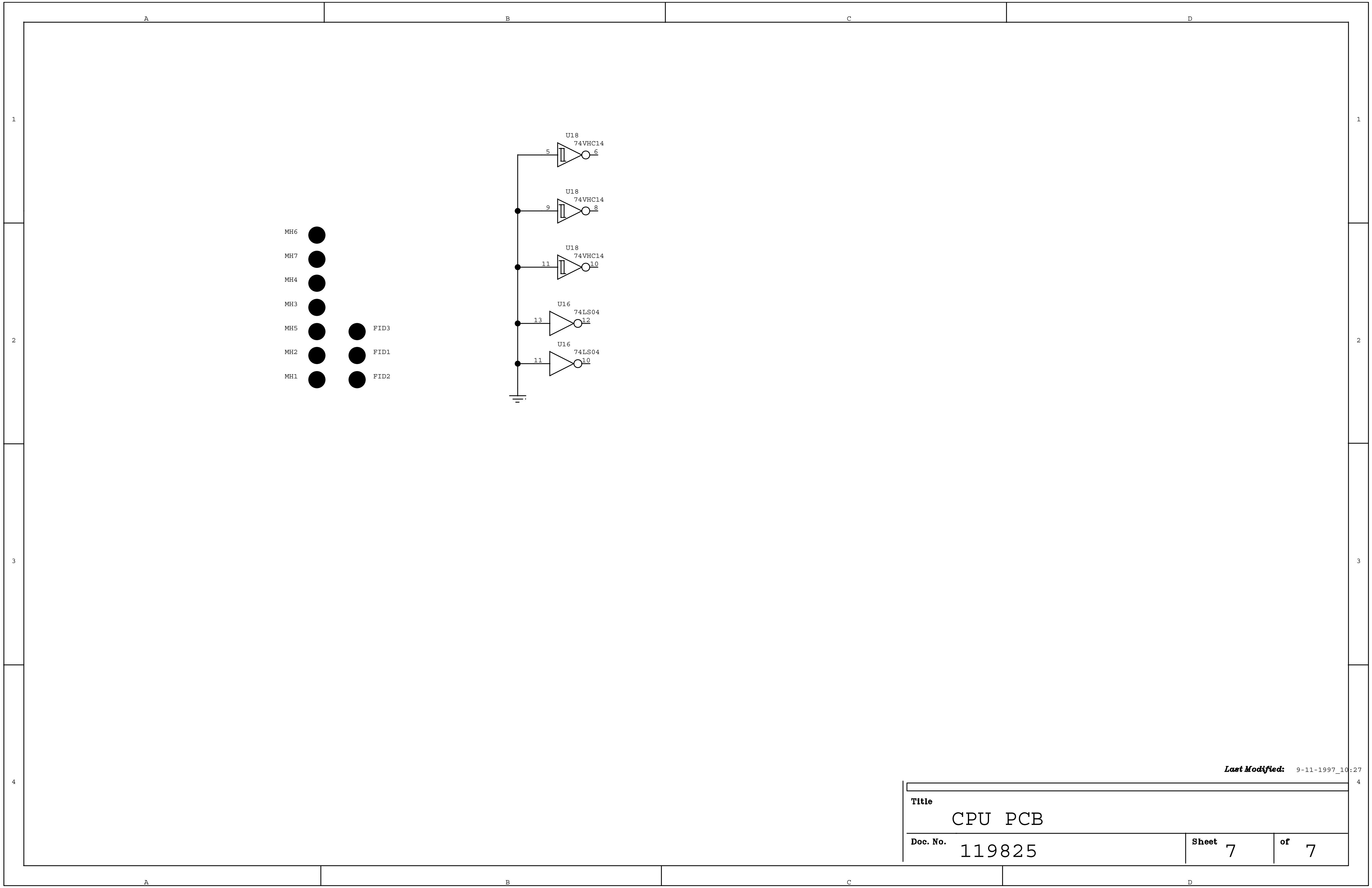

U18
74VHC14
5
6
9
8
11
10
U16
74LS04
13
12
11
10
MH6
MH7
MH4
MH3
MH5
MH2
MH1
FID3
FID1
FID2
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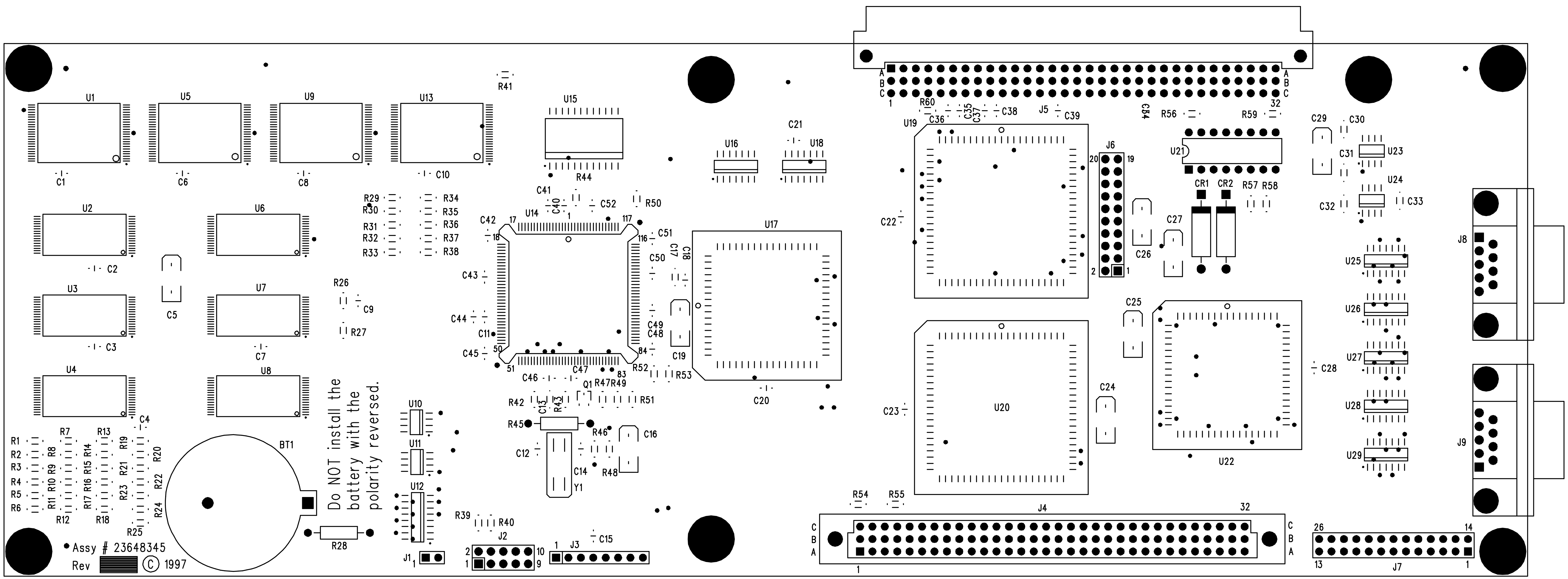

PCB Layout for CPU (119823)

5.5

Temperature Feedback and Digital I/O

This chapter describes the Temperature Feedback and Digital I/O (TF & DIO) PCB of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

The Temperature Feedback and Digital I/O (TF & DIO) PCB provides the microprocessor with the following information:

- Temperature of temperature controlled zones
- Ambient temperature inside the electronics compartment
- Value of the line voltage
- State of various digital control inputs

In addition, it provides digital output control for values, timed events, handshake signals, and other functions.

Figure 5.5-1 shows a more detailed block diagram of the temperature feedback circuit.

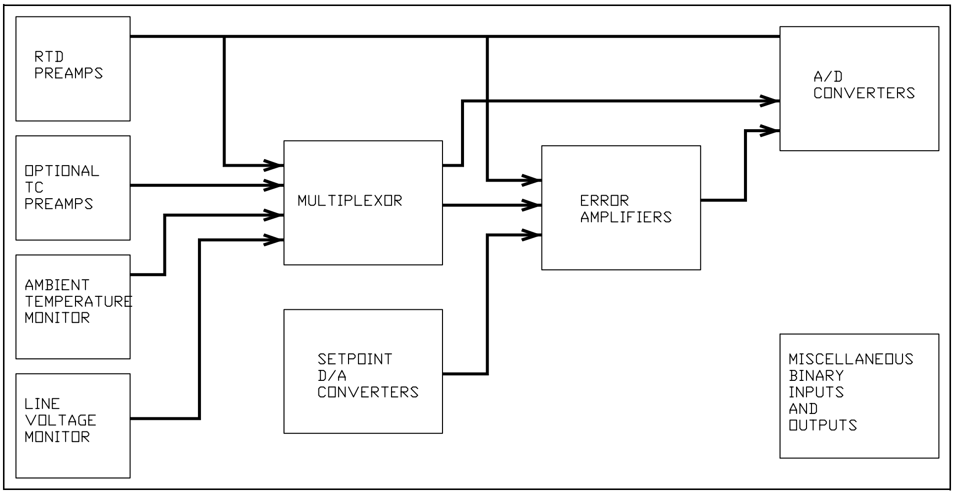

Figure 5.5-1. Block Diagram of Temperature Feedback Circuit

Input channels are provided for 10 RTDs (temperature sensors), 2 thermocouples, ambient temperature, and power line voltage.

The temperature channels are separated into two classes: low priority and high priority. The high priority channels are those that require the most stable temperature control or the most frequent temperature monitoring.

Figure 5.5-2 shows a more detailed block diagram of the temperature feedback circuit for a high priority channel.

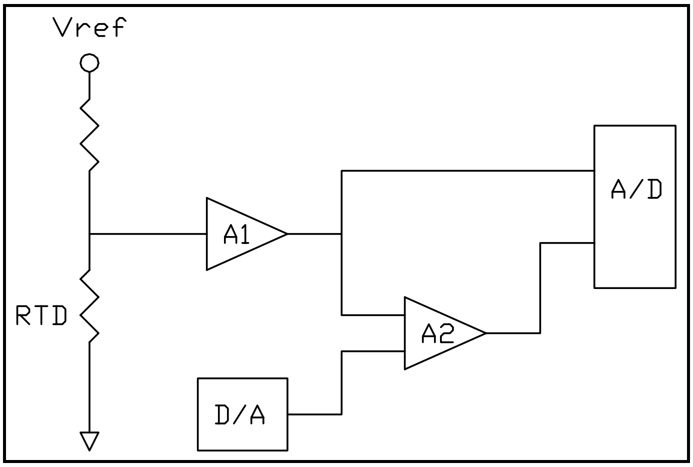

Figure 5.5-2. Detailed Block Diagram of Temperature Feedback Circuit

The voltage across the RTD is amplified by Al and input into one channel of the A/D. This signal provides the microprocessor with information about the RTD temperature. The signal resolution is approximately 0.2 °C/bit on the A/D. The microprocessor uses a D/A to generate a voltage representing the desired setpoint temperature. The setpoint and the actual temperature from Al are fed into error amplifier A2. The output of the error amplifier represents the difference between the desired temperature and the actual temperature. This signal is presented to a second channel on the A/D with a resolution of about 0.0025 °C/bit. The low priority channels function the same way, except the signals are multiplexed instead of having dedicated A/D channels.

The signal names of the temperature controls are listed in Table 5.5-1.

Table 5.5-1. Temperature Controls

Temp Zone	Signal Name on Schematic
RTDs	
Oven	OV-RTD
Right Detector Base	DA-RTD
Left Detector Base	DB-RTD
Right Inlet	IA-RTD
Left Inlet	IB-RTD
Detector 1 Secondary	DAX-RTD
Detector 2 Secondary	DBX-RTD
Detector 3 Secondary	DCX-RTD
Jet Separator	JS-RTD
Valve Oven	VO-RTD

Table 5.5-1. Temperature Controls (Continued)

Temp Zone	Signal Name on Schematic
Thermocouples	
PTV	Inlet-A-TC
OCI	Inlet-B-TC

Most of the required binary input and output signals are controlled or monitored through PLD U42. The signals that control devices external to the PCB are listed in Table 5.5-2. In addition, U42 provides the control signals for the analog multiplexer.

All of the RTD input channels are monitored with comparator circuits. This allows checking of the oven temperature conditions. If any channel goes over approximately 525 °C, a signal is generated to the power control module that turns off all heaters. An open RTD represents a very high temperature. Therefore, all unused RTD channels must have a jumper in place of the RTD. Some temperature zones are controlled through the detector cards. If no detector is installed, or if the detector installed does not have a secondary heater, a jumper must be installed on the motherboard adjacent to the detector card connector.

Table 5.5-2. External Input/Output Signals

Input Signals
Detector A ID (3 bits)
Detector B ID (3 bits)
Detector C ID (3 bits)
Handshake Signals (2 bits) and Inhibit Ready
Output Signals
Handshake Signals (4 bits) and Start Run, Ready Out, End Run, Running
GC Phase (6 bits)
Right Inlet Valves (3 bits)
Left Inlet Valves (3 bits)
Right Detector Valves (3bits)
Left Detector Valves (3 bits)
Auxiliary Makeup Valve (1 bit)
Three-way Inlet Valve (1 bit)
Timed Events (8 bits)
Right Inlet Cooling Fan
Left Inlet Cooling Fan
Watch Dog

Two options for the TRACE GC 2000 require temperature feedback using thermocouples instead of RTDs. These options are the PTV and the OCHOT.

When a thermocouple is required, an additional amplifier circuit is needed. This circuit is in the form of a “piggyback” PCB which is plugged onto the TF & DIO PCB. Up to two of these amplifiers may be installed. When installed, they plug on to connector J1 or J2.

Some of the early assemblies of the TF & DIO PCB included a special circuit which stabilized the temperature of RN4. The network RN4 was moved onto a special piggyback PCB and the temperature of RN4 was controlled by the circuitry on the piggyback PCB.

Adjustment Procedures

The Temperature Feedback and Digital I/O (TF & DIO) card is factory-calibrated with values stored in EEPROM on the card. No field adjustments are possible.

Schematics and Component Layout

The schematics and component layout information for the Temperature Feedback and Digital I/O (TF & DIO) PCB is listed below in Table 5.5-3. Also included are the schematics and component layout information for the Thermocouple Amplifier piggyback circuit (used for PTV and OCHOT options) and the RN4 Temperature Stabilizer piggyback circuit (used on some early assemblies). The number of drawings has been included for each schematic and its corresponding layout. There are 13 drawings for reference in this section.

Table 5.5-3. Temperature Feedback and Digital I/O Schematics

Board	PN	Drawing	Layout
TF & DIO	23648340	119822F, 1–8	119820, 1
Thermocouple Amplifier	23648400	119834, 1	119832, 1
RN4 Temperature Stabilizer	119977	119978, 1	119976, 1

NOTE The last drawing in this section is the layout of the board.

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REV	ECO NO.	DATE	BY	CHK
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C	ECO 31511	1/6/98	L Baldwin	L Baldwin
D	ECO 31537	4/8/98	L Baldwin	G Phinney
E	ECO 31607	4/8/98	L Baldwin	G Phinney
F	ECO 31693	7/6/98	L Baldwin	

	BY	Date
DRN	Larry Baldwin	10/16/97
CHK	Larry Baldwin	10/16/97
ENGR	Larry Baldwin	10/16/97
APPD		

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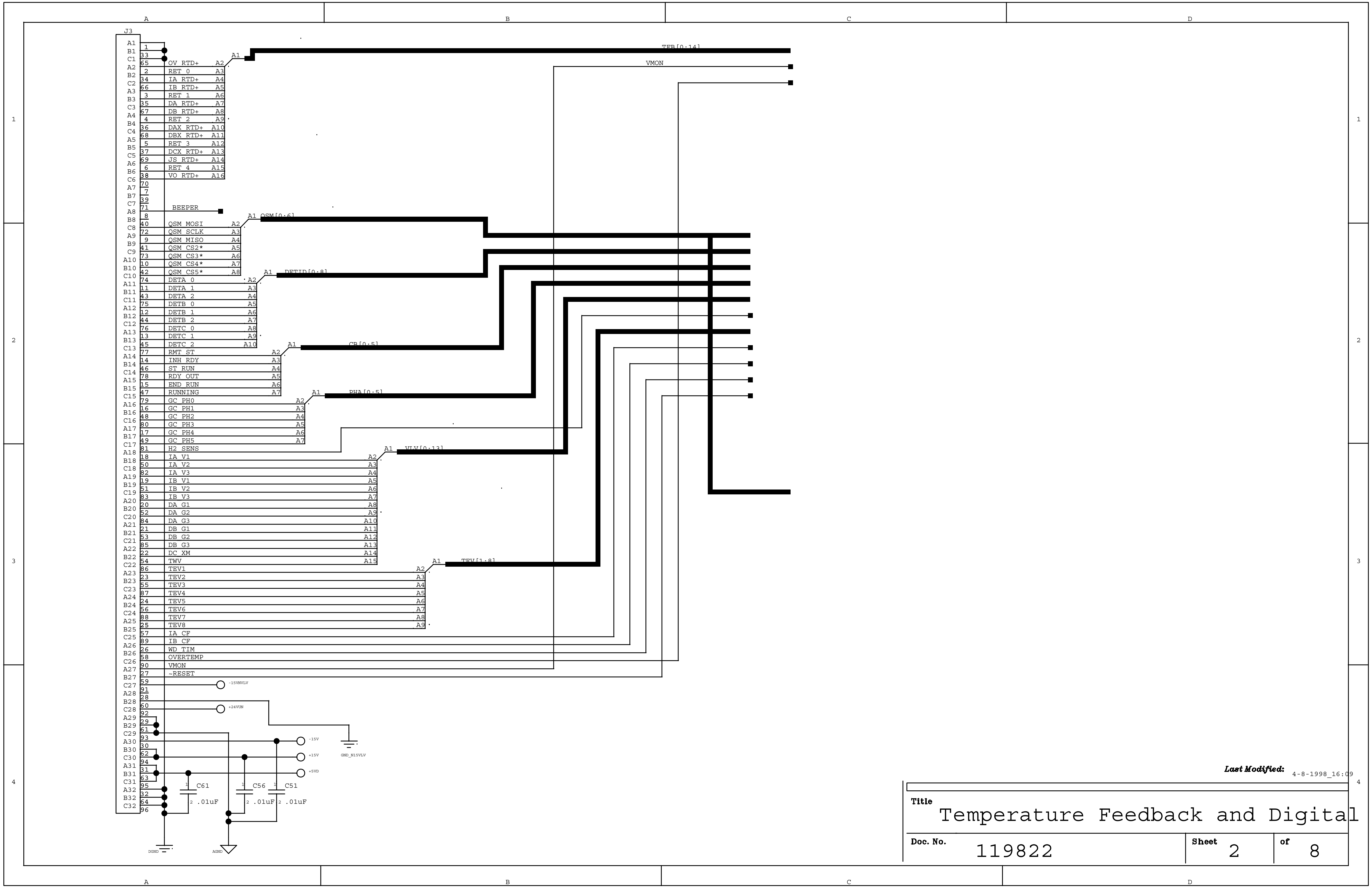
Title: Temperature Feedback and Digital I

Document Number: 119822 | Rev: F

Date: 12/8/97 | Size: B | Sheet 1 of 8


J3
OV RTD+
RET 0
IA RTD+
IB RTD+
RET 1
DA RTD+
DB RTD+
RET 2
DAX RTD+
DBX RTD+
RET 3
DCX RTD+
JS RTD+
RET 4
VO RTD+
TFB[0:14]
VMON
BEEPER
QSM[0:6]
QSM MOSI
QSM SCLK
QSM MISO
QSM CS2*
QSM CS3*
QSM CS4*
QSM CS5*
DETID[0:8]
DETA 0
DETA 1
DETA 2
DETB 0
DETB 1
DETB 2
DETC 0
DETC 1
DETC 2
CB[0:5]
RMT ST
INH RDY
ST RUN
RDY OUT
END RUN
RUNNING
PHA[0:5]
GC PH0
GC PH1
GC PH2
GC PH3
GC PH4
GC PH5
H2 SENS
VLV[0:13]
IA V1
IA V2
IA V3
IB V1
IB V2
IB V3
DA G1
DA G2
DA G3
DB G1
DB G2
DB G3
DC XM
TWV
TEV[1:8]
TEV1
TEV2
TEV3
TEV4
TEV5
TEV6
TEV7
TEV8
IA CF
IB CF
WD TIM
OVERTEMP
VMON
~RESET
-15VNVLV
+24VUN
GND_N15VLV
-15V
+15V
+5VD
C61
C56
C51
.01uF
.01uF
.01uF
DGND
AGND
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Doc. No.
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2
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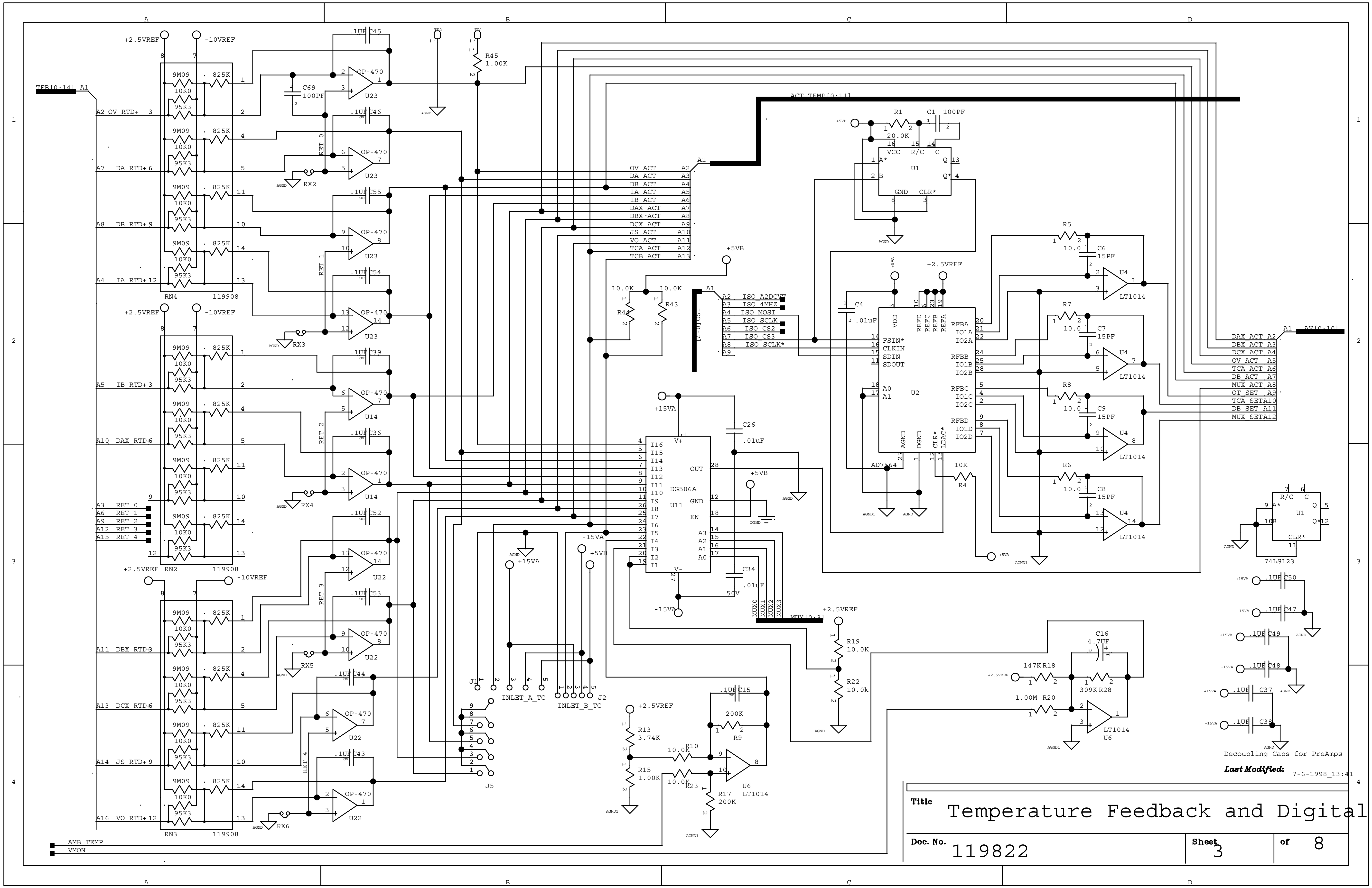
8



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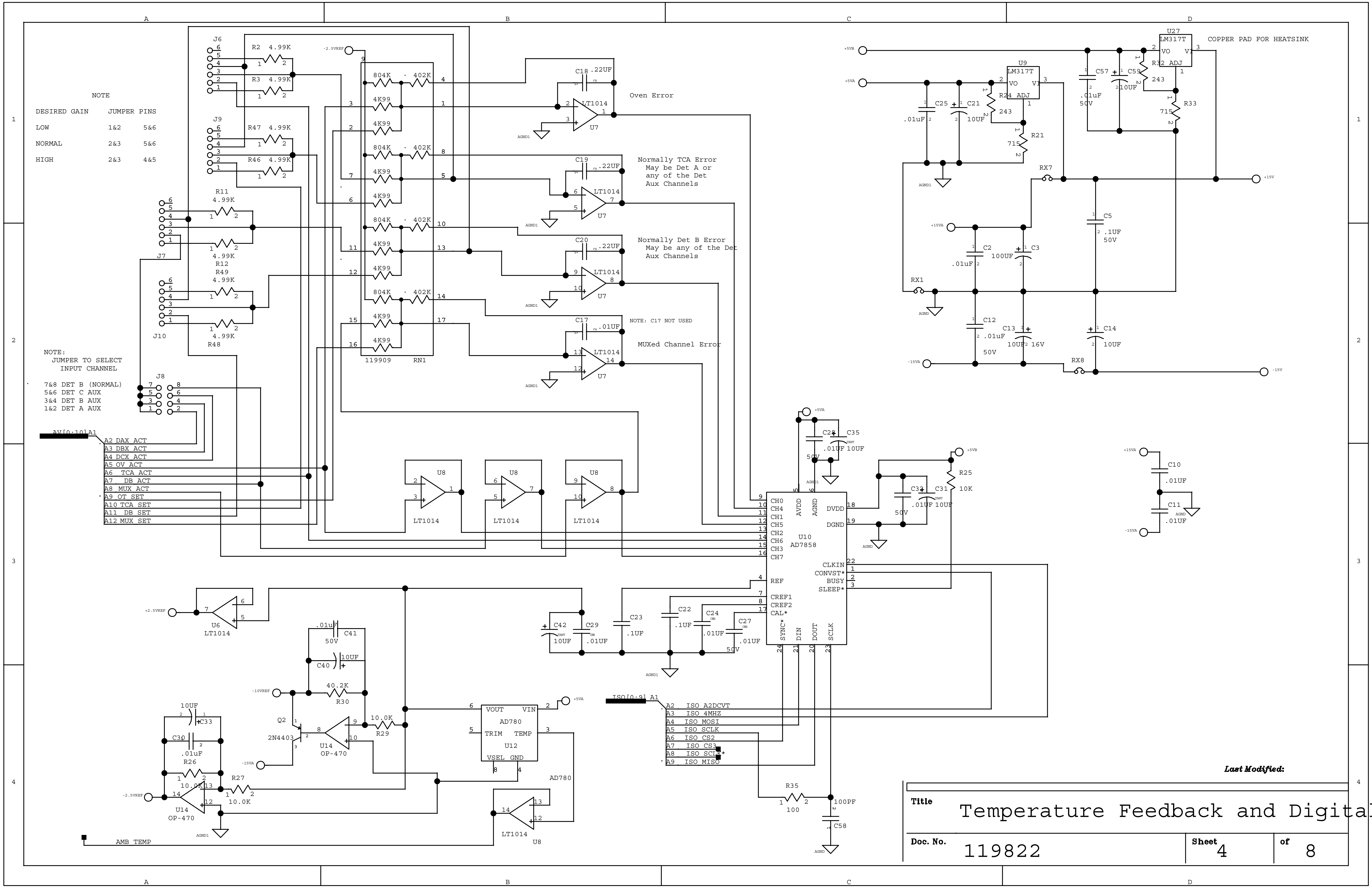
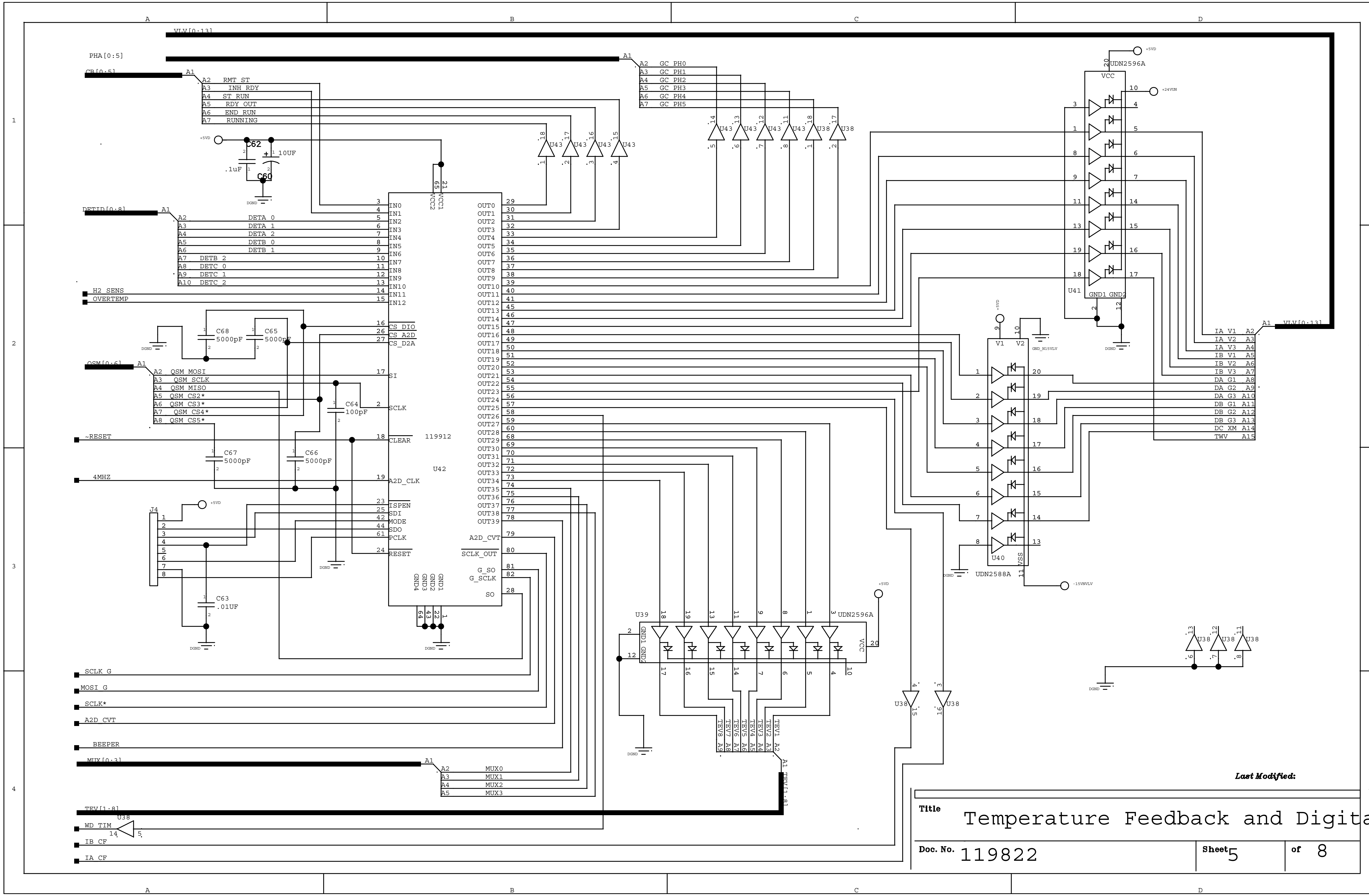
Temperature Feedback and Digital
Doc. No. 119822
Sheet 3 of 8
Last Modified: 7-6-1998_13:41
Decoupling Caps for PreAmps



Title Temperature Feedback and Digital

Doc. No. 119822 **Sheet** 4 **of** 8



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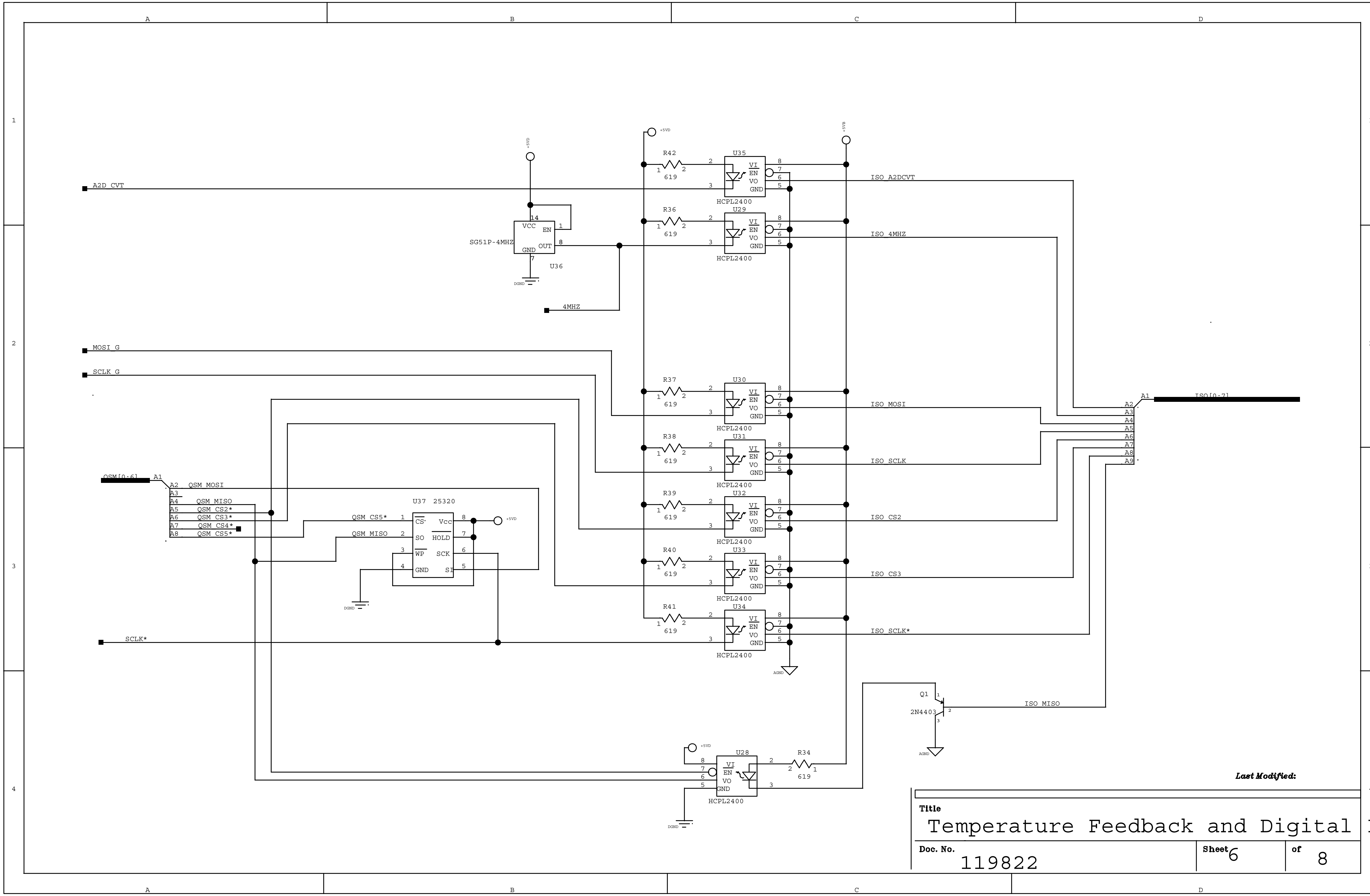
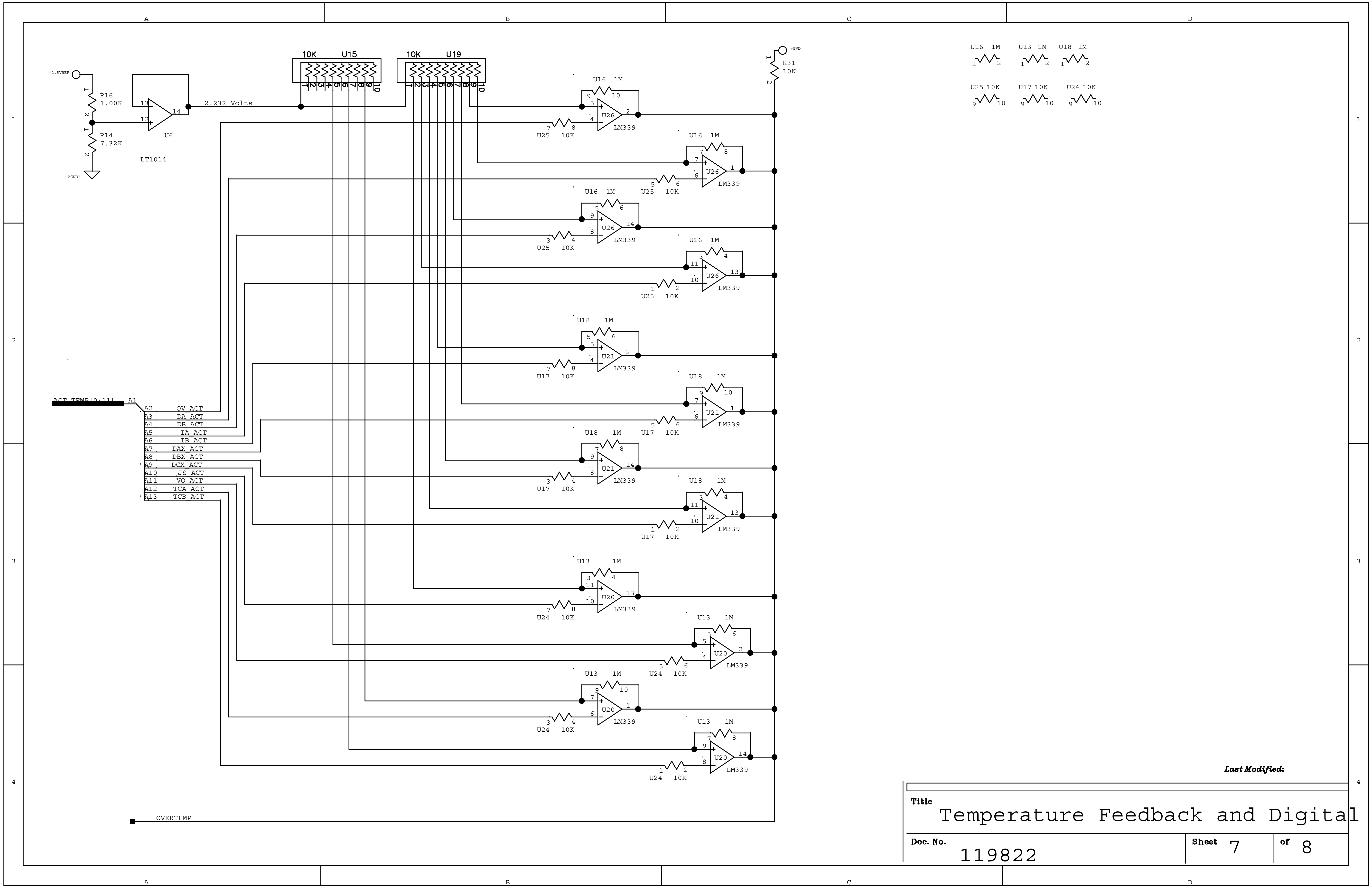
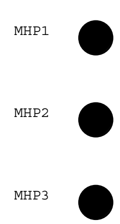
Title Temperature Feedback and Digital

Doc. No. 119822 **Sheet** 5 **of** 8



A2D CVT
MOSI G
SCLK G
QSM[0:6]
QSM MOSI
QSM MISO
QSM CS2*
QSM CS3*
QSM CS4*
QSM CS5*
SCLK*
4MHZ
SG51P-4MHZ
U36
U37 25320
R42
R36
R37
R38
R39
R40
R41
R34
619
HCPL2400
ISO A2DCVT
ISO 4MHZ
ISO MOSI
ISO SCLK
ISO CS2
ISO CS3
ISO SCLK*
ISO MISO
ISO[0:7]
Q1
2N4403
Last Modified:
Title
Temperature Feedback and Digital I/
Doc. No.
119822
Sheet 6
of 8

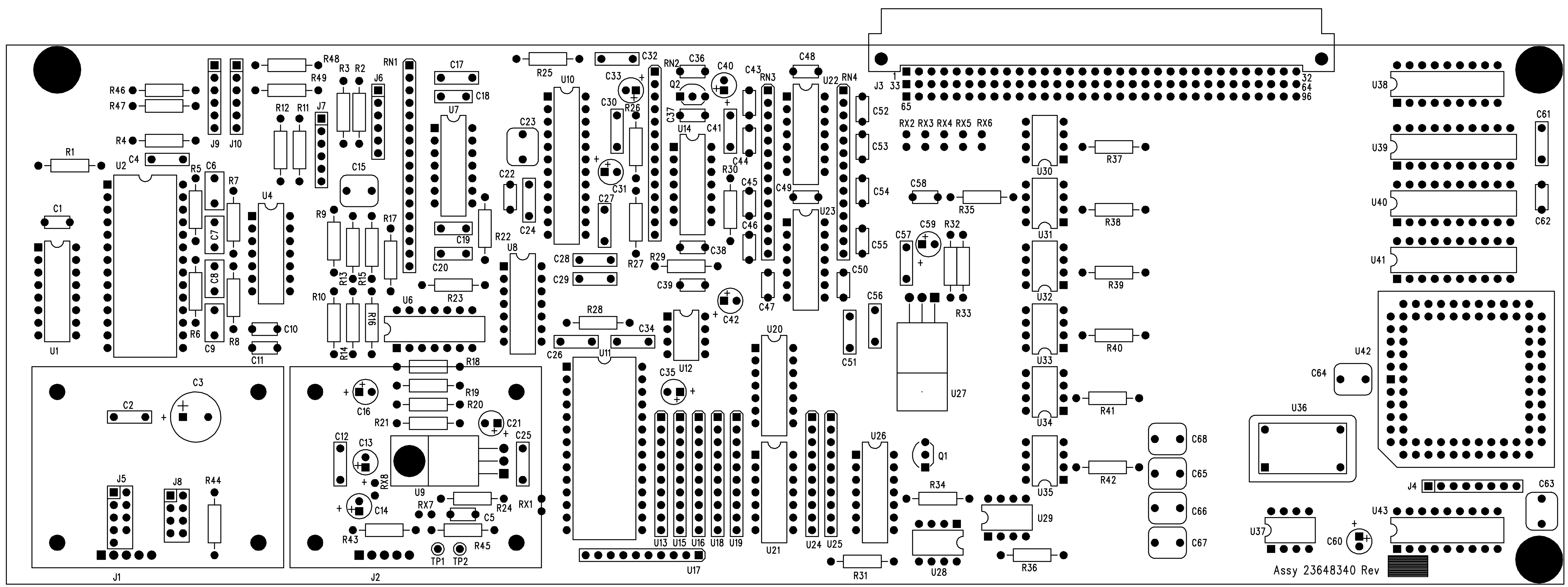

U16 1M
U13 1M
U18 1M
U25 10K
U17 10K
U24 10K
+2.5VREF
R16
1.00K
R14
7.32K
AGND1
U6
LT1014
2.232 Volts
10K U15
10K U19
+5VD
R31
10K
LM339
U26
U21
U20
ACT_TEMP[0:11]
A1
A2 OV_ACT
A3 DA_ACT
A4 DB_ACT
A5 IA_ACT
A6 IB_ACT
A7 DAX_ACT
A8 DBX_ACT
A9 DCX_ACT
A10 JS_ACT
A11 VO_ACT
A12 TCA_ACT
A13 TCB_ACT
OVERTEMP
Last Modified:
Title
Temperature Feedback and Digital
Doc. No.
119822
Sheet 7
of 8



Last Modified:

Title
Temperature Feedback and Digital]

Doc. No. 119822 | Sheet 8 | of 8



PCB Layout for Temperature Feedback and Digital I/O (119820)

	European Thermocouple	United States Thermocouple
Chromel	Red	Purple
Constantan	Black	Red

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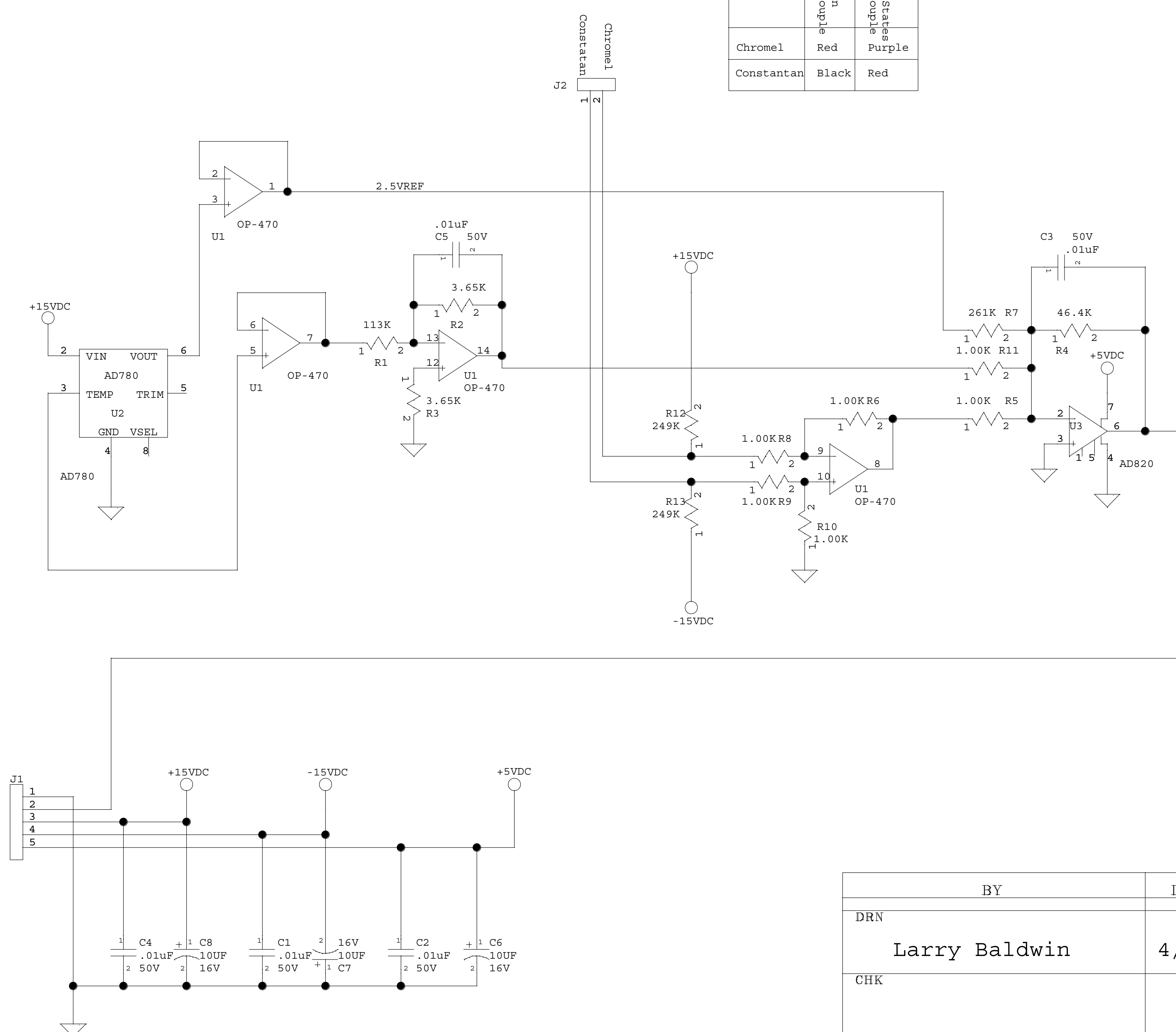
D	DRN 4215	5/1/98	L BALDWIN	L BALDWIN
E	ECO 31652	7/6/98	L BALDWIN	



BY	Date
DRN Larry Baldwin	4/29/98
CHK	
ENGR Larry Baldwin	4/29/98
APPD	

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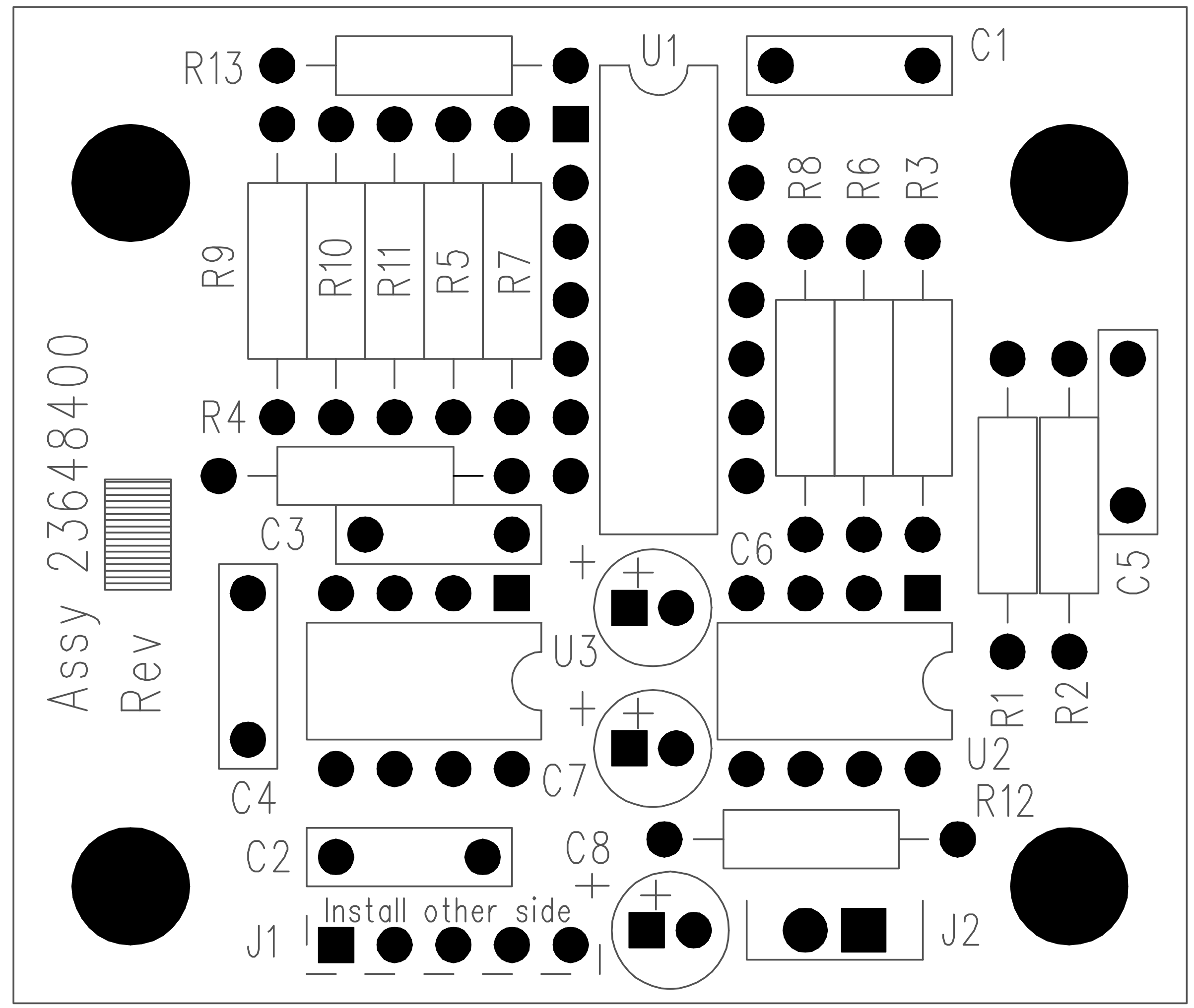
Title
THERMOCOUPLE PRE-AMPLIFIER

Document Number 119834 — Rev E

Date — Size B — Sheet 1 of



PCB Layout for Thermocouple Amplifier (119832)

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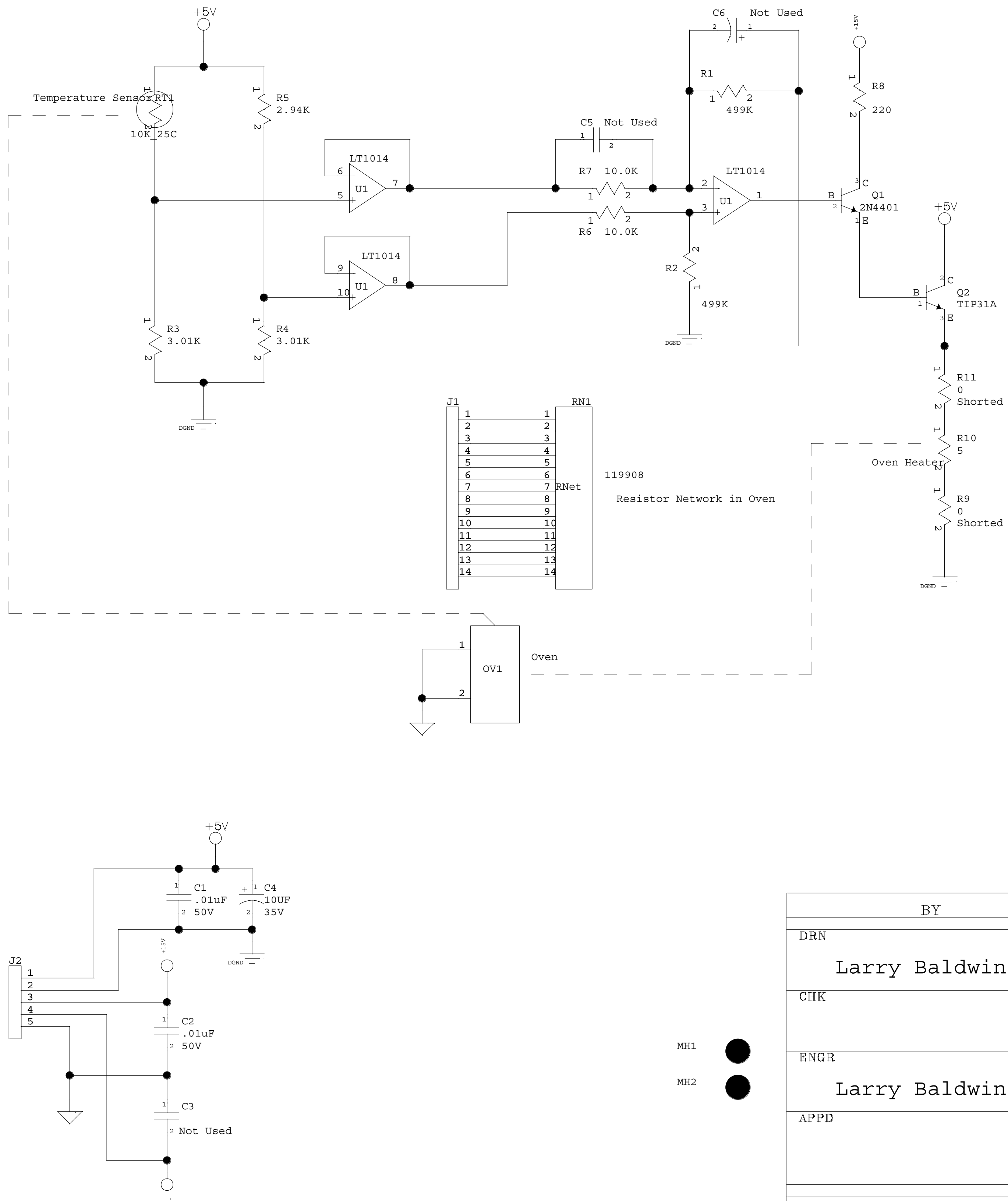
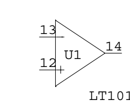
A	DRN ______			





BY	Date
DRN Larry Baldwin	4/28/98
CHK	
ENGR Larry Baldwin	4/28/98
APPD	

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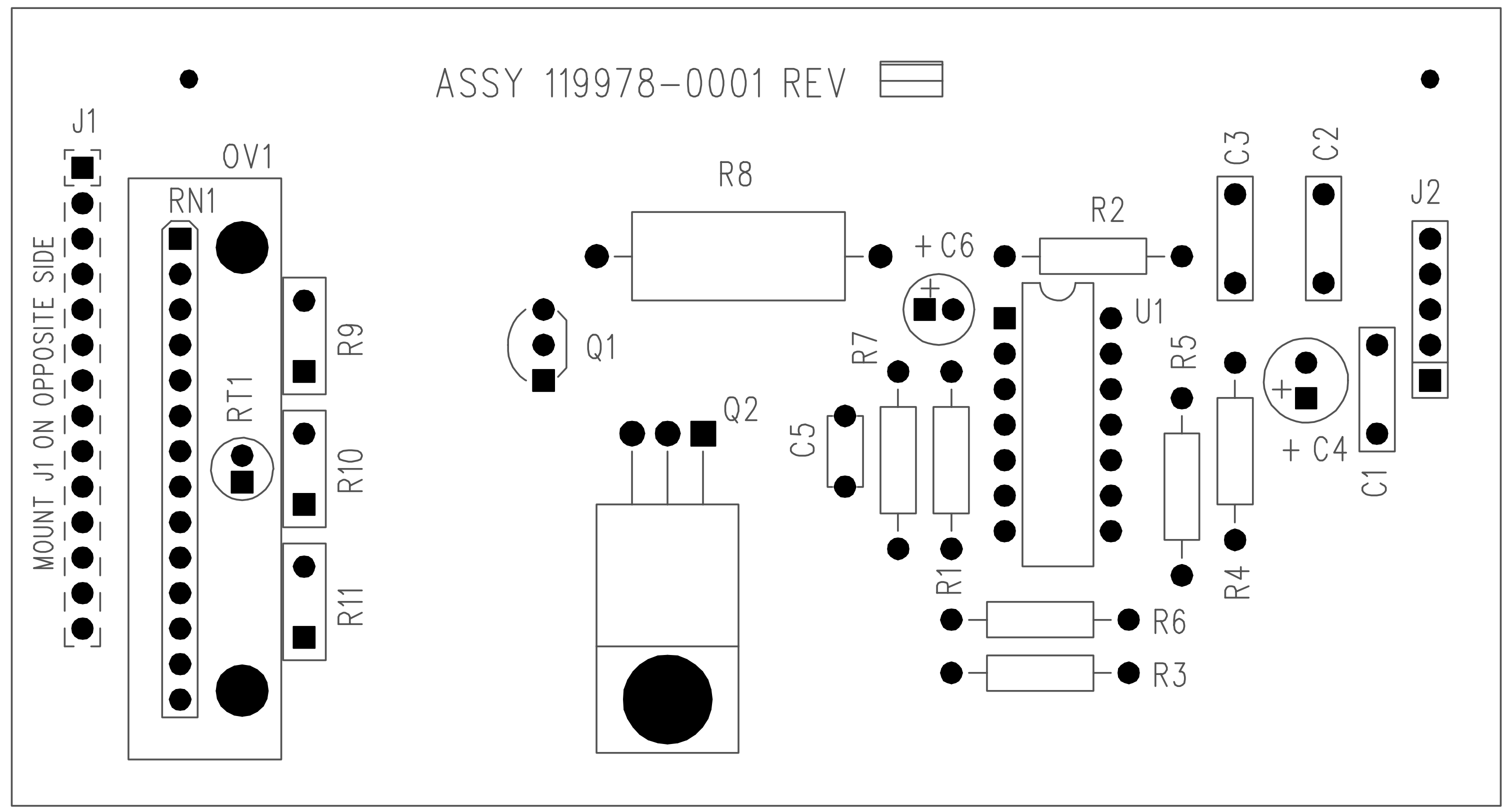
Austin, TX 78728

Title
R-Net Temperature Controller

Document Number 119978 Rev A

Date 4/15/98 Size B Sheet 1 of 1



PCB Layout for RN4 Temperature Stabilizer (119976)

5.6

Power Control Module

This chapter describes the PCB for the Power Control Module (PCM) of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

The Power Control Module (PCM) provides the system power supply and the controls for all of the heaters.

The dc voltages required by the GC are supplied by a commercial power supply. This supply provides +5 V, +15 V, –15 V, and +24 V. The +5 V is used by the microprocessor and the logic circuits. The +15 V and –15 V are used by the analog circuitry in the basic frame and oven of the GC. The +24 V is used by the detectors to provide local voltages for the analog circuitry and for driving valves.

A relay in the PCM chassis controls power to all of the heaters. If it is open, no power is available to any of the heaters. The watchdog signal generated on the Temperature Feedback and Digital I/O (TF & DIO) PCB triggers a retriggerable one-shot (U13) that controls the relay. The software must trigger the one-shot several times per second to maintain power availability to the heater and the inlet cooling fans. The PCM has a thermal cutout (SW1 on the PCB) that will disable the heater power if the temperature in the PCM exceeds 55 °C.

Each line voltage heater channel is controlled by a triac interfaced to the microprocessor with an optocoupler. Each low-voltage heater is controlled by a triac interfaced to the microprocessor with a transistor.

The PCB in the PCM contains a transformer with two secondary windings. One winding drives a comparator (U10) that generates a square wave from the line voltage sine wave. The square wave drives two one-shots (U11) that trigger on opposite edges. The outputs of the one-shots are combined in the PLD (U3) to create a clock two times the power line frequency and synchronized to the zero crossing of the power line voltage.

The second winding of the transformer generates an unregulated DC voltage. This voltage is proportional to the line voltage and is monitored by the microprocessor.

Circuits are provided to monitor the voltages from the DC power supply. If any supply is not present, the power available to the heaters is disabled. The status of the DC supplies is input to the microprocessor through the PLD (U3). In addition, these signals drive LEDs on the motherboard.

An oven door interlock switch provides an override for the control of the oven heater and the oven blower. If the door is open, both the heater and the blower are disabled. Depending on the GC configuration, a combination of up to two out of three possible transformers may be installed in the PCM.

Transformer 1 (119916) provides voltage for the FID ignitor. This transformer is used when an FID is present, but there are no requirements for low-voltage heaters.

Transformer 2 (119917) provides voltage for ignitors and low-voltage heaters. This transformer is used when there is a requirement for low-voltage heaters.

Transformers 1 and 2 are mutually exclusive. A pigtail on the transformer leads must be plugged into J6 on the Power Control PCB to indicate to the microprocessor which transformer (if any) is present.

Transformer 3 (PN 230 43444) (119917) provides power for the NPDs. It is present only when the NPD is present. A pigtail on the transformer leads must be plugged into J4 on the Power Control PCB to indicate that the transformer is present.

The Power Control PCB can be configured for 115- or 230-volt operation. A jumper on J3 indicates the selected voltage configuration to the microprocessor. Place the jumper between pins 1 and 2 for 115 V ac or between pins 2 and 3 for 230 V ac. The jumper assembly on J 12 changes the connections to the transformers and the oven fan motor. For 115 V ac, position the block with the black lead toward the end near the transformer on the PCB. For 230 V ac, position the block with the black lead away from the end near the transformer on the PCB.

WARNING! **For conversion from 120 V ac to 230 V ac, all line voltage heaters must be changed. For European configuration, it is necessary to convert from 230 V ac to 120 V ac. Again, all line voltage heaters must be changed.**

Adjustment Procedures

No field adjustments are necessary.

Schematics and Component Layout

The schematics and component layout information for the Power Control Module (PCM) PCB is listed below in Table 5.6-1. The number of drawings has been included for each schematic and its corresponding layout. There are six drawings for reference in this section.

The Power Supply PCB schematics and component layout are not included in this manual because the PCB must be replaced as a unit. When ordering a replacement Power Supply PCB, refer to the part number (PN) in Table 5.6-1.

Table 5.6-1. Power Control Module PCB Schematics

Board	PN	Drawing	Layout
PCM PCB	23699500	119837D, 1–5	119835, 1
Power Supply PCB	76330 0031	—	—

NOTE The last drawing in this section is the layout of the board.

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REV	ECO NO.	DATE	BY	CHK
B	DRN 4175	12/8/97	L Baldwin	L Baldwin
C	ECO 31512	1/7/98	L Baldwin	L Baldwin
D	ECO 31601	4/7/98	L Baldwin	

	BY	Date
DRN	L Baldwin	12/8/97
CHK	L Baldwin	12/8/97
ENGR	L Baldwin	12/8/97
APPD	L Baldwin	12/8/97

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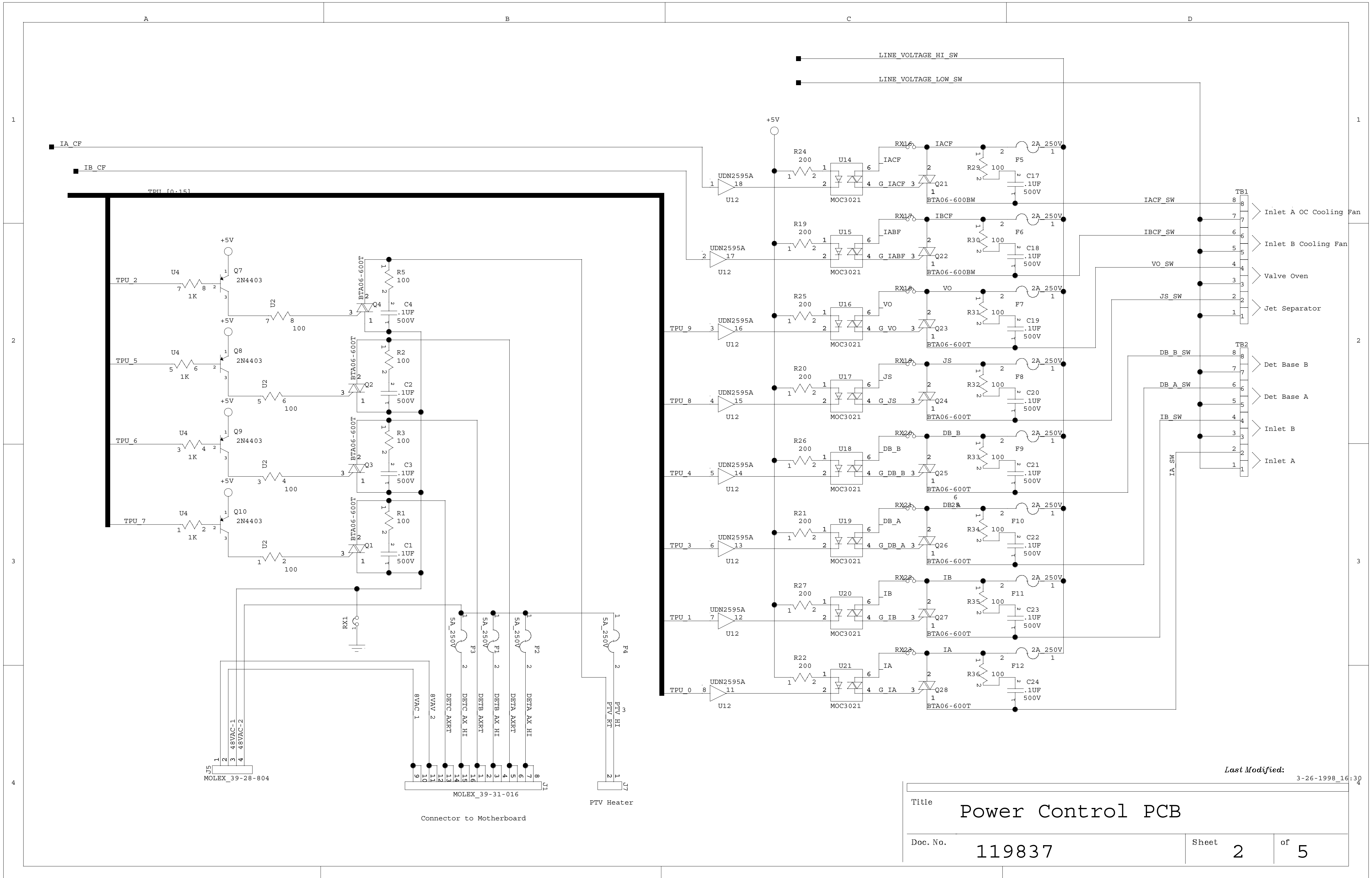
Title: Power Control PCB

Document Number: 119837

Rev: D

Date: 12/8/97 | Size: B | Sheet 1 of 5



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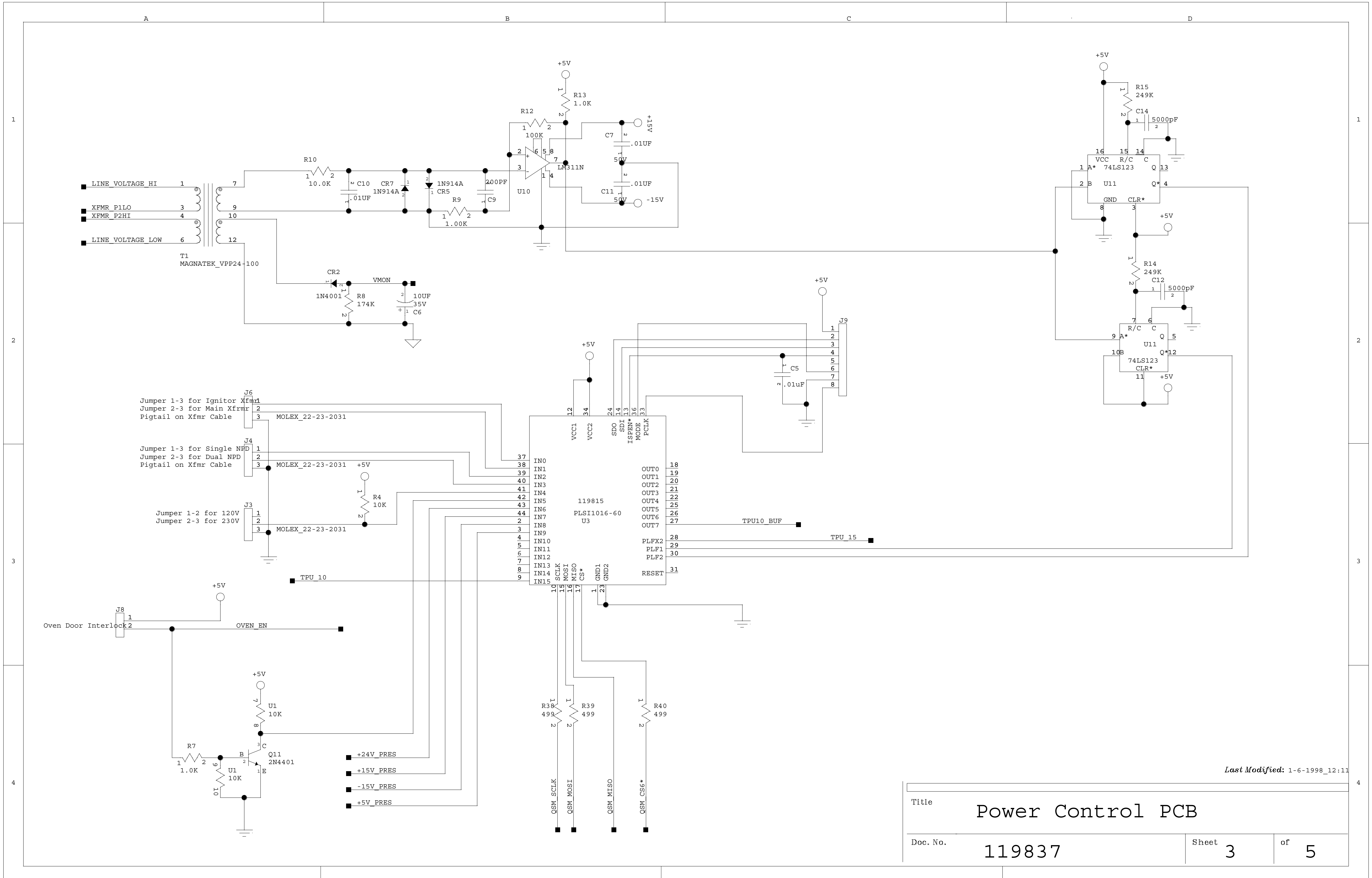
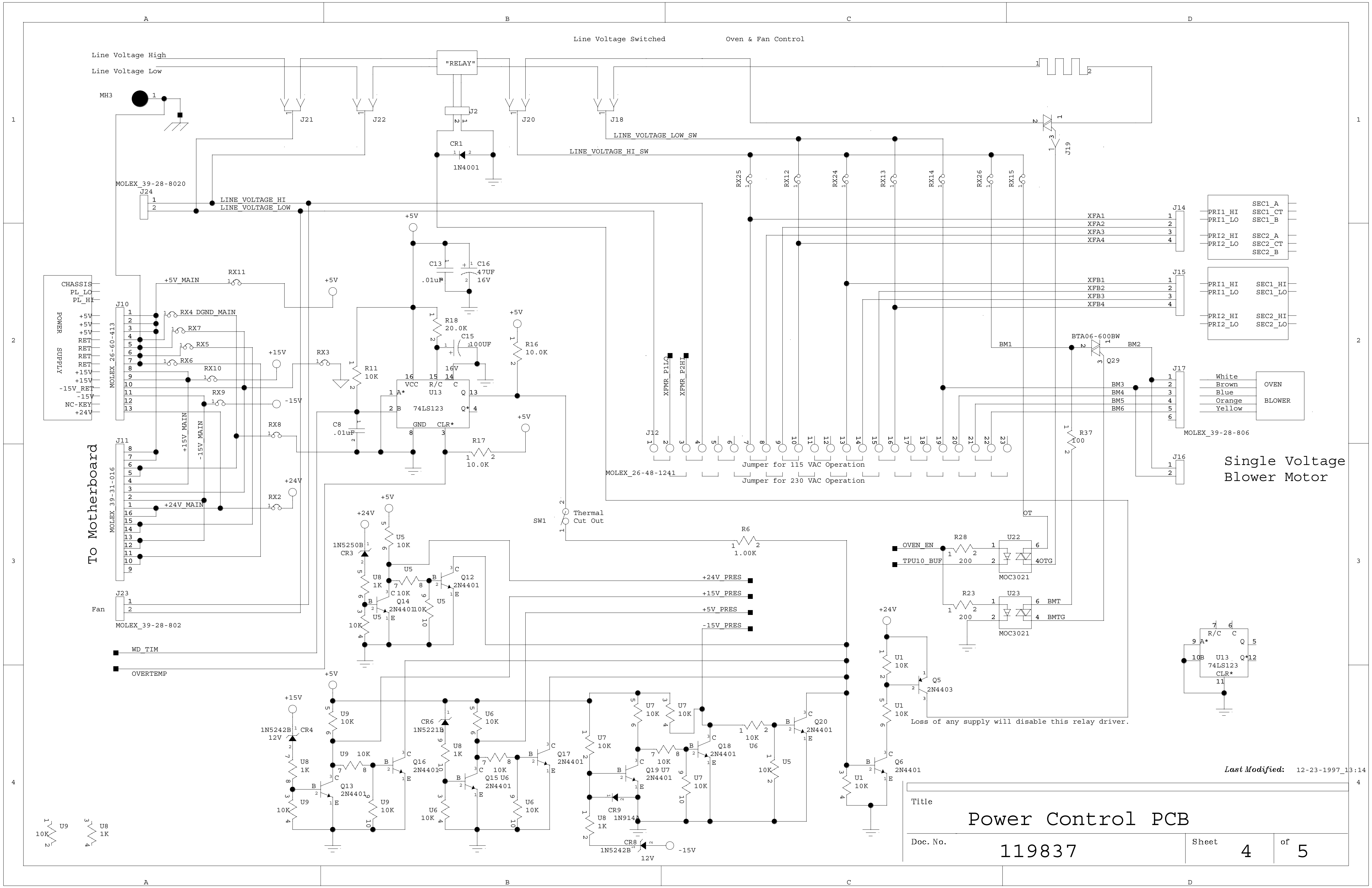
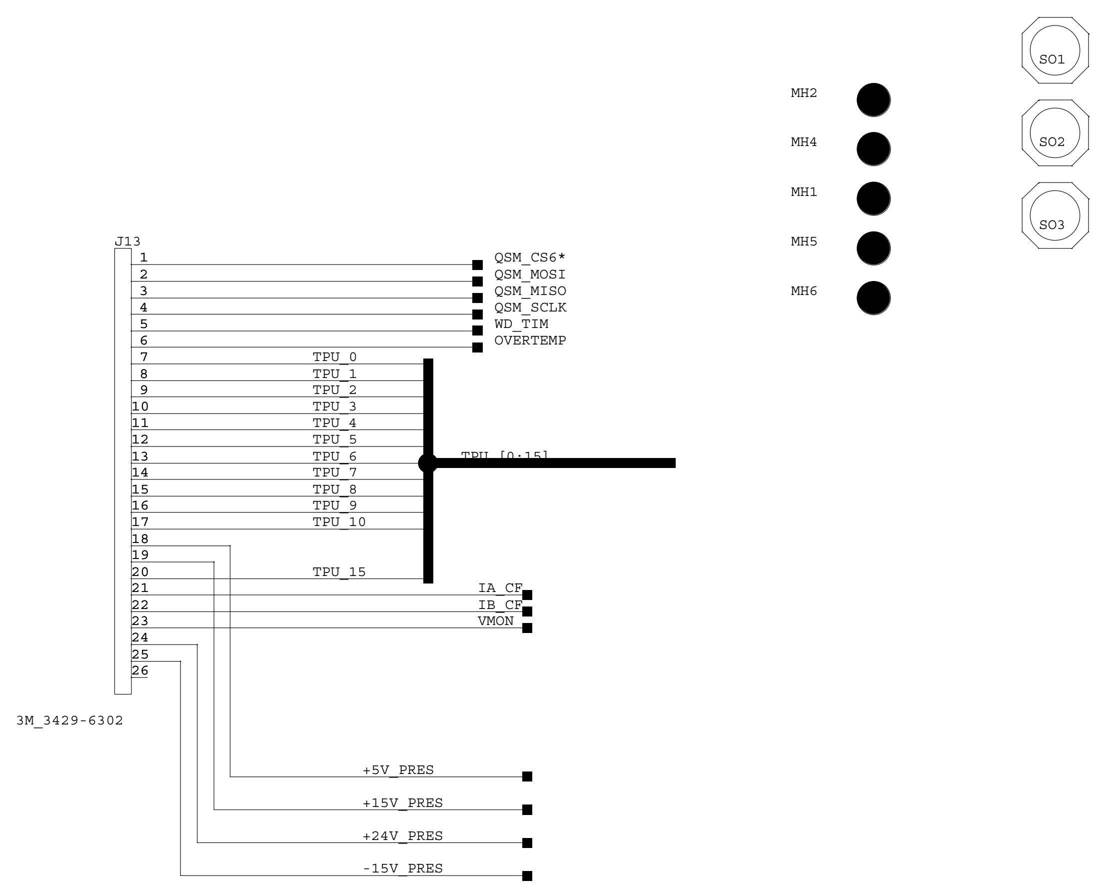
Title **Power Control PCB**

Doc. No. 119837 | Sheet 2 of 5



LINE_VOLTAGE_HI
XFMR_P1LO
XFMR_P2HI
LINE_VOLTAGE_LOW
T1
MAGNATEK_VPP24-100
R10 10.0K
C10 .01UF
CR7 1N914A
1N914A CR5
R9 1.00K
200PF C9
R12 100K
R13 1.0K
+5V
U10 LM311N
C7 .01UF 50V
C11 .01UF 50V
+15V
-15V
CR2 1N4001
VMON
R8 174K
10UF 35V C6
R15 249K
C14 5000pF
VCC R/C C
A* 74LS123 Q
B U11 Q*
GND CLR*
R14 249K
C12 5000pF
R/C C
A* Q
U11
B 74LS123 Q*
CLR*
J9
C5 .01uF
Jumper 1-3 for Ignitor Xfmr
Jumper 2-3 for Main Xfmr
Pigtail on Xfmr Cable
J6
MOLEX_22-23-2031
Jumper 1-3 for Single NPD
Jumper 2-3 for Dual NPD
Pigtail on Xfmr Cable
J4
MOLEX_22-23-2031
R4 10K
Jumper 1-2 for 120V
Jumper 2-3 for 230V
J3
MOLEX_22-23-2031
VCC1 VCC2 SDO SDI ISPEN* MODE PCLK
IN0 IN1 IN2 IN3 IN4 IN5 IN6 IN7 IN8 IN9 IN10 IN11 IN12 IN13 IN14 IN15
OUT0 OUT1 OUT2 OUT3 OUT4 OUT5 OUT6 OUT7
119815
PLSI1016-60
U3
PLFX2 PLF1 PLF2
RESET
SCLK MOSI MISO CS* GND1 GND2
TPU10_BUF
TPU_15
TPU_10
J8
Oven Door Interlock
OVEN_EN
U1 10K
Q11 2N4401
R7 1.0K
U1 10K
+24V_PRES
+15V_PRES
-15V_PRES
+5V_PRES
R38 499
R39 499
R40 499
QSM_SCLK
QSM_MOSI
QSM_MISO
QSM_CS6*
Last Modified: 1-6-1998_12:11
Title
Power Control PCB
Doc. No.
119837
Sheet 3
of 5


Line Voltage Switched
Oven & Fan Control
Line Voltage High
Line Voltage Low
"RELAY"
LINE_VOLTAGE_LOW_SW
LINE_VOLTAGE_HI_SW
LINE_VOLTAGE_HI
LINE_VOLTAGE_LOW
POWER SUPPLY
To Motherboard
Jumper for 115 VAC Operation
Jumper for 230 VAC Operation
Thermal Cut Out
+24V_PRES
+15V_PRES
+5V_PRES
-15V_PRES
WD_TIM
OVERTEMP
OVEN_EN
TPU10_BUF
OVEN BLOWER
Single Voltage Blower Motor
Loss of any supply will disable this relay driver.
Last Modified: 12-23-1997_13:14
Title
Power Control PCB
Doc. No.
119837
Sheet 4 of 5



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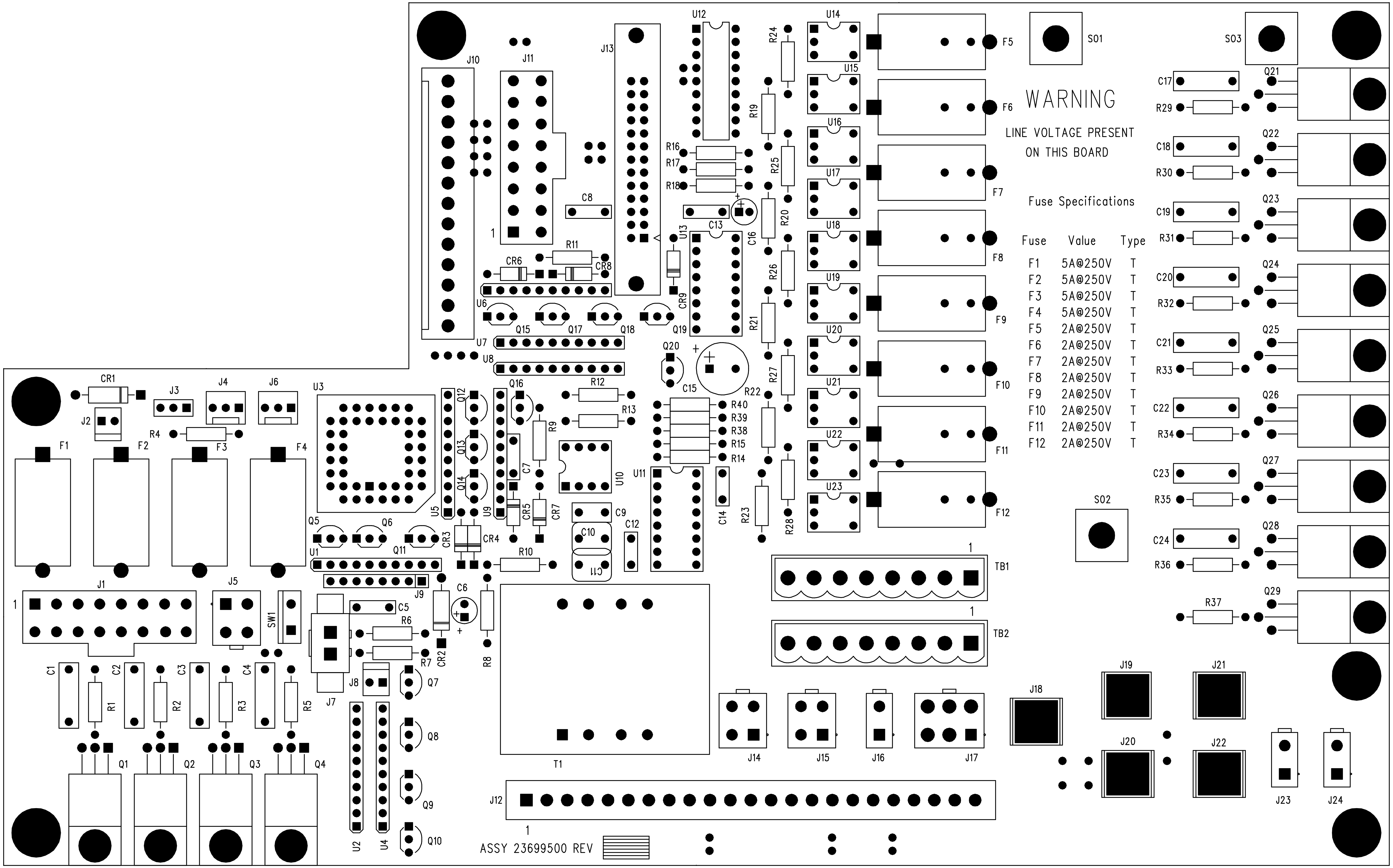
Title Power Control PCB

Doc. No. 119837 Sheet 5 of 5



PCB Layout for Power Control Module (119835)

5.7

Digital Pressure Flow Control

This chapter describes the PCB for the Digital Pressure Flow Control (DPFC) of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

Circuit Function

The Digital Pressure Flow Control (DPFC) PCB is located on the rear of the Analytical Unit. The DPFC PCB is controlled by SPI (Serial Peripheral Interface) signals that come from the motherboard through the P6 connector (MOSI, MISO, SS, OVEN, SCK), and take the +5L, +/–15A, +15P, COMMON (Analog, Digital, Power) through the P8 connector.

An X1 quartz crystal generates the clock frequency of 8 MHz. The crystal is connected directly to the local MC68HC11A1 microprocessor (U14, Xtal and Extal) through the resistor (R11).

NOTE The DPFC PCB uses an on-board MC68HC11A1 microprocessor. In this section, the term microprocessor refers specifically to the MC68HC11A1.

The 8-bit single-chip microprocessor 68HC11A1 (U14) includes 512B of EPROM and 256B of static RAM. This microprocessor controls:

- EPROM 27C512 memory (U13, 64KB)
- Data bus (AD0–AD7)
- Address (A8–A15) bus

Two stages of the integrated circuit 74HCT00 (U19) generate the RESET signal (active low) to initialize the microprocessor to a known startup state. The microprocessor provides an E output frequency signal on pin 5 (used as reference timing). Pin 5 is actually one-fourth of the input frequency of 8 MHz at the Xtal and Extal pins. Two CNY17/II optocouplers (U4, U5) read the PURG1 and PURG2 input signals to recognize the presence of the purge line of the split/splitless injectors controlled by DPFC devices.

Chip-selects (O10–O16, O20–O24) are generated by two 74HCT374 3-State buffers. The other two stages of the integrated circuit 74HCT00 generate the digital output signals to select the 74LS138 decoder (U23) and the 27C512 EPROM (U13).

The following connectors control all signals for five DPFC devices:

- DET1 (right)
- DET2 (left)
- DET3 (aux)
- CAR1 (right)
- CAR2 (left)

The circuit consists of two TL082 integrated circuits (U17, U21) and the NPC1210. The purpose of the circuit is to read the ambient pressure.

Integrated circuits 74LS139 (U12) and 74LS04 (U11) generate three enable signals to select three ADG408 integrated circuits (U2, U6, U8), which read all analog inputs for DPFC pressure and flow data. The output D of the ADG408 is an analog serial data output. The microprocessor will digitally read this output (DADY, AMISO, ASCLK, AMOSI, RES) through the AD7715 (U1).

The voltage regulator 78L05 (U26) supplies the +5 V dc.

Adjustment Procedures

No field adjustments are necessary.

Schematics and Component Layout

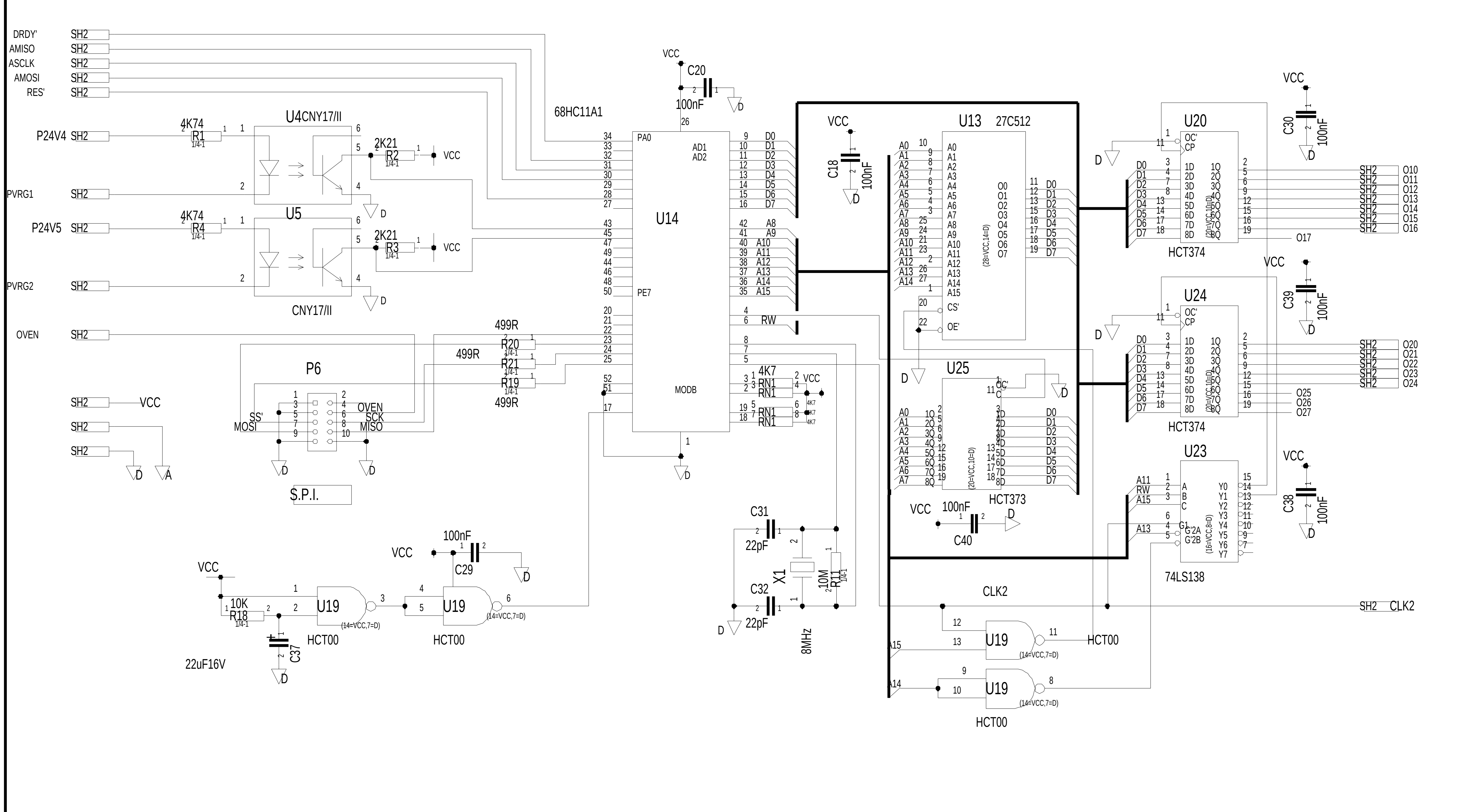
The schematics and component layout information for the Digital Pressure Flow Control (DPFC) PCB is listed below in Table 5.7-1. The number of drawings has been included for each schematic and its corresponding layout. There are three drawings for reference in this section.

Table 5.7-1. Digital Pressure Flow Control Schematics

Board	PN	Drawing	Layout
DPFC (EPC)	23648330	SE 1391 - sh. 2, 1–2	PC 1111, 1

NOTE The last drawing in this section is the layout of the board.

MOD/RDM		MODIFICHE	DATA	FIRMA/VISTO
A	PR/REV	DEL.TEST & RS232 CIRCUIT;MASTER REV. 1.1.	22/7/97	
B	PR/REV	ADDED R19,R20,R21 ON SPI CONN. - MASTER REV. 1.2 .	22/12/97	
C	PR/REV	MOD. U21 FROM TL082 TO OP200,ON SHEET 2 .	5/2/98	



strumento: TRACE GC	disegnatore: BOLLA C.	data: 16/5/97	A3
assieme: EPCTRC - Rev. 1.2	sostituisce	scala	
particolare: CPU & MEM SECTION	codice	visto	
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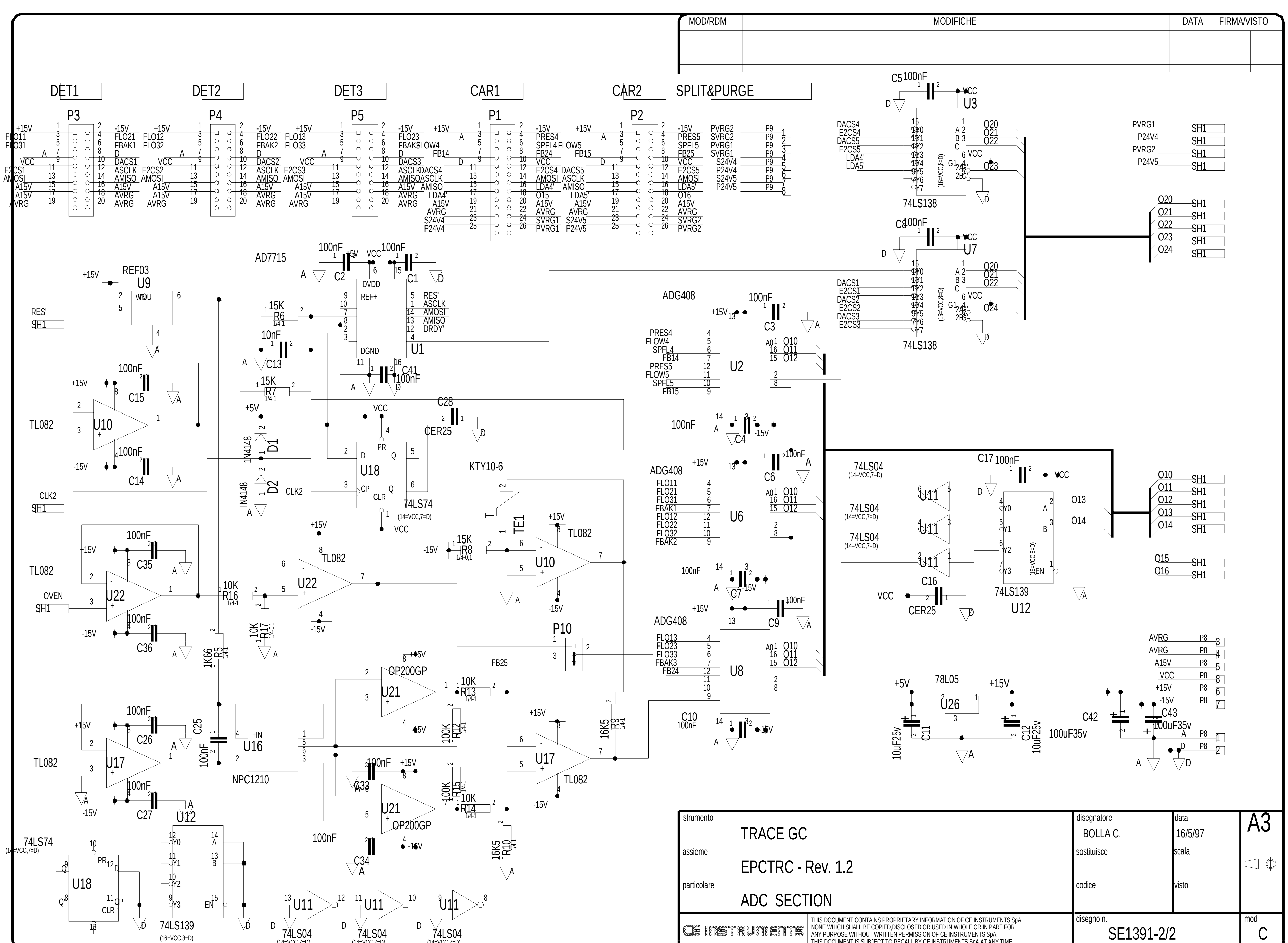
TRACE GC
EPCTRC - Rev. 1.2
ADC SECTION
BOLLA C.
16/5/97
A3
SE1391-2/2
C
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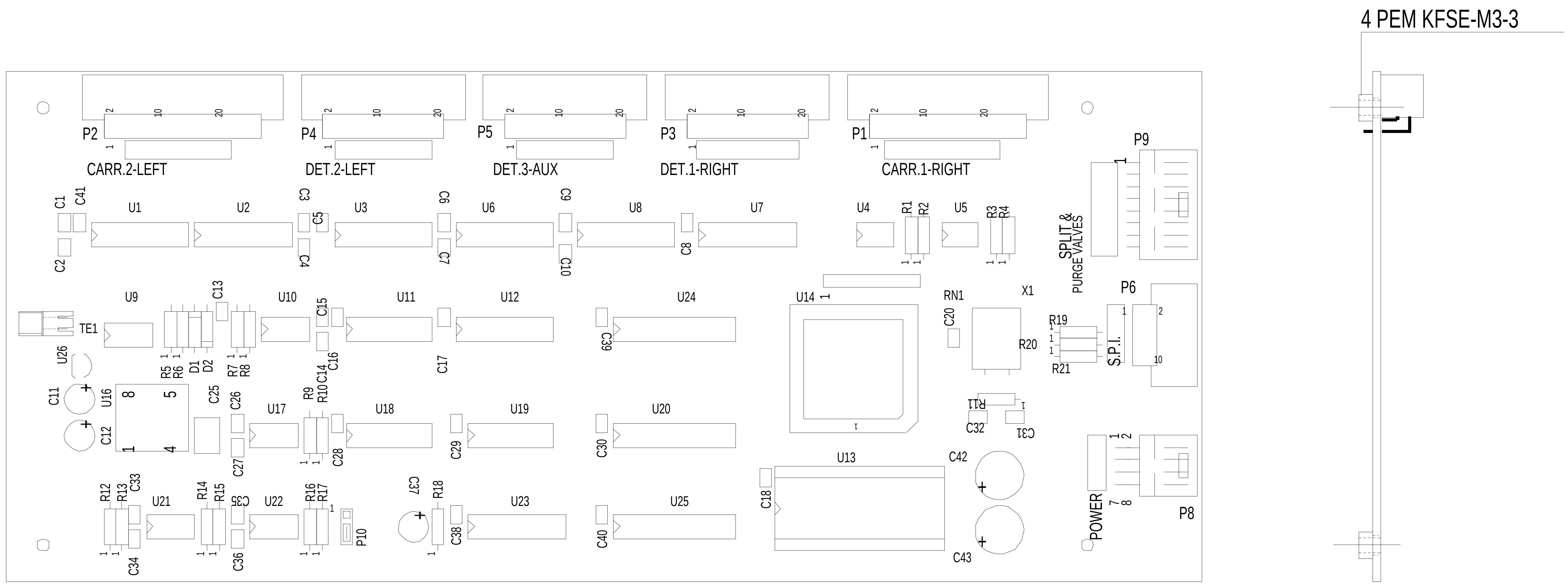

PCB Layout for Digital Pressure Flow Control (PC 1111)

5.8

Keypad and Display Panel

This chapter describes the PCB for the Keypad and Display Panel of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

The keypad and display panel are the primary means by which the user communicates with the GC.

Drawing 119841 shows the keypad schematic. See *Schematics and Component Layout*. One PLD provides control for scanning the display and for driving the status display LEDs. The microprocessor communicates with the PLD through the SPI bus several times per second. With each communication, the PLD sends data to the microprocessor to indicate which key, if any, is pressed. The microprocessor then interprets this information and takes the appropriate action.

The display receives serial data from the microprocessor's SCI output and displays it on the vacuum florescent display.

NOTE The display is a purchased assembly. It is a non-repairable component. The keypad and display panel module is designed to be replaced and not repaired.

Adjustment Procedures

No field adjustments are possible.

Schematics and Component Layout

The schematics and component layout information for the keypad and display panel PCB is listed below in Table 5.8-1. The number of drawings has been included for each schematic and its corresponding layout. There are two drawings for reference in this section.

Table 5.8-1. Keypad and Display Panel Schematics

Board	PN	Drawing	Layout
Keypad and Display Panel	43210025	119841B, 1–2	not available

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REV	ECO NO.	DATE	BY	CHK

Key Definition

SW1	STOP	SW28	STATUS
SW2	PREPARE RUN	SW29	PRESS
SW3	START	SW30	TEMP
SW4	OVEN	SW31	FLOW
SW5	LEFT INLET	SW32	TIME
SW6	RIGHT INLET	SW33	RAMP #
SW7	LEFT DETECTOR	SW34	3
SW8	RIGHT DETECTOR	SW35	2
SW9	LEAK CHECK	SW36	1
SW10	AUX	SW37	INFO/DIAG
SW11	LEFT CARRIER	SW38	RUN LOG
SW12	RIGHT CARRIER	SW39	0
SW13	LEFT SIGNAL	SW40	. (DECIMAL)
SW14	RIGHT SIGNAL	SW41	- (MINUS)
SW15	COLUMN EVAL	SW42	SEQUENCE
SW16	CONFIG	SW43	METHOD
SW17	"UP ARROW"	SW44	STORE
SW18	"DOWN ARROW"	SW45	LOAD
SW19	9	SW46	EDIT/ACTIVE
SW20	8	SW47	RUN TABLE
SW21	5	SW48	CLOCK TABLE
SW22	7	SW49	VALVE #
SW23	ENTER	SW50	AUTO SAMPLER
SW24	MODE/TYPE	SW51	ON/YES
SW25	OFF/NO	SW52	"INFINITY SIGN"
SW26	6	SW53	CLEAR
SW27	4	SW54	SEQ CONTROL

	BY	Date
DRN	L Baldwin	12/10/97
CHK		
ENGR	L Baldwin	12/10/97
APPD		

Thermo Quest Corporation

2215 Grand Avenue Parkway
Austin, TX 78728

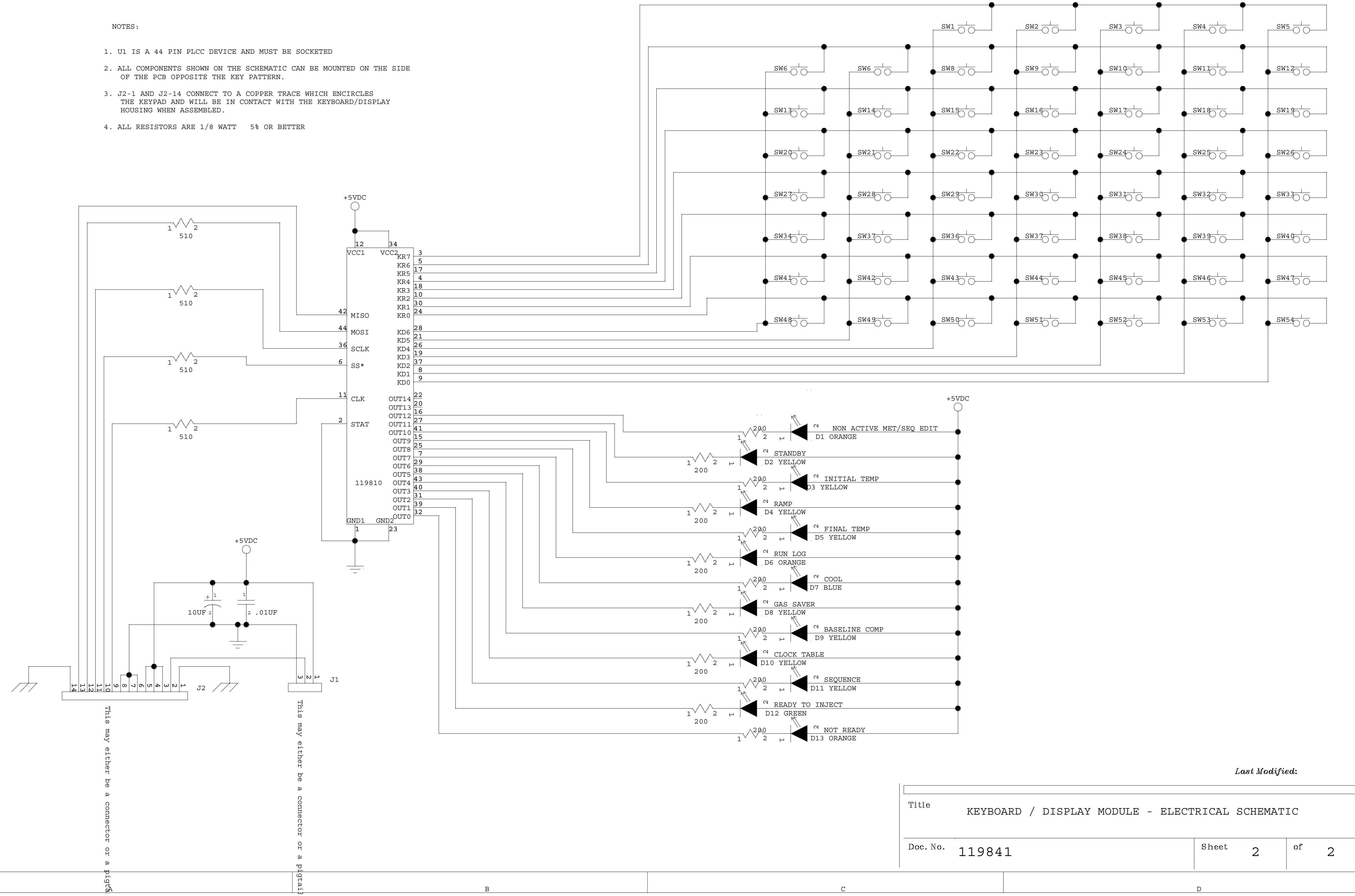
Title: Keyboard Assembly

Document Number: 119841 | Rev: B

Date: 12/10/97 | Size: B | Sheet 1 of 2

NOTES:

1. U1 IS A 44 PIN PLCC DEVICE AND MUST BE SOCKETED
2. ALL COMPONENTS SHOWN ON THE SCHEMATIC CAN BE MOUNTED ON THE SIDE OF THE PCB OPPOSITE THE KEY PATTERN.
3. J2-1 AND J2-14 CONNECT TO A COPPER TRACE WHICH ENCIRCLES THE KEYPAD AND WILL BE IN CONTACT WITH THE KEYBOARD/DISPLAY HOUSING WHEN ASSEMBLED.
4. ALL RESISTORS ARE 1/8 WATT 5% OR BETTER



Last Modified:

Title KEYBOARD / DISPLAY MODULE - ELECTRICAL SCHEMATIC

Doc. No. 119841 Sheet 2 of 2

5.9

Theory of Detector Cards

This chapter contains a representative block diagram for the following 6 detector chapters:

- 5.10, *Flame Ionization Detector Controller*
- 5.11, *Electron Capture Detector Controller*
- 5.12, *Nitrogen Phosphorous Detector Controller*
- 5.13, *Flame Photometric Detector Controller (FPD)*
- 5.14, *Photoionization Detector Controller (PID)*
- 5.15, *Thermal Conductivity Detector Controller (TCD)*

The diagram is representative of *only* the detector cards in the above listed chapters.

Chapter at a Glance...

Block Diagram for Detector Cards

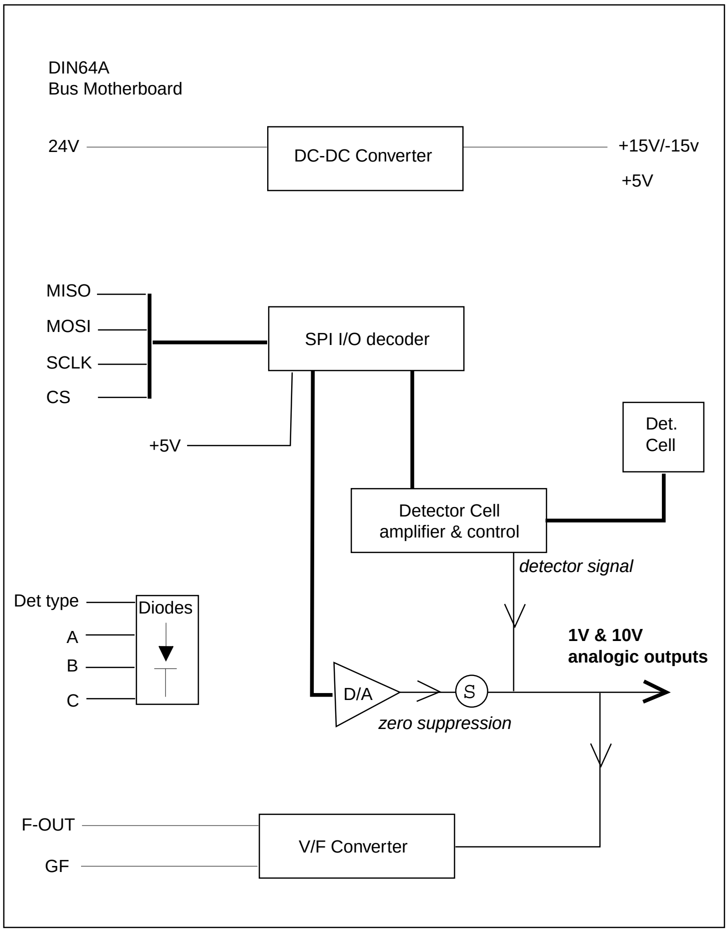


Figure 5.9-1. Block Diagram for Detector Cards

5.10

Flame Ionization Detector Controller

This chapter describes the Flame Ionization Detector (FID) controller of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

Circuit Function

The main purpose of the Flame Ionization Detector (FID) PCB is to control the IGNIT (flame igniter coil), –300 V (flame jet polarization), and input (low current produced) of the FID. The FID PCB takes all digital inputs/outputs (P1 connector) and the power voltages (+5 V dc, +/–15 V dc, +24 V dc) from the motherboard.

The low-current signal (DET CABLE) produced from the FID is connected to the input of the 2N5909 preamplifier (U24) by a dedicated cable with coaxial connector. The output signal then goes to the OP07 amplifier (U25).

There are four J201 FETs (Q8–Q11) to select the range of the input current. The input current then goes to the first analog input of the amplifier OP77 (U26) on pin 3, together with the second analog input on pin 2 as a back-off current signal (VBO).

A back-off bucking current is generated from the DAC0801 converter (U18, U19) and the OP07C amplifier (U23). The LM324 integrated circuit (U22) generates four signals to select the range input current (PN1–PN4).

Three 74HC595 integrated circuits (U13, U15, U16) generate the output chip-select (O1–O6) and the background chip-select (Z0–Z15).

Integrated circuit 74HC240 takes the input serial data (CLOCK, MOSI, MISO), the chip-select (CS), the +5 V dc, and GND from the motherboard.

Custom chip 24SCR4.5D15M (U12) takes the input voltage of +24 V dc to generate the +/–15 V dc and the +5 V dc through the 78L05 regulator (Q1).

The integrated circuit MOC3020 (U20) takes the input voltage of 8 V dc through the BTA06 triac to supply the flame igniter coil of the FID (P5). The integrated circuit MOC3020 (U20) is selected from two signals (O4, O5) generated by 74HC595 (U16).

The electronic circuit includes:

- BC107–BC177 transistors (Q2–Q7)
- IN4148 diodes (D3–D13)
- Capacitors (C12–C45)

The function of the electronic circuit is to generate a negative voltage of –300 V to polarize the flame jet of the FID. The P2 connector gives 0 V (signal common), 1 V, 10 V, and GND (chassis) outputs to connect an integrator or to handle chromatograph data externally.

Output Specifications

+/–15 V @ 130 mA

+5 V @ 25 mA

Adjustment Procedures

Calibration Adjustments

Refer to the calibration of potentiometers shown in the F1/4 drawing located in *Schematics and Component Layout*.

Special Notes

In order to verify the FID electrometer noise level, follow this technical procedure:

1. Remove the coaxial connectors of the signal cable from the FID
2. Wrap up the coaxial connectors using aluminum foil
3. Connect the analog output signal (0–10 mV) to recorder
4. Set parameters ATT=0 and RNG=0 (max sensitivity)

The noise level must be within 1% of full scale.

Schematics and Component Layout

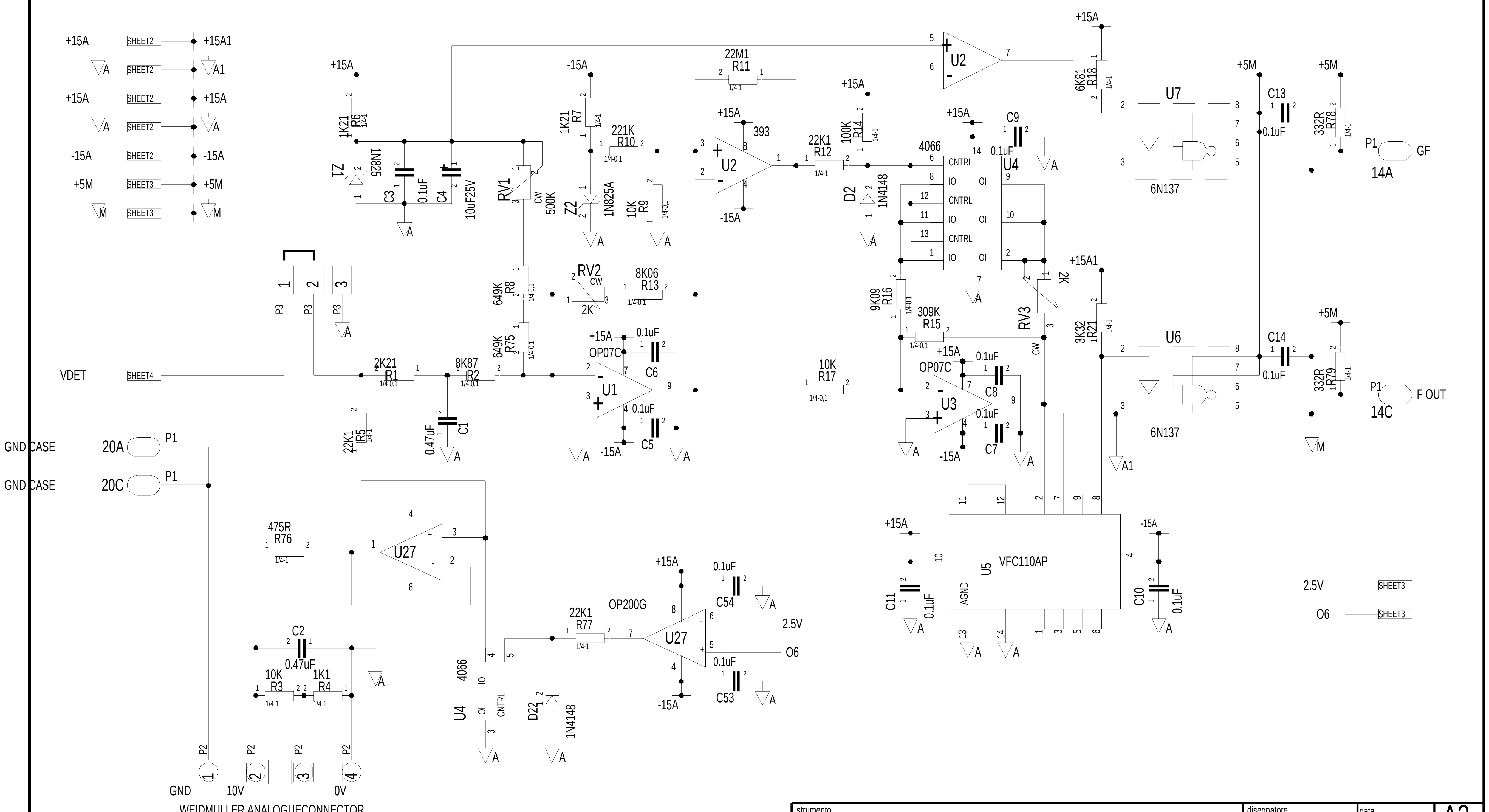
The schematics and component layout information for the FID controller is listed below in Table 5.10-1. The number of drawings has been included for each schematic and its corresponding layout. There are two sets of five drawings for reference in this section. The first set of drawings is for version 1.3 of the FID controller. The second set of drawings is for version 1.4 of the FID controller.

Table 5.10-1. FID Controller Schematics

Board	PN	Drawing	Layout
FID 1.3	23648320	SE 1388 - sh. 4, 1–4	PC 1105, 1
FID 1.4	23648320	SE 1388 - sh. 4, 1–4	PC 1105, 1

NOTE The last drawing in each set is the layout of the board.

MOD/RDM		MODIFICHE	DATA	FIRMA/VISTO
A	PR/REV	ADDED RV10 ON SH4	3/6/97	
B	PR/REV	CHANGE R78,R79 FROM 2K21 TO 332R ON SH1	8/9/97	
C	PR/REV	CHANGE U27 FROM TL082 TO OP200G ON SH1	9/12/97	
D	PR/REV	CHANGE R83 FROM 1K TO 150 Ohm ON SH2	28/01/98	



CALIBRATION:

1 V-DET= 0mV ADJ RV1 FOR F.OUT=400KHz

2 V-DET=250mV ADJ RV2 FOR F.OUT=2.9MHz

3 V-DET=10V ADJ RV3 FOR F.OUT=3.137MHz

4 REPEAT POINT 1...3 UNTIL ALL OK

strumento: TRACE	disegnatore: E.CARRARA	data: 22/04/97	A3
assieme: FID F1/4	sostituisce	scala	
particolare: Schematic diagram	codice	visto	
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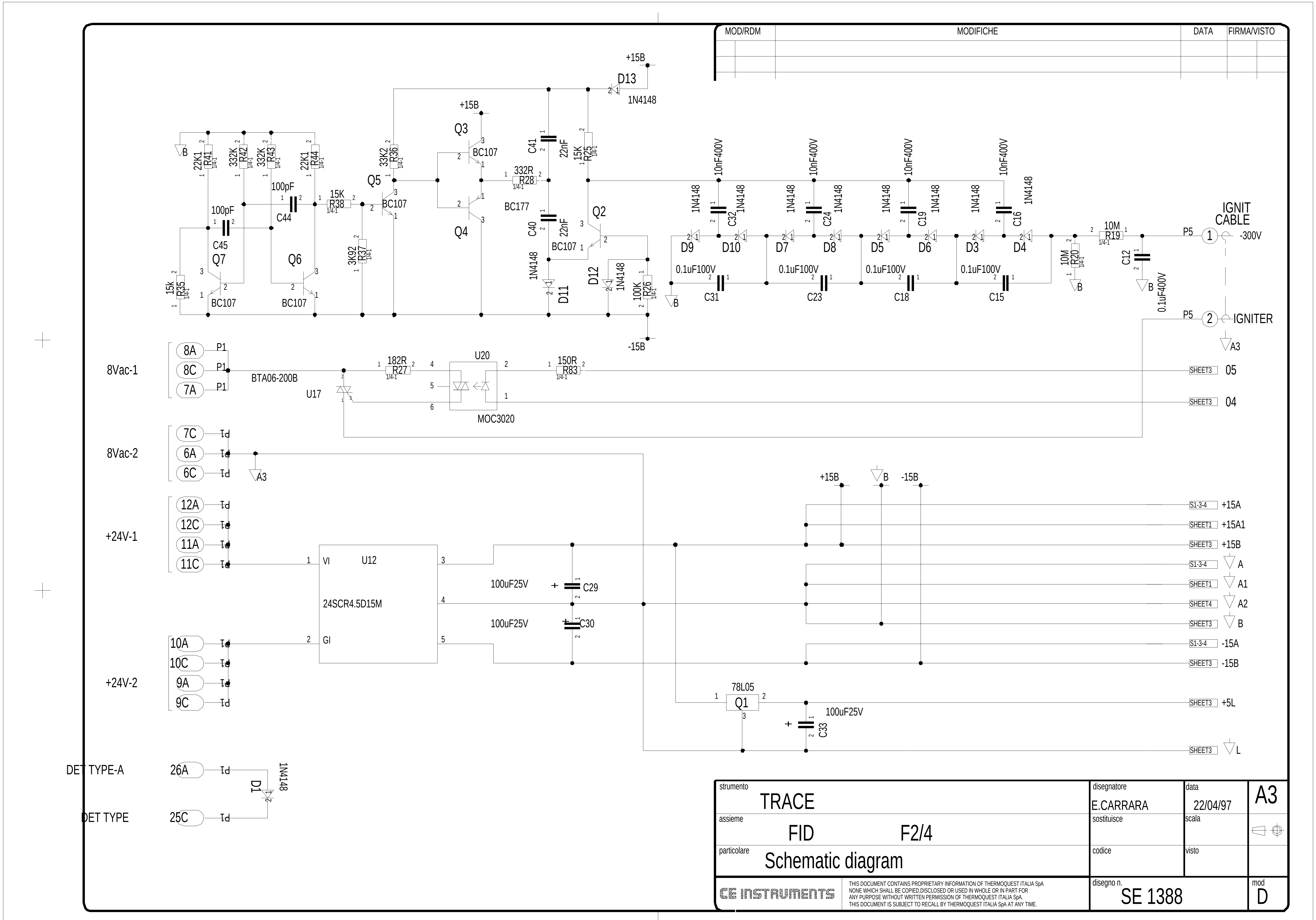

MOD/RDM
MODIFICHE
DATA
FIRMA/VISTO
+15B
D13
1N4148
+15B
Q3
BC107
Q5
BC107
332R
R28
BC177
Q4
C41
22nF
15K
R25
C40
22nF
Q2
BC107
1N4148
D11
D12
1N4148
100K
R26
-15B
22K1
R41
332K
R42
332K
R43
22K1
R44
33K2
R36
100pF
C44
15K
R38
100pF
C45
Q7
Q6
BC107
BC107
15k
R35
3K92
R37
10nF400V
1N4148
C32
C24
C19
C16
D9
D10
D7
D8
D5
D6
D3
D4
0.1uF100V
C31
C23
C18
C15
10M
R19
10M
R20
C12
0.1uF400V
IGNIT
CABLE
P5
-300V
IGNITER
A3
8Vac-1
8A
8C
7A
P1
BTA06-200B
U17
182R
R27
U20
MOC3020
150R
R83
SHEET3
05
04
8Vac-2
7C
6A
6C
+24V-1
12A
12C
11A
11C
VI
U12
24SCR4.5D15M
GI
100uF25V
C29
100uF25V
C30
+24V-2
10A
10C
9A
9C
+15B
B
-15B
S1-3-4
+15A
SHEET1
+15A1
+15B
A
A1
SHEET4
A2
B
-15A
-15B
78L05
Q1
100uF25V
C33
+5L
L
DET TYPE-A
26A
D1
1N4148
DET TYPE
25C
strumento
TRACE
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F2/4
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Schematic diagram
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SE 1388
mod
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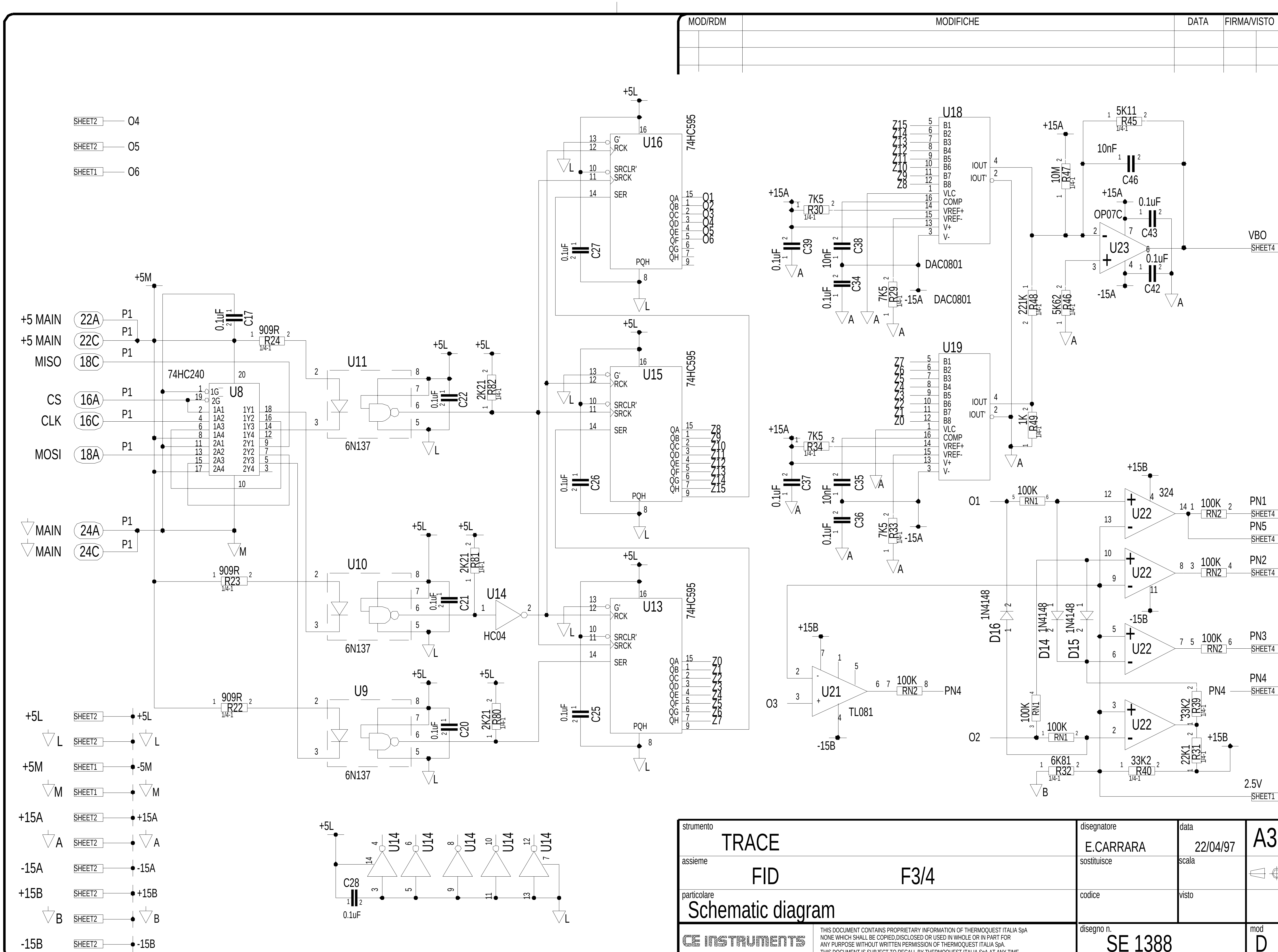
MOD/RDM
MODIFICHE
DATA
FIRMA/VISTO
+5 MAIN 22A
+5 MAIN 22C
MISO 18C
CS 16A
CLK 16C
MOSI 18A
MAIN 24A
MAIN 24C
74HC240 U8
U11 6N137
U10 6N137
U9 6N137
U14 HC04
U16 74HC595
U15 74HC595
U13 74HC595
U18 DAC0801
U19 DAC0801
U23 OP07C
VBO
U21 TL081
U22 324
PN1
PN2
PN3
PN4
PN5
2.5V
1N4148
D14
D15
D16
strumento TRACE
assieme FID F3/4
particolare Schematic diagram
disegnatore E.CARRARA
data 22/04/97
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disegno n. SE 1388
mod D
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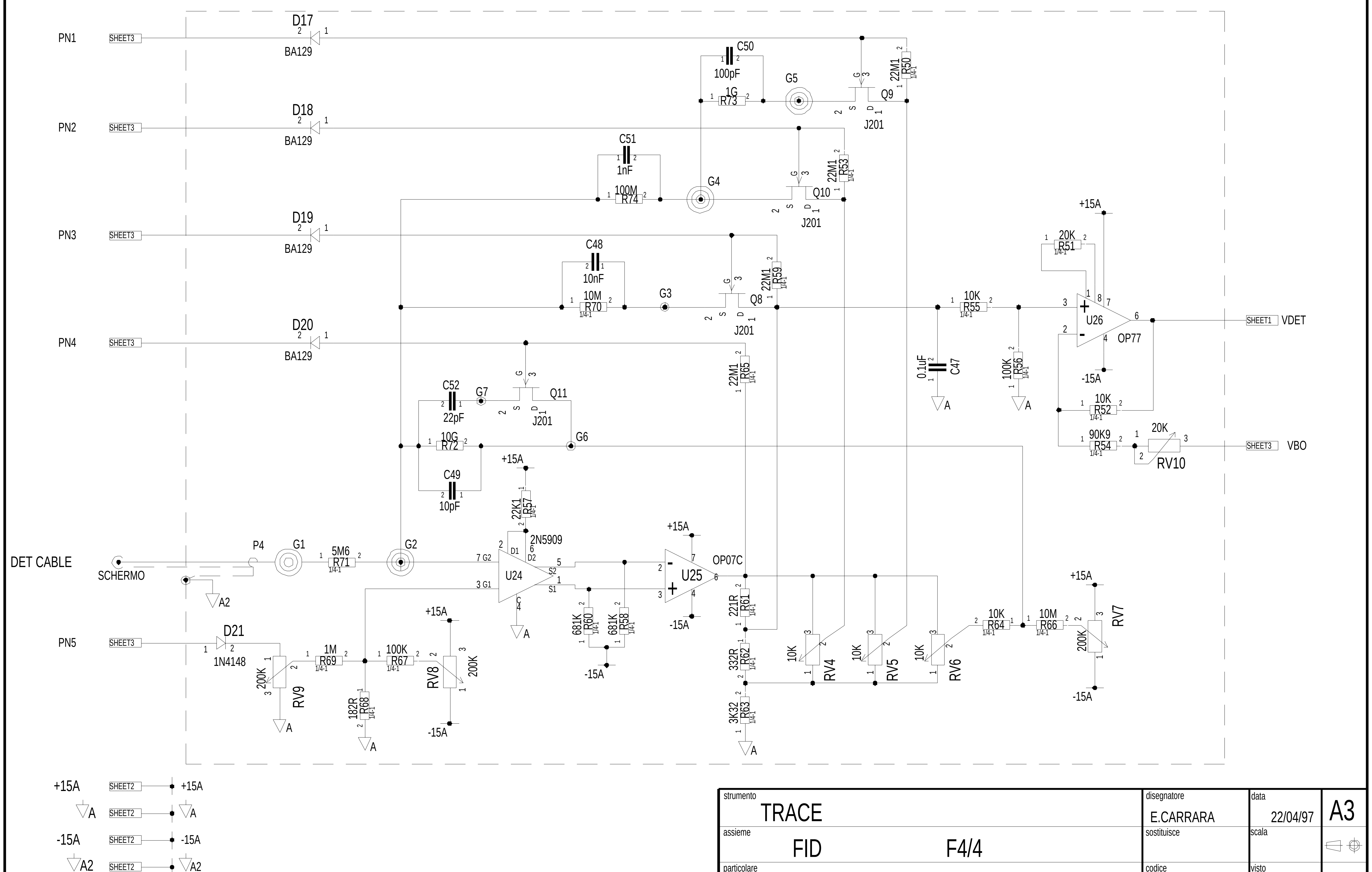
MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



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TRACE		E.CARRARA	22/04/97	
assieme FID	F4/4	sostituisce	scala	
particolare **Schematic diagram**		codice	visto	
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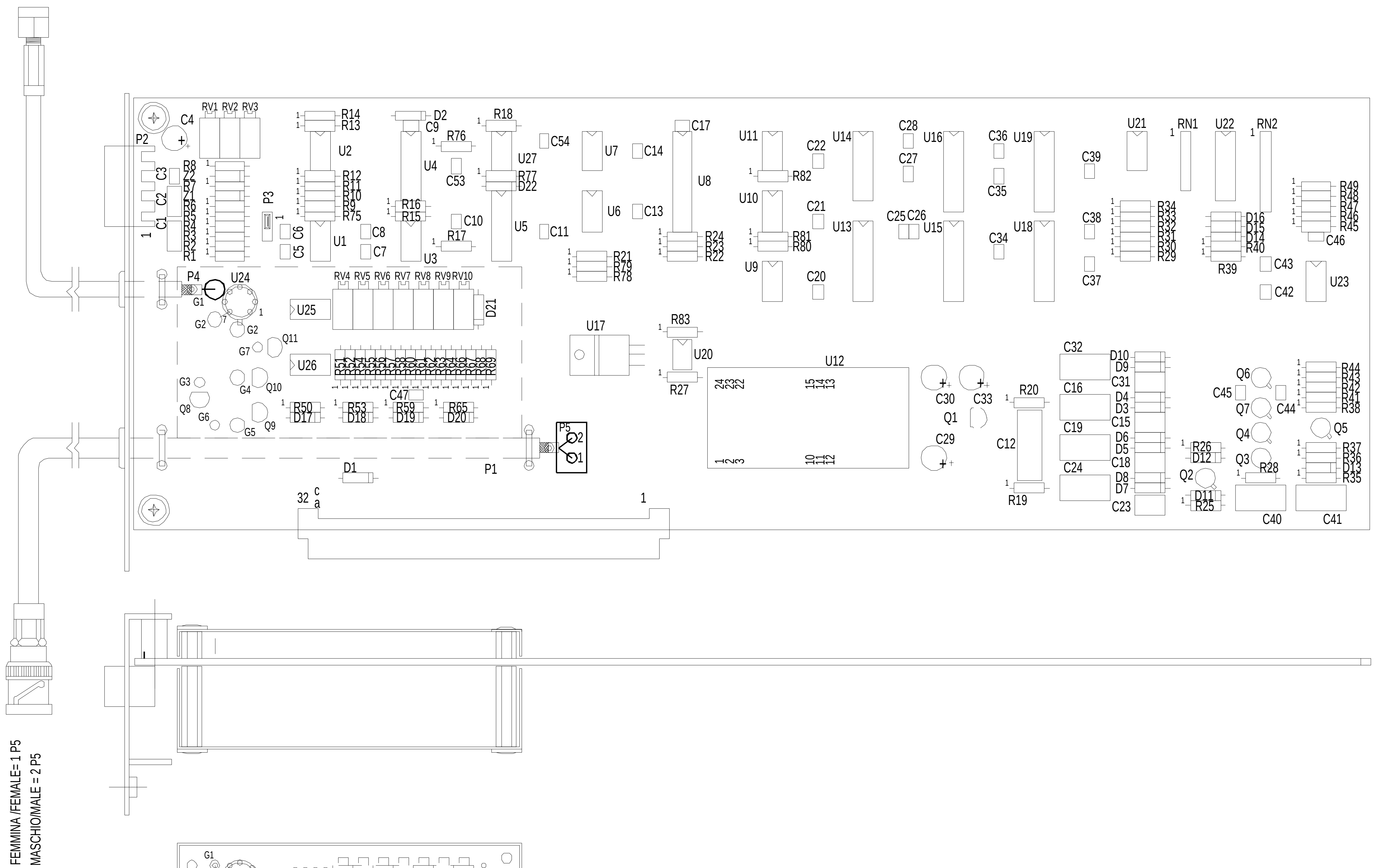
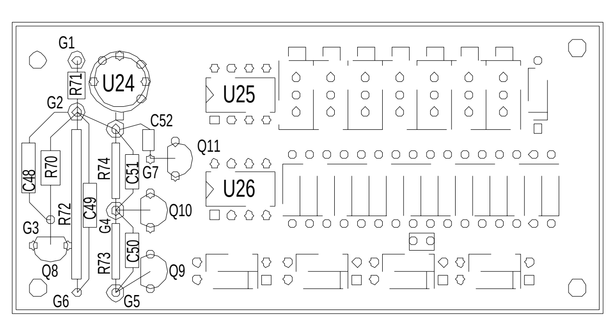
MOD/RDM		MODIFICHE	DATA	FIRMA/VISTO
A	REV/PR	AGGIUNTO RV10 ESEGUITO REV 1.2 DEL MASTER	3/06/97	
B	REV/PR	MOD.U27 DA TL082 A OP200G. ESEGUITO REV 1.3 DEL MASTER	9/12/97	





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assieme: C.S. FID	sostituisce	scala	
particolare	codice	visto	
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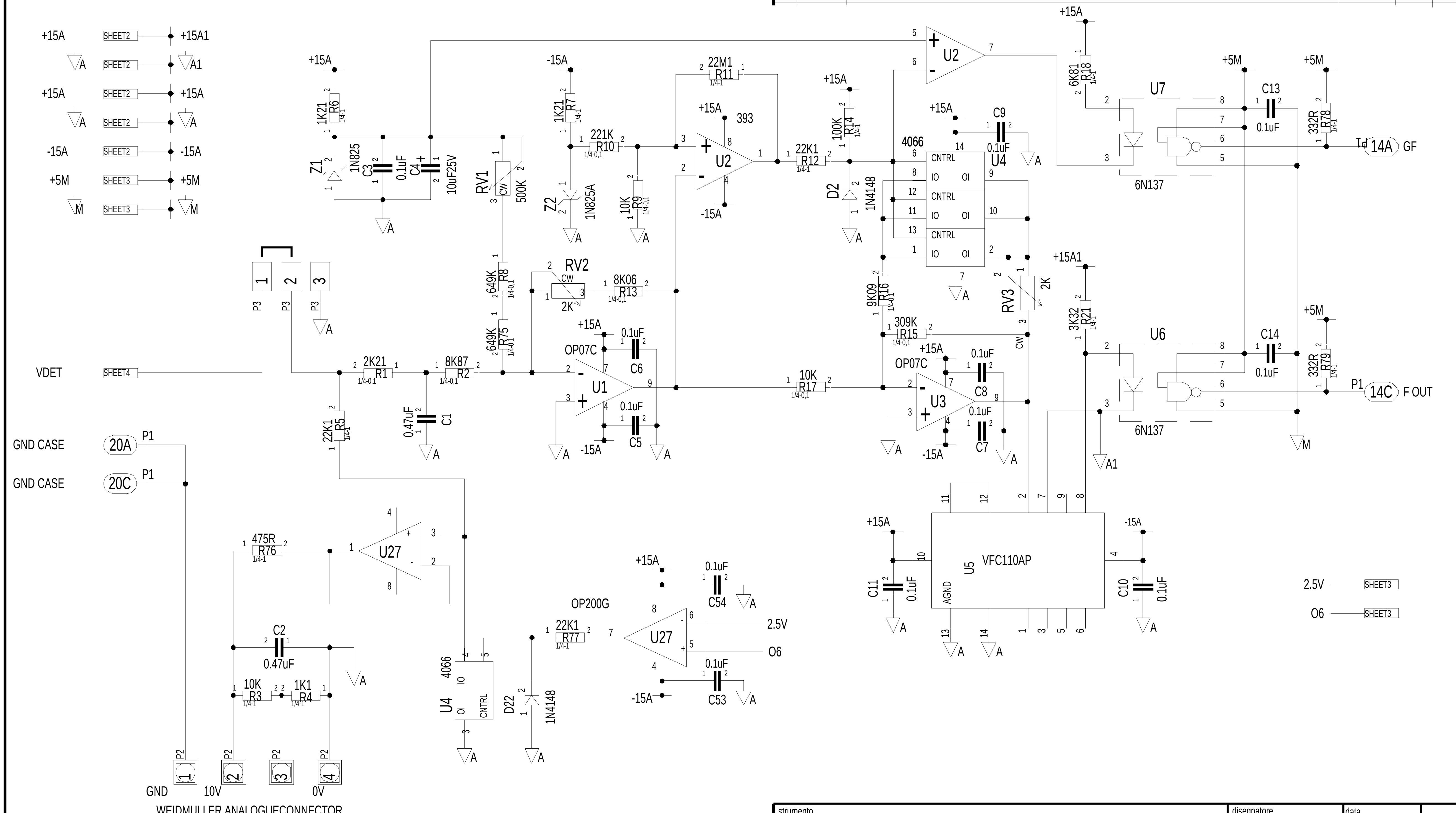
MOD/RDM		MODIFICHE	DATA	FIRMA/VISTO
A	PR/REV	ADDED RV10 ON SH4	3/6/97	
B	PR/REV	CHANGE R78,R79 FROM 2K21 TO 332R ON SH1	8/9/97	
C	PR/REV	CHANGE U27 FROM TL082 TO OP200G ON SH1	9/12/97	
D	PR/REV	CHANGE R83 FROM 1K TO 150 Ohm ON SH2	28/01/98	
E	PR/REV	ADDED J6 CONN. ON SH2. MASTER REV. 1.4 .	9/4/98	



CALIBRATION:

1 V-DET= 0mV ADJ RV1 FOR F.OUT=400KHz

2 V-DET=250mV ADJ RV2 FOR F.OUT=2.9MHz

3 V-DET=10V ADJ RV3 FOR F.OUT=3.137MHz

4 REPEAT POINT 1...3 UNTIL ALL OK

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particolare: Schematic diagram		codice	visto	
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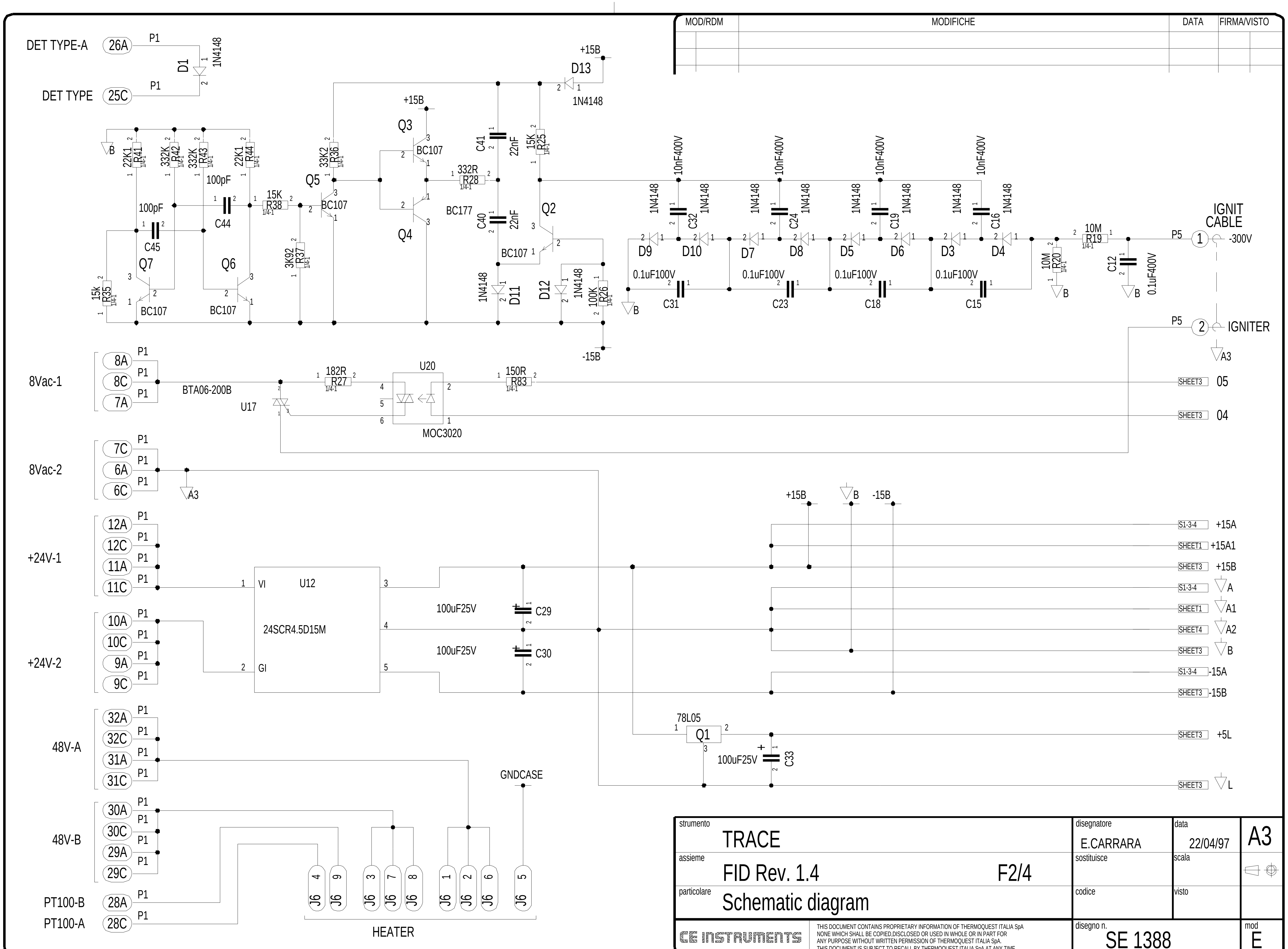
MOD/RDM
MODIFICHE
DATA
FIRMA/VISTO
DET TYPE-A
DET TYPE
8Vac-1
8Vac-2
+24V-1
+24V-2
48V-A
48V-B
PT100-B
PT100-A
BTA06-200B
U17
U20
MOC3020
U12
24SCR4.5D15M
100uF25V
78L05
GNDCASE
HEATER
IGNIT CABLE
-300V
IGNITER
+15A
+15A1
+15B
-15A
-15B
+5L
strumento
TRACE
assieme
FID Rev. 1.4
F2/4
particolare
Schematic diagram
disegnatore
E.CARRARA
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scala
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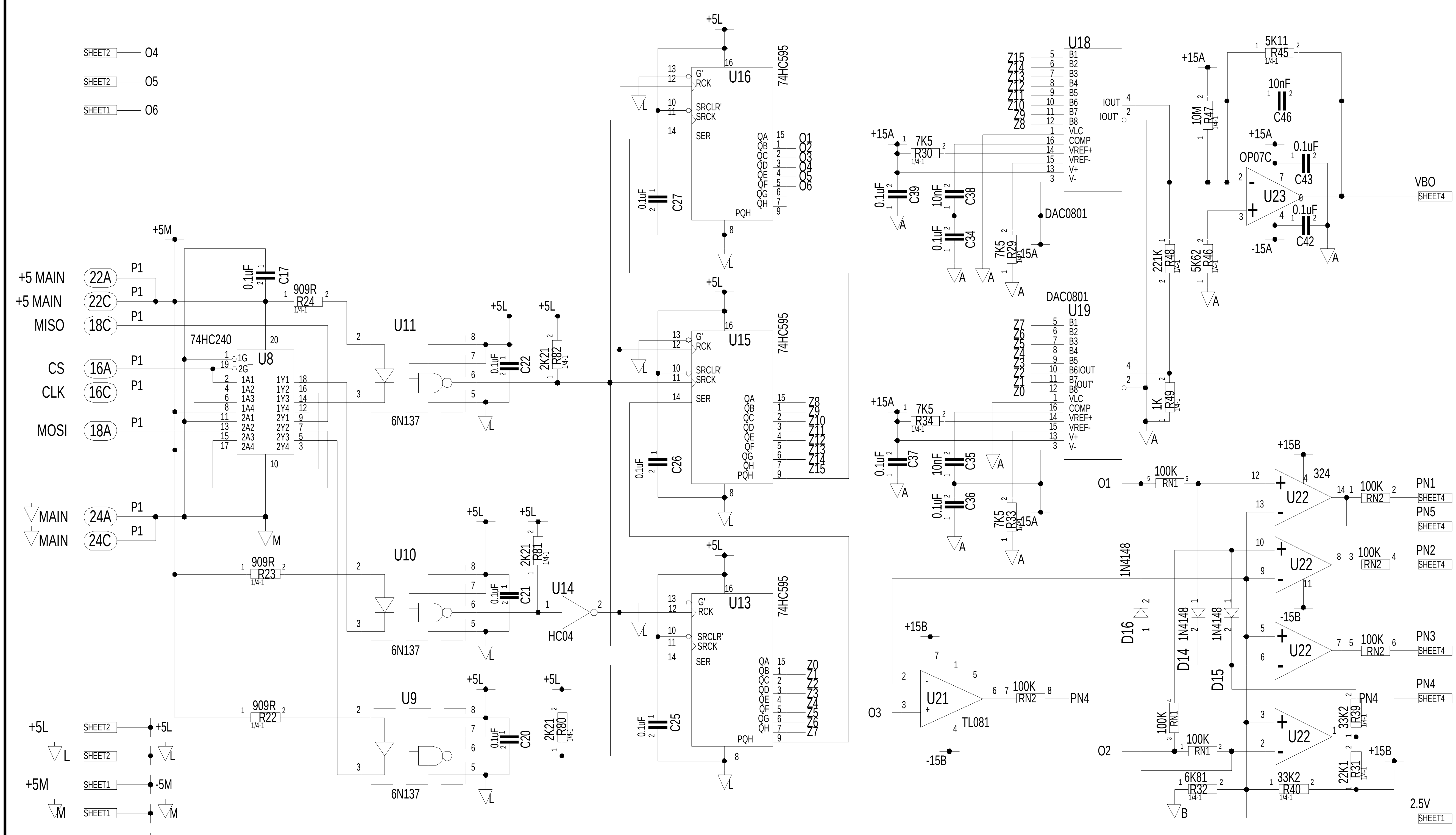

MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO

strumento: TRACE

assieme: FID Rev. 1.4 F3/4

particolare: Schematic diagram

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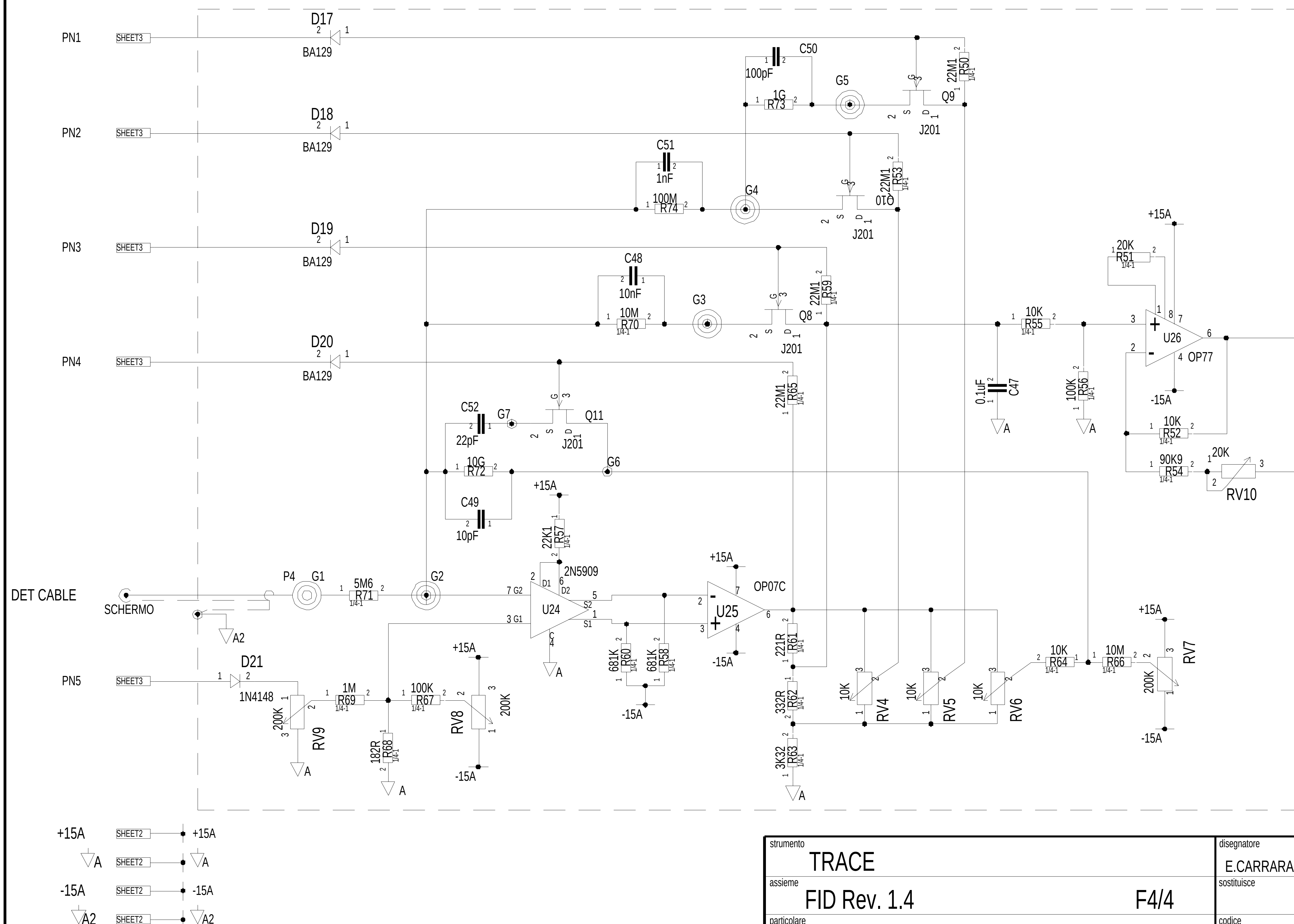
MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



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assieme: FID Rev. 1.4 F4/4	sostituisce	scala	
particolare: Schematic diagram	codice	visto	
CE INSTRUMENTS	disegno n.: SE 1388		mod: E

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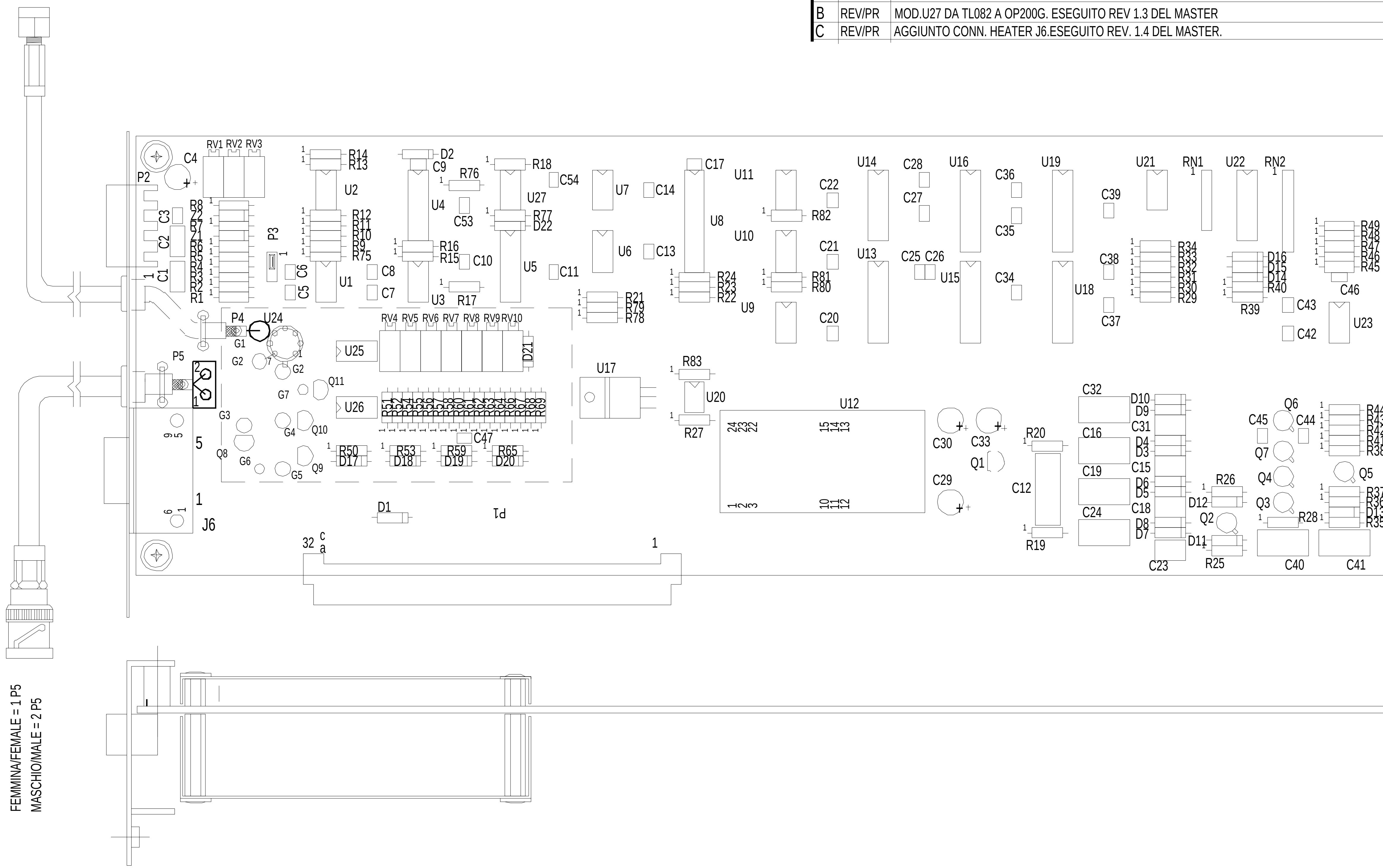
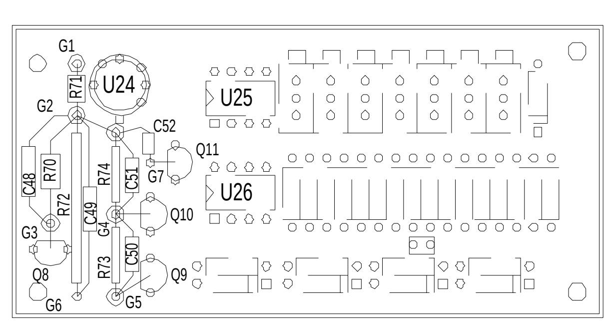
MOD/RDM		MODIFICHE	DATA	FIRMA/VISTO
A	REV/PR	AGGIUNTO RV10 ESEGUITO REV 1.2 DEL MASTER	3/06/97	
B	REV/PR	MOD.U27 DA TL082 A OP200G. ESEGUITO REV 1.3 DEL MASTER	9/12/97	
C	REV/PR	AGGIUNTO CONN. HEATER J6.ESEGUITO REV. 1.4 DEL MASTER.	10/4/98	





strumento: TRACE	disegnatore: E.CARRARA	data: 22/04/97	A3
assieme: C.S. FID Rev. 1.4	sostituisce	scala	
particolare	codice	visto	
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5.11

Electron Capture Detector Controller

This chapter describes the Electron Capture Detector (ECD) controller of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

Circuit Function

The main purpose of the Electron Capture Detector (ECD) PCB is to control the pulse frequency (FC1034, J5) of the radioactive source (^{63}Ni) and the input (low current produced) of the ECD. The ECD PCB takes all digital inputs/outputs (J8 connector) and the power voltages (+5 V dc, +24 V dc, GND) from the motherboard.

The low-current input signal (FC1033) produced by the ECD is connected to the input of the 5909 preamplifier (U1, point N1) by a dedicated cable with a coaxial connector. The output signal then goes to the OP07 amplifier (U11). The 48 V dc output voltage required to supply the heater elements (thermoregulation) and the input signal of the PT100 sensor (reading temperature) of the ECD are connected to the female connector (J9). The analog output signal (V DET) of the operational amplifier OP07 (U12) goes to the VFC110AP converter circuit (U26) through two OP07 operational amplifiers (U2, U3).

The output frequency signal (F-OUT) of the VFC110AP (pin 8) goes to the motherboard through 6N137 (I1) and the J8 connector to be read by the main TRACE microprocessor. The same V DET signal goes to the TL082 output stage (U4A) and three resistors (R50, R56, R57) to generate the output voltages of 0–1 V and 0–10 V. These outputs are used for external connections to:

- A recorder
- An integrator
- A data handling system (ChromCard or ChromQuest)

The circuit for the autozero function consists of the OP200 (U4B) and 4066 (U5A), which are controlled from the DOING AZ input signal.

The autozero analog signal is generated by:

- Two 74HC273 integrated circuits (U27, U28)
- Two DAC0800 converters (U22, U23)
- OP07 amplifier (U20)

A local MC68HC705 microprocessor (U24) controls the following:

- Data bus
- Address bus
- Clock
- Interrupt
- Reset
- SPI signals

The integrated circuits 74HC240 (U29A–B) and four 6N137 (I3–I6) are used to perform the serial communication with the motherboard through the J8 connector. The pulse width (0.1µS, 0.5µS, 1µS) of the outpulse frequency (J5 connector) is generated by four 74LS221 circuits (U8, U13) and the 74LS153.

The circuit consists of:

- Diodes
- Resistors
- Capacitors
- Transistors (Q3–Q7)

The current circuit consists of:

- Integrated circuit 74HC273 (U18)
- Converter DAC0800 (U14)
- Amplifier OP07 (U9)

The voltage circuit consists of:

- Integrated circuit 74HC273 (U19)
- Converter DAC0800 (U15)
- Amplifier OP07 (U10)

The regulator LM7805 (U31) generates the +5 V dc. Two regulators, LM7815 (U32) and LM7915 (U33), generate the +/–15 V dc. The J2 connector gives the 0 V (signal common), 1 V, 10 V, and GND (chassis) outputs to connect an integrator or to handle chromatograph data externally.

Detector Heat

The Electron Capture detectors require additional heat control for the detector cell. This heater voltage is furnished from the Power Control PCB on the power control module. The heater voltage output from the power control PCB is passed through the detector control electronic module which is mounted on the right side of the GC. The heater voltage enters the detector control module through the main jack on the motherboard slot A, B, or C. The voltage is then passed through J9 to the ECD Heater.

Each detector control module slot has an independent heater channel on the Power Control PCB. The temperature feedback from the detector RTD is also fed through this module to the motherboard.

A jumper must be made on the motherboard to enable the RTD. Module A uses J8, module B uses J7 and module C uses J6. The top two pins must be jumped to enable the RTD.

Output Specifications

+/–15 V @ 165 mA

+5 V @ 25 mA

Frequency read @ 0–1000 kHz

Adjustment Procedures

No field adjustments are necessary.

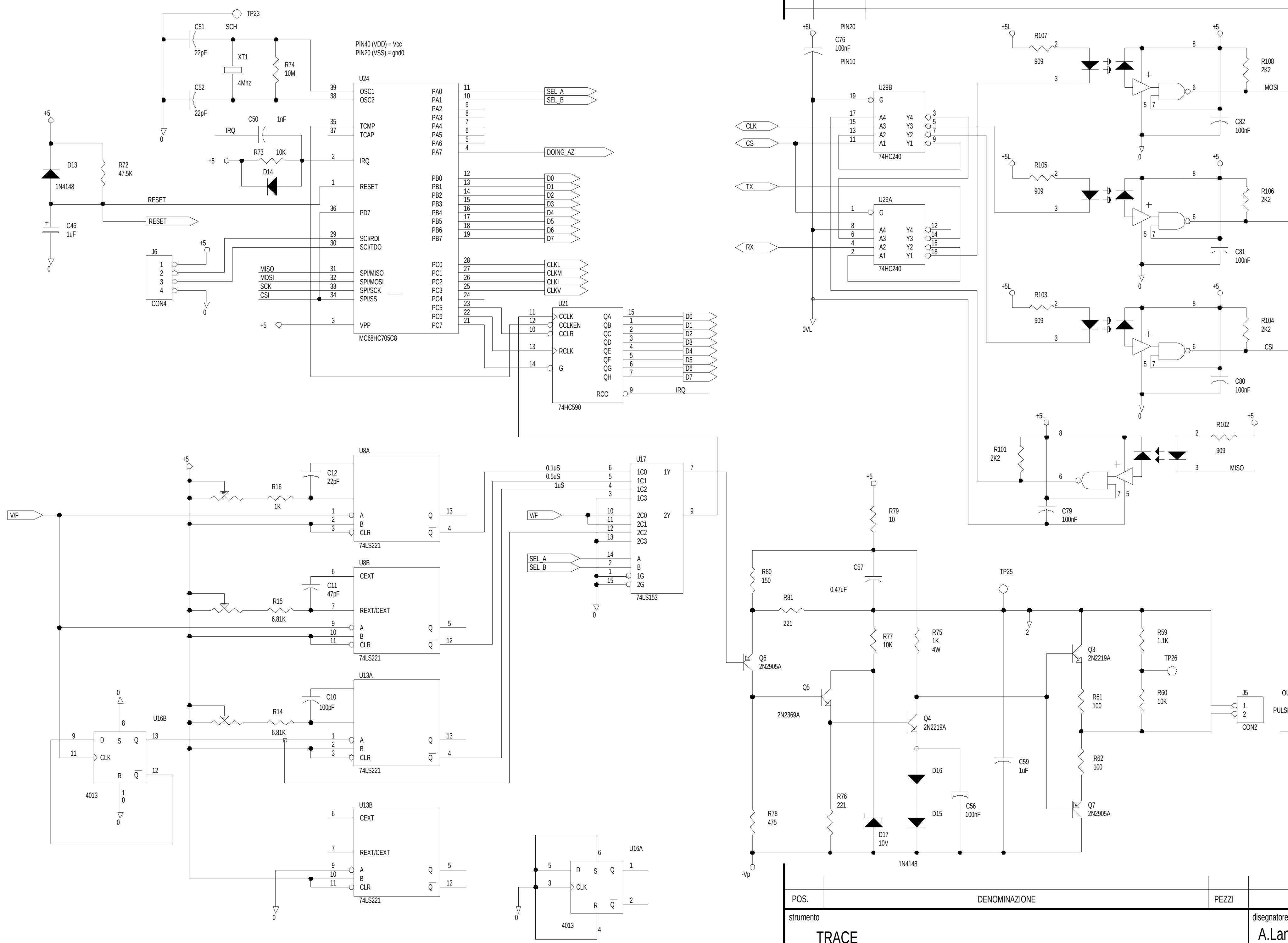
Schematics and Component Layout

The schematics and component layout information for the ECD controller is listed below in Table 5.11-1. The number of drawings has been included for each schematic and its corresponding layout. There are six drawings for reference in this section.

Table 5.11-1. ECD Controller Schematics

Board	PN	Drawing	Layout
ECD	23648325	SE 1389 - sh. 5, 1–5	PC 1106, 1

NOTE The last drawing in this section is the layout of the board.



MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO

POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento: TRACE

assieme: C.S. ECD rev. 1.1

particolare: Schematic Diagram - CPU Freq. & Pulse gen.

disegnatore: A.Lamperti

data: 19/11/97

sostituisce

scala

codice

visto

A3

Toll. Gen. ± 0,1 ± 30'

Fil. 6H-6g

1,6

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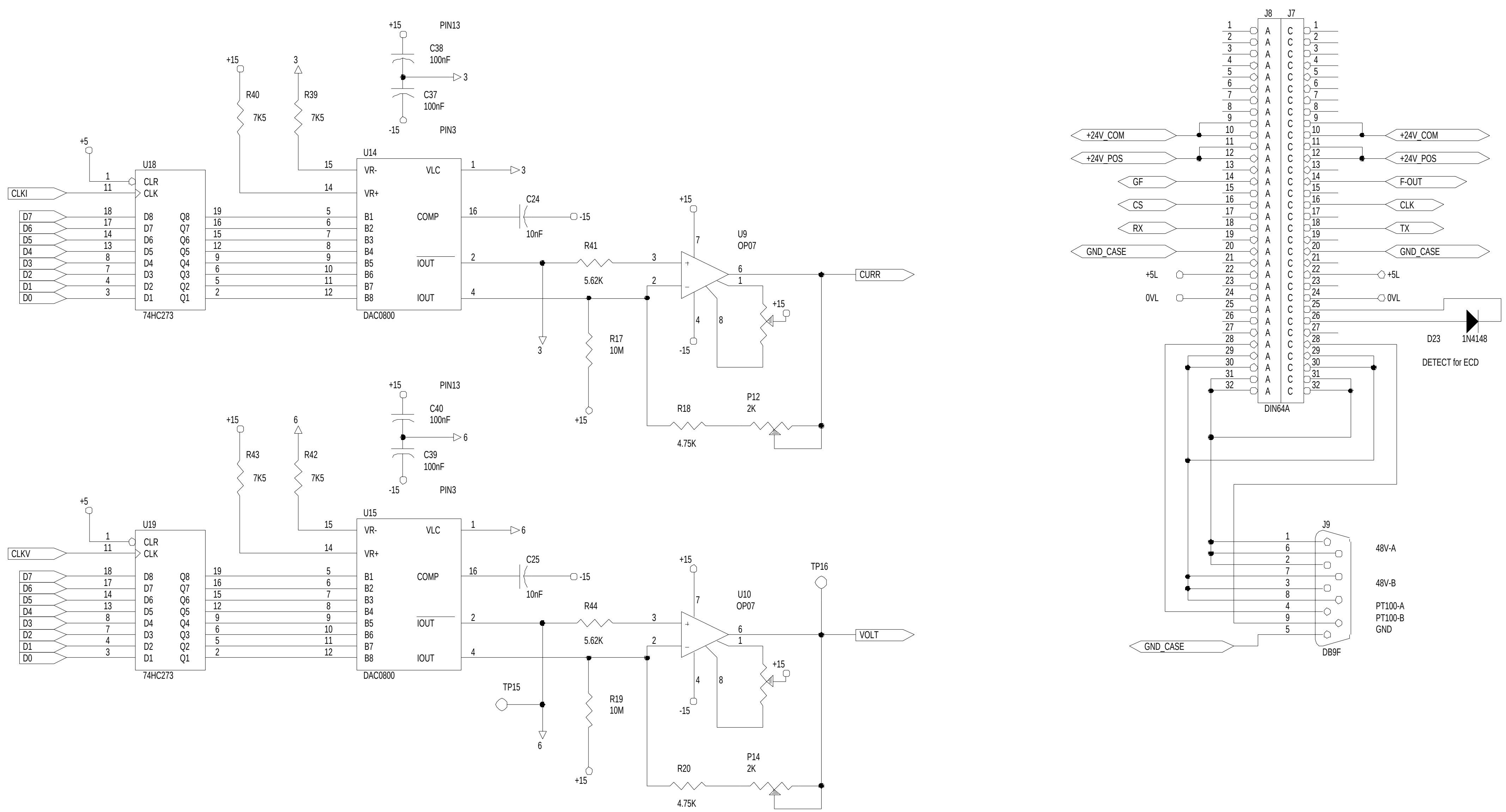
disegno n: SE1389 sh.1/5

modif.

MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento TRACE	disegnatore A.Lamperti	data 19/11/97	A3 Toll. Gen.
assieme C.S. ECD rev. 1.1	sostituisce	scala	— ± 0,1 ∠ ± 30'
particolare Schematic Diagram - D/A converter & I/O connector	codice	visto	Fil. 6H-6g 1,6

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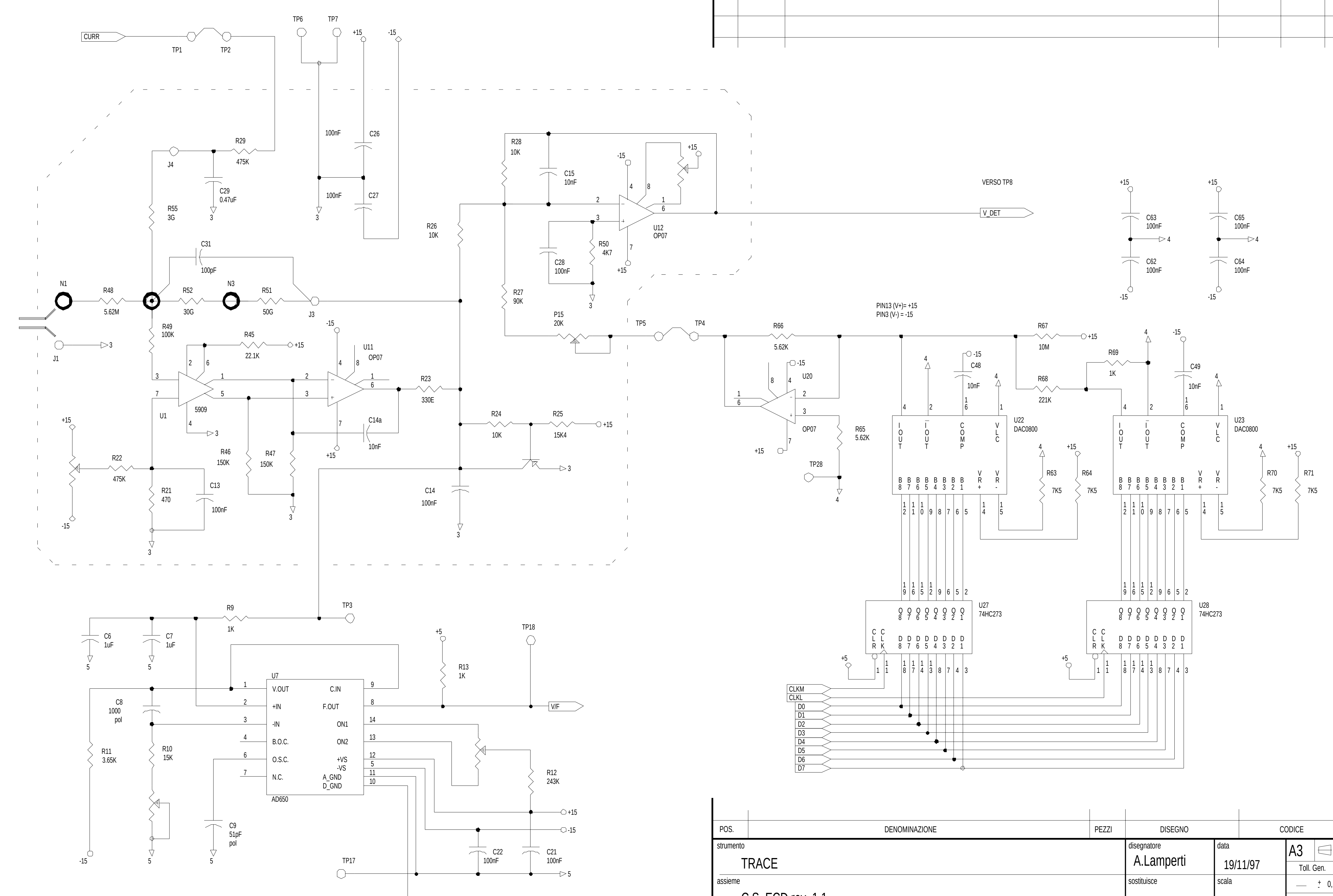
disegno n
SE1389 sh.2/5

modif.

MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento TRACE	disegnatore A.Lamperti	data 19/11/97	A3 Toll. Gen.
assieme C.S. ECD rev. 1.1	sostituisce	scala	± 0,1 ± 30'
particolare Schematic Diagram - Electr.,autozero, V/F conv.	codice	visto	Fil. 6H-6g 1,6
CE INSTRUMENTS	disegno n SE1389 sh.3/5		modif.

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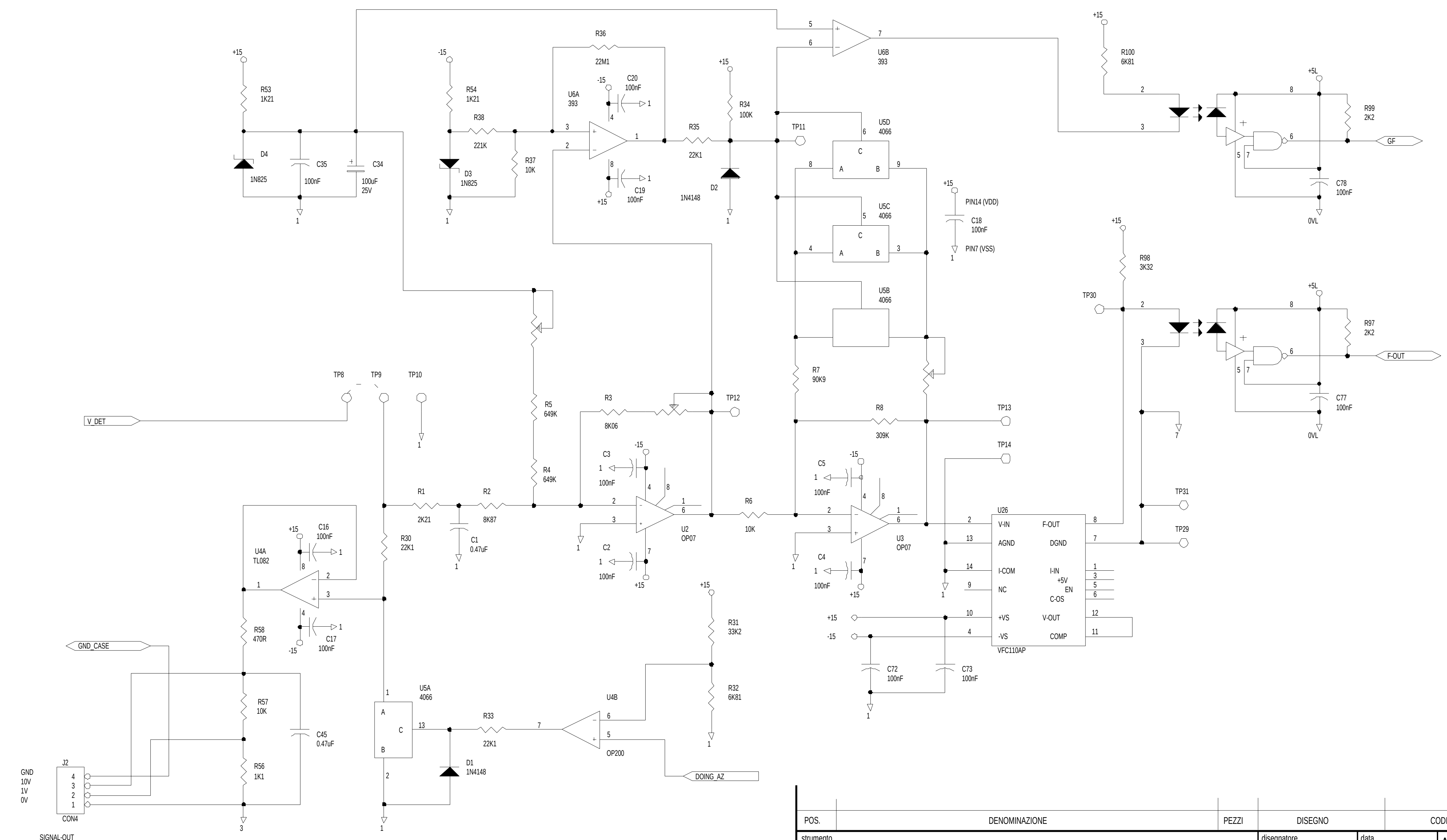
MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento TRACE	disegnatore A.Lamperti	data 19/11/97	A3 Toll. Gen.
assieme C.S. ECD rev. 1.1	sostituisce	scala	± 0.1 ± 30'
particolare Schematic Diagram - V/F converter signal out	codice	visto	Fil. 6H-6g 1,6
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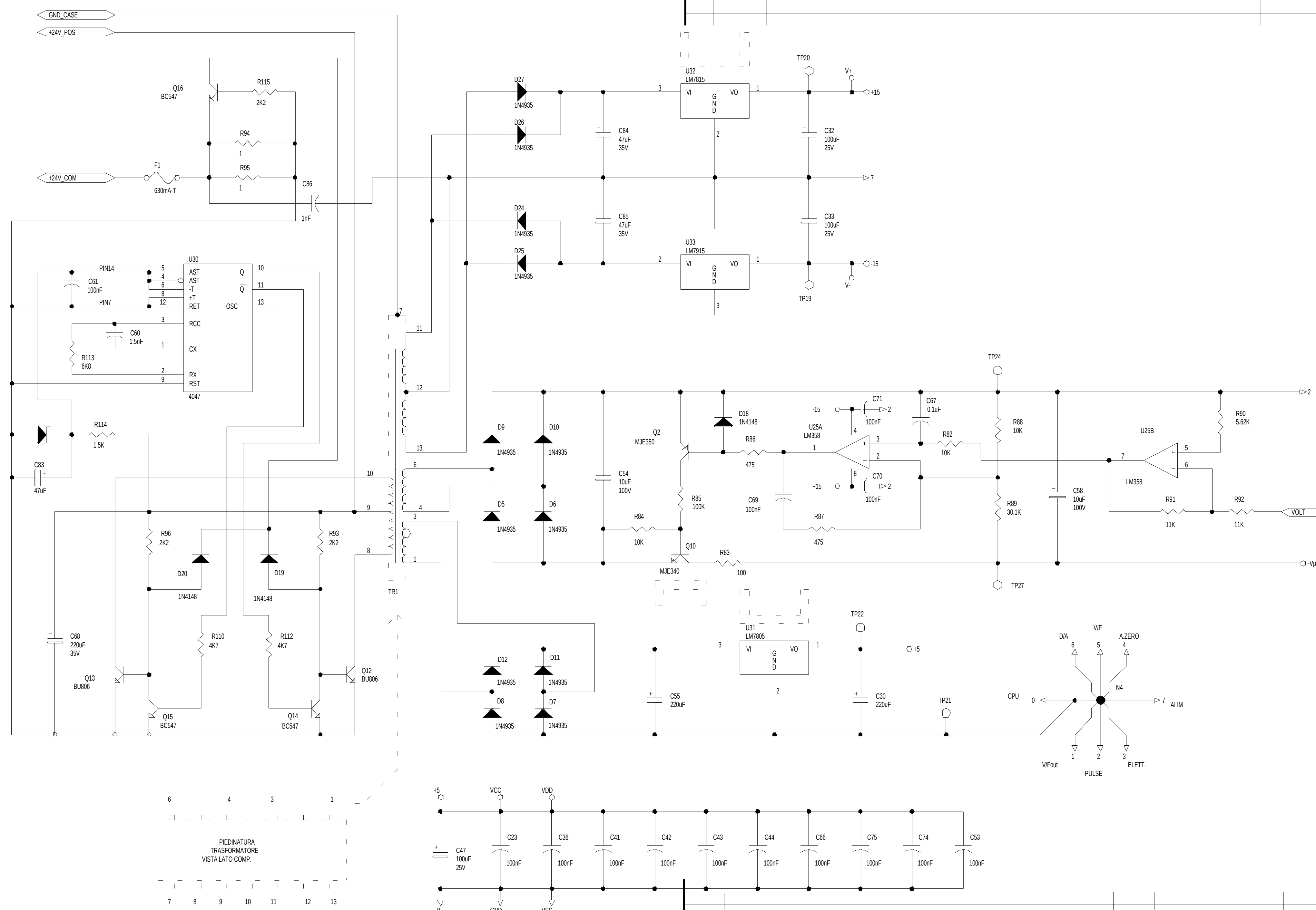
MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento: TRACE

assieme: C.S. ECD rev. 1.1

particolare: Schematic Diagram - +5/+15/-15/-Vp

disegnatore: A.Lamperti

data: 19/11/97

sostituisce

scala

codice

visto

A3

Toll. Gen.

± 0,1

± 30'

Fil. 6H-6g

1,6

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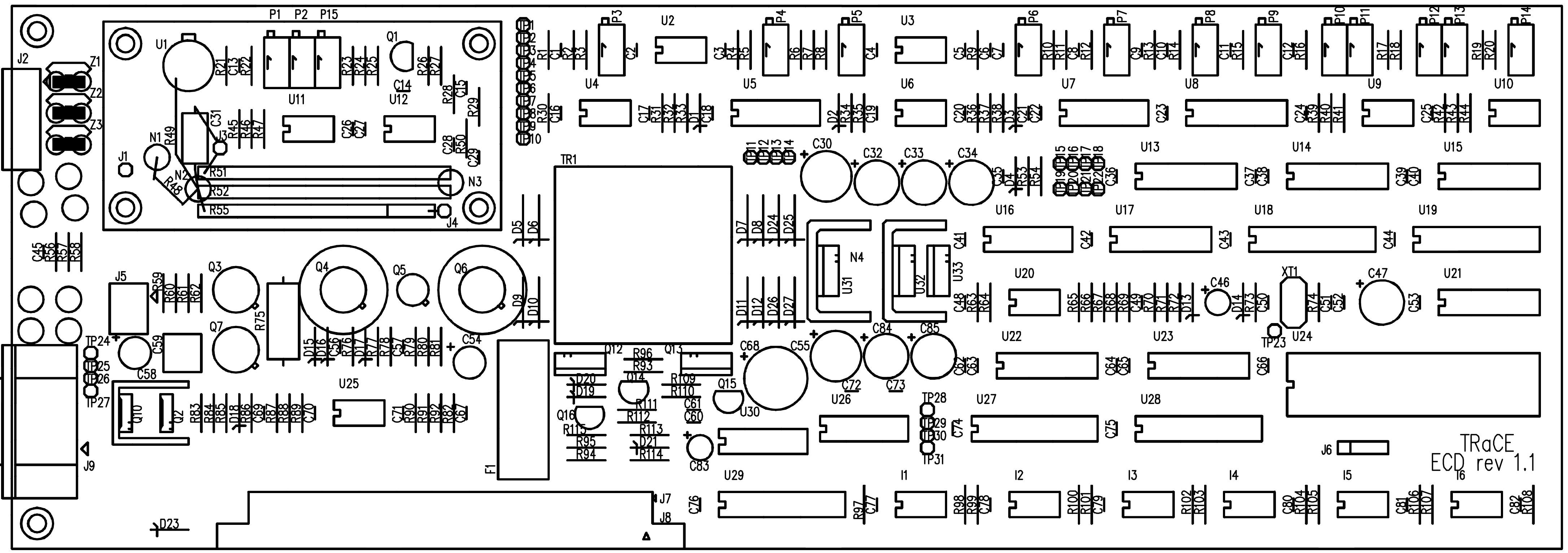
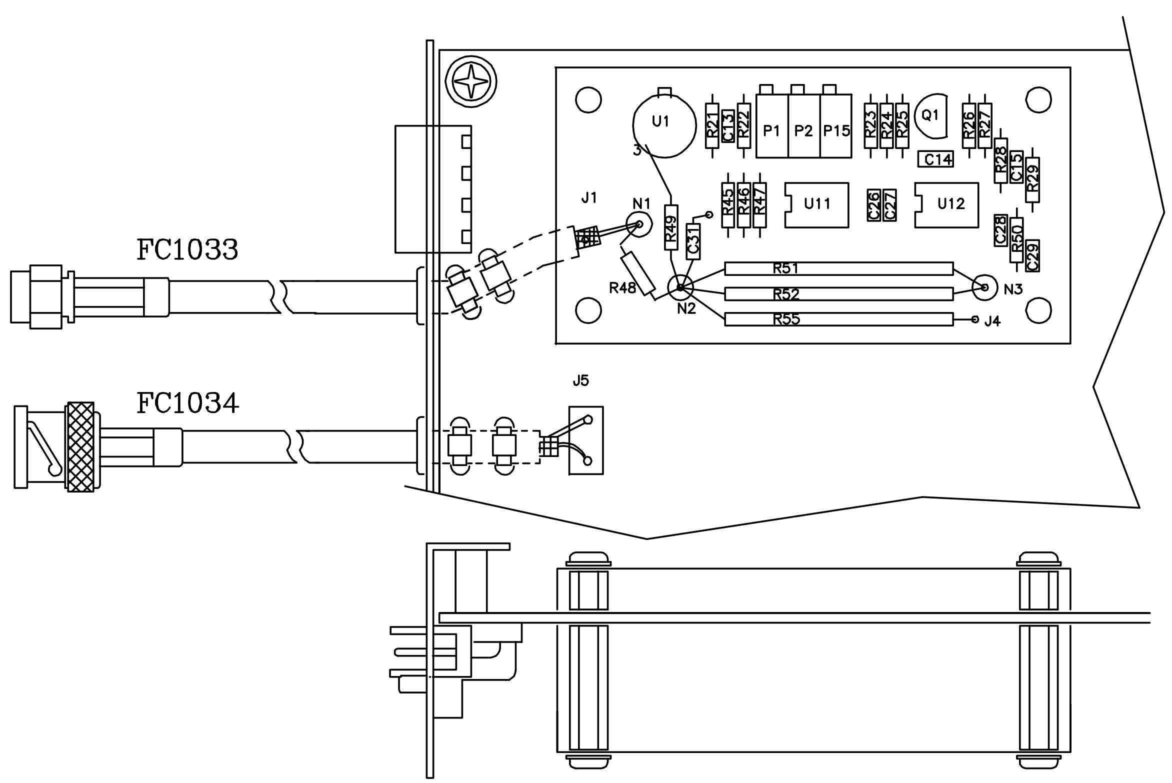
disegno n°: SE1389 sh.5/5

modif.

MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO





POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento: *TRACE*	disegnatore: *A.Lamperti*	data: 25/11/97	A3 — Toll. Gen.
assieme: *C.S. ECD rev. 1.1*	sostituisce	scala	— ± 0,1; ∠ ± 30'
particolare: *Components lay-out*	codice	visto	Fil. 6H–6g; 1.6
CE INSTRUMENTS	disegno n° PC1106		modif.

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5.12

Nitrogen Phosphorous Detector Controller

This chapter describes the Nitrogen Phosphorous Detector (NPD) controller of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

Circuit Function

The main purpose of the Nitrogen Phosphorus Detector (NPD) PCB is to amplify the low current produced from the detector and to supply its thermionic source.

A local single-chip microprocessor 68HC05 (U34), part of 74HC240 (U35A–B), and four optocouplers 6N137 (I4–I7), control the SPI interface bus for the serial communication (MOSI, SCK, CSI, MISO) to the main microprocessor (CPU PCB) through the motherboard (J6, J7).

Integrated circuit MAX538 (U12) and amplifier TLO82 (U11A) generate the analog output command VOLT (0–10 V) to select the polarization source circuit (LM741, U21).

The input electrometer current amplifier circuit consists of:

- Integrated circuits 5909 (U2), OP07 (U19), JFN FET (Q1–Q4), and OP07 (U20)
- Resistors
- Capacitors
- Potentiometers
- Diodes

The integrated circuit LM324 (U3A–U3C) gives the gain (1–3) commands to select the range (0–3). The LM324 (U3D) gives the filter command to the input electrometer through JFN FET (Q2).

Two digital/analog converters DAC0800 (U30–U31) and the amplifier OP07 (U25) make up the zero suppression circuit (back-off current, 16 bits). The analog output of the amplifier OP07 (U20) goes through TP15–TP16 (split points) to the integrated circuit OP200 (U6A). The integrated circuit generates the analog output voltages of 0–1 V and 0–10 V for the integrator and computer external connections (J1, 4-pin). The output of OP07 (U20) also goes to the OP07 amplifiers (U7, U8), a v/f converter VFC110AP (U13), and an optocoupler 6N137 (I2) to generate a frequency output (F-OUT, 0–4 MHz) to be read from the main microprocessor (CPU).

The regulator U4 (LM78L05) supplies the +5 VB. The regulator LM7815 (U36) supplies the +15 VB. The regulator LM79L15 (U17) supplies the –15 VB.

Integrated circuit MAX538 (U5) is selected from the single-chip microprocessor 68HC05 (U34) signal (SEL_I) to enable the driving source current circuit. This circuit consists of:

- LM358 (U10, U27A)
- TL082 (U18A–B)

- LM311 (U29)
- NE555 (U32)
- Transistors (Q7, Q8)
- Resistors
- Diodes

The amplifier OP07 (U26) and the amplifier TL082 (U28B) are a protection source circuit for generating an alarm output signal (STS).

A special oscillator circuit is formed by:

- Integrated circuit 4047 (U33)
- Two transistors BC547 (Q16–Q17)
- Resistors
- Capacitors
- A diode

This oscillator circuit is the primary supply of the internal transformer. The amplifier LM741 (U21) is selected from the input VOLT (variable voltage 0–10 V) for generating the source polarization voltage (0–100 V).

The regulator LM7815 (U23) supplies +15 V. The regulator LM7915 (U22) supplies –15 V. The regulator 7805 (U24) supplies +5 V.

Two input voltages (8.5 V ac, 8.5 V ac 2) come from an external transformer in the GC oven through the motherboard (J6). The P2 connector gives the 0 V (signal common), 1 V, 10 V, and GND (chassis) outputs to connect an integrator or to handle chromatograph data externally.

Output Specifications

+/–15 V @ 165 mA

100 V @ 0.01 A

+5 V @ 25 mA

Adjustment Procedures

No field adjustments are necessary.

Schematics and Component Layout

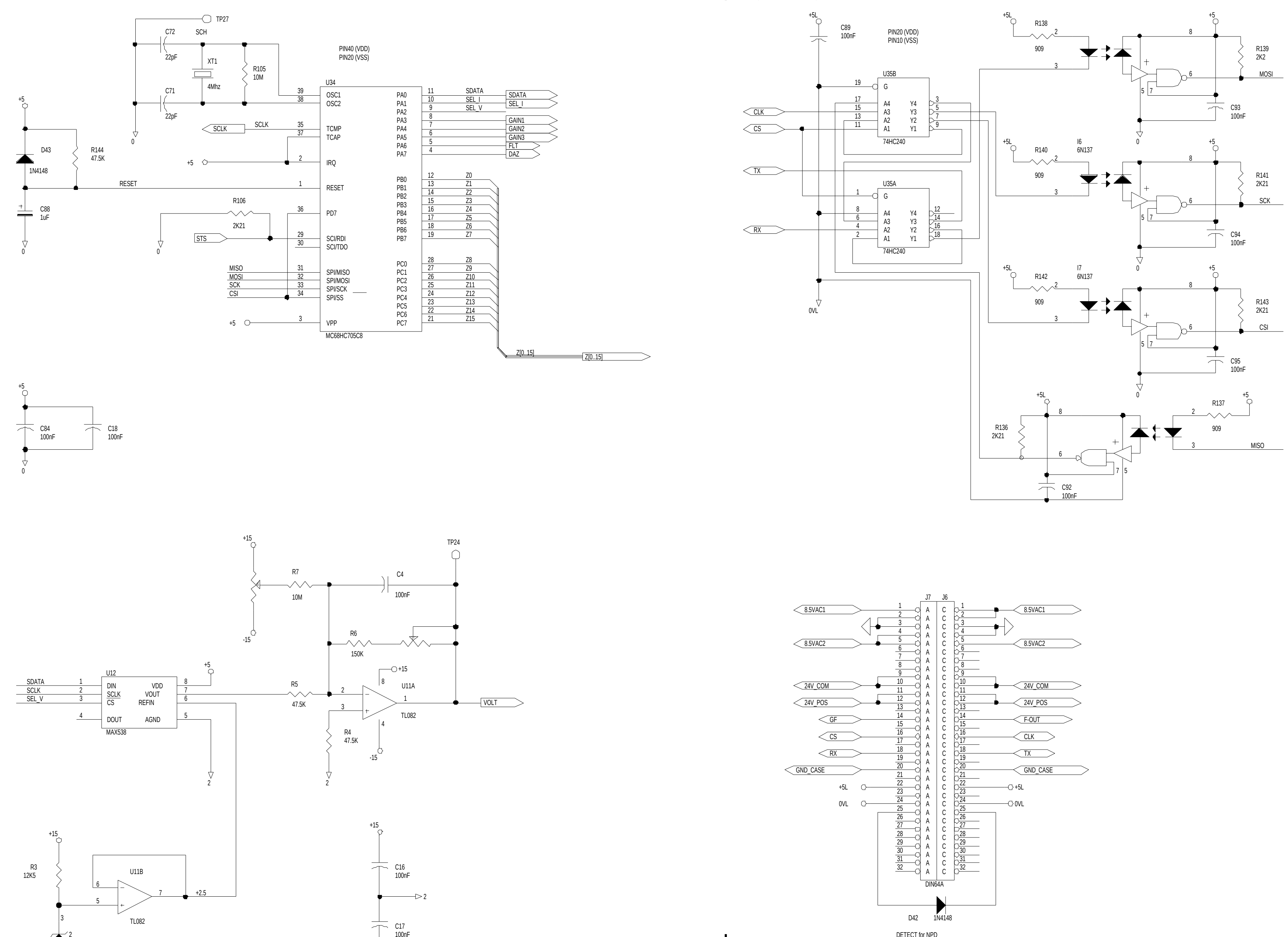
The schematics and component layout information for the NPD controller is listed below in Table 5.12-1. The number of drawings has been included for each schematic and its corresponding layout. There are six drawings for reference in this section.

Table 5.12-1. NPD Controller Schematics

Board	PN	Drawing	Layout
NPD	23648355	SE 1424 - sh. 5, 1–5	PC 1107, 1

NOTE The last drawing in this section is the layout of the board.

MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento: TRACE
assieme: C.S. NPD rev. 1.1
particolare: Schematic Diagram - CPU A/D & SPI Interface
disegnatore: A.Lamperti
data: 5/2/98
sostituisce
scala
codice
visto
A3
Toll. Gen.
± 0,1
± 30'
Fil. 6H-6g
1,6
disegno n°: SE1424 sh.1/5
modif.

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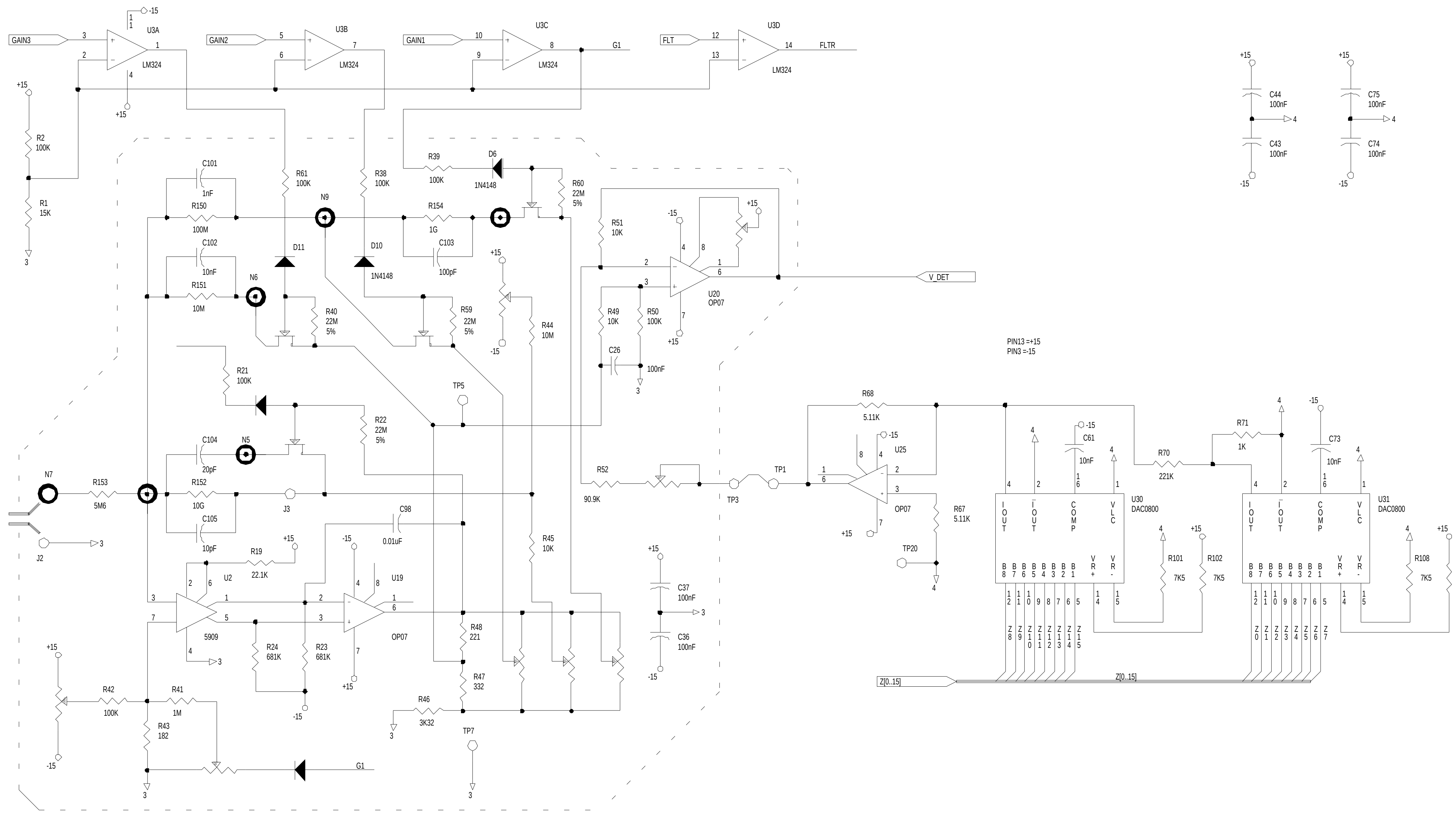
MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento TRACE	disegnatore A.Lamperti	data 5/2/98	A3 Toll. Gen.
assieme C.S. NPD rev. 1.1	sostituisce	scala	± 0,1 ± 30'
particolare Schematic Diagram - Electrometer & Autozero	codice	visto	Fil. 6H-6g 1,6
CE INSTRUMENTS	disegno n SE1424 sh.2/5		modif.

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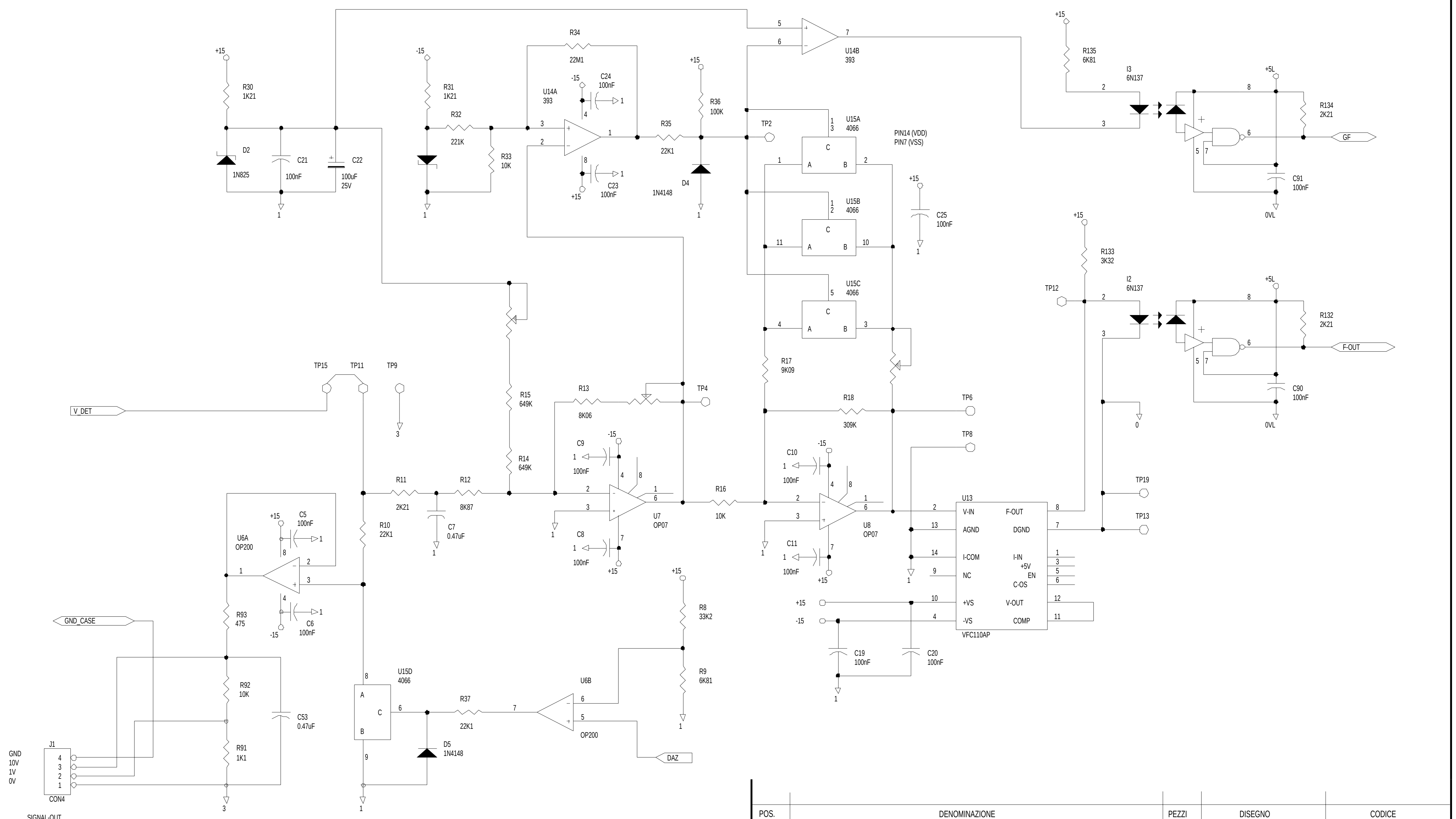
MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento: TRACE	disegnatore: A.Lamperti	data: 5/2/98	A3	
assieme: C.S. NPD rev. 1.1	sostituisce	scala	Toll. Gen. — ± 0,1 ∠ ± 30'	
particolare: Schematic Diagram - V/F Converter Signal-out	codice	visto	Fil. 6H-6g 1,6	
CE INSTRUMENTS	disegno n: SE1424 sh.3/5			modif.

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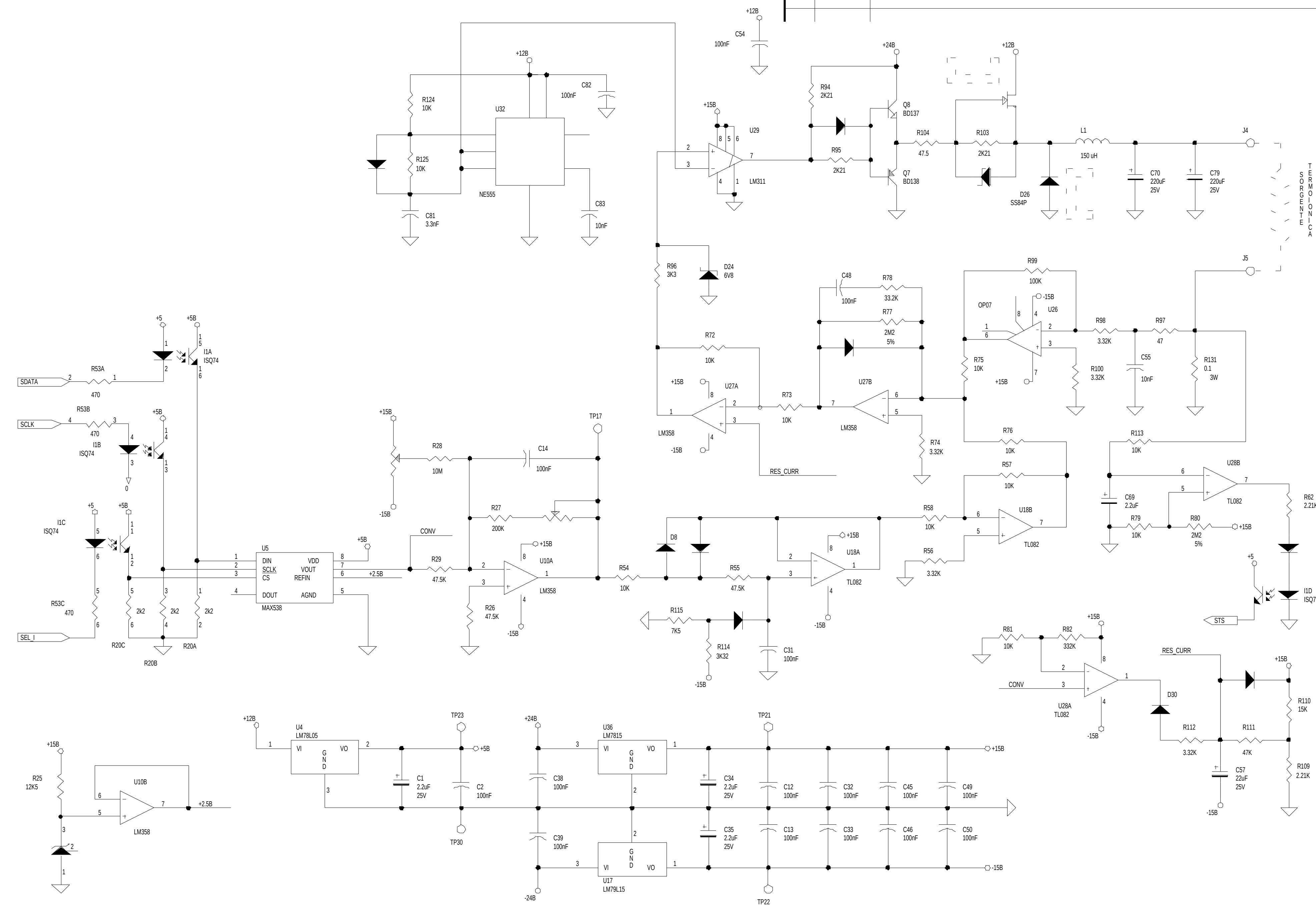
MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO



POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento TRACE	disegnatore A.Lamperti	data 5/2/98	A3
assieme C.S. NPD rev. 1.1	sostituisce	scala	Toll. Gen. ± 0,1 ± 30'
particolare Schematic Diagram - Current Generator	codice	visto	Fil. 6H-6g 1,6
CE INSTRUMENTS	disegno n SE1424 sh.4/5		modif.

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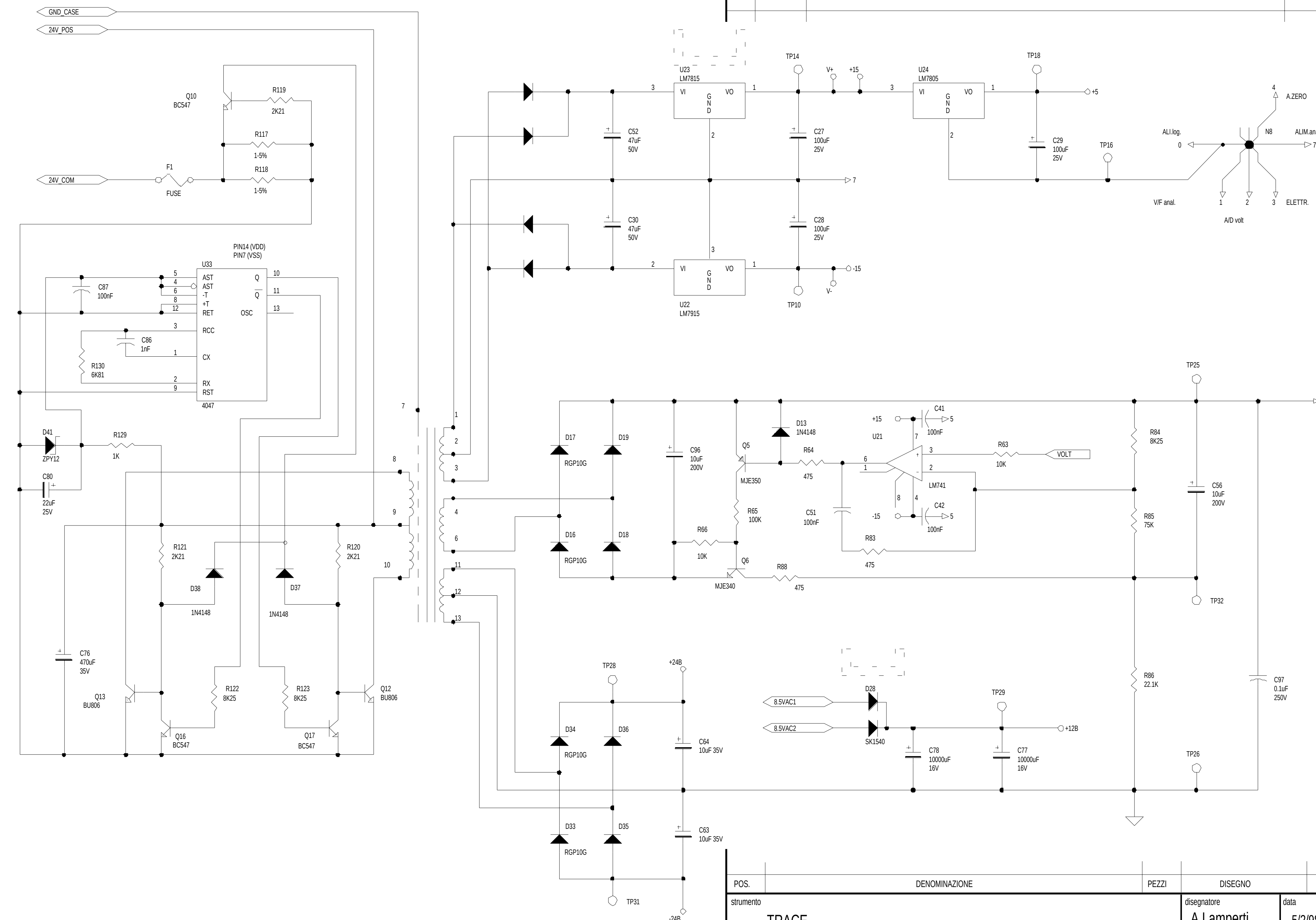

MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO

POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento: TRACE	disegnatore: A.Lamperti	data: 5/2/98	A3 — Toll. Gen.
assieme: C.S. NPD rev. 1.1	sostituisce	scala	— ± 0,1 / ∠ ± 30'
particolare: Schematic Diagram - Power Supply	codice	visto	Fil. 6H-6g — 1,6
CE INSTRUMENTS	disegno n: SE1424 sh.5/5		modif.

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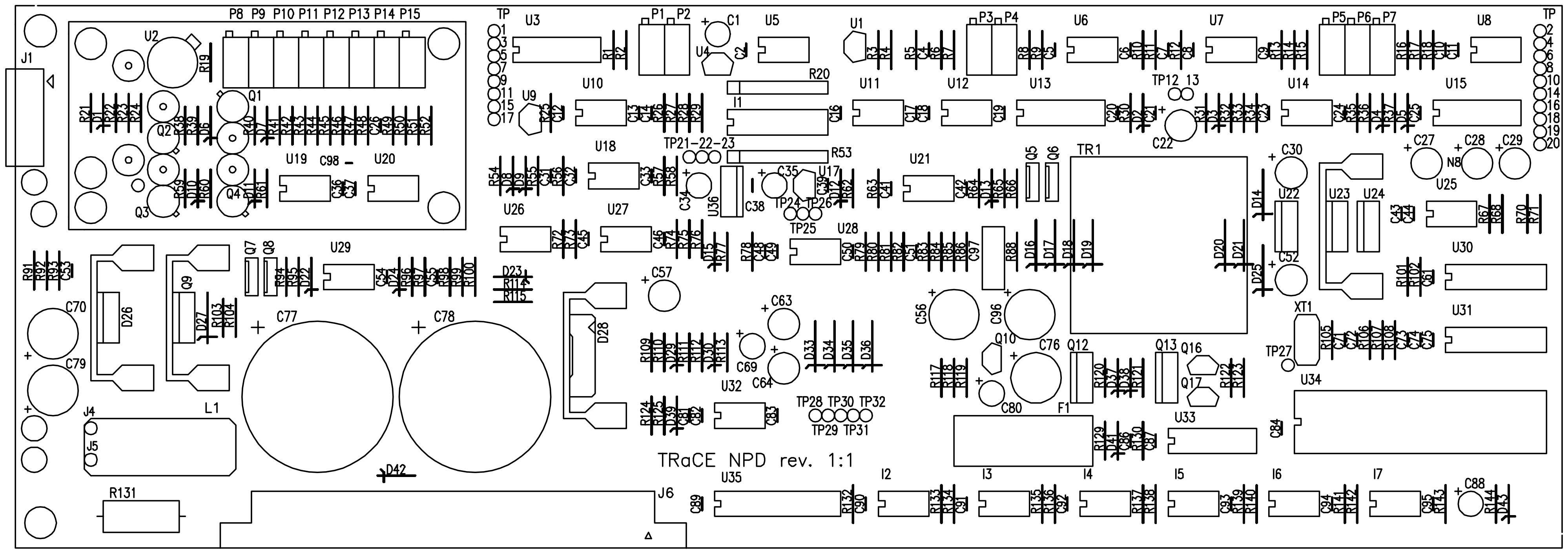
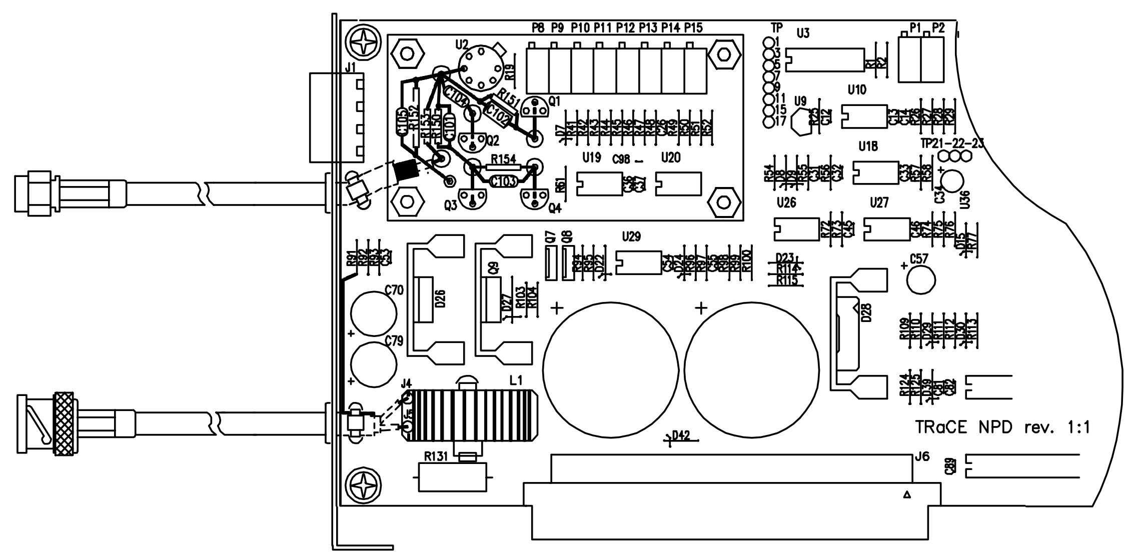
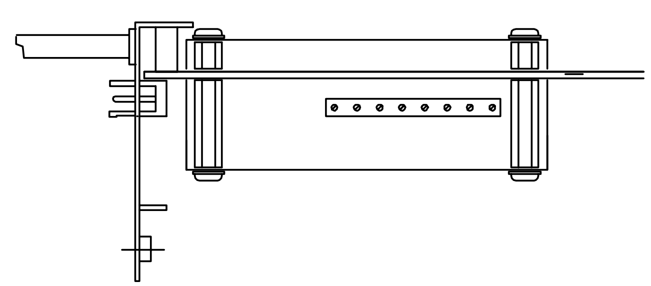
MOD/RDM	MODIFICHE	DATA	FIRMA/VISTO







POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento: *TRACE*	disegnatore: *A.Lamperti*	data: 3/2/98	A3
			Toll. Gen.
assieme: *C.S. NPD rev. 1.1*	sostituisce	scala	— ± 0,1
			∠ ± 30'
particolare: *Components lay-out*	codice	visto	Fil. 6H–6g
			1,6
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5.13

Flame Photometric Detector Controller (FPD)

This chapter describes the TRACE GC 2000 Flame Photometric Detector (FPD) controller.

Chapter at a Glance...

Theory of Operations

Circuit Functions

The FPD pcb controls:

- input analogic current
- flame ignition
- photomultiplier voltage through the J5, J3, J4 and J1 connectors on the FPD detector board.

The cell is independently heated and requires 100W @ 48 Vac (2 resistors 24V 50W in series). Cell temperature is controlled by a FEEDBACK ANALOG pcb and CPU pcb through the motherboard and PT100 temperature sensor.

On the J6 and J7 DIN64A connector, all voltages (24vdc, 8v, 5vdc, 0v, GND) and all digital signals (F-OUT, CLK, Tx, Rx, CS, GF) interfacing with the motherboard bus pcb are present. Two diodes, IN4148 (D28-D29), set the type of detector controller automatically recognized by the main CPU microprocessor.

The electronic circuit created with 74HC240 (U22A/B), three 6N137 (I1,I3,I6) and three 74HC595 (U9-U11) is a serial communication interface (SPI) between the FPD pcb, the motherboard, and the CPU pcb bus connection.

IGNITER 48V A-B (from an additional transformer located in the Power Module) and PT100 A-B signals are present on the J5 connector. The integrated circuit 2N5909 (U1), OP07 (U7), and OP07 (U14) with some resistors, and FET J201 (Q2) create the electrometer input current amplifier. The low input current signal (pA) produced from the FPD is present at J2(N1).

The electronic circuit created by two LM358 (U26A/B) select the RANGE (10n; 0-1-2) through two bits, GAIN 1 and GAIN 0.

Two integrated circuits DAC0800 (U3-U4) and OP07 (U2) create the zero suppression circuit by 16 bits input digital values (Z0-Z15).

The amplifier OP200 (U5A) takes the electrometer amplifier output (V_DET) giving the analogic output voltages (0V, 1V, 10V, GND), which connect the integrator or computer through terminal block J1 (SIGNAL_OUT).

Integrated circuits 4066 (U12D) and OP200 (U12B) hold the above analogic outputs voltage when they are selected during the autozero.

Two amplifiers, 393 (U17A/B) and 6N137 (I5), give the output signal (GF) for a gain of the frequency (1 bit, L=gain 1 or H=gain 32).

Two amplifiers OP07 (U6, U13), VFC110AP (U16) and 6N137(I4) have voltage-frequency-converter (0-10V to 0-3,5Mhz), which reads the CPU pcb through a digital signal F-OUT.

The DC-DC converter 4047 (U21) takes the input voltage 24Vdc and using high voltage resistors, transistors, diodes, transformer TR2, and the elevator voltage circuit (D12-D19) generates a 800/900 v voltage. This is used for photomultiplier excitation voltage.

Regulators LM7815 (U19) and LM7915 (U18) supply the +15/-15Vdc (TP17/18). Regulator LM7805 (U20) takes the input voltage +15Vdc (TP15) to supply +5Vdc.

Two amplifiers LM358 (U25A/B), transistor PNP (Q3) and transistor MJE340 (D11) select the HIGH (-900V) or LOW (-800V) voltage for the photomultiplier through the input signal HIGH_V.

The electronic circuit created by integrated circuit MOC3020 (I2) and triac BTA06-400 (Q7) supplies the igniter voltage 8Vac for the flame detector.

Output Specifications

+15/-15 Vdc @ 165mA (generated by 5W DC-DC converter from 24Vdc).

FPD may use +5Vdc @25mA max taken from main system.

FPD flame ignition 2.0A@8Vac.

Adjustment Procedure

No field adjustments are necessary

Protection Circuits

None.

Special Notes

FPD cell temperature is variable from ambient to 350 ºC in increments of 1 ºC.

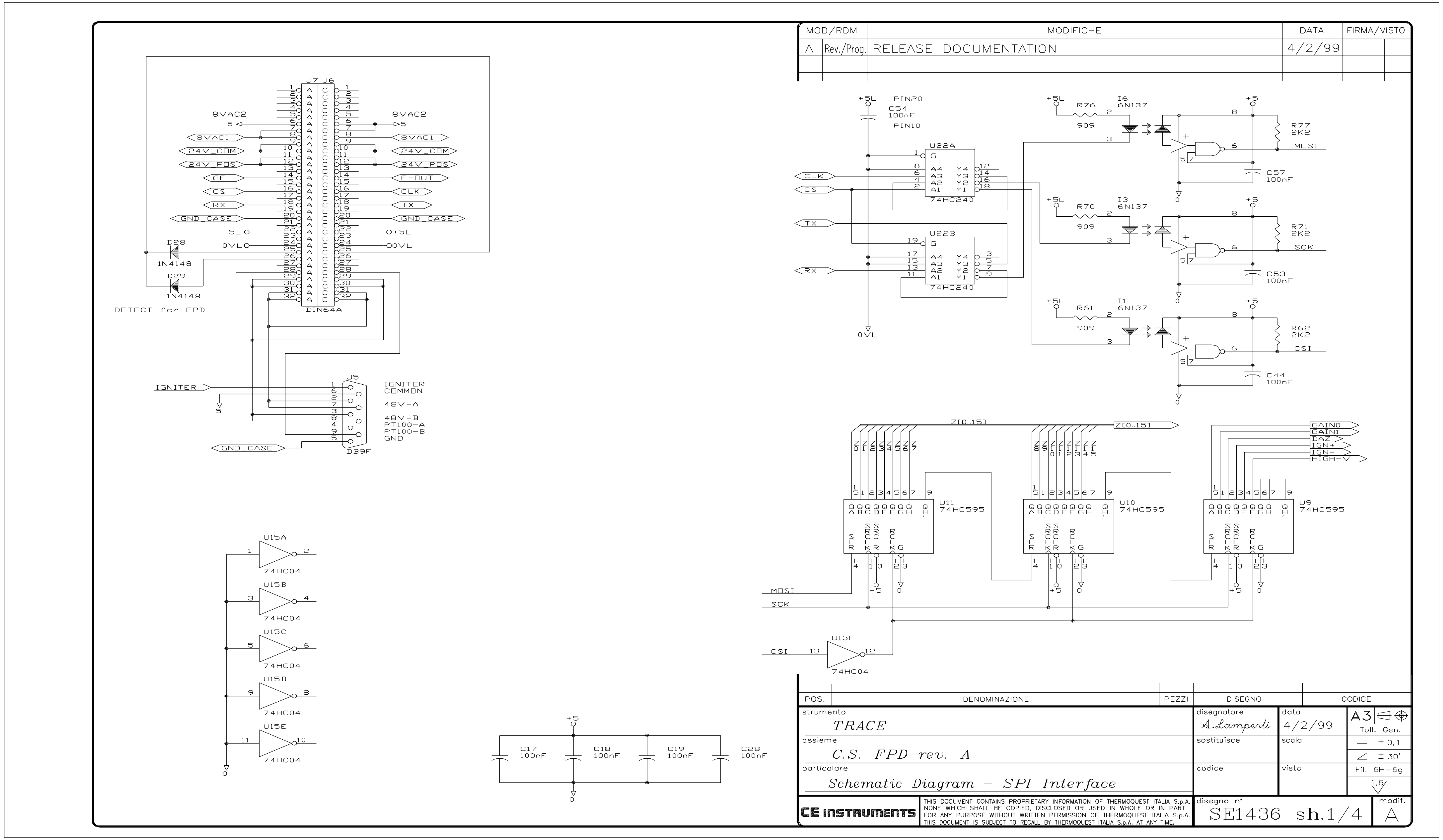
Schematics and Component Layout

The schematics and component information for the FPD controller is listed below in table 5.13-1. The number of drawings has been included for each schematic and its corresponding layout. There are 5 drawings in this section.

Table 5.13-1.

Board	PN	Drawing	Layout
FPD	236 48365	SE 1436 sh. 1/4	PC 1109
FPD	236 48365	SE 1436 sh. 2/4	PC 1109
FPD	236 48365	SE 1436 sh. 3/4	PC 1109
FPD	236 48365	SE 1436 sh. 4/4	PC 1109
FPD	236 48365	SE 1436 PCB	PC 1109

NOTE The last drawing in this section is the layout of the board.


MOD/RDM
MODIFICHE
DATA
FIRMA/VISTO
A
Rev./Prog.
RELEASE DOCUMENTATION
4/2/99
J7 J6
DIN64A
DETECT for FPD
J5
DB9F
IGNITER
COMMON
48V-A
48V-B
PT100-A
PT100-B
GND
U22A
U22B
74HC240
6N137
U11
U10
U9
74HC595
U15A
U15B
U15C
U15D
U15E
U15F
74HC04
MOSI
SCK
CSI
POS.
DENOMINAZIONE
PEZZI
DISEGNO
CODICE
strumento
TRACE
assieme
C.S. FPD rev. A
particolare
Schematic Diagram - SPI Interface
disegnatore
A.Lamperti
data
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Fil. 6H-6g
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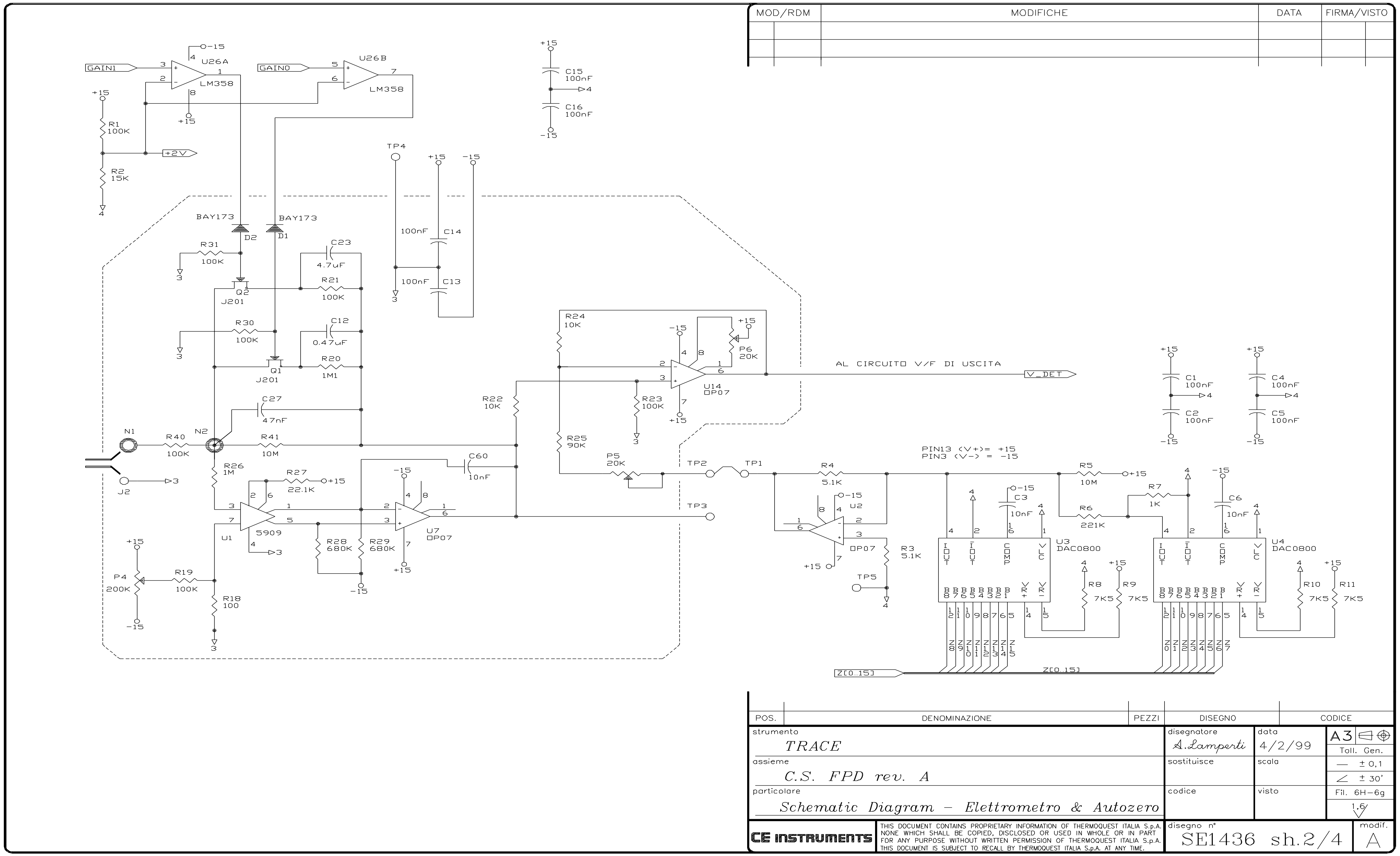
MOD/RDM
MODIFICHE
DATA
FIRMA/VISTO
AL CIRCUITO V/F DI USCITA
V_DET
PIN13 (V+)= +15
PIN3 (V-) = -15
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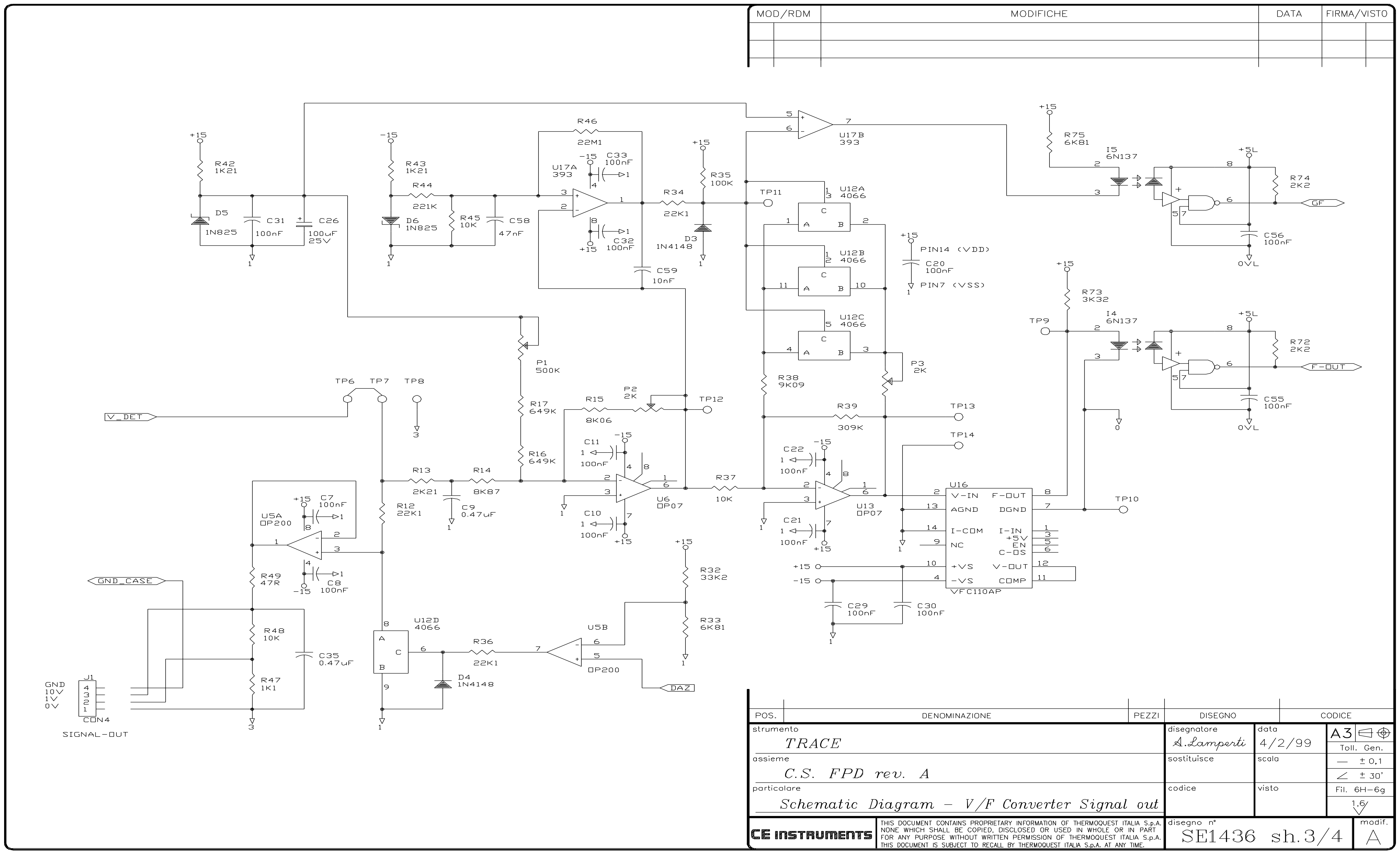
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FIRMA/VISTO
V_DET
GND_CASE
DAZ
GF
F-OUT
SIGNAL-OUT
CON4
GND
10V
1V
0V
U17A 393
U17B 393
U12A 4066
U12B 4066
U12C 4066
U12D 4066
U5A OP200
U5B OP200
U6 OP07
U13 OP07
U16 VFC110AP
I5 6N137
I4 6N137
PIN14 (VDD)
PIN7 (VSS)
TP6
TP7
TP8
TP9
TP10
TP11
TP12
TP13
TP14
POS.
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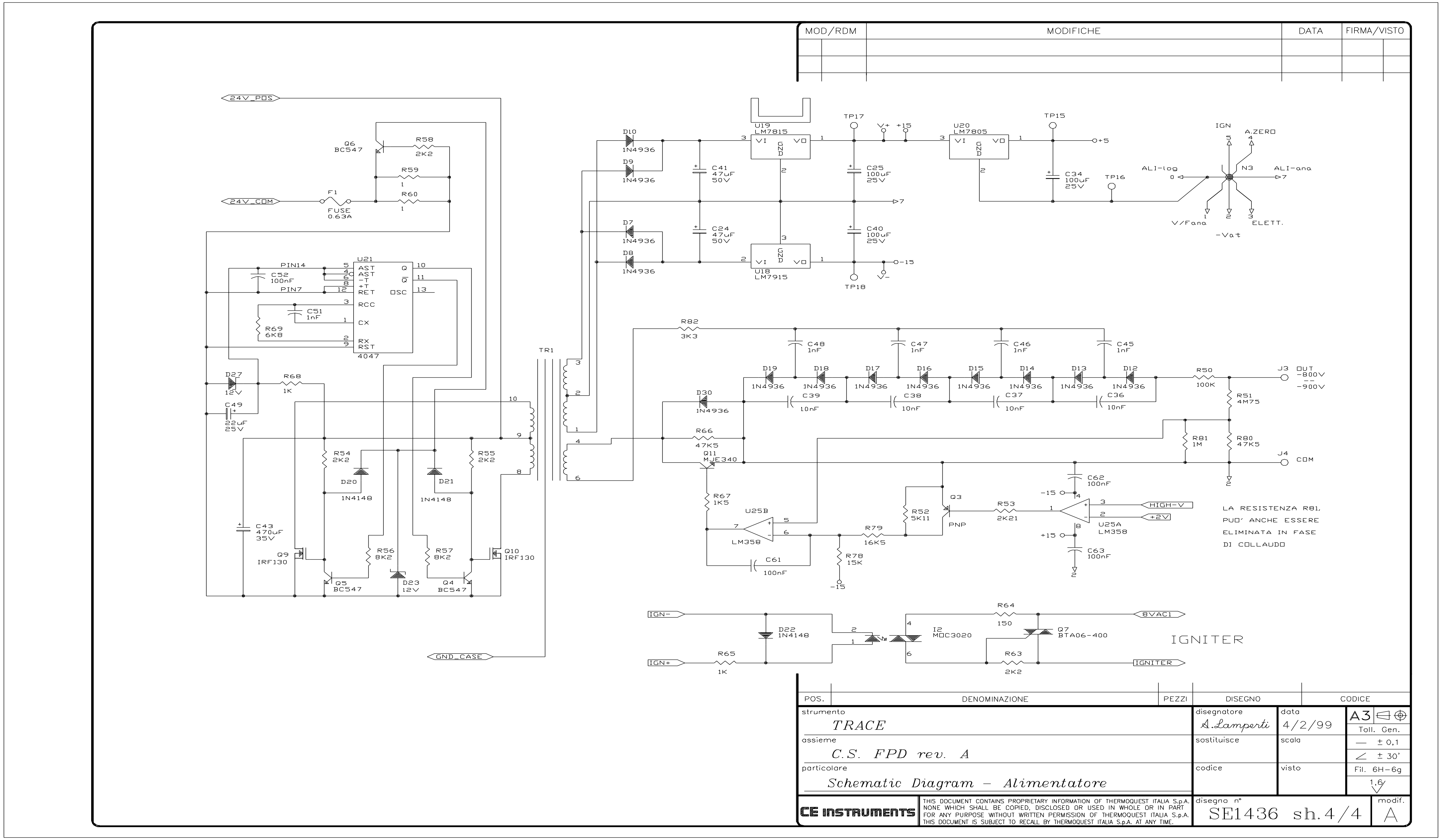
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24V_POS
24V_COM
F1
FUSE 0.63A
Q6 BC547
R58 2K2
R59 1
R60 1
U21 4047
PIN14
PIN7
C52 100nF
C51 1nF
R69 6K8
D27 12V
C49 22uF 25V
R68 1K
R54 2K2
R55 2K2
D20 1N4148
D21 1N4148
C43 470uF 35V
Q9 IRF130
Q10 IRF130
R56 8K2
R57 8K2
Q5 BC547
Q4 BC547
D23 12V
TR1
GND_CASE
D10 1N4936
D9 1N4936
D7 1N4936
D8 1N4936
C41 47uF 50V
C24 47uF 50V
U19 LM7815
U18 LM7915
TP17
TP18
V+ +15
V- -15
C25 100uF 25V
C40 100uF 25V
U20 LM7805
TP15
+5
C34 100uF 25V
TP16
IGN
A.ZERO
N3
ALI-log
ALI-ana
V/Fana
-Vat
ELETT.
R82 3K3
C48 1nF
C47 1nF
C46 1nF
C45 1nF
D19 D18 D17 D16 D15 D14 D13 D12 1N4936
C39 10nF
C38 10nF
C37 10nF
C36 10nF
D30 1N4936
R66 47K5
Q11 MJE340
R50 100K
J3 OUT -800V -900V
R51 4M75
R81 1M
R80 47K5
J4 COM
R67 1K5
U25B LM358
C61 100nF
R79 16K5
R78 15K
R52 5K11
Q3 PNP
R53 2K21
U25A LM358
HIGH-V
+2V
C62 100nF
C63 100nF
LA RESISTENZA R81 PUO' ANCHE ESSERE ELIMINATA IN FASE DI COLLAUDO
IGN-
IGN+
D22 1N4148
R65 1K
I2 MOC3020
R64 150
R63 2K2
Q7 BTA06-400
8VAC1
IGNITER
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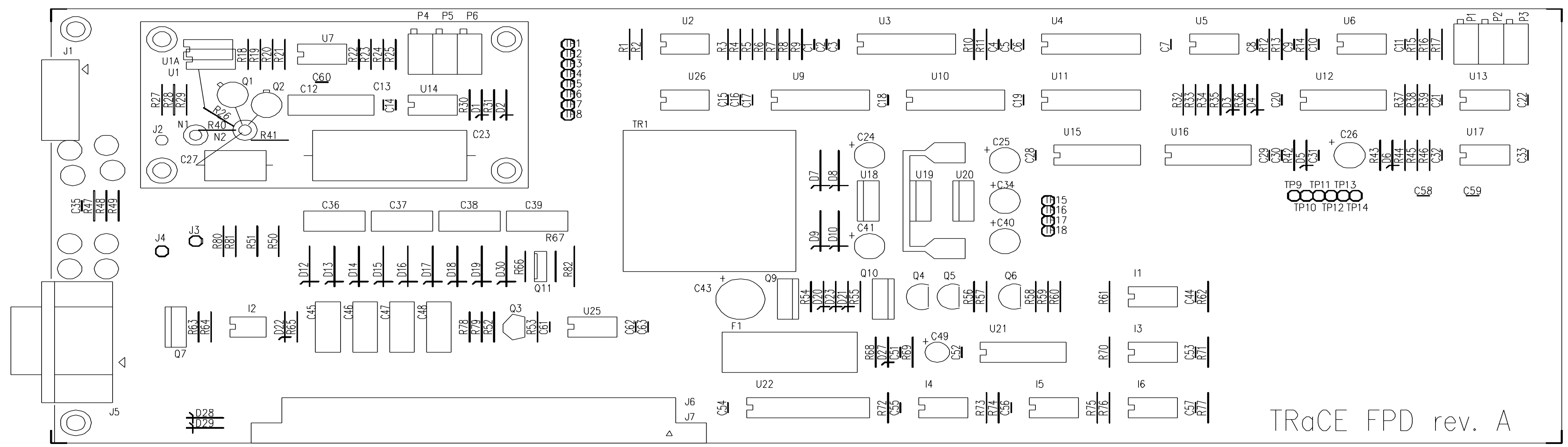
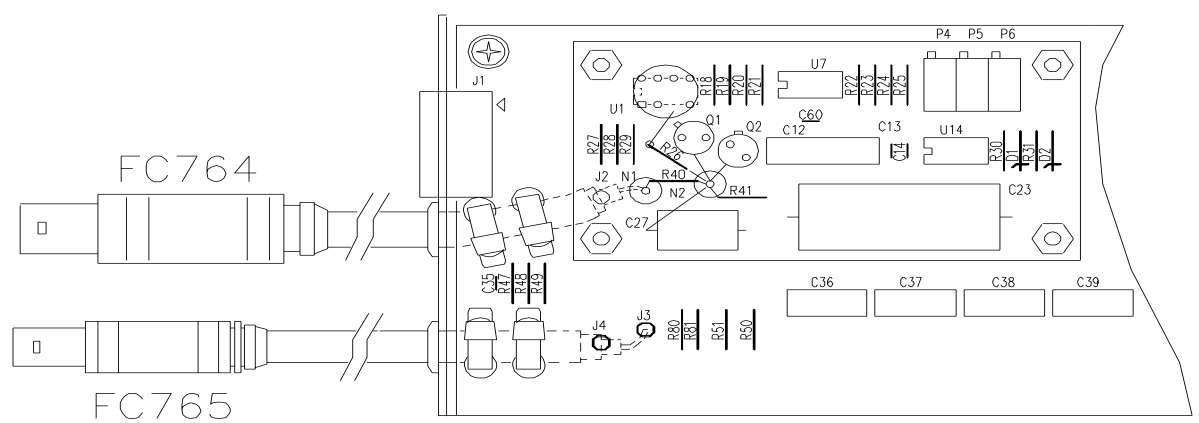
MOD/RDM		MODIFICHE	DATA	FIRMA/VISTO
A	Rev./Prog.	Revisione per rilascio documentazione	4/2/99	





POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

strumento: *TRACE*	disegnatore: *A. Lamperti*	data: 4/2/99	A3 — Toll. Gen.
assieme: *C.S. FPD rev. A*	sostituisce	scala	— ± 0,1 / ∠ ± 30'
particolare: *Componets lay-out*	codice	visto	Fil. 6H-6g / 1,6
CE INSTRUMENTS	disegno n° PC1109		modif. A

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5.14

Photoionization Detector Controller (PID)

This chapter describes the TRACE GC 2000 Photoionization Detector (PID) controller.

Chapter at a Glance...

Theory of Operations

Circuit Function

The PID pcb controls:

- input analogic current
- lamp current
- polarization voltage through J2, J6 and J7 connectors present on the PID detector board.

On the J9 and J10 DIN64A connector all voltages (24v, +5v dc, 0v, Gnd) and all digital signals (FOUT, CLK, Tx, Rx, CS, GF) interfacing with Mother board bus pcb are present. Two IN4148 diodes (D38-D39) set the type of detector controller automatically recognized by the main CPU microprocessor on the motherboard. The electronic circuit created with 74HC240 (U28), three 6N137 (I4-I6) and three 74HC595 (U9-U11) is a serial communication interface (SPI) between PID pcb, the Motherboard, and CPU pcb bus connections.

Integrated circuits 74HC165 (U8) and 6N137 (I7) read the Status lamp (ON, OFF and Open Circuit) in serial mode.

Integrated circuits 2N5909 (U1), OP07 (U14), OP07 (U15) with some resistors, and FET J201 (Q1-Q4) realize the electrometer input current amplifier. The low input current signal (pA) produced from the PID detector is present to J2.

The electronic circuit is created by three 74HC00 (U7) and four LM324 (U2). The RANGE (10n; 0-1-2-3) is selected by two bits, RNG L and RNG H.

Two integrated circuit DAC0800 (U4-U5) and OP07 (U3) create the autozero circuit (Az) by 16 bits digital values.

The amplifier OP200 (U12A) takes the electrometer amplifier output (V_DET) and passes it to the analogic output terminal (0V, 1V, 10V, GND), which connects the integrator or computer.

Integrated circuits 4066 (U13D) and OP200 (U12B) hold the analogic outputs voltage when they are selected during the autozero.

Two amplifiers 393 (U27A/B) and 6N137 (I9) select the output signal (GF) for a frequency gain (1 bit, L=gain 1 or H=gain 32).

Two amplifiers OP07 (U6, U24), VFC110AP and 6N137 (I8) realize a voltage-frequency-converter (0-10V to 0-3,5Mhz) read from the CPU pcb through a digital signal F-OUT.

The electronic circuit has three transistors, TIP137 (Q10), BC237 (Q12), and BU806 (Q9); resistors; capacitors; a transformer (TR1). Diodes (D23, D24, D27, D32, D33) supplies -2000V to the PID detector lamp through the J7 connector. The amplifier, LM358 (U23B), and optocoupler, CNY17 (I2), give the output signal for the detector's lamp status (LMP_ST; 0=OK, 1=OPEN CIRCUIT).

Two integrated circuits, 4066 (U16A/B) and optocoupler CNY17 (I1), are selected from the input signal (LMP_H/L), and they activate two equal circuits, which have two 4066 (U16C/D) and two amplifiers (LM358 (U21A/B)) to get a LOW or HIGH lamp current.

The electronic circuit created with optocoupler CNY17 (I3), diodes IN4148 (D25, D26, D35), and amplifier LM358 (U23A) is a safety protection circuit which disables the -2000V circuit through the output signal (BLOC).

The DC-DC converter 4047 (U25) takes the input voltage (24V) to generate +300V using resistors, transistors, diodes and transformer TR2 to polarize the PID detector.

Four regulators, two LM7815 (U18,U20) and two LM7915 (U17,U22), supply two different +15/-15Vdc. The regulator LM7805 (U19) takes the input voltage +15Vdc (TP16/V+) to supply +5Vdc.

Output Specifications

+15/-15Vdc @ 130mA, +5Vdc @25mA

Adjustment Procedures

No field adjustments are necessary.

Protection Circuits

Lamp Status (1 bit, 0=OK / 1=Open circuit)

Special Notes

+300V polarize is generated by +15/-15Vdc and 4W DC-DC converter from 24Vdc. -2000V is generated from 24V 4W DC-DC converter from 24Vdc

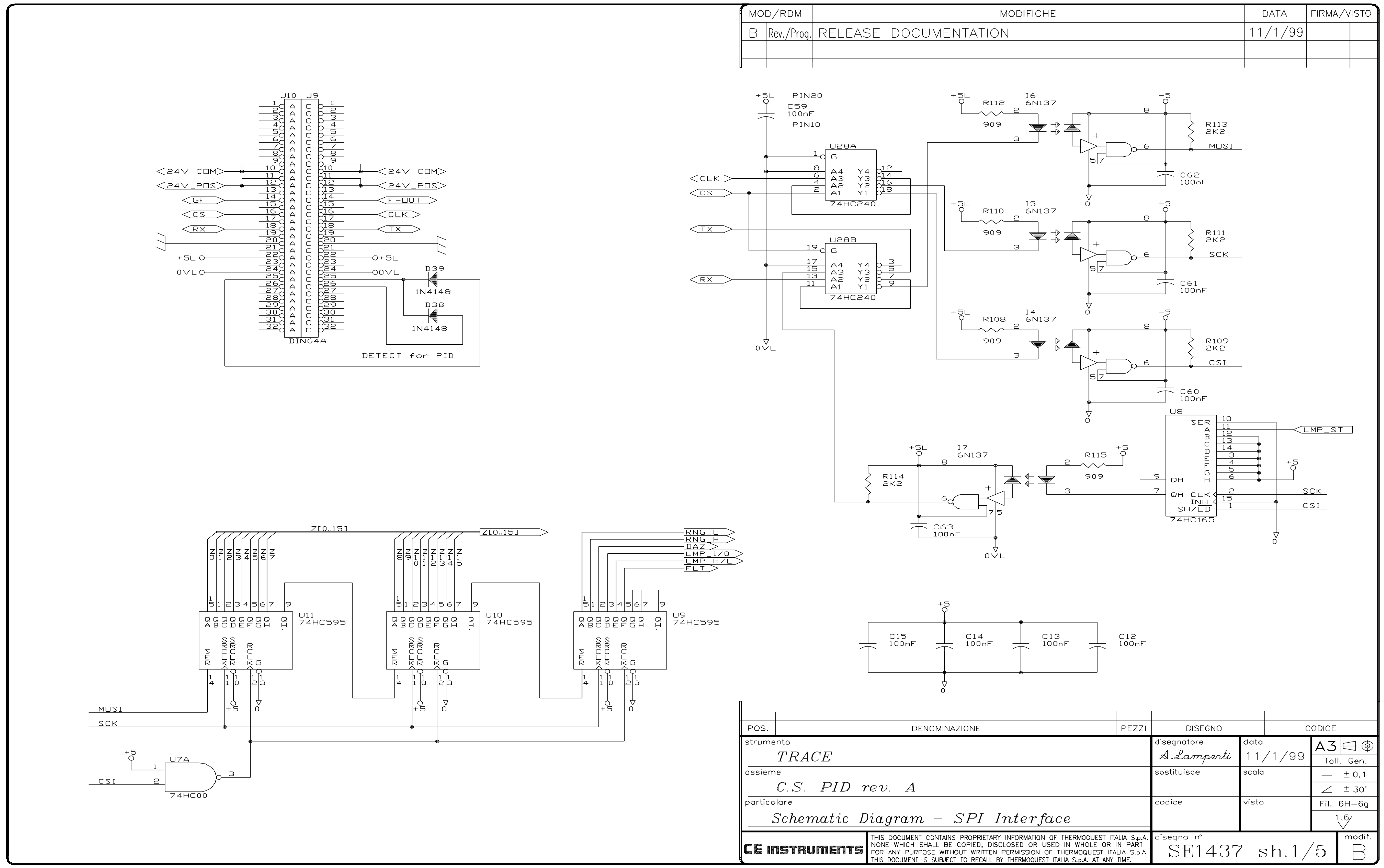
Schematics and Component Layout

The schematics and component information for the PID controller is listed below in table 5.14-1. The number of drawings has been included for each schematic and its corresponding layout. There are 6 drawings in this section.

Table 5.14-1.

Board	PN	Drawing	Layout
PID	236 48360	SE 1437 sh. 1/5	PC 1110
PID	236 48360	SE 1437 sh. 2/5	PC 1110
PID	236 48360	SE 1437 sh. 3/5	PC 1110
PID	236 48360	SE 1437 sh. 4/5	PC 1110
PID	236 48360	SE 1437 sh. 5/5	PC 1110
PID	236 48360	SE 1437 PCB	PC 1110

NOTE The last drawing in this section is the layout of the board.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6N137
74HC165
74HC595
74HC00
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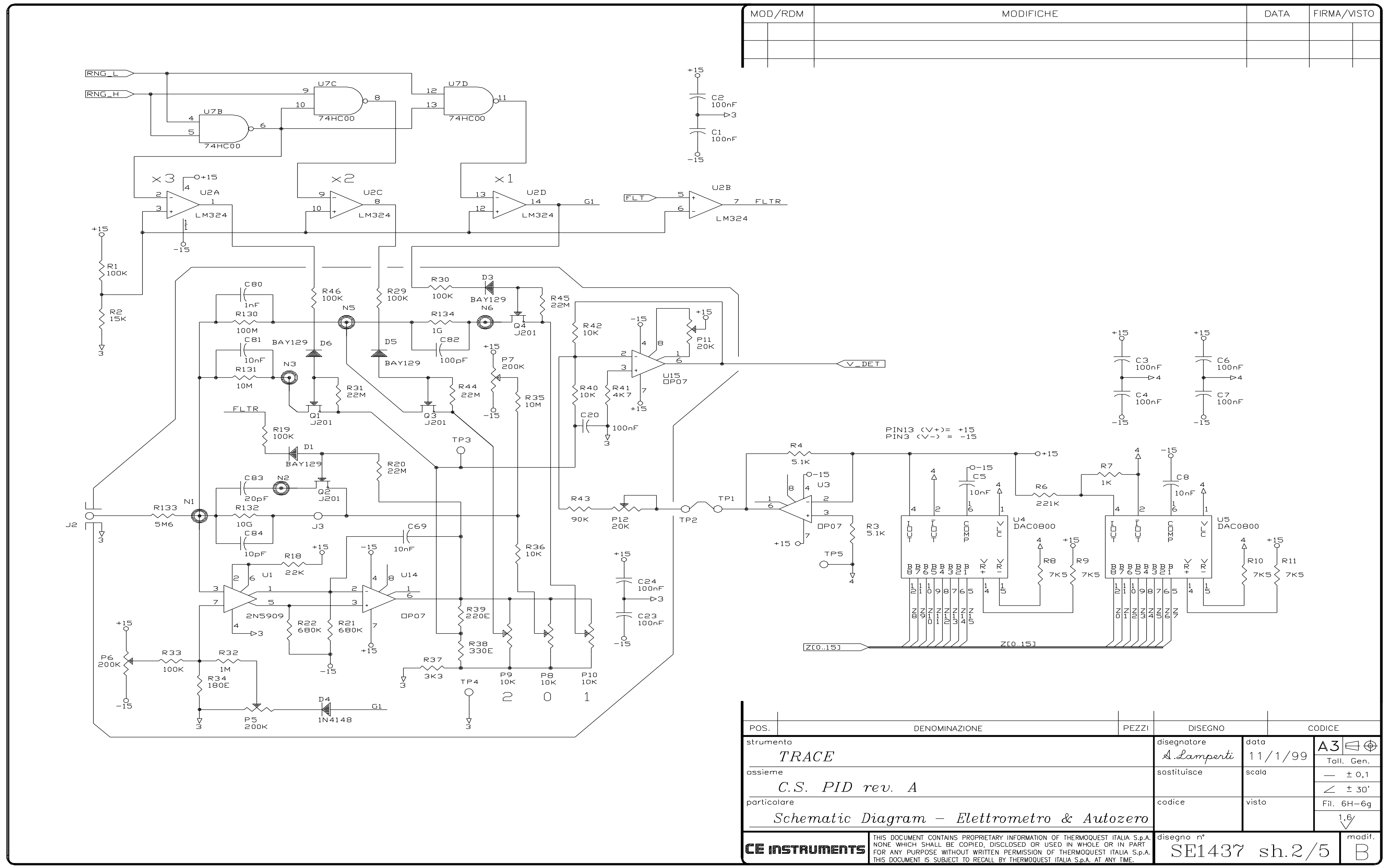
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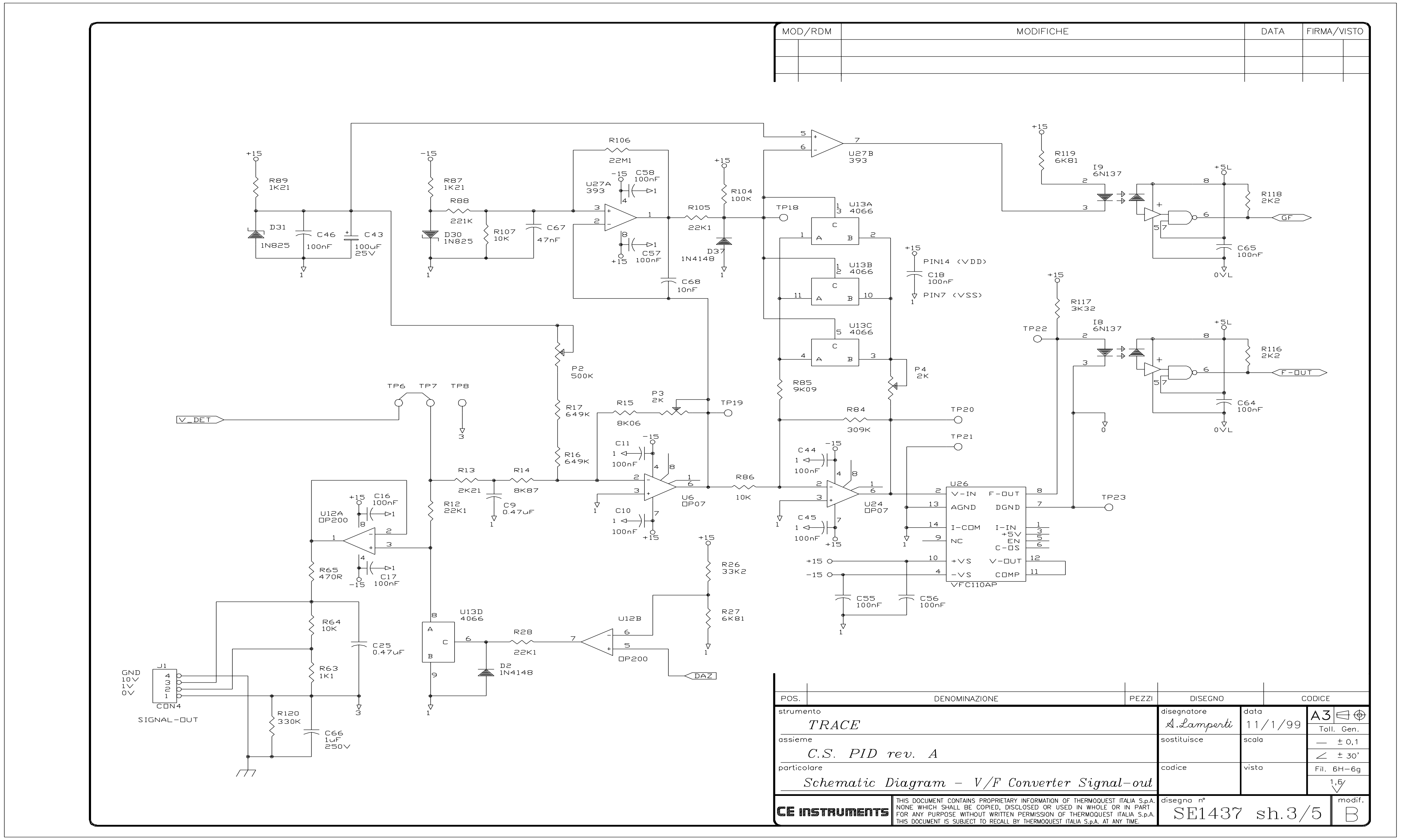
B
RNG_L
RNG_H
U7B
U7C
U7D
74HC00
x3
x2
x1
U2A
U2C
U2D
U2B
LM324
G1
FLT
FLTR
V_DET
U15
OP07
U3
U4
U5
DAC0800
U1
U14
2N5909
PIN13 (V+)= +15
PIN3 (V-) = -15
Z[0..15]
J2
J3
TP1
TP2
TP3
TP4
TP5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Schematic Diagram - V/F Converter Signal-out
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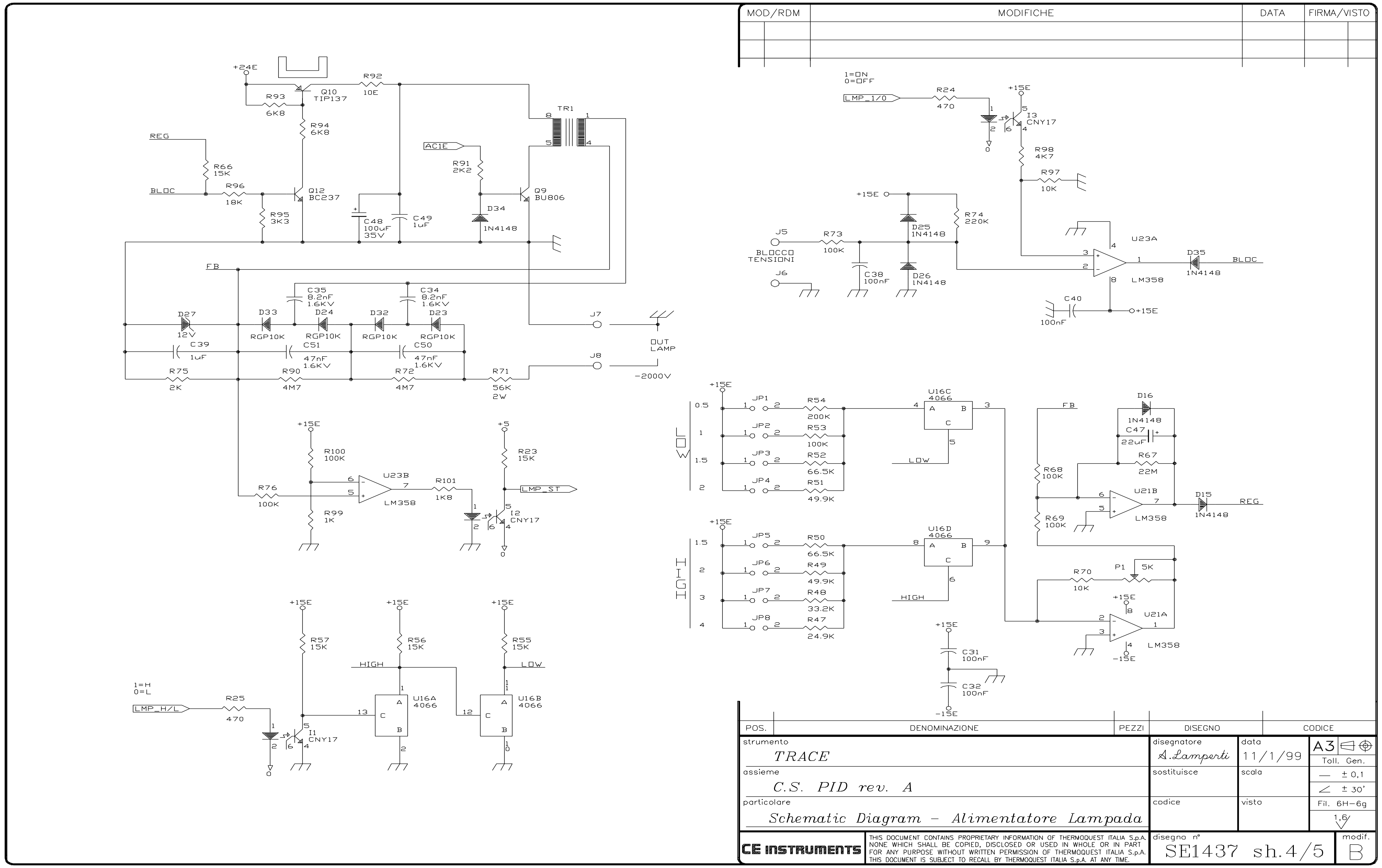
B
SIGNAL-OUT
V_DET
DAZ
GF
F-OUT
VFC110AP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particolare
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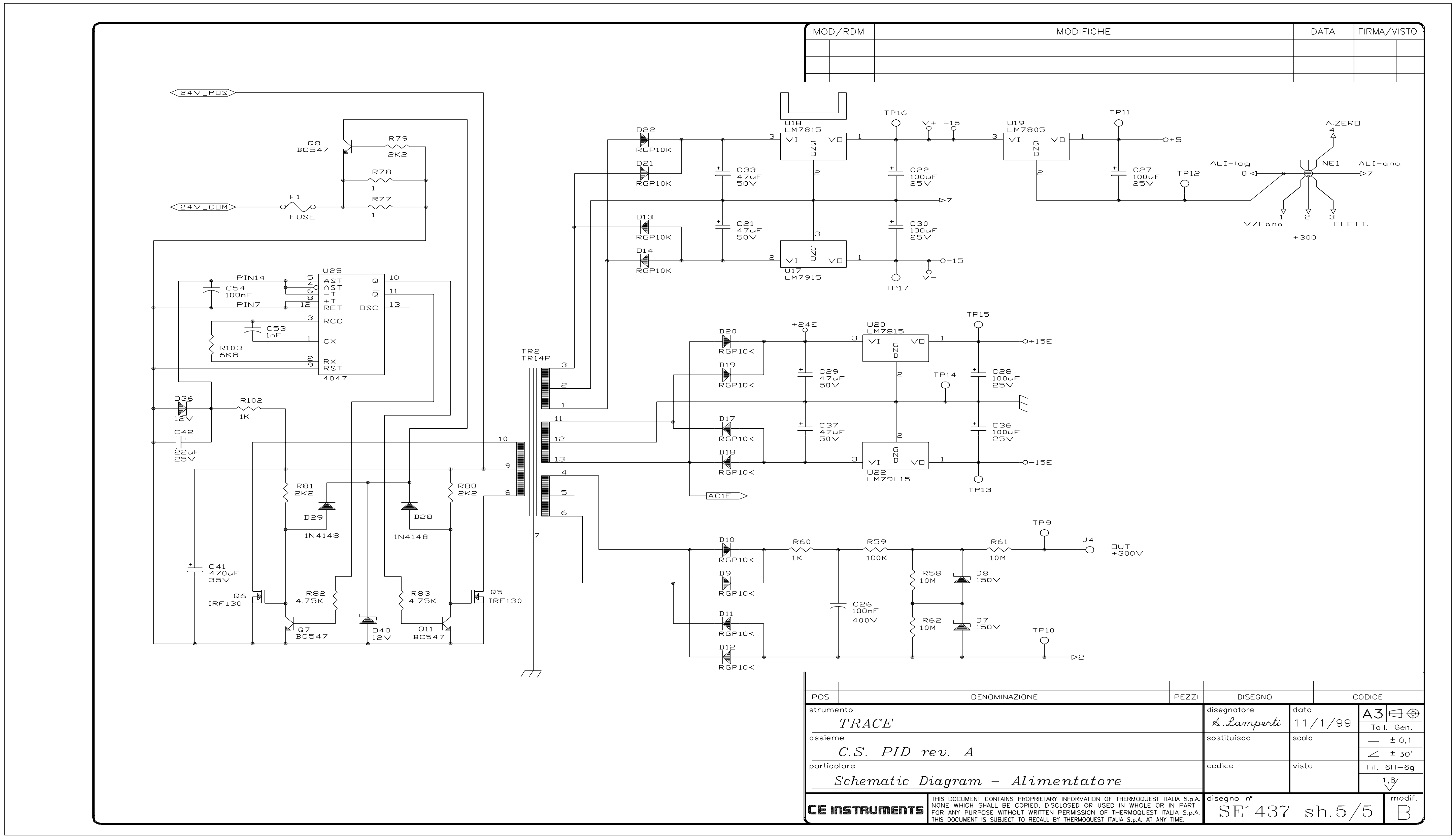
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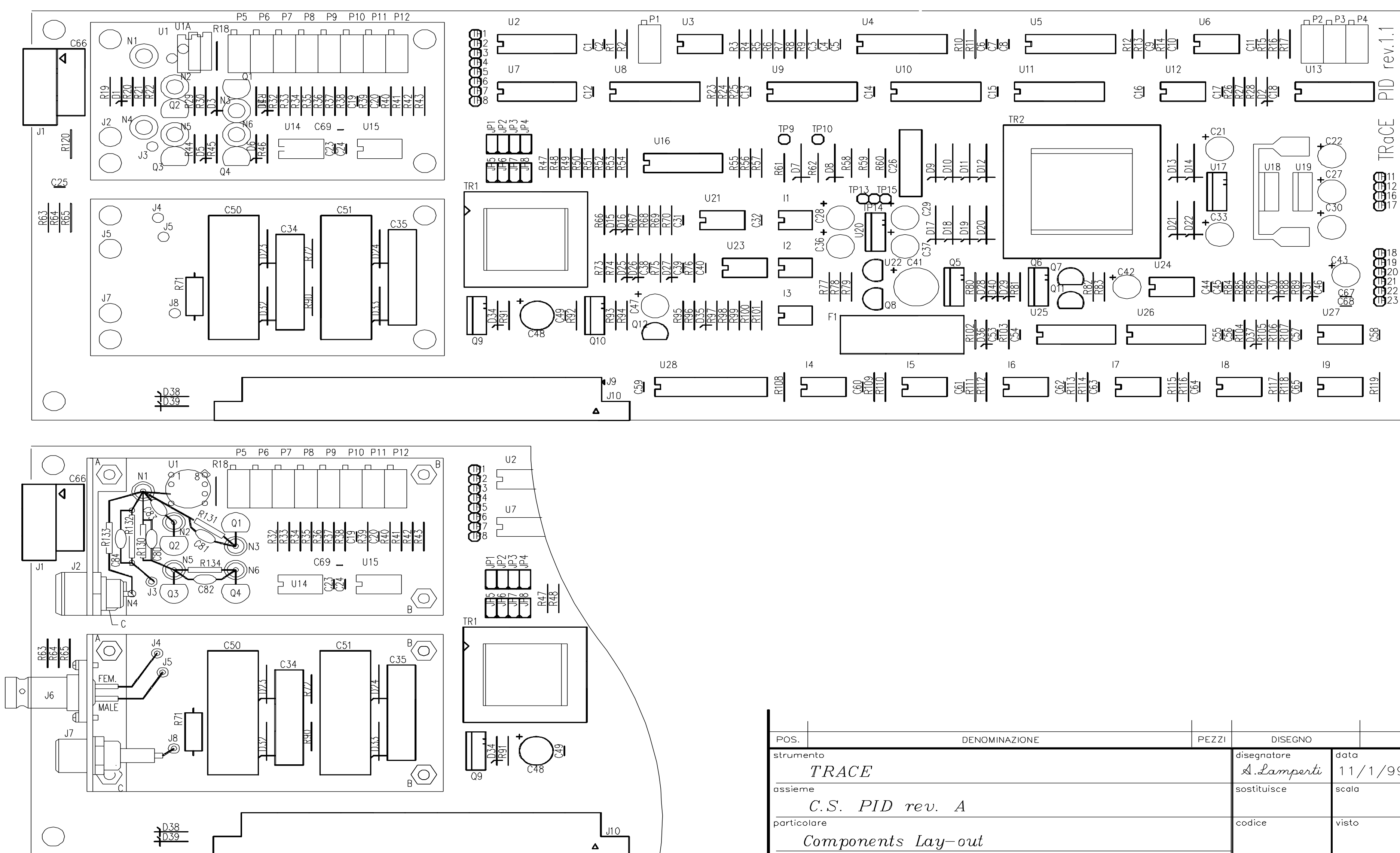
MOD/RDM		MODIFICHE	DATA	FIRMA/VISTO
A	Rev./Prog.	Revisione di rilascio documentazione	11/1/99	



POS.	DENOMINAZIONE	PEZZI	DISEGNO	CODICE

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assieme: C.S. PID rev. A	sostituisce	scala	Toll. Gen. — ± 0,1; ∠ ± 30'; Fil. 6H-6g
particolare: Components Lay-out	codice	visto	1,6
CE INSTRUMENTS	disegno n°: PC1110		modif.: A

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5.15

Thermal Conductivity Detector Controller (TCD)

This chapter describes the TRACE GC 2000 Thermal Conductivity Detector (TCD) controller.

Chapter at a Glance...

Theory of Operations

Circuit Functions

The HWDTRC pcb controls the TCD bridge filaments the 9 pole Male connector (P3).

The differential input amplifier INA114BP (U19) takes the unbalance input signal from two points of the bridge detector through connector P3 (pin 6 and 2). Two OP07C buffers (U25,U26) control two other bride detector points (sensing) through connector P3 (pin 3 and 4).

Use RV1 potentiometer for COARSE ZERO adjustments. Use the AD7541AJP (U20), with two OP07 amplifiers (U12, U13), is used for FINE ZERO adjustments.

Analogic output signals of the INA114BP (U19, pin 6) go to the input of two OP07 amplifiers (U11, Gain x 10 and U4, Gain x1), which are selected by digital-analogic switch DG413 (U2, GSET).

A digital input signal (ENA0) selects the DG413 digital-analogic switch (U3) and the OP07 amplifier (U1) to enable the analogic outputs (0V, 1V, 10V, GND), which are present on the P2 terminal block. These outputs are used for external connections to:

- A recorder
- An integrator
- A chromatography data handling system

The OP07 amplifier (U7) inverts the analogic signal polarity while the LP311N comparator (U27) and 6N137 optocoupler (U31) give the "threshold" digital output to the main microprocessor (P1). The analogic output of the OP07 (U14, pin 6) goes to the OP07 amplifier (U6, gain change) to be converted in frequency by VFC110AP (U33). The output frequency (0-4Mhz at 0-10V) is then optoisolated through 6N137 (U32) and read from the main microprocessor.

Integrated circuit PM7524 (U28) and amplifier OP07 (U29) generate two set-points:

- Filaments Temperature (SETT), which is read through the comparator OP07 (U24) giving a CT (constant temperature) output signal.
- Filaments Voltage (SETV) which is read through the comparator OP07 (U23) giving a CV (constant voltage) output signal.

Using the comparator OP07 (U10) to give a CC output signal, the amplifier OP07 (U16) reads the filaments current (10V max).

The purpose of the hybrid circuit CE 9760 (U15) is to memorize all internal signals to be interfaced with the main microprocessor by a serial communication (SPI). DC/DC converter IMR15 (U18) takes the +24 V input voltage to generate two +/- 15 V (A-P) output voltages and regulator 7805 (Q3) generates a +5 V voltage.

Regulator LT1021 (U30) and amplifier OP07 (U39) generate the -10 V voltage (A). An additional 48V transformer and PT100 sensors are used for a second TCD transfer line through connectors P7 (9 poles Female) and P1 (Bus mother board).

Two IN4148 diodes (D19,D20) set the type of detector controller (for example DETAB = TCD) for an automatic recognition by the motherboard's main microprocessor. The P2 connector gives the 1V/10V/OV/GND outputs to connect an external integrator or data handling.

Output Specifications

+/-15 V @ 350 mA

+5 V @ 25mA

Adjustment Procedures

No field adjustments are necessary. The RV2, RV3, RV4, RV5 and RV7 potentiometers concerning the off-set and full-scale are factory adjusted.

Protection Circuits

The filament current is limited to 250 mA.

Special Notes

The CE9761(U40) hybrid circuit is present and the R54 resistance has a different value only if the TCD detector bridge has two filaments instead of four.

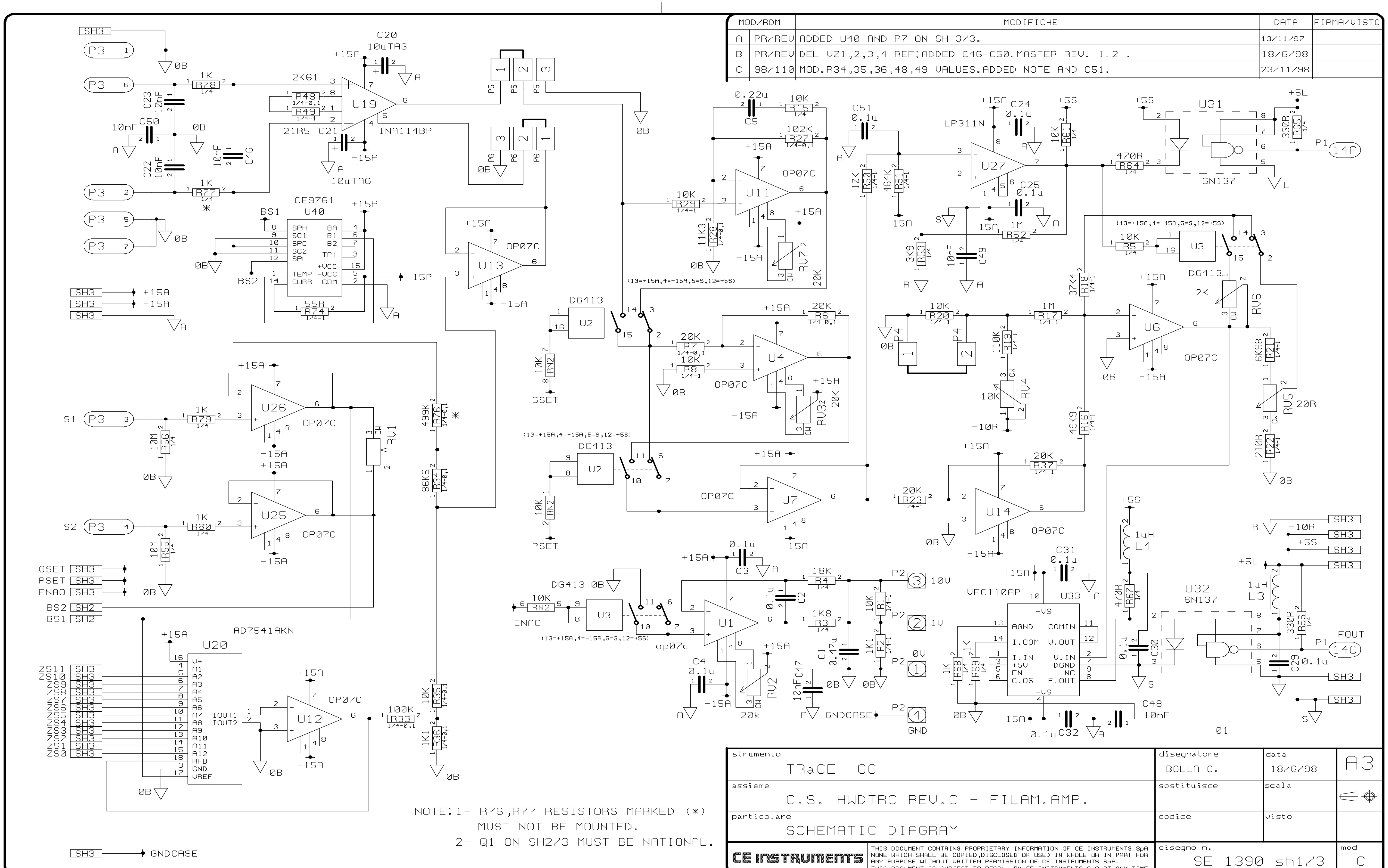
Schematics and Component Information

The schematics and component information for the TCD controller is listed below in table X.X. The number of drawings has been included for each schematic and its corresponding layout. There are 5 drawings in this section.

Table 5.15-1.

Board	PN	Drawing	Layout
TCD	236 48335	SE 1390 sh. 1/3	PC 1113
TCD	236 48335	SE 1390 sh. 2/3	PC 1135
TCD	236 48335	SE 1390 sh. 3/3	PC 1135
TCD	236 48335	SC 763 - Wiring Diagram	PC 1135
TCD	236 48335	SE 1390 PCB	PC 1135

MOD/RDM		MODIFICHE	DATA	FIRMA/VISTO
A	PR/REV	ADDED U40 AND P7 ON SH 3/3.	13/11/97	
B	PR/REV	DEL VZ1,2,3,4 REF;ADDED C46-C50.MASTER REV. 1.2 .	18/6/98	
C	98/110	MOD.R34,35,36,48,49 VALUES.ADDED NOTE AND C51.	23/11/98	



NOTE:1- R76,R77 RESISTORS MARKED (*) MUST NOT BE MOUNTED.
2- Q1 ON SH2/3 MUST BE NATIONAL.

strumento	disegnatore	data	
TRaCE GC	BOLLA C.	18/6/98	A3
assieme	**sostituisce**	**scala**	
C.S. HWDTRC REV.C - FILAM.AMP.			
particolare	**codice**	**visto**	
SCHEMATIC DIAGRAM			
disegno n.			**mod**
SE 1390 sh1/3			C

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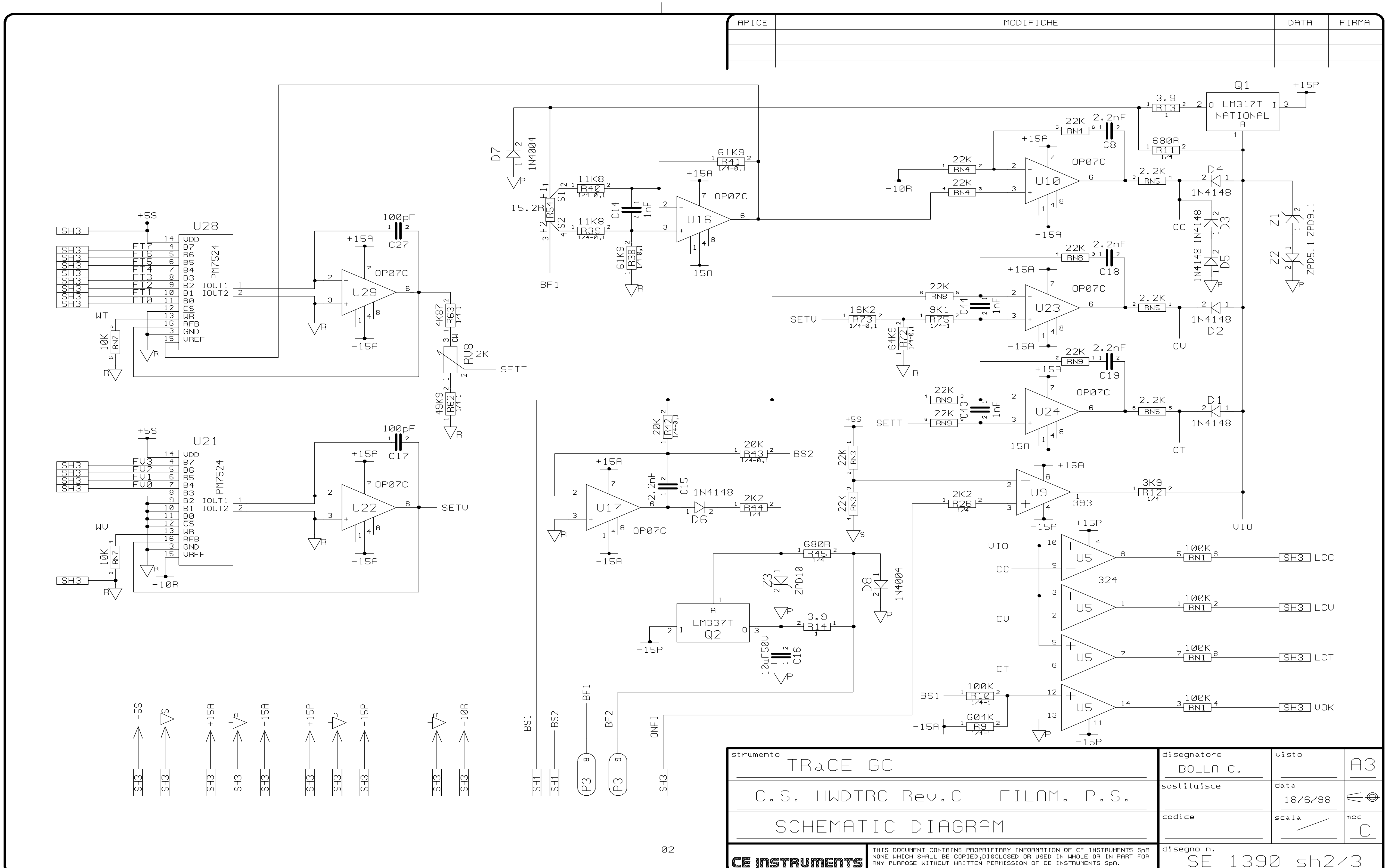
APICE
MODIFICHE
DATA
FIRMA
strumento
TRaCE GC
C.S. HWDTRC Rev.C - FILAM. P.S.
SCHEMATIC DIAGRAM
CE INSTRUMENTS
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disegnatore
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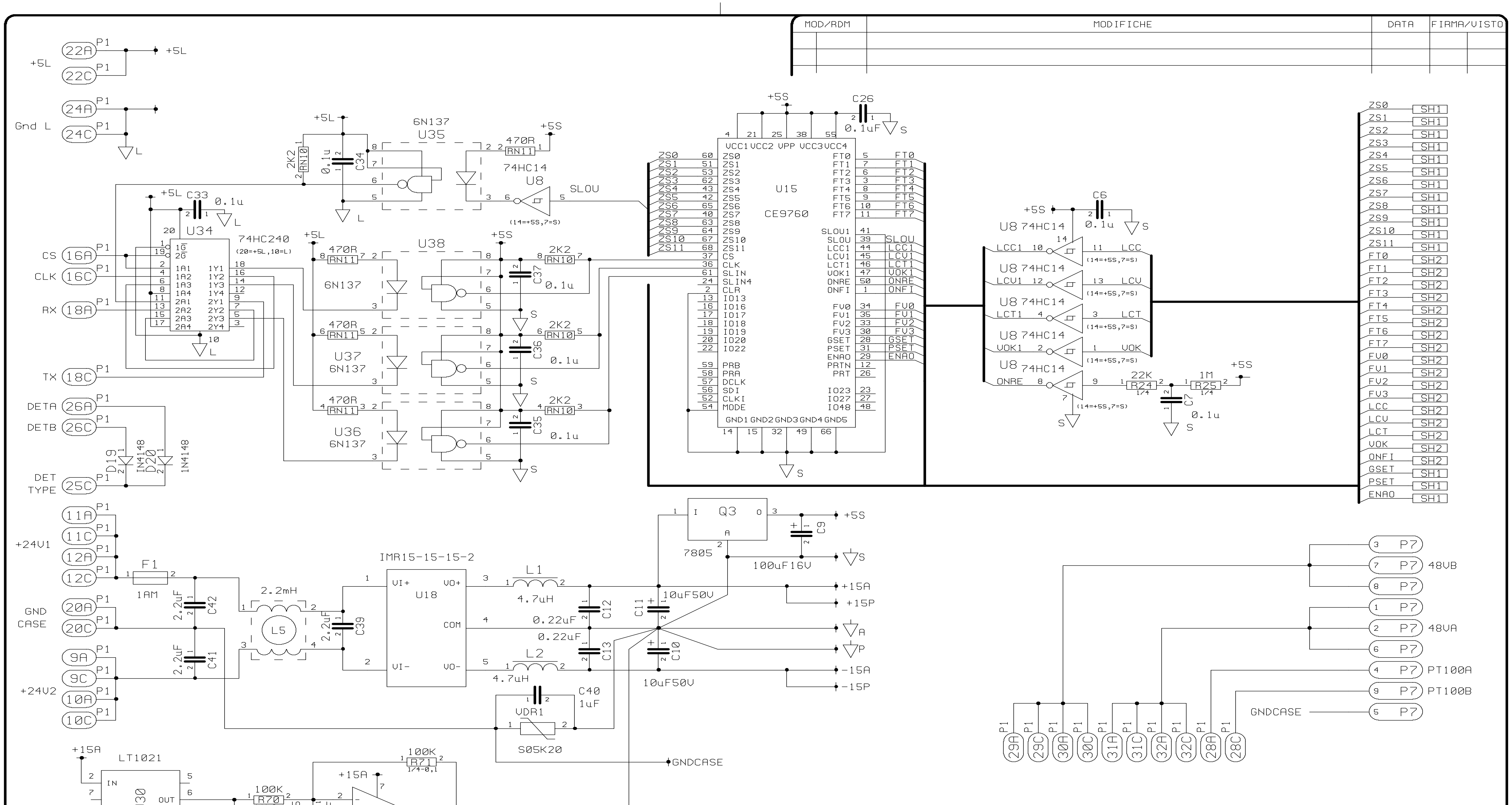
A3
sostituisce
data
18/6/98
codice
scala
mod
C
disegno n.
SE 1390 sh2/3
02
U28
PM7524
U21
U29
U22
U16
U17
U10
U23
U24
U9
U5
OP07C
393
324
Q1
LM317T
NATIONAL
Q2
LM337T
SETT
SETV
VIO
CC
CV
CT
BS1
BS2
BF1
BF2
ONFI
LCC
LCV
LCT
VOK



strumento: TRaCE GC	disegnatore: BOLLA C.	data: 18/6/98	A3
assieme: C.S. HWDTRC Rev.C - I/O & P.S.	sostituisce	scala	
particolare: SCHEMATIC DIAGRAM	codice	visto	
CE INSTRUMENTS	disegno n.: SE 1390 sh 3/3		mod: C

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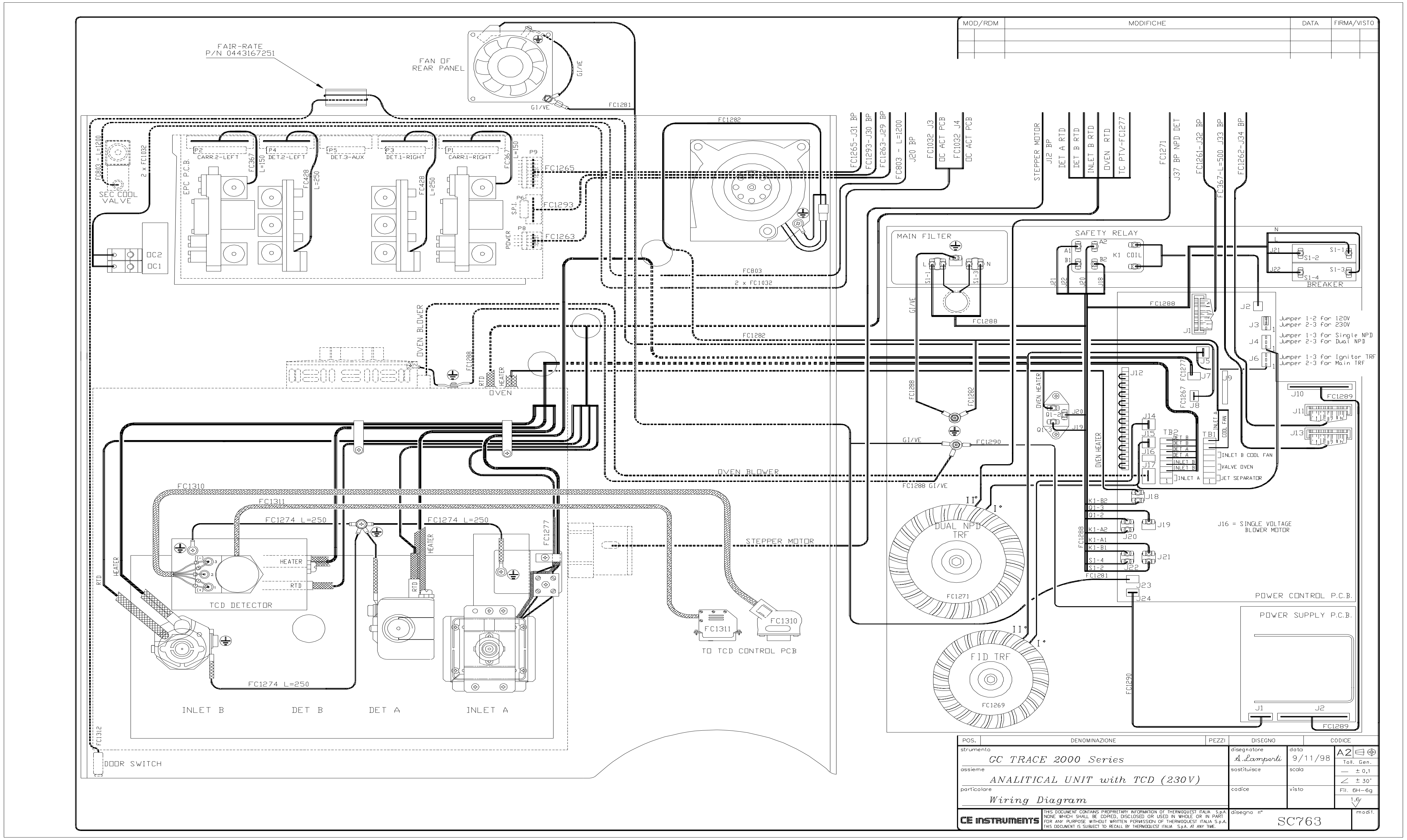
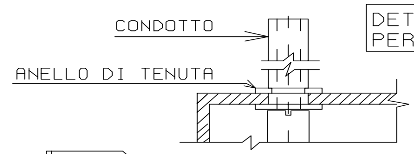
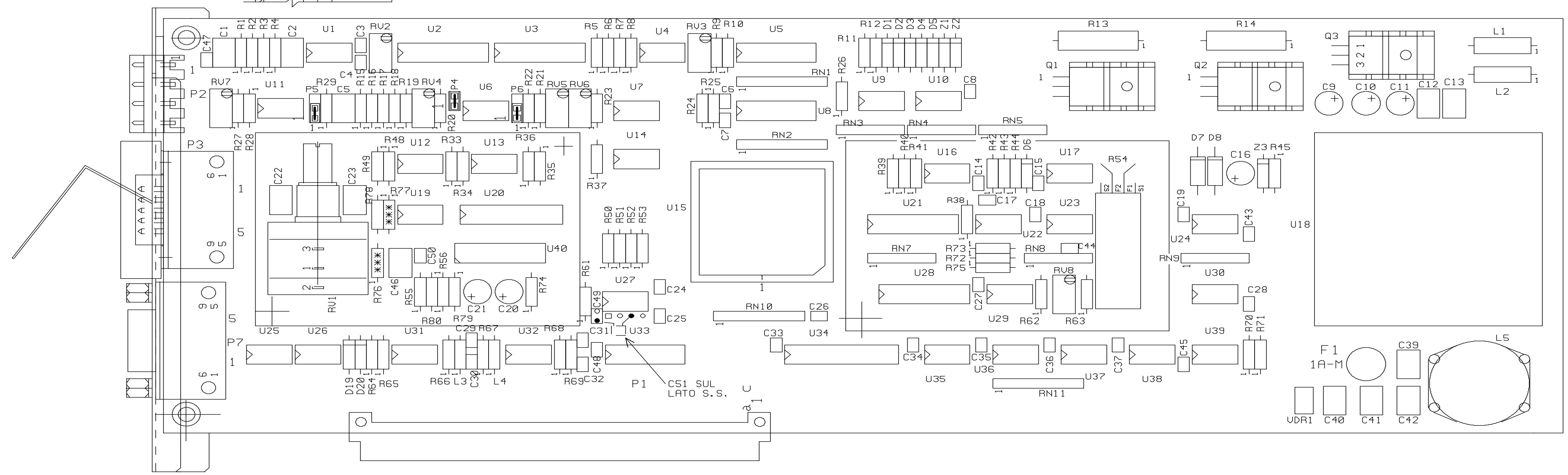


FAIR-RATE
P/N 0443167251
FAN OF
REAR PANEL
SEC COOL
VALVE
EPC P.C.B.
CARR2-LEFT
DET2-LEFT
DET3-AUX
DET1-RIGHT
CARR1-RIGHT
OVEN BLOWER
OVEN
MAIN FILTER
SAFETY RELAY
BREAKER
STEPPER MOTOR
TCD DETECTOR
INLET B
DET B
DET A
INLET A
TO TCD CONTROL PCB
DOOR SWITCH
DUAL NPD TRF
FID TRF
POWER CONTROL P.C.B.
POWER SUPPLY P.C.B.
Jumper 1-2 for 120V
Jumper 2-3 for 230V
Jumper 1-3 for Single NPD
Jumper 2-3 for Dual NPD
Jumper 1-3 for Ignitor TRF
Jumper 2-3 for Main TRF
J16 = SINGLE VOLTAGE BLOWER MOTOR
GC TRACE 2000 Series
ANALITICAL UNIT with TCD (230V)
Wiring Diagram
A. Lamperti
9/11/98
SC763
CE INSTRUMENTS

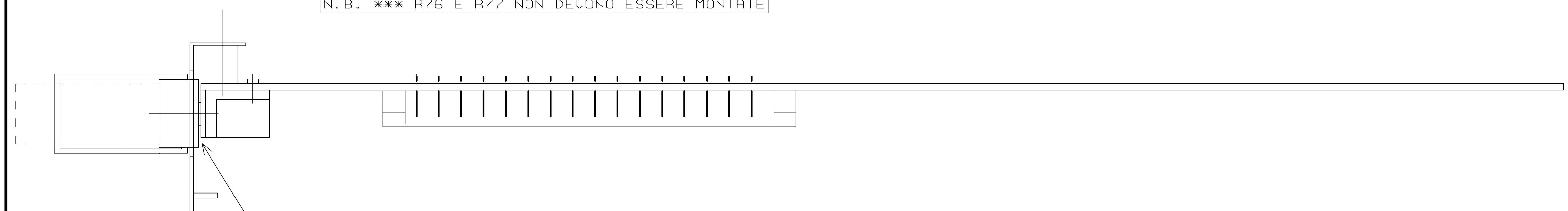
MOD/RDM		MODIFICHE	DATA	FIRMA/VISTO
A	PR/REV.	AGGIUNTI P7 E U40;MASTER REV 1.1.	17/11/97	
B	PR/REV.	AGGIUNTI C46-C50;MASTER REV. 1.2.	9/7/98	
C	98/110	AGGIUNTE NOTE DI MONTAGGIO.	23/11/98	
D	99/011	AGGIUNTA GUIDA PER POTENZIOMETRO.	29/1/99	

DETTAGLIO MONTAGGIO GUIDA PER POTENZIOMETRO.





N.B. *** R76 E R77 NON DEVONO ESSERE MONTATE



INTERPORRE TRA LA CALOTTA E IL CONNETTORE
2 RONDELLE PIANE D.I. 3,3 SP. 0,5 ACC.INOX.

strumento	disegnatore	data	A3
GC TRaCE	BOLLA C.	24/6/97	
assieme: C.S. HWDTRC REV. D	sostituisce	scala: 1:1	
particolare	codice	visto	
CE INSTRUMENTS	disegno n.: PC 1113		mod: D

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5.16

Thermocouple Preamplifiers

This chapter describes the PCB for the thermocouple preamplifiers of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

Two inlet configurations require temperature feedback from thermocouples instead of RTDs. These are the PTV and the OC HOT.

Refer to schematic 119834 in *Schematics and Component Layout*.

The thermocouple is an optional PCB which plugs onto the TFB & DIO PCB. It amplifies and offsets the temperature signal, so the A/D on the TFB & DIO PCB can input the temperature to the microprocessor.

The thermocouple amplifier is designed for use with a type E (Chromel/Constantan) thermocouple.

Integrated circuit U2 provides a 2.5 V reference and a voltage proportional the temperature of U2. Circuit U1(output pin 1) buffers the 2.5 V reference from U2 and supplies it as a fixed offset to the summing amplifier U3.

Circuits U1(output pin 7) and U1(output pin 14) buffer and scale the temperature output of U2 and supply it to the summing amplifier U3.

The thermocouple feeds the circuit via J2. Amplifier U1(output pin 8) buffers the signal, which allows the thermocouple to be shorted to ground. The output of this amplifier also feeds the summing amplifier U3.

The output of U3 is a voltage representing the temperature of the thermocouple. It has been compensated for the unwanted thermocouple effects at J2.

Adjustment Procedures

No field are adjustments possible.

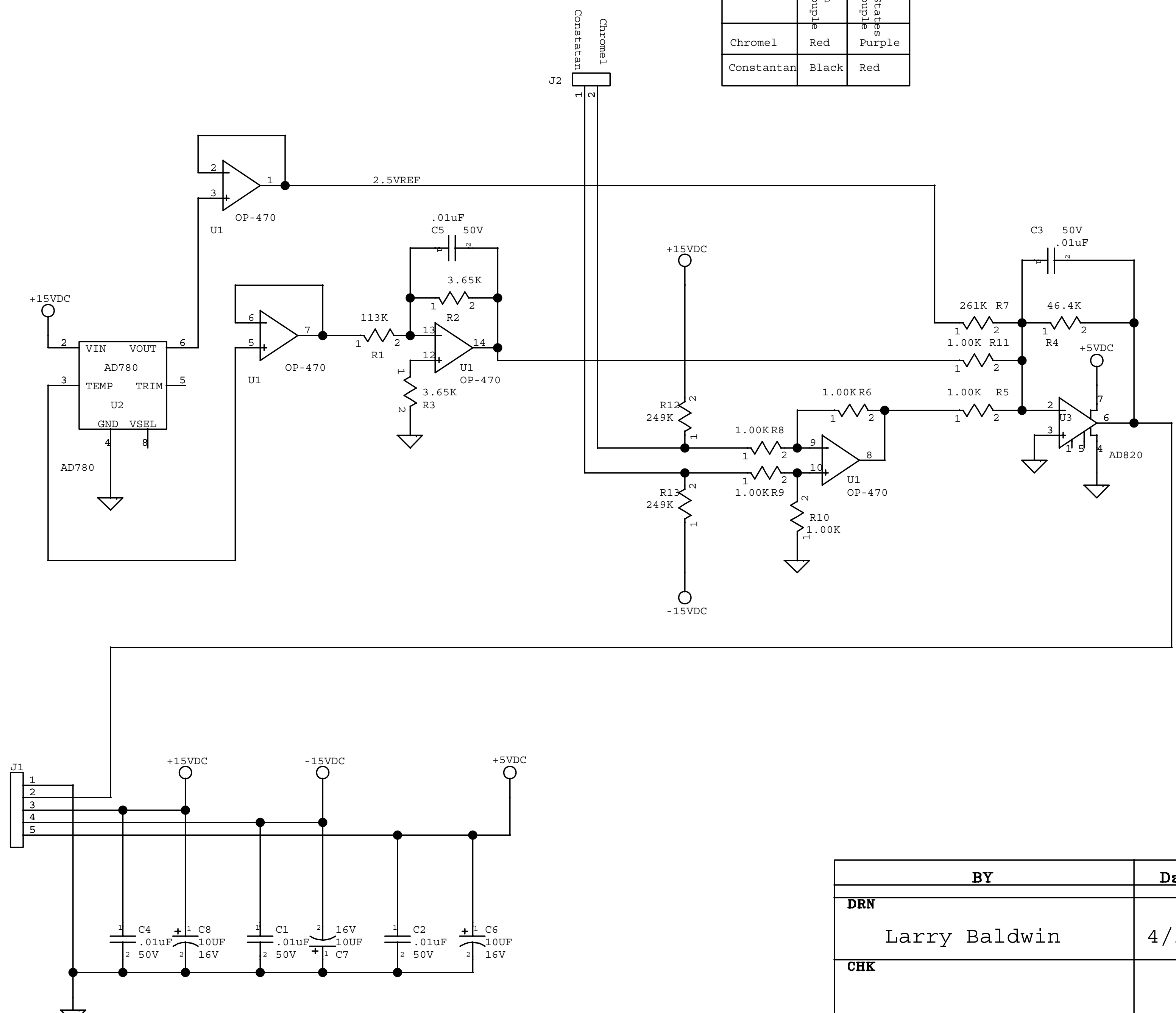
Schematics and Component Layout

The schematics and component layout information for the thermocouple preamplifiers PCB is listed below in Table 5.16-1. The number of drawings has been included for each schematic and its corresponding layout. There are two drawings for reference in this section.

Table 5.16-1. Thermocouple Preamplifiers Schematics

Board	PN	Drawing	Layout
Thermocouple Preamplifiers	23648400	119834E, 1	119832, 1

NOTE The last drawing in this section is the layout of the board.



	European Thermocouple	United States Thermocouple
Chromel	Red	Purple
Constantan	Black	Red

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D	DRN 4215	5/1/98	L BALDWIN	L BALDWIN
E	ECO 31652	7/6/98	L BALDWIN	

	BY	Date
DRN	Larry Baldwin	4/29/98
CHK		
ENGR	Larry Baldwin	4/29/98
APPD		

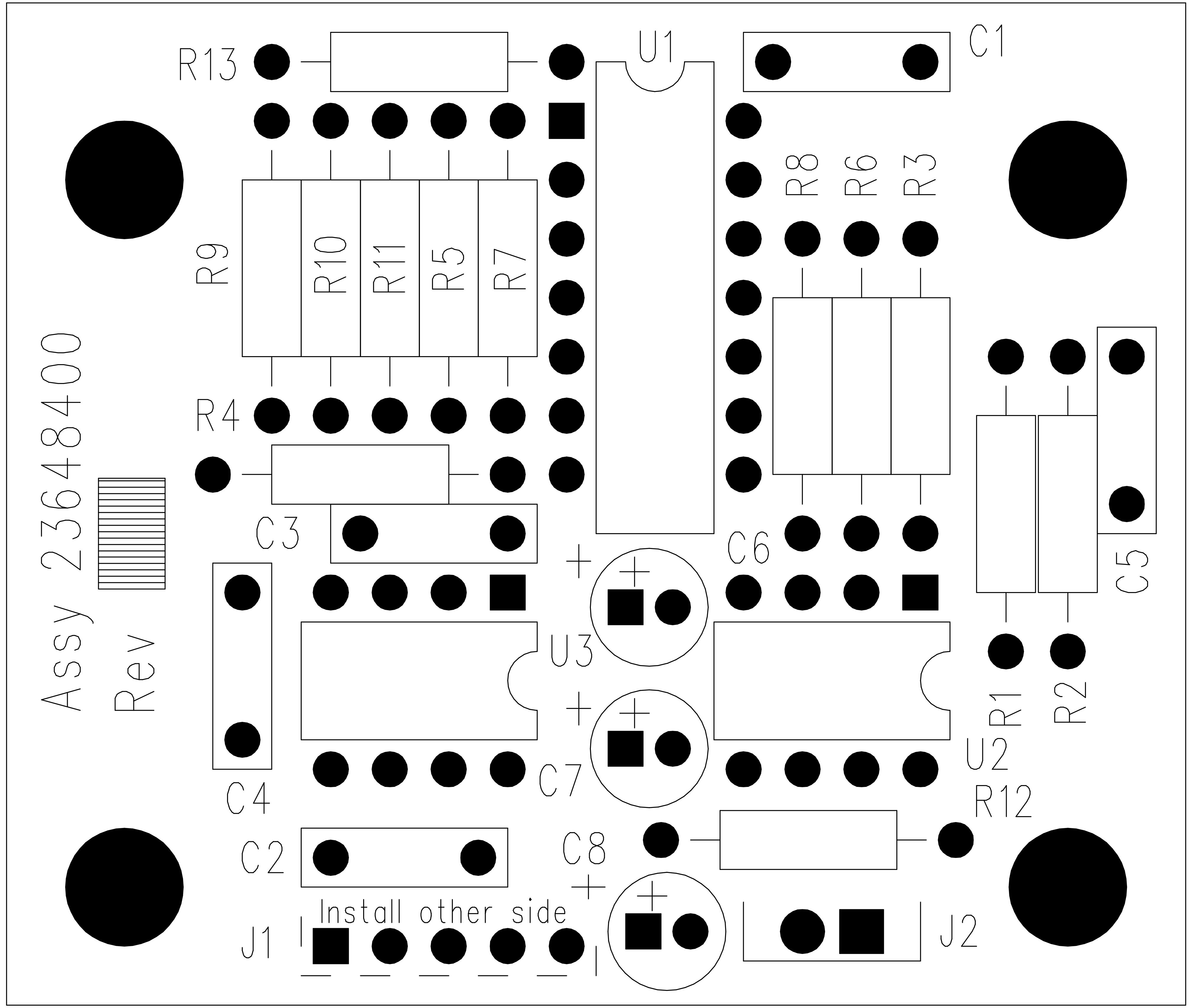
Thermo Quest

2215 Grand Avenue Parkway
Austin, TX 78728

Title THERMOCOUPLE PRE-AMPLIFIER

Document Number 119834 **Rev** E

Date **Size** B **Sheet** 1 **of**



PCB Layout for Thermocouple Preamplifiers (119832)

5.17

On-Column Semiautomatic Actuator

This chapter describes the PCB for an on-column semiautomatic actuator of the TRACE GC 2000.

Chapter at a Glance...

Theory of Operations

Some on-column inlet options include a semiautomatic actuator for opening and closing the valve. These require a small PCB which must be installed on the motherboard. If the system has two on-column actuators, then two of these PCBs can be installed with one on top of the other.

The insertion of the syringe is sensed by an opto-interruptor (see schematic 119947 in *Schematics and Component Layout*). A flag mechanism on the assembly causes the beam to be unbroken when the syringe is inserted.

Inserting the syringe causes light from the LED to strike the phototransistor in the opto-interruptor. This causes the signal SYR_IN to go high. As a result, the output of U1 switches low. Transistor Q1 inverts the output of U1. These two signals are buffered by U3, and control the valves which pneumatically open or close the valve in the injector assembly.

A start pulse is generated by one-shot U2. Jumper E2 permits selection of the polarity of the start pulse to be generated.

Adjustment Procedures

No field adjustments are necessary.

Schematics and Component Layout

The schematics and component layout information for the on-column semiautomatic actuator PCB is listed below in Table 5.17-1. The number of drawings has been included for each schematic and its corresponding layout. There are three drawings for reference in this section.

Table 5.17-1. On-Column Semiautomatic Actuator Schematics

Board	PN	Drawing	Layout
On-Column Semiautomatic Actuator	23648395	119947B, 1–2	119945, 1

NOTE The last drawing in this section is the layout of the board.

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REV	ECO NO.	DATE	BY	CHK
B	DRN			

	BY	Date
DRN	M. Garrett	01-23-98
CHK		
ENGR	M. Garrett	12-01-97
APPD		

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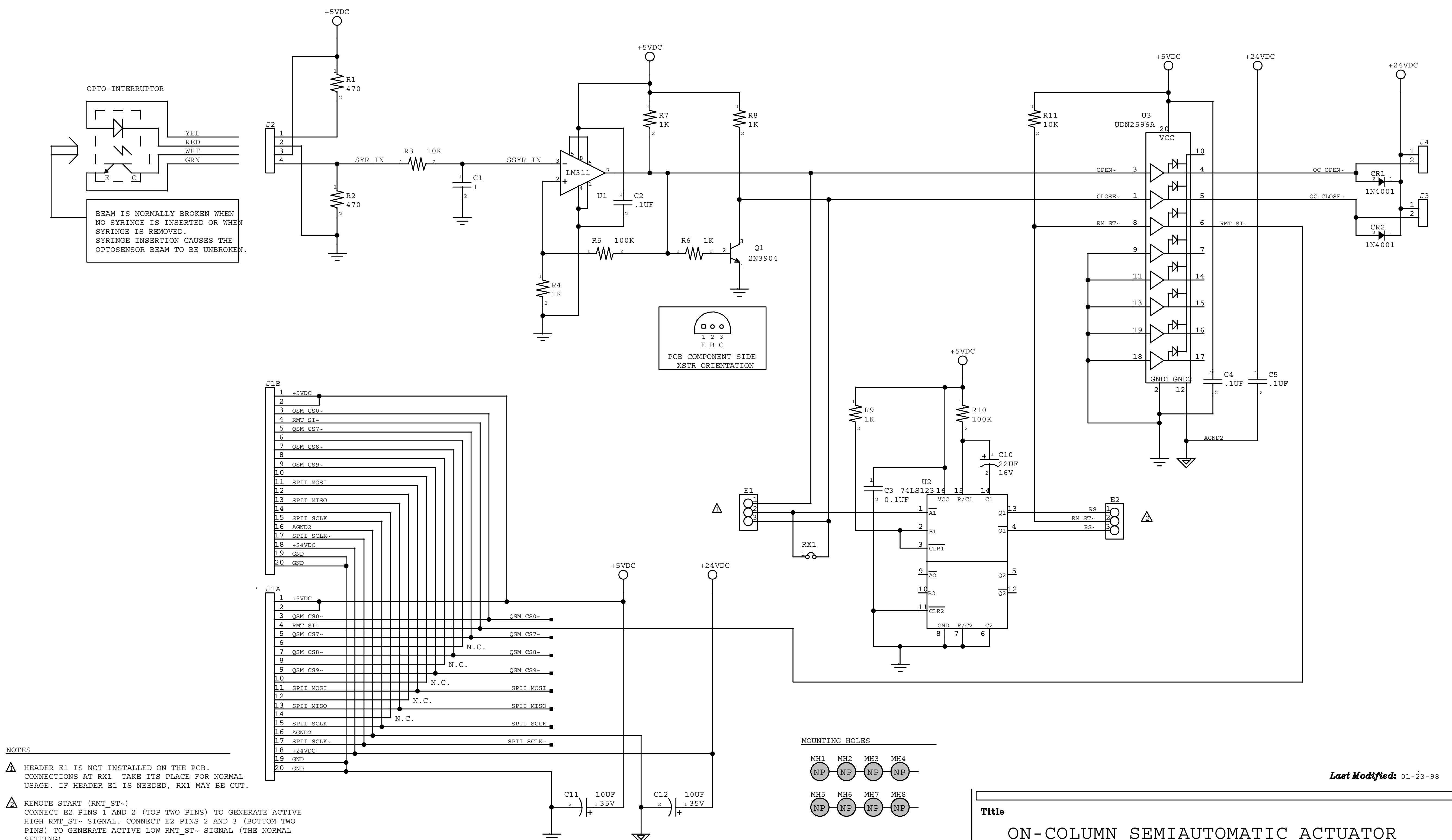
Title
ON-COLUMN SEMIAUTOMATIC ACTUATOR

Document Number 119947 Rev B

Date 01-23-98 Size B Sheet 1 of 2

ON-COLUMN SEMIAUTOMATIC ACTUATOR CIRCUIT



NOTES

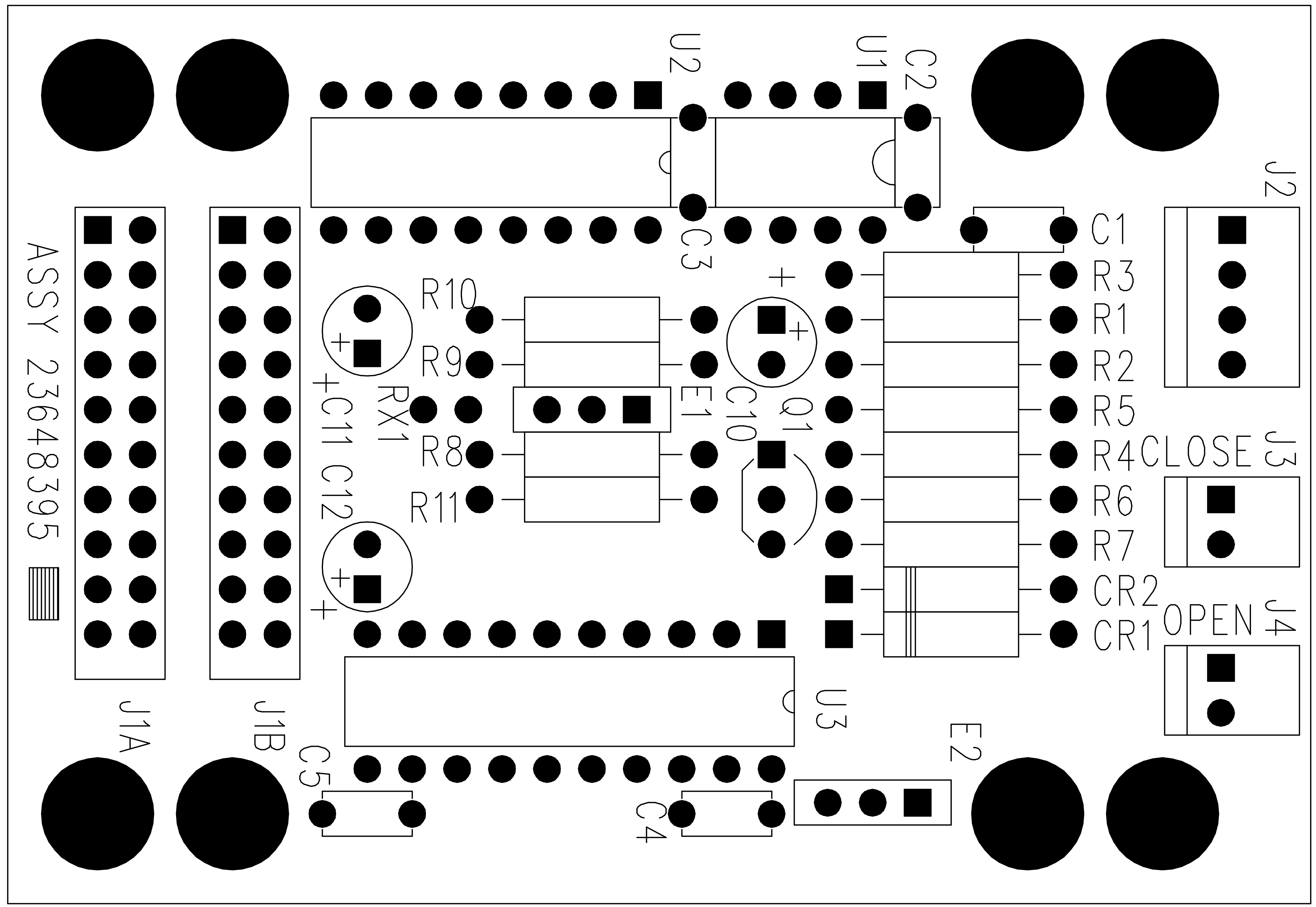
1. HEADER E1 IS NOT INSTALLED ON THE PCB. CONNECTIONS AT RX1 TAKE ITS PLACE FOR NORMAL USAGE. IF HEADER E1 IS NEEDED, RX1 MAY BE CUT.

2. REMOTE START (RMT_ST~) CONNECT E2 PINS 1 AND 2 (TOP TWO PINS) TO GENERATE ACTIVE HIGH RMT_ST~ SIGNAL. CONNECT E2 PINS 2 AND 3 (BOTTOM TWO PINS) TO GENERATE ACTIVE LOW RMT_ST~ SIGNAL (THE NORMAL SETTING). REMOVE THE SHUNT ENTIRELY FROM E2 TO PREVENT RMT_ST~ FROM BEING GENERATED.

Last Modified: 01-23-98

Title ON-COLUMN SEMIAUTOMATIC ACTUATOR

Doc. No. 119947 **Sheet** 2 **of** 2



PCB Layout for On-Column Semiautomatic Actuator (119945)

SECTION VI

Service Equipment

This section provides specifications for recommended test equipment used with the TRACE GC 2000. The TRACE GC 2000 Service Kit is also included.

Chapter 6.1, *Recommended Test Equipment*, provides test equipment specifications that should enable isolation of problems, repair, and calibration of the TRACE GC 2000.

Chapter 6.2, *TRACE GC 2000 Service Kit*, provides a list of the parts found in the TRACE GC 2000 Service Kit. Part numbers are included.

6.1

Recommended Test Equipment

This chapter provides test equipment specifications that should enable isolation of problems, repair, and calibration of the TRACE GC 2000.

Chapter at a Glance...

PCB Replacement

The TRACE GC 2000 has a modular design intended for printed circuit board (PCB) replacement. The complexity of the various PCBs used in the TRACE GC 2000 discourages component level troubleshooting. Troubleshooting to the PCB level may require the use of specialized test equipment.

Digital Flowmeter

A variety of digital flowmeters are available for monitoring flows on the TRACE GC 2000. Some flowmeters require selection of a specific gas type. Monitoring detector flows on the TRACE GC 2000 may require the mixing of gas types. To reduce errors in flow measurement, it is recommended you use a flowmeter that is not gas type dependent. Hand-held digital flowmeters are available that are independent of gas type. Digital bubble flowmeters intended for laboratory use are also available.

Digital Voltmeter (DVM)

Troubleshooting and monitoring of voltages and resistance on the TRACE GC 2000 and its associated peripherals can be accomplished with a 3½ digit DVM. It is recommended that the DVM have manual range selection as opposed to auto ranging. The input impedance should be >10 meg ohm. Alligator-type clip leads (or similar) should be available to make reliable contact to test points.

Oscilloscope

Most troubleshooting to isolate problems to the PCB level can be performed with a DVM. Should an oscilloscope be required, it is recommended to use one with a 100 MHz time base, 5 mV to 50 V/division range, and an X1 and X10 selectable input probe.

Leak Test Meter

The TRACE GC 2000 can perform an automatic injector leak test. However, it cannot identify the actual location of the leak or identify leaks other than those associated with the injector. Liquid leak detectors are not recommended since these may introduce contaminates into the gas stream.

Leak testing should be performed using an electronic leak detector. Portable as well as bench-mounted electronic leak detectors are available for use. Most electronic leak detectors calibrate using room air as a reference, so the detection of air leaks may not be possible. Air supplied to a GC may have to be substituted with helium to perform leak test of the air flow paths.

6.2

TRACE GC 2000 Service Kit

This chapter provides a list of the parts found in the TRACE GC 2000 Service Kit. Part numbers are included.

Chapter at a Glance…

Introduction

The TRACE GC 2000 Service Kit includes parts necessary for the installation and repair of the TRACE GC 2000. It is recommended that service representatives have these parts on hand when performing installation and repair. However, additional parts may be necessary to resolve unusual service problems.

NOTE Contents of the TRACE GC 2000 Service Kit are subject to change based on service history.

Table 6.2-1. Electronics

Item	PN
Power Supply Assembly	208 060 10
Keypad/Display Panel	432 100 25
Analog Feedback PCB	236 483 40
CPU PCB	236 483 45
Motherboard	236 483 50
DPFC PCB	236 483 30
FID Controller	236 483 20
ECD Controller	236 483 25
Transformer 48V (ECD Heaters)	230 434 43
TCD Controller	236 483 35
Transformer 48V (TCD Heaters)	230 434 43
NPD Controller	236 483 55
Transformer (NPD bead)	230 434 44
PID Controller	236 483 60
Transformer 48V (PID Heaters)	230 434 43
FPD Controller	236 483 65
Transformer 48V (FPD Heaters)	230 434 43
Breaker 16 A (230 V)	237 099 16
Breaker 20 A (115 V)	237 099 15

Table 6.2-2. Oven

Item	PN
Oven Baffle with Heater and RTD PT100 (230 V)	354 080 30
Oven Baffle with Heater and RTD PT100 (115 V)	354 080 20
Replacement Oven Blower Motor with Bracket	155 990 00
Door Switch Assembly	230 434 45
Oven PT100 RTD	119884-0001
Stepper Motor	318 070 46

Table 6.2-3. Injector Assemblies

Item	PN
Terminal Fitting at Bottom of Injector	347 054 51
Septa Support S/SL — Package of Two	350 254 33
Septa Holder S/SL	233 030 15

Table 6.2-4. Injector Consumables

Item	PN
Injector Heater (230 V)	354 250 57
Injector Heater (115 V)	354 250 58
PT100 Temperature Sensor	403 112 30
SVE Heater (230 V)	354 250 59
SVE Heater (115 V)	354 250 60
Split Liner, 5-mm ID — 2 Each	453 200 30
Split Liner, 3-mm ID — 2 Each	453 200 31
Splitless Liner, 3-mm ID — 2 Each	453 200 32
Splitless Liner, 5 mm — 2 Each	45 3200 33
Wide-Bore Liner for S/SL Injector	453 003 10
Wide-Bore Injector, 4-mm Glass Liner — 2 Each	453 220 49
Wide-Bore Injector, 2-mm Glass Liner — 2 Each	453 220 50
Septa, BTO Type, S/SL Injector — Package of 10	313 032 11
Septa, Wide-Bore Injector, High Temp — Package of 50	313 032 09
Ferrules 0.35 mm for 0.25-mm ID Column — Set of 2	290 134 88
Ferrules 0.45 mm for 0.32-mm ID Column — Set of 2	290 134 87
Ferrules 0.8 mm for 0.53-mm ID Column — Set of 2	290 134 86
Nuts for Column Connection — Package of 5	350 324 23
S/SL Septum Cap Tool	205 070 10

Table 6.2-4. Injector Consumables (Continued)

Item	PN
Graphite S/SL Liner Seal	290 034 06
S/SL Silver Seal for Terminal Fitting — Package of 10	290 336 29

NOTE The PT100 is the same for all hot injectors except the PTV. Both devices have the same physical dimensions as the temperature sensing end. The heater is the same for all hot injectors except the PTV. Each injector has one heater. However, the DoublePro has two. The entire PTV must be replaced if the PTV heater or thermocouple fails.

Table 6.2-5. Large Volume Injections

Item	PN
OCV80T (for AS2000)	299 022 70
Secondary Cooling Value 24V	405 160 15
SVE Valve Assembly	405 171 46
Seal, PTFE OCI	290 070 01
Clip	426 003 57
Vespel Ferrule, 0.45-mm ID for 0.32-mm Column — Set of 2	290 134 60
Vespel Ferrule, 0.35-mm ID for 0.25-mm Column — Set of 2	290 134 61
Vespel Ferrule, 0.8-mm ID for 0.53-mm Column — Set of 2	290 134 71
Septa for Automatic LVI/OCI — Package of 100	350 158 50
Ferrules 1-mm ID for 0.8-mm ID Tube — Set of 2	290 134 85
Low Volume Tee Connector	347 084 48
Syringe, 250 µL with 80-mm Needle	365 050 23
Backwasher/Cooling Sleeve for OC Injector	452 000 01
Column Retaining Nut and Backwasher for OC Injector	452 100 01

Table 6.2-6. Detector Assemblies

Item	PN
Base Body Heater (230 V)	354 250 53
Base Body Heater (115 V)	354 250 52
PT100 Temperature Sensor	403 112 30
Silver Seal, Base Body Terminal Fitting — 10 Each	290 371 00
Capillary Adapter — 2 Each	347 254 36

Table 6.2-7. Detector Consumables

Item	PN
FID/NPD Jet Tool	205 019 00
FID Jet	404 043 01
FID Collector Electrode Assembly	259 011 15
FID/NPD Ceramic Insulator	302 023 10
FID/NPD Base Retaining Screw	311 060 08
Ignitor/Polarizer Assembly	206 016 03
FID Collector Electrode Assembly	206 016 02
NPD Jet	404 043 02
NPD TD-2 Source	465 002 55
NPD Collector	259 011 10
NPD Ceramic Insulator	302 023 10
ECD Collector	277 003 50
ECD Jet Seal	290 150 60
ECD Tool	205 021 50
ECD Heater and Sensor Assembly	190 500 87
ECD Seal, Top — Package of 10	290 326 08

Table 6.2-8. Fans

Item	PN
OC/PTV Fan, 230 V	406 006 82
OC/PTV Fan, 115 V	406 006 87
Rear Fan (230 V) 24170-0016	406 007 05
Rear Fan (115 V) 24170-0015	406 007 10

Table 6.2-9. Pneumatics

Item	PN
Flow Regulator MOD ECD Only, AA	425 090 50
Flow Regulator MOD ECD, PID, FPD FID (without makeup), AB	425 090 51
Flow Regulator MOD ECD, PID, FPD FID (with makeup), AC	425 090 53
Flow Regulator MOD NPD, ECD, PID, FPD FID (without makeup), AD	425 090 54
Flow Regulator MOD 250 for PKD/Megabore Injector	425 090 60
Flow Regulator MOD 700 for PKD/Megabore Injector	425 090 61
Flow Regulator MOD 250 for S/SL Injector	425 090 58
Flow Regulator MOD 700 for S/SL Injector	425 090 59
Flow Regulator MOD 250KPA, Pack/Widebore	425 090 71
Flow Regulator MOD 700 for Packed Injector	425 090 62
Flow Regulator MOD TCD Ref., AB	425 090 52

Table 6.2-10. AS 2000 Left/Right

Item	PN
CNT800/CNS800/CNN810 PCBs (Turret)	236 482 55
CP800 PCB (EPROM DX)	236 483 00
ANB801 PCB	236 482 90
AC801 PCB	236 482 95
Transformer	413 250 56
Motor, Plunger	318 079 00
Motor, Plunger, Tray, Turret	318 078 00

Table 6.2-11. HS 2000

Item	PN
CP850 PCB (EPROM version)	236 483 05
ANB850 PCB	236 483 10
AC850 PCB	236 483 15
Transformer	413 250 57

Table 6.2-12. Service Tools

Item	PN
Service Manual	317 092 70
Tools Kit, Standard Metric Wrenches	t.b.d.
Travel Kit with Containers	t.b.d.

SECTION VII

Replacement Parts List

For a list of replacement parts and component part numbers for the TRACE GC 2000 please refer to the *Spare Parts Catalog*, **PN 31709210**.

SECTION VIII

Service Information

This section provides service and technical information for the TRACE GC 2000.

Chapter 8.1, *Service Notes (TSB)*, contains service notes and Technical Service Bulletins (TSBs) for the TRACE GC 2000.

Chapter 8.2, *Additional Technical Information*, contains additional technical information for the TRACE GC 2000.

8.1

Service Notes (TSB)

This chapter contains service notes and Technical Service Bulletins (TSB) for the TRACE GC 2000.

NOTE Insert any TSBs you receive into this section.

8.2

Additional Technical Information

This chapter contains additional technical information for the TRACE GC 2000.

Chapter at a Glance...

OPERATING PROCEDURE

How to Update Your TRACE GC 2000 Software

It is necessary to periodically update the software for the TRACE GC 2000. Follow these steps to update the embedded systems software in the TRACE GC 2000:

For a boot load, it will be necessary to cycle the power on and off before you begin.

1. Turn the GC off.
2. Press the enter key and hold.
3. Turn the GC on.

Now you are ready to load the new software.

4. Insert the diskette into the computer.
5. Run the **install.exe** program.
   - From the **Windows NT Explorer**, click on the **A** drive. Double-click the `install.exe` icon.
   - From the **Windows NT toolbar**, choose **Start»Run**. Type `a:install`. Click **OK**.

   The **Install New TRACE 2000 Software** dialog box is displayed. See Figure 8.2-1.

6. Select the GCs to install on. Click **OK** to continue.

The software installation will be monitored by the computer. The software will be loaded in 1000-byte increments. A message will be displayed when the installation is complete.

7. Turn the power off, and then back on. The GC now displays the updated software version.

Figure 8.2-1 shows the **Install New TRACE 2000 Software** dialog box.

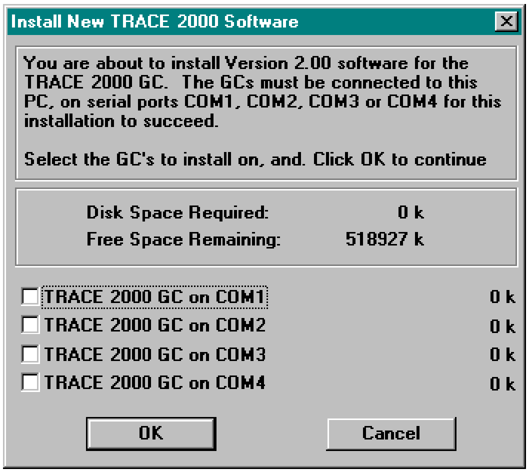


Figure 8.2-1. Install New TRACE 2000 Software Dialog Box

OPERATING PROCEDURE

Using the Configure Menu

Use the Configure menu to view and modify your hardware configurations. Press the **CONFIG** key to go to the `Configure` menu. However, inlets and detector items need to be added or deleted by going to the Hidden Configuration menu. For example, if your Right Inlet is a split/splitless, and your Configure menu does not list the Left Inlet item, you must go into the `Hidden Configuration menu`.

1. Press **Left Inlet** to verify that the displayed selection matches your hardware configuration.
2. Press **Right Inlet** to verify that the displayed selection matches your hardware configuration.
3. Press **Valves** to verify that the displayed selection matches your hardware configuration.

4. Press **CONFIG** to verify that the displayed selections matches your hardware configuration.

Table 8.2-1. `Configure` **Menu**

Oven	
Right CARRIER	
LEFT INLET	
LEFT CARRIER	
AUX ZONES	
TIME	
AUTOSAMPLER	
HANDSHAKING	
KEYBOARD & DISPLAY	

If an item matches, use the down key to scroll down the menu. Use the up key to scroll up the menu. If they do not match, press **ENTER** at the selection and make the change. To get back to the `beginning of the Configure` menu press the **CLEAR** key.

OPERATING PROCEDURE

Using the Hidden Configuration Menu

When you need to change items (add or remove inlets and detectors) listed in your `Configure` menu, all you have to do is press **Config** and enter **2000** to enter the `Hidden Configuration` menu. While in the Hidden Configuration menu, use the down key to scroll to options where you can make other hardware selections based on your hardware configuration. Press **ENTER** on each configuration display that matches your hardware. Press **CLEAR** to step backwards in the menu.

1. After powering on your TRACE GC, press the **CONFIG** key. The `Configure` menu displays your current GC configuration.

Table 8.2-2. `Configure` Menu

OVEN	
RIGHT CARRIER	
LEFT INLET	
LEFT CARRIER	
AUX ZONES	
TIME	
AUTOSAMPLER	
HANDSHAKING	
KEYBOARD & DISPLAY	

2. Move the cursor to the `Left Inlet` and press the **ENTER** key. The `CONFIG LEFT INLET` menu displays. If your Configure menu does not list a left inlet then you must enter the `Hidden Configuration` menu.

3. Press **Enter** at the `CONFIG LEFT INLET` display. A list of available inlets displays.

```
OCI*
HOTOC
LVOCI
```

To change the inlet configuration move the cursor to the appropriate inlet choice and press the **ENTER** key twice. A menu showing available inlets display. An asterisk indicates your current choice.

4. If the desired inlet is not selected, move the cursor to select it and press the **ENTER** key to return to the `Configure` menu.

```
OCI
HOTOC
LVOCI *
```

If for example, you see `NONE` for the `Right Inlet` listed in the `Configure` menu, then you must access the `Hidden Configuration` menu to activate the Inlet.

5. To access the `Hidden Configuration`, press the key labeled **Configure** and then enter **2000.** The `Hidden Configuration` displays.

Table 8.2-3. `HIDDEN CONFIGURATION` Menu

ver. 3.01.10 R (c) 1998			
DS Baud Rate			
RTD Offsett			
MAX GC Amps			
AC			
Oven Cryo			
Right Detector			
Left Detector			
Aux Detector			
L Det Module			
A Det Module			
Hydrogen Sensor			
Aux 1		Aux 2	
Double Pro Inlets			
R Inlet			
L Inlet			
Serial #			
Manufactured			
Total Runs			
Saave Default Mthd			
Erase / Mthd / Cnfg			

6. Move the cursor to Right Inlet and press **ENTER**. The `Config Right Inlet` menu displays the `Right Inlet Type` and the current inlet choice.

Table 8.2-4. `Config Right Inlet` Menu

Right Inlet Type	S/SL

7. Press **ENTER** again to view to view the list of available inlets. Move the cursor to the inlet choice and press the **ENTER** key. This marks the inlet choice and returns you to the beginning of the `Configure Right Inlet` menu. For example, if you select the `S/SL` an asterisk will mark it the next time you enter the `Config Right Inlet` menu.

Table 8.2-5. `Config Right Inlet` Type Menu

S/SL	
PKD	
PPKD	
PTV	
OCI	
NONE	

8. Press the **CLEAR** key to return to the `Hidden Configuration` menu.

OPERATING PROCEDURE

Controlling LVOCI Inlet Parameters

There may be times you need to manually control your LVOCI parameters. Using your keypad you can:

- Check existing LVOCI parameters
- Verify the carrier flows
- Open and Close the secondary valve

1. Press the **Left Inlet** key, the following parameters will be displayed:

Table 8.2-6. `Left Inlet` Menu

Left Inlet	LVOCI
Pressure	24
Sec. Cool Time	0.50
SVE Temp	150
SVE Duration	0.45
Evap Pressure	100
Evap Duration	0.50

2. Press **Left Carrier** to view the flow rates:

Table 8.2-7. Left Carrier `Col Flow` Rates Menu

Col. Flow	**1.5**
Pressure	7
Flow Mode	Con Flow
Vacuum Comp	On

3. Press **Valves** to LVOCI valves.:Press **ENTER** to view the left Valves menu.To

Table 8.2-8. `Valves` Menu

Valves
Inlet Valves

turn the valve on, move the cursor to the appropriate line item and press the **ON/ YES** key.

:

Table 8.2-9. `Left Valves` Menu

L SVE Valve	Off
L Sec Cool	Valve Off

4. Press the **Right Inlet** or **Right Carrier key** to view Split/Splitless inlet parameters.

Scroll down to the `Save Default Mthd` line and press **ENTER**. `OK` displays, indicating you saved your configuration. Press Clear again to return to the `Config` menu.

A

Flame Ionization Detector

This appendix contains the manual **FID Installation Instructions** (PN M 317 09 327), which provides instructions for installing and configuring the Flame Ionization Detector on your TRACE GC 2000.

Guide at a Glance...

Operating Procedures

About This Guide

It provides the instructions to install and configure the Flame Ionization Detector on your TRACE GC™ 2000.

NOTE For Conventions, Symbols and Costumer Communications, please refer to the TRACE GC 2000 Operating Manual.

Introduction

The upgrade kit contains all the material required to install the Flame Ionization Detector on your TRACE GC 2000:

- FID Assembly for TRACE
- FID Control Card
- FID Standard Outfit

CAUTION **The detector gas control module is not part of this kit.**

Who Performs the Installation of the Kit

If, for any reason, the kit is not installed by ThermoQuest technical personnel, you must carefully adhere to the following instructions.

Detector Gases Requirements

The FID requires air and hydrogen as fuel gases. The use of the make-up gas is optional. Optimum performance with capillary column are achieved with make-up gas.
According to the required gases, the DGFC or the Non-DGFC module may be:

- Type AB for the control of air and hydrogen.
- Type AD for the control of air and hydrogen.
- Type AC for the control of air, hydrogen and make-up gas.

1. Verify that the detector gas control module installed on your GC is compatible with the FID gas requirements.

2. The connections of the detector gases must be performed as described in the following table:

Installed Module	Connect Hydrogen to	Connect Air to	Connect Make-up Gas to
AB	Gas 2	Gas 1	—
AC	Gas 2	Gas 1	Gas 3
AD	Gas 3	Gas 1	—

For further details, refer to *Chapters 15* and *Chapter 16* of the TRACE GC 2000 Operating Manual.

Transformer for FID

NOTE If your GC has serial number lower than 983808 (Milan) or TR101089 (Austin), the installation of a dedicated transformer might be necessary. Please contact us for details.

Getting Started

This paragraph contains the instruction to install the FID on your GC. To properly install the FID upgrade kit, the following sequential operations must be performed:

- Remove the top and right side panels of the GC.
- Install the detector control card into the GC electronic compartment (control unit).
- Mount the FID on the GC.
- Remount GC panels.
- Restart the GC.
- Configure the detector.

Before starting, the following preliminary operations must be carried out:

1. Cool the oven and detector base body to room temperature.
2. Make sure that the detector base body is leak free.
3. Close the gas supplies.
4. Turn off the main power on the rear panel of the GC.
5. Disconnect the main power cable from the rear of the GC.

Installing FID Upgrade Kit

Follow this instruction to properly install the FID Upgrade Kit.

1. Injector and detector cassette	2. Column oven door
3. Upper cover	4. Right hand-side panel

Figure A-1. TRACE GC 2000

Removing the GC Panels

This operation allows to access the GC upper parts and the electronic compartment.

Materials needed:

- 2-mm Allen wrench
- 3-mm Allen wrench

Remove the GC Top Cover

1. Lift the detector cover off the GC top cover.
2. Open the oven door and unscrew the two top cover fastening screws.
3. Push the cover back about 1 cm and lift it up and off the GC.

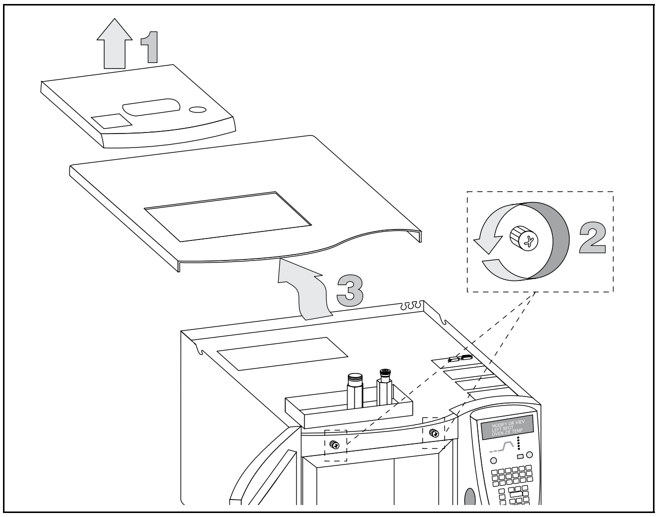
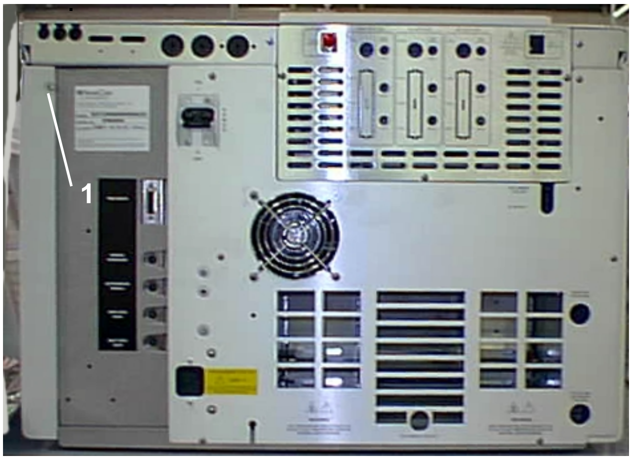


Figure A-2. TRACE GC 2000 Top Cover

Remove the GC Right Side Panel

1. Loosen and remove the screw that secures the right side panel to the right upper rear corner of the GC by using the 3-mm Allen wrench. Refer to Figure A-3.
2. Slide the side panel towards the back of the GC and then tilt the top of the side panel outwards. Continue to slide the panel towards the rear of the GC.
3. Hold the side panel parallel to the GC, and pull the lower edge of the panel away from the GC.



1. Right Panel Securing Screw

Figure A-3. TRACE GC 2000 Rear Panel

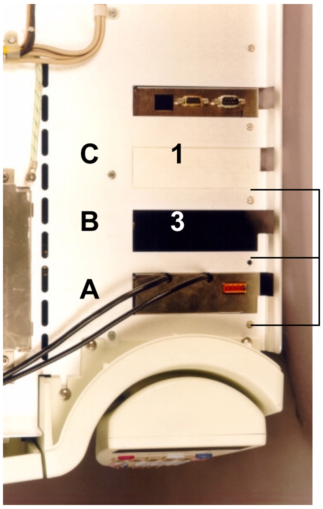
Installing the FID Control Card

The FID control card must be installed into the proper expansion slot marked A, B or C located on the left part of the GC mother board in the electronic compartment. Refer to Figures A-4 and A-5.

NOTE In the case all the expansion slots are occupied, it is necessary to remove one of the three detector control card currently installed and replace it with the FID control card.

Materials needed:

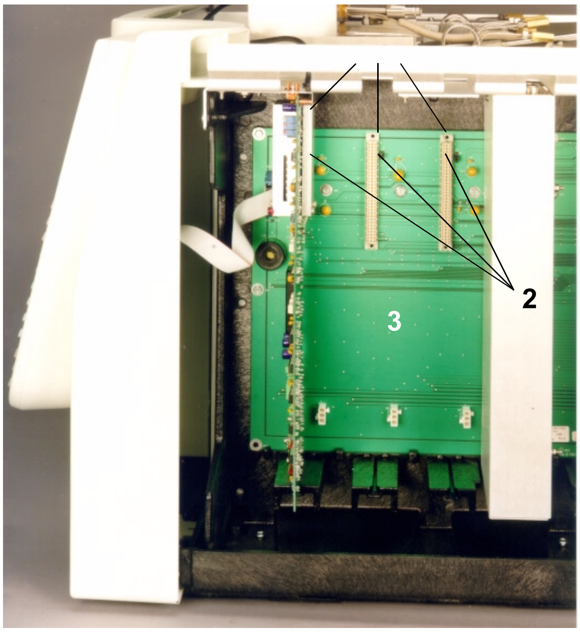
- 3-mm Allen wrench



1. Slot cover plate	2. Cover plates fixing screw
3. Free slot	A B C. Extension slot position

Figure A-4. Extension Slots Top View

1. Loosen the fixing screw of the slot cover plate that corresponds to the selected A, B or C expansion slot on the mother board.



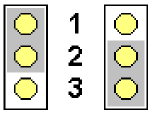
1. Detector control card expansion Slots	2. Additional heat control jumpers
3. Mother board	

Figure A-5. Detector Control Card Expansion Slots

2. Verify that the jumper marked *Jx*, adjacent to the defined detector control card connector on the mother board, is positioned between the pins **2** and **3**. Refer to the following table.

Expansion slot	Corresponding Jumper
A	J8
B	J7
C	J6

Jumper Positioning



Pins 1-2 = additional heat control **enabled**

Pins 2-3 = additional heat control **not enabled**

WARNING! The jumper marked "Jx" must be positioned between the pins 2 and 3.

3. Guide through the slot mentioned at point 1 the signal and ignition cables coming from the top of the card.

4. Plug the detector control card into the selected expansion slot on the mother board.

5. Fix the control card by using the same screw previously removed at point 1.

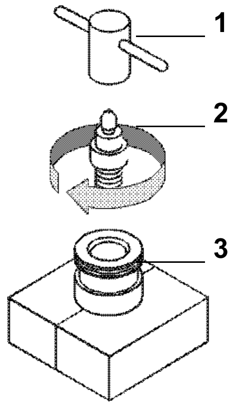
Mounting the FID on the GC

This operation allows the correct installation of the FID on your TRACE GC 2000.

Materials needed:

- Jet for FID
- Tool for jet

1. Place the jet into the detector base body housing and tighten it with the proper tool. Ensure the jet is perfectly vertically aligned to avoid damaging its ceramic part.

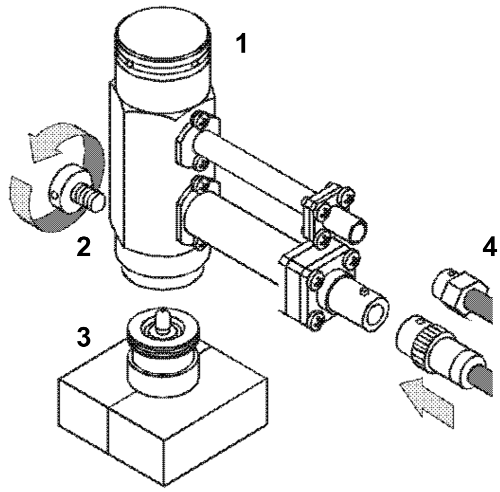


1. Tool for jet	2. Jet
3. Detector base body	

Figure A-6. Jet for FID

2. Install the FID on the detector base body and secure it by using the fixing screw on the front of the detector cell.

3. Carefully, connect the signal and ignition polarization cables coming from the detector control card, to the detector cell.



1. FID	2. Fixing screw
3. Detector base body	4. Signal cable
5. Ignition polarization cable	

Figure A-7. Installation of the FID

Reinstall the GC Panels

This operation allows to reinstall the GC panels

Materials needed:

- 3-mm Allen wrench

1. Reconnect the chassis ground wire to the GC rear oven terminal.
2. Reinstall all the GC panels proceeding in the reverse order of their removal (refer to *Removing the GC Panels* on page 347) being sure to reconnect the rear panel cooling fan.

Restarting the GC

1. Verify that the connections of the detector gases has been correctly performed.
2. Open the gas supplies.
3. Reconnect the main power.
4. Turn on main power.

Configuration

This paragraph contains the instructions to configure your GC to operate with FID. You configure the detector and make-up gas in the **CONFIGURE** menu. Refer to *Chapter 15* of the TRACE GC 2000 Operating manual.

Configuring Detector and Make-up Gas

1. Press **CONFIG** then scroll to `Left detector` or `Right detector` depending on the location of the detector to configure. Press **ENTER** to open the detector gas menu.

LEFT DETECTOR	
Detector type	<
Makeup gas[1]	

1 This line appears only if the DGFC module is present. Refer to note.

2. Select `Detector type`. This line indicates the type of detector mounted and the slot (A, B or C) of the relevant control board. Press **ENTER** to display the submenu.

3. To change detector type, scroll to the desired detector and press **ENTER** to confirm the selection. An asterisk appears beside the detector selected.

4. When the DGFC Module is present scroll to `Makeup gas` and press **ENTER**. The gases applicable to the detector in use are displayed in the submenu. An asterisk appears beside the currently active make-up gas is also displayed in parentheses in the title bar.

5. To change the make-up gas, scroll to the desired gas and press **ENTER** to confirm the selection. An asterisk appears beside the make-up gas selected.

Set FID Parameters

To set FID parameters, it is necessary to open the FID menu and the FID Signal menu.

- The **DETECTOR (FID)** menu contains the detector control parameters.
  To set parameters, refer to the Chapter 16 of the TRACE GC 2000 Operating Manual.
- The **DETECTOR SIGNAL** menu contains the parameters that control the detector signal. To set parameters, refer to the Chapter 15 of the TRACE GC 2000 Operating Manual.

NOTE To verify the correct installation of the detector on your GC, perform the FID Checkout as described in Section II of the TRACE GC 2000 Standard Operating Procedures manual PN 31709200.

Parameters Setting

1. To open FID menu, press **LEFT DETECTOR** or **RIGHT DETECTOR** depending on the location of the detector. The following menu is displayed:

LEFT DETECTOR (FID)[1]		
Flame		Off
Base temp	250	250
Signal pA[2]	(5.5)	
Ign.thresh[2]	2.0	
Flameout retry[2]	Off	
H2[3]	35	35
Air[3]	350	350
Mkup N2[3]	30	30<

1. These settings could also be for a right detector.
2. This parameter lines will be displayed according to the Range parameter in the DETECTOR SIGNAL menu. See *Range Parameter* on page 16.
3. If you have a non-DGFC module, the actual value are not displayed, and you can only turn the flows on and off.

2. To open FID Signal menu, press **LEFT SIGNAL** or **RIGHT SIGNAL** according to the location of the detector. The following menu is displayed:

LEFT SIGNAL (FID)[1]	
Output	(1000)
Offset	100
Auto zero?	Y/N
Range 10^(0..3)	0<
Analog filter	Off

1. These settings could also be for a right signal

Range Parameter

The `Range 10^` parameter is an input attenuation value. It is set from 0 (high sensitivity) to 3 (low sensitivity). The dynamic of the FID card is as follows:

Range	Input Signal	Output Signal
0	1 nA	1 Volt
1	10 nA	1 Volt
2	100 nA	1 Volt
3	1 µA	1 Volt

This means that if we have a small variation (in pA) of the baseline value when the `Range 10^` is set 0 or 1, the input amplifier circuit of FID card can read it, and, according with threshold value set, can qualify the Flameout retry (if it is set ON). If the `Range 10^` is set 2 or 3, the small variation (in pA) of the baseline is not detected from the FID card. For this reason, when the `Range 10^` is set 2 or 3, the `Signal pA`, `Ign. thresh` and `Flameout retry` parameters will be not displayed in the **`DETECTOR FID`** menu.

B

Nitrogen Phosphorus Detector

This appendix contains the manual **NPD Installation Instructions** (PN M 317 09 329) which provides the instructions to install and configure the Nitrogen Phosphorus Detector on your TRACE GC 2000.

Guide at a Glance...

Operating Procedures

About This Guide

It provides the instructions to install and configure the Nitrogen Phosphorus on your TRACE GC™ 2000.

NOTE For Conventions, Symbols and Costumer Communications, please refer to the TRACE GC 2000 Operating Manual.

Introduction

The upgrade kit contains all the material required to install the Nitrogen Phosphorus Detector on your TRACE GC 2000:

- NPD Assembly for TRACE
- NPD Control Card
- Transformer for NPD
- NPD Standard Outfit

CAUTION **The detector gas control module is not part of this kit.**

Who Performs the Installation of the Kit

If, for any reason, the kit is not installed by ThermoQuest technical personnel, you must carefully adhere to the following instructions.

Detector Gases Requirements

The NPD requires air and hydrogen as fuel gases and nitrogen or helium as make-up gas. Make-up gas is not necessary when packed column is used.

According to the required gases, the DGFC or the Non-DGFC module is:

- Type AD for the control of air, hydrogen and make-up gas.

1. Verify that the detector gas control module installed on your GC is compatible with the NPD gas requirements.
2. The connections of the detector gases must be performed as described in the following table:

Installed Module	Connect Hydrogen to	Connect Air to	Connect Make-up Gas to
AD	Gas 2	Gas 1	Gas 3

For further details, refer to *Chapters 15* and *Chapter 16* of the TRACE GC 2000 Operating Manual.

Transformer for NPD

To supply NPD, the dedicated transformer provided must be installed on the Power Control Module of the GC.

WARNING! This operation must be carried out by authorized ThermoQuest technical personnel.

Getting Started

This paragraph contains the instruction to install the NPD on your GC.
To properly install the NPD upgrade kit, the following sequential operations must be performed:

- Remove the top, right side and rear panels of the GC.
- Install the detector control card into the GC electronic compartment (control unit).
- Remove the GC Power Control Module
- Mount the transformer for NPD.
- Mount the NPD on the GC.
- Remount GC panels.
- Restart the GC.
- Configure the transformer.
- Configure the detector.

Before starting, the following preliminary operations must be carried out:

1. Cool the oven and detector base body to room temperature.
2. Make sure that the detector base body is leak free.
3. Close the gas supplies.
4. Turn off the main power on the rear panel of the GC.
5. Disconnect the main power cable from the rear of the GC.

Installing NPD Upgrade Kit

Follow this instruction to properly install the NPD Upgrade Kit.

1. Injector and detector cassette	2. Column oven door
3. Upper cover	4. Right hand-side panel

Figure B-1. TR ACE GC 2000

Removing the GC Panels

This operation allows to access the GC upper parts and the electronic compartment.

Material needed:

- 2-mm Allen wrench
- 3-mm Allen wrench

Remove the GC Top Cover

1. Lift the detector cover off the GC top cover.

2. Open the oven door and unscrew the two top cover fastening screws.

3. Push the cover back about 1 cm and lift it up and off the GC.

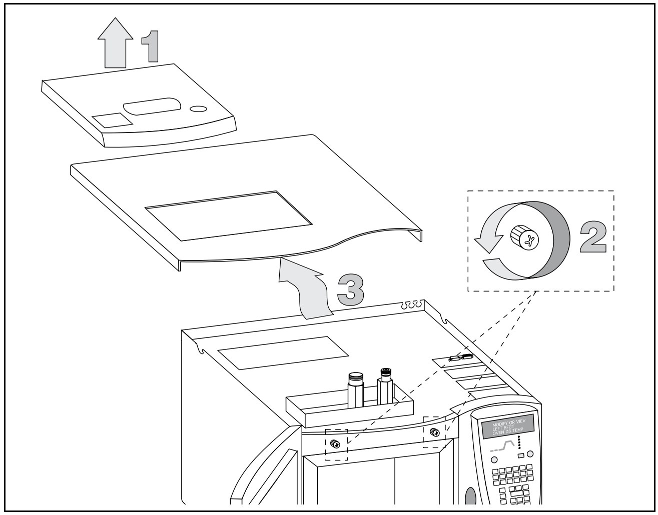


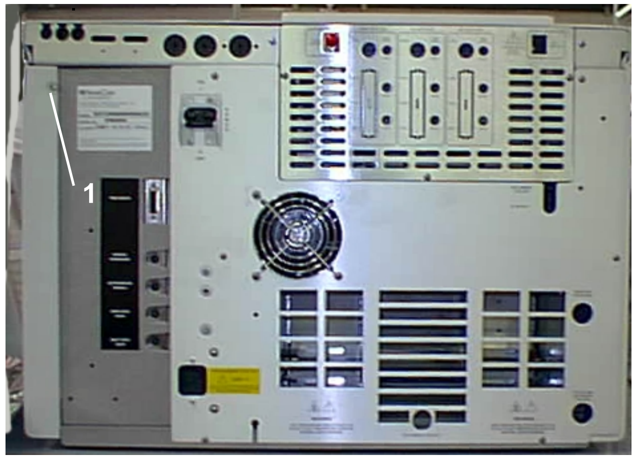
Figure B-2. TRACE GC 2000 Top Cover

Remove the GC Right Side Panel

1. Loosen and remove the screw that secures the right side panel to the right upper rear corner of the GC by using the 3-mm Allen wrench. Refer to Figure B-3.

2. Slide the side panel towards the back of the GC and then tilt the top of the side panel outwards. Continue to slide the panel towards the rear of the GC.

3. Hold the side panel parallel to the GC, and pull the lower edge of the panel away from the GC.



1. Right Panel Securing Screw

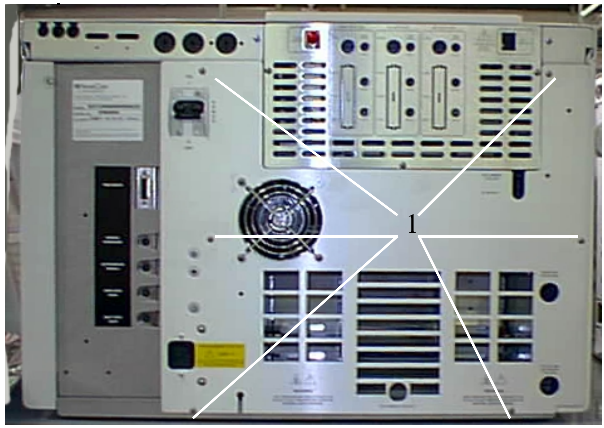
Figure B-3. TRACE GC 2000 Rear Panel

Remove the GC Rear Panel

1. Locate the six Allen screws that secure the rear panel to the GC. Remove these screws using the 2-mm Allen wrench. See Figure B-4.

2. Carefully remove the rear panel of the GC. Be aware that the cooling fan is attached to the rear panel.

NOTE Pay attention to the positioning of the cooling fan plug, so it can be reconnected in the same way it was removed.



1. Rear Panel Fixing Screws

Figure B-4. GC Rear Panel Fixing Screws

Installing the NPD Control Card

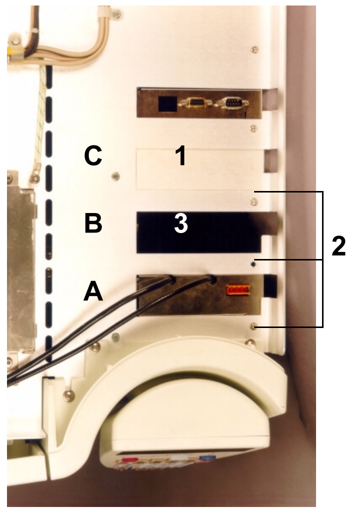
The NPD control card must be installed into the proper expansion slot marked A, B or C located on the left part of the GC mother board in the electronic compartment. Refer to Figures B-5 and B-6.

NOTE In the case all the expansion slots are occupied, it is necessary to remove one of the three detector control card currently installed and replace it with the NPD control card.

Materials needed:

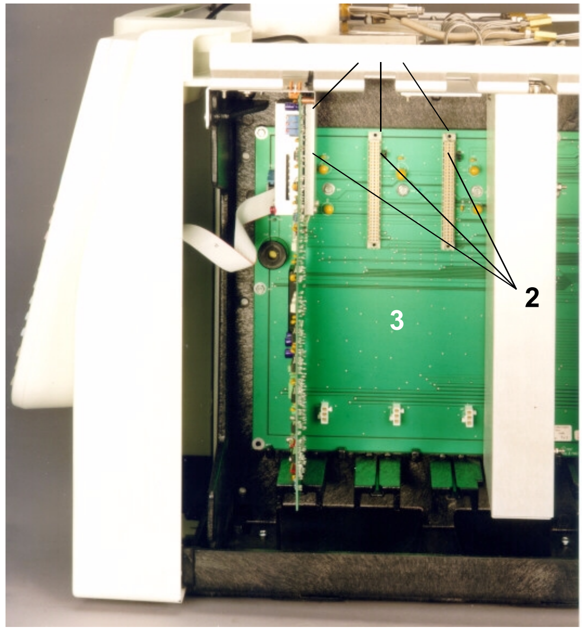
- 3-mm Allen wrench

1. Loosen the fixing screw of the slot cover plate that corresponds to the selected A, B or C expansion slot on the mother board.



1. Slot cover plate	2. Cover plates fixing screw
3. Free slot	A B C. Extension slot position

Figure B-5. Extension Slots Top View



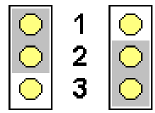
1. Detector control card expansion Slots	2. Additional heat control jumpers
3. Mother board	

Figure B-6. Detector Control Card Expansion Slots

2. Verify that the jumper (marked *J6, J7,* or *J8*), adjacent to the defined detector control card connector on the mother board, is positioned between the pins 2 and 3. Refer to the following table.

Expansion slot	Corresponding Jumper
A	J8
B	J7
C	J6

Jumper Positioning



Pins 1-2 = additional heat control **enabled**

Pins 2-3 = additional heat control **not enabled**

WARNING! The jumper (marked J6, J7, or J8) must be positioned between the pins 2 and 3.

3. Guide through the slot mentioned at point 1 the signal and ignition cables coming from the top of the card.

4. Plug the detector control card into the selected expansion slot on the mother board.

5. Fix the control card by using the same screw previously removed at point 1.

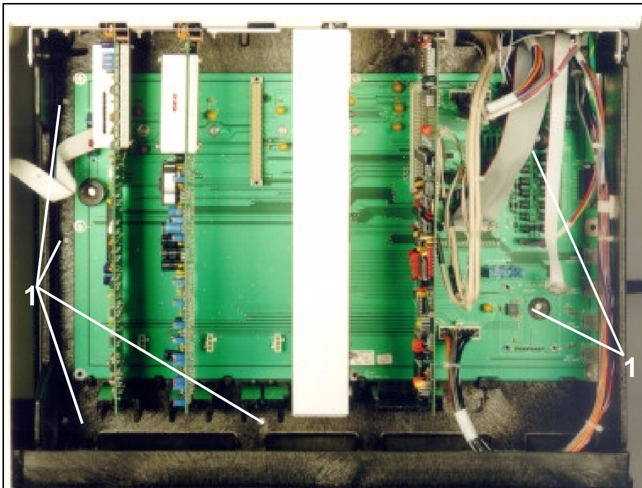
Removing the Power Control Module

Materials Needed:

- Phillips screwdriver

Six screws fix the Power Control Module. Two large Phillips screws are located in the rear of the right hand-side of the GC, while the remaining four screws are located just behind the front panel of the GC.

1. Remove the six screws. Refer to Figure B-7.

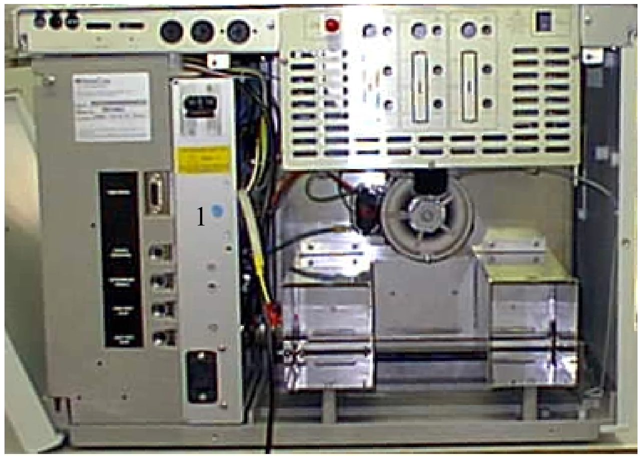


1. Large Phillips Screws

Figure B-7. TRACE GC 2000 Right Side View

2. Slide the Power Control Module very slowly and gently outward towards the rear of the GC. See Figure B-8 on page 370.

CAUTION **This operation requires particular attention because several cables are connected to the Power Control Module. It must be removed gradually paying attention to disconnect step by step all the cables available until the power control module is completely free. Be very careful not to damage any wire during this operation.**



1. Power Control Module

Figure B-8. TRACE GC 2000 Rear View

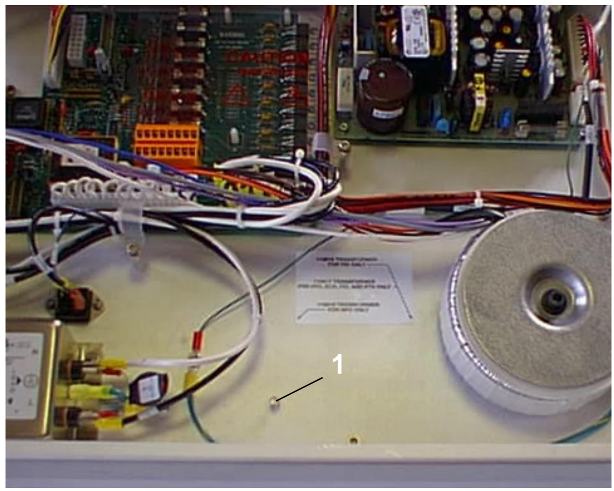
3. As the Power Control Module is being removed, disconnection of the parts must be carried out in the following order:

- J1, 16-pin white connector.
- J8, 2-pin connector.
- J11, 16-pin white connector located in the upper rear quadrant of the chassis.
- J13, ribbon cable.
- Oven heater wire connected to the oven heater triac.
- TB1 and TB2, orange terminal strips for the heater wire connections.
- J17, oven blower motor.
- J8, second oven heater wire.
- Chassis ground wire from the GC rear oven terminal.

4. Place the Power Control Module on a free working table.

Install the Transformer for Detector

Figure B-9 shows the positions on the GC Power Control Module where the detector trasformer must be installed.



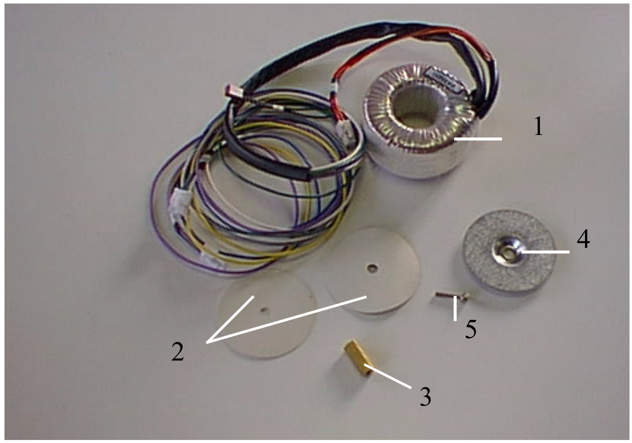
1. Installation Position of the Transformer for NPD

Figure B-9. Transformer Installation

Install the transformer proceeding as follows. To identify the parts, refer to Figure B-10 on page 372.

1. Screw the spacer on the threaded pin.
2. Insert the first protection disk on the spacer.
3. Place the transformer over the protection disk.
4. Place the second protection disk over the transformer.
5. Place the metal plate over the assembly.
6. Insert the fixing screw in the spacer passing through the metal plate.

7. Screw until the transformer assembly is blocked.



1. Transformer	2. Protection disks
3. Spacer	4. Metal Plate
5. Fixing Screw	

Figure B-10. Transformer Assembly Identification Parts

The transformer has three cables and four female connectors marked “**Px**”. Connect the female connectors to the corresponding male connectors marked “**Jx**”on the power control module PCB (J14, J15) and on the mother board PCB (J35, J36, J37) depending where the NPD board has been installed.

Cable Connector	Connect To...
P15	J15
P4	J4
P35 or 36	J35 or 36
P36 or 37	J36 or 37

The result of the operation is shown in Figure B-11 on page 373.

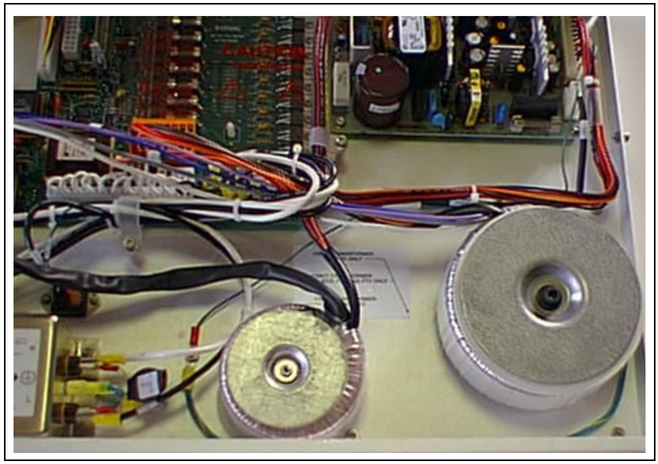


Figure B-11. Installation of the Transformer for NPD

Reinstall the Power Control Module

CAUTION **This operation requires particular attention because several cables must be reconnected to the Power Control Module. It must be gradually reinserted paying attention to reconnect step by step all the cables until the power control module is completely reinstalled into the GC.**

1. Reconnect the previous disconnected connections in the reverse order of their removal.
2. Secure the six Phillips screws that fix the Power Control Module in place.
3. Reconnect the chassis ground wire to the GC rear oven terminal.

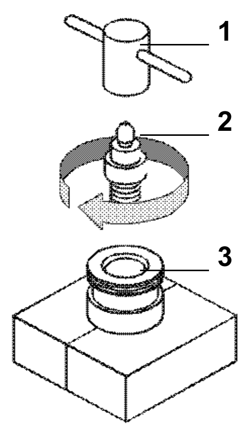
Mounting the NPD on the GC

This operation allows the correct installation of the NPD on your TRACE GC 2000.

Materials needed:

- Jet for NPD
- Tool for jet

1. Place the jet into the detector base body housing and tighten it with the proper tool. Ensure the jet is perfectly vertically aligned to avoid damaging its ceramic part. Refer to Figure B-12.

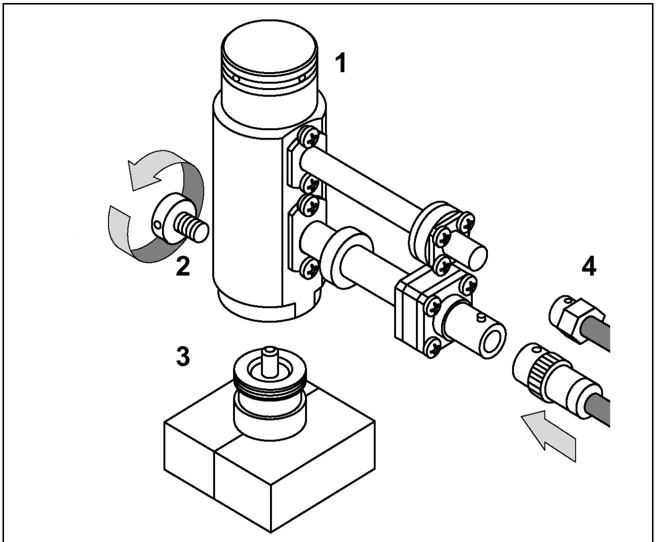


1. Tool for jet	2. Jet
3. Detector base body	

Figure B-12. Jet for NPD

2. Install the NPD on the detector base body and secure it by using the fixing screw on the front of the detector cell. Refer to Figure B-13 on page 375.

3. Carefully, connect the signal and ignition polarization cables coming from the detector control card, to the detector cell. Refer to Figure B-13 on page 375.



1. NPD	2. Fixing screw
3. Detector base body	4. Signal cable
5. Ignition polarization cable	

Figure B-13. Installation of the NPD

Reinstall the GC Panels

This operation allows to reinstall the GC panels

Materials needed:

- 3-mm Allen wrench

1. Reconnect the chassis ground wire to the GC rear oven terminal.
2. Reinstall all the GC panels proceeding in the reverse order of their removal (refer to *Removing the GC Panels* on page 362) being sure to reconnect the rear panel cooling fan.

Restarting the GC

1. Verify that the connections of the detector gases has been correctly performed.
2. Open the gas supplies.
3. Reconnect the main power.
4. Turn on main power.

Configuration

This paragraph contains the instructions to configure your GC to operate with NPD. The following operations must be performed:

- Hardware Configuration
- Detector and Make-up Gas Configuration

Configuring Hardware, Detector and Make-up Gas

Hardware Configuration

This operation must be performed to verify if the GC has recognized the presence of the transformer previously installed.

1. Press **INFO/DIAG** twice to open **`Diagnostics`** menu.
2. Scroll to `Hardware Config` and press **ENTER**.
3. Address the hardware configuration menu. Scroll down until the type of transformer installed in the system is displayed.
4. If not, verify the transformer connections.

Detector and Make-up Gas Configuration

You configure the detector and make-up gas in the **`CONFIGURE`** menu. Refer to *Chapter 15* of the TRACE GC 2000 Operating manual.

1. Press **CONFIG** then scroll to `Left detector` or `Right detector` depending on the location of the detector to configure. Press **ENTER** to open the detector gas menu.

```
LEFT  DETECTOR
  Detector  type          <
Makeup gas[1]
```

1 This line appears only if the DGFC module is present. Refer to note.

2. Select `Detector type`. This line indicates the type of detector mounted and the slot (A, B or C) of the relevant control board. Press **ENTER** to display the submenu.

3. To change detector type, scroll to the desired detector and press **ENTER** to confirm the selection. An asterisk appears beside the detector selected.

4. When the DGFC Module is present scroll to `Makeup gas` and press **ENTER**. The gases applicable to the detector in use are displayed in the submenu. An asterisk appears beside the currently active make-up gas is also displayed in parentheses in the title bar.

5. To change the make-up gas, scroll to the desired gas and press **ENTER** to confirm the selection. An asterisk appears beside the make-up gas selected.

Set NPD Parameters

To set NPD parameters, it is necessary to open the NPD menu and the NPD Signal menu.

- The **DETECTOR (NPD)** menu contains the detector control parameters. To set parameters, refer to the Chapter 16 of the TRACE GC 2000 Operating Manual.
- The **DETECTOR SIGNAL** menu contains the parameters that control the detector signal. To set parameters, refer to the Chapter 15 of the TRACE GC 2000 Operating Manual.

NOTE To verify the correct installation of the detector on your GC, perform the NPD Checkout as described in Section IV of the TRACE GC 2000 Standard Operating Procedures manual PN 31709200.

Parameters Setting

1. To open NPD menu, press **LEFT DETECTOR** or **RIGHT DETECTOR** depending on the location of the detector. The following menu is displayed:

LEFT DETECTOR (NPD)[1]		
Source curr.A		2.740
Base temp	300 300	
Signal pA	(10.4)	
Polarizer V	3.5	
H2 delay time	Off	
H2[2]	2.3 2.3	
Air[2]	60 60	
Mkup N2[2]	15 15<	

1. These settings could also be for a right detector.

2. If you have a non-DGFC module, the actual value are not displayed, and you can only turn the flows on and off.

2. To open NPD Signal menu, press **LEFT SIGNAL** or **RIGHT SIGNAL** according to the location of the detector. The following menu is displayed:

LEFT SIGNAL (NPD)[1]	
Output	(1000)
Offset	100
Auto zero?	Y/N
Range 10^(0..3)	0<
Analog filter	Off

1. These settings could also be for a right signal

C

Flame Photometric Detector

This appendix contains the manual **FPD Installation Instructions** (PN M 317 09 331) which provides the instructions to install and configure the Flame Photometric Detector on your TRACE GC 2000.

Guide at a Glance...

Operating Procedures

About This Guide

It provides the instructions to install and configure the Flame Photometric Detector on your TRACE GC™ 2000.

NOTE For Conventions, Symbols and Costumer Communications, please refer to the TRACE GC 2000 Operating Manual.

Introduction

The upgrade kit contains all the material required to install the Flame Photometric Detector on your TRACE GC 2000:

- FPD Assembly for TRACE
- FPD Control Card
- FPD Standard Outfit

CAUTION **The detector gas control module is not part of this kit.**

Who Performs the Installation of the Kit

If, for any reason, the kit is not installed by ThermoQuest technical personnel, you must carefully adhere to the following instructions.

Detector Gases Requirements

The FPD requires air and hydrogen as fuel gases. FPD applications typically do not require the use of the make-up gas.

According to the required gases, the DGFC or the Non-DGFC module may be:

- Type AB for the control of air and hydrogen.
- Type AD for the control of air and hydrogen.
- Type AC for the control of air, hydrogen and make-up gas.

1. Verify that the detector gas control module installed on your GC is compatible with the FPD gas requirements.

2. The connections of the detector gases must be performed as described in the following table:

Installed Module	Connect Hydrogen to	Connect Air to	Connect Make-up Gas to
AB	Gas 2	Gas 1	—
AC	Gas 2	Gas 1	Gas 3
AD	Gas 3	Gas 1	—

For further details, refer to *Chapters 15* and *Chapter 16* of the TRACE GC 2000 Operating Manual.

Getting Started

This paragraph contains the instruction to install the FPD on your GC.
To properly install the FPD upgrade kit, the following sequential operations must be performed:

- Remove the top and right side panels of the GC.
- Install the detector control card into the GC electronic compartment (control unit).
- Mount the FPD on the GC.
- Remount GC panels.
- Restart the GC.
- Configure the detector.

Before starting, the following preliminary operations must be carried out:

1. Cool the oven and detector base body to room temperature.
2. Make sure that the detector base body is leak free.
3. Close the gas supplies.
4. Turn off the main power on the rear panel of the GC.
5. Disconnect the main power cable from the rear of the GC.

Installing FPD Upgrade Kit

Follow this instruction to properly install the FPD Upgrade Kit.

1. Injector and detector cassette	2. Column oven door
3. Upper cover	4. Right hand-side panel

Figure C-1. TRACE GC 2000

Removing the GC Panels

This operation allows to access the GC upper parts and the electronic compartment.

Materials needed:

- 2-mm Allen wrench
- 3-mm Allen wrench

Remove the GC Top Cover

1. Lift the detector cover off the GC top cover.

2. Open the oven door and unscrew the two top cover fastening screws.

3. Push the cover back about 1 cm and lift it up and off the GC.

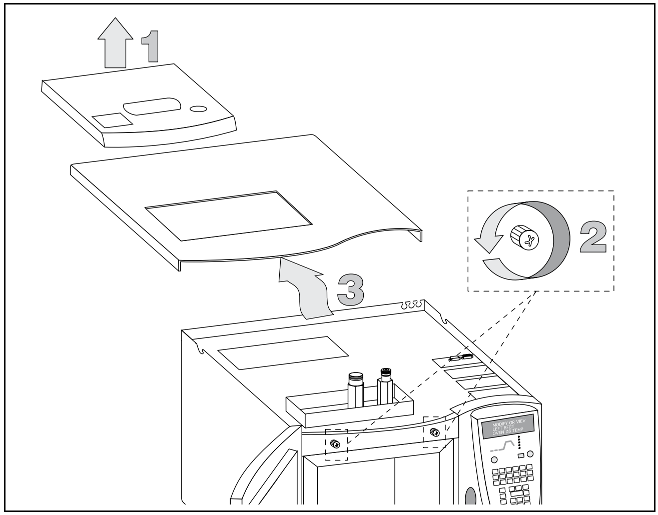


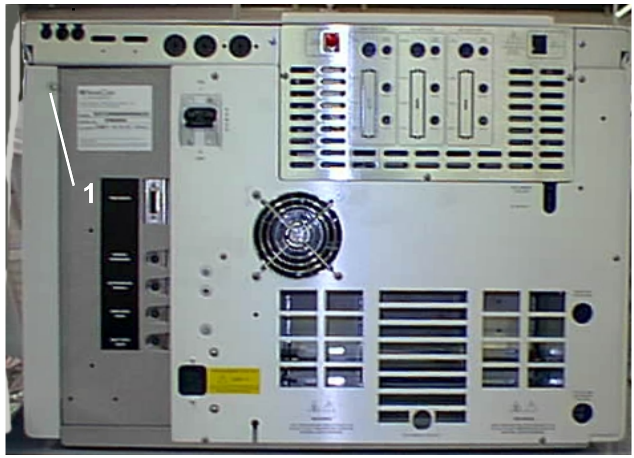
Figure C-2. TRACE GC 2000 Top Cover

Remove the GC Right Side Panel

1. Loosen and remove the screw that secures the right side panel to the right upper rear corner of the GC by using the 3-mm Allen wrench. Refer to Figure C-3.

2. Slide the side panel towards the back of the GC and then tilt the top of the side panel outwards. Continue to slide the panel towards the rear of the GC.

3. Hold the side panel parallel to the GC, and pull the lower edge of the panel away from the GC.



1. Right Panel Securing Screw

Figure C-3. TRACE GC 2000 Rear Panel

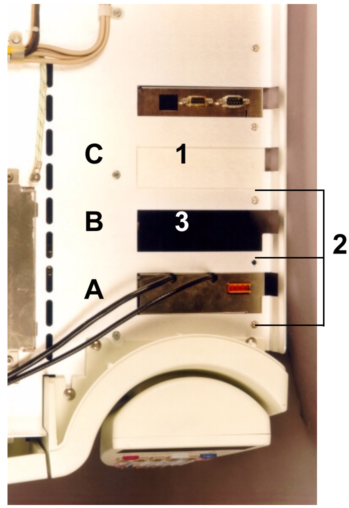
Installing the FPD Control Card

The FPD control card must be installed into the proper expansion slot marked A, B or C located on the left part of the GC mother board in the electronic compartment. Refer to Figures C-4 and C-5.

NOTE If all expansion slots are occupied, remove one of the three detector control cards currently installed and replace it with the FPD control card.

Materials needed:

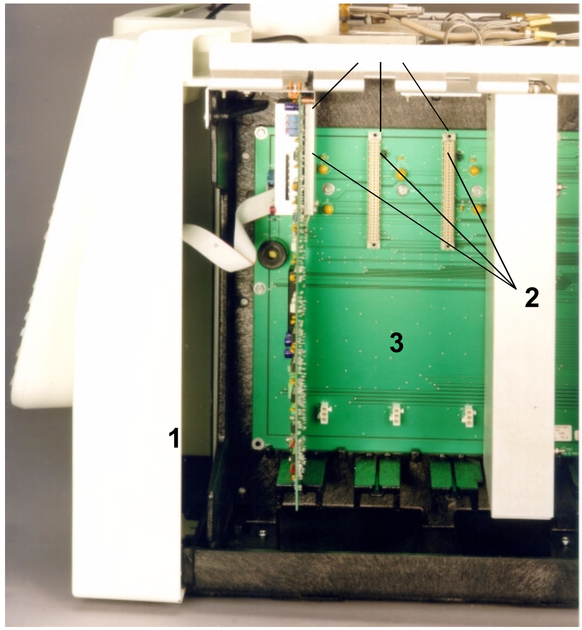
- 3-mm Allen wrench



1. Slot cover plate	2. Cover plates fixing screw
3. Free slot	A B C. Extension slot position

Figure C-4. Extension Slots Top View

1. Loosen the fixing screw of the slot cover plate that corresponds to the selected A, B or C expansion slot on the mother board.



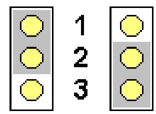
1. Detector control card expansion Slots	2. Additional heat control jumpers
3. Mother board	

Figure C-5. Detector Control Card Expansion Slots

2. Verify that the jumper (marked *J6, J7,* or *J8*), adjacent to the defined detector control card connector on the mother board, is positioned between the pins 1 and 2. Refer to the following table.

Expansion slot	Corresponding Jumper
A	J8
B	J7
C	J6

Jumper Positioning



Pins 1-2 = additional heat control **enabled**

Pins 2-3 = additional heat control **not enabled**

WARNING! The jumper marked "Jx" must be positioned between the pins 1 and 2.

3. Guide through the slot mentioned at point 1 the signal and ignition cables coming from the top of the card.

4. Plug the detector control card into the selected expansion slot on the mother board.

5. Fix the control card by using the same screw previously removed at point 1.

6. Connect the ignition/hetaing cable to the connector located on the top of the detector control card.

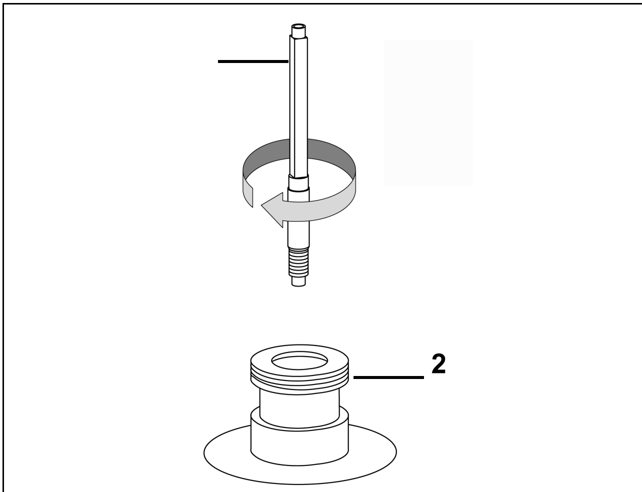
Mounting the FPD on the GC

This operation allows the correct installation of the FPD on your TRACE GC 2000.

Materials needed:

- Jet for FPD
- 5-mm wrench
- FPD fixing tool.

1. Place the jet into the detector base body housing and tighten it. Ensure the jet is perfectly vertically aligned to avoid damage.

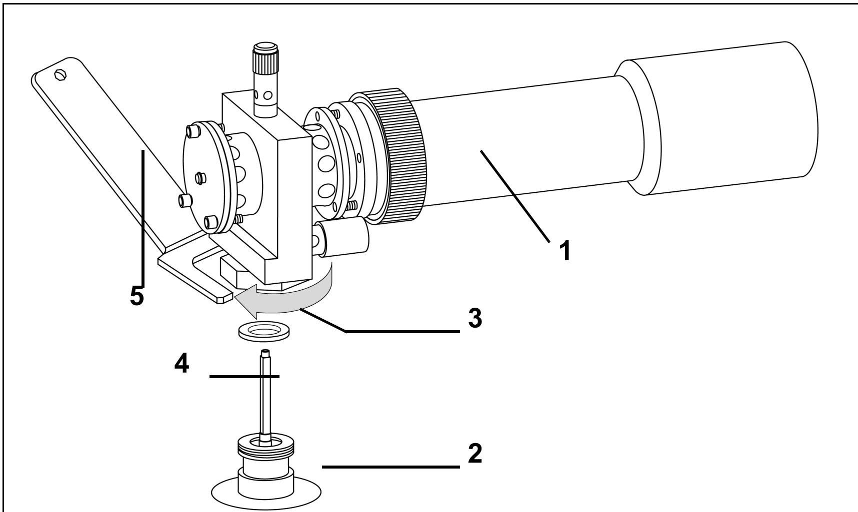


1. Jet	2 .Detector Base Body

Figure C-6. Jet for FPD

2. Place the FPD on the detector base body, paying attention that the alluminium ring has been inserted in the correct position.

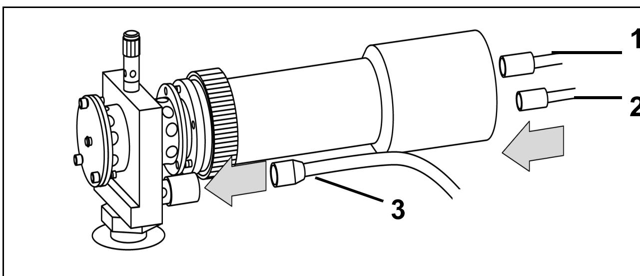
3. Tighten the fixing nut by using the FPD fixing tool.



1. FPD	2. Detector Base Body
3. Aluminium ring	4. Jet
5. FPD Fixing Tool	

Figure C-7. Installation of the FPD

4. Carefully, connect the signal, excitation voltage and ignition/heating cables coming from the detector control card, to the detector cell.



1. Signal Cable	2. Excitation Voltage Cable
3. Ignition/heating Cable	

Figure C-8. Cables Connection

Reinstall the GC Panels

This procedure reinstalls the GC panels.

Materials needed:

- 3-mm Allen wrench

1. Reconnect the chassis ground wire to the GC rear oven terminal.
2. Reinstall all the GC panels proceeding in the reverse order of their removal (refer to *Removing the GC Panels* on page 386) being sure to reconnect the rear panel cooling fan.

Restarting the GC

1. Verify that the connections of the detector gases has been correctly performed.
2. Open the gas supplies.
3. Reconnect the main power.
4. Turn on main power.

Configuration

This paragraph contains the instructions to configure your GC to operate with FPD. You configure the detector and make-up gas in the **`CONFIGURE`** menu. Refer to *Chapter 15* of the TRACE GC 2000 Operating manual.

Configuring Detector and Make-up Gas

1. Press **CONFIG** then scroll to `Left detector` or `Right detector` depending on the location of the detector to configure. Press **ENTER** to open the detector gas menu.

LEFT DETECTOR
Detector type <
Makeup gas[1]

1. This line appears only if the DGFC module is present. Refer to note.

2. Select `Detector type`. This line indicates the type of detector mounted and the slot (A, B or C) of the relevant control board. Press **ENTER** to display the submenu.

3. To change detector type, scroll to the desired detector and press **ENTER** to confirm the selection. An asterisk appears beside the detector selected.

4. When the DGFC Module is present scroll to `Makeup gas` and press **ENTER**. The gases applicable to the detector in use are displayed in the submenu. An asterisk appears beside the currently active make-up gas is also displayed in parentheses in the title bar.

5. To change the make-up gas, scroll to the desired gas and press **ENTER** to confirm the selection. An asterisk appears beside the make-up gas selected.

Set FPD Parameters

To set FPD parameters, it is necessary to open the FPD menu and the FPD Signal menu.

- The **DETECTOR (FPD)** menu contains the detector control parameters. To set parameters, refer to the Chapter 16 of the TRACE GC 2000 Operating Manual.
- The **DETECTOR SIGNAL** menu contains the parameters that control the detector signal. To set parameters, refer to the Chapter 15 of the TRACE GC 2000 Operating Manual.

NOTE To verify the correct installation of the detector on your GC, perform the FPD Checkout as described in Section V of the TRACE GC 2000 Standard Operating Procedures manual PN 31709200.

Parameters Setting

1. To open FPD menu, press **LEFT DETECTOR** or **RIGHT DETECTOR** depending on the location of the detector. The following menu is displayed:

LEFT DETECTOR (FPD)[1]		
Flame		Off
Base temp	300 300	
FPD temp	150 150	
Signal pA	(1.4)	
High voltage mode?	N	
H2[2]	90 90	
Air[2]	115 115	
Mkup N2[2]	00 00	

1. These settings could also be for a right detector.

2. If you have a non-DGFC module, the actual value are not displayed, and you can only turn the flows on and off.

2. To open FPD Signal menu, press **LEFT SIGNAL** or **RIGHT SIGNAL** according to the location of the detector. The following menu is displayed:

LEFT SIGNAL (FPD)[1]	
Output	(1000)
Offset	100
Auto zero?	Y/N
Range 10^(0..2)	0<
Analog filter	Off

1. These settings could also be for a right signal

D

Photoionization Detector

This appendix contains the manual **PID Installation Instructions** (PN M 317 09 333) the instructions to install and configure the Photoionization Detector on your TRACE GC 2000.

Guide at a Glance...

Operating Procedures

About This Guide

It provides the instructions to install and configure the Photoionization Detector on your TRACE GC™ 2000.

NOTE For Conventions, Symbols and Costumer Communications, please refer to the TRACE GC 2000 Operating Manual.

Introduction

The upgrade kit contains all the material required to install the Photoionization Detector on your TRACE GC 2000:

- PID Assembly for TRACE
- PID Control Card
- PID Standard Outfit

CAUTION **The detector gas control module and the UV lamp for PID are not parts of this kit.**

Who Performs the Installation of the Kit

If, for any reason, the kit is not installed by ThermoQuest technical personnel, you must carefully adhere to the following instructions.

Detector Gases Requirements

The PID requires helium or nitrogen as make-up and sheath gas.

According to the required gases, the DGFC or the Non-DGFC module may be:

- Type AB, AC or AD for the control of make-up and sheath gas.

1. Verify that the detector gas control module installed on your GC is compatible with the PID gas requirements.
2. The connections of the detector gases must be performed as described in the following table:

Installed Module	Connect Make-up Gas to	Connect Sheath Gas to
AB	Gas 2	Gas 1
AC	Gas 3	Gas 1
AD	Gas 3	Gas 1

For further details, refer to *Chapters 15* and *Chapter 16* of the TRACE GC 2000 Operating Manual.

Getting Started

This paragraph contains the instruction to install the PID on your GC.
To properly install the PID upgrade kit, the following sequential operations must be performed:

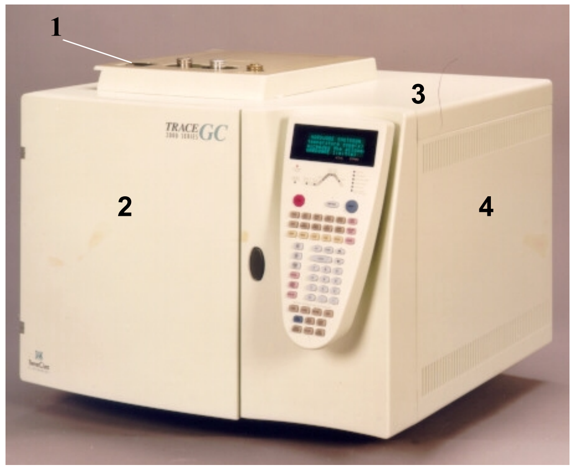
- Remove the top and right side panels of the GC.
- Install the detector control card into the GC electronic compartment (control unit).
- Mount the PID on the GC.
- Connect the capillary column and the exit line
- Remount GC panels.
- Restart the GC.
- Configure the detector.

Before starting, the following preliminary operations must be carried out:

1. Cool the oven and detector base body to room temperature.
2. Make sure that the detector base body is leak free.
3. Close the gas supplies.
4. Turn off the main power on the rear panel of the GC.
5. Disconnect the main power cable from the rear of the GC.

Installing PID Upgrade Kit

Follow this instruction to properly install the PID Upgrade Kit.



1. Injector and detector cassette	2. Column oven door
3. Upper cover	4. Right hand-side panel

Figure D-1. TRACE GC 2000

Removing the GC Panels

This operation allows to access the GC upper parts and the electronic compartment.

Materials needed:

- 2-mm Allen wrench
- 3-mm Allen wrench

Remove the GC Top Cover

1. Lift the detector cover off the GC top cover.
2. Open the oven door and unscrew the two top cover fastening screws.

3. Push the cover back about 1 cm and lift it up and off the GC.

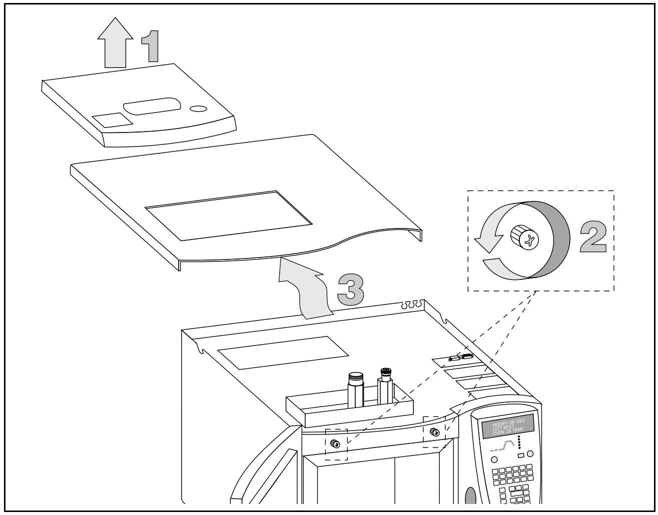


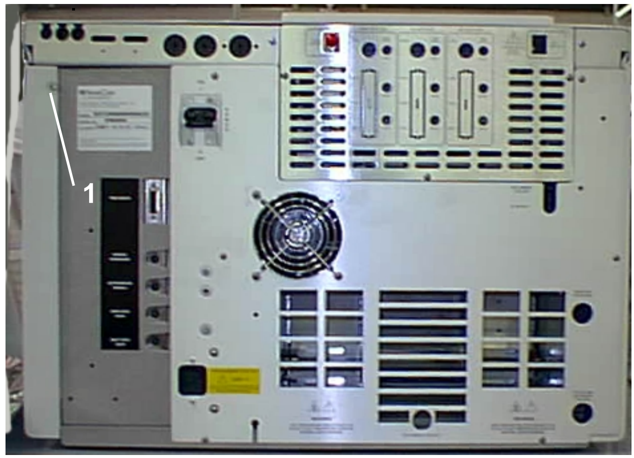
Figure D-2. TRACE GC 2000 Top Cover

Remove the GC Right Side Panel

1. Loosen and remove the screw **1** that secures the right side panel to the right upper rear corner of the GC by using the 3-mm Allen wrench. Refer to Figure D-3.

2. Slide the side panel towards the back of the GC and then tilt the top of the side panel outwards. Continue to slide the panel towards the rear of the GC.

3. Hold the side panel parallel to the GC, and pull the lower edge of the panel away from the GC.



1. Right Panel Securing Screw

Figure D-3. TRACE GC 2000 Rear Panel

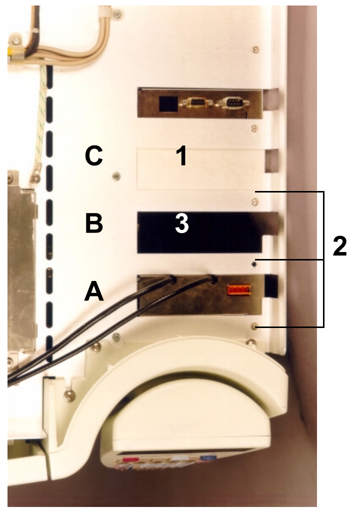
Installing the PID Control Card

The PID control card must be installed into the proper expansion slot marked A, B or C located on the left part of the GC mother board in the electronic compartment.

NOTE In the case all the expansion slots are occupied, it is necessary to remove one of the three detector control card currently installed and replace it with the PID control card.

Materials needed:

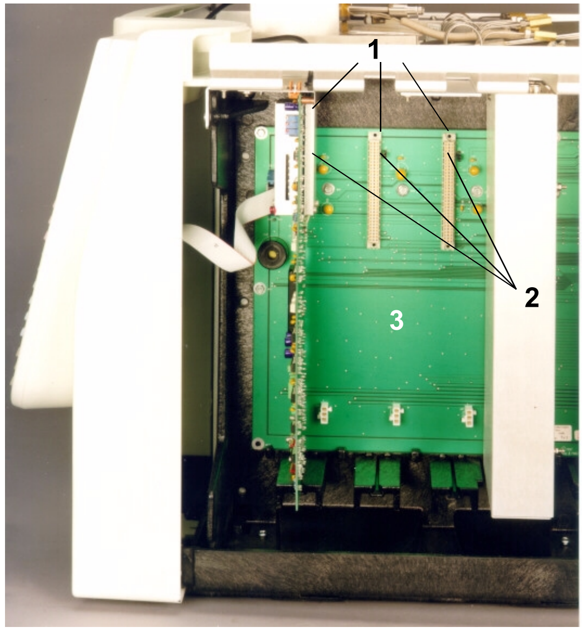
- 3-mm Allen wrench



1. Slot cover plate	2. Cover plates fixing screw
3. Free slot	A B C. Extension slot position

Figure D-4. Extension Slots Top View

1. Loosen the fixing screw of the slot cover plate that corresponds to the selected A, B or C expansion slot on the mother board.



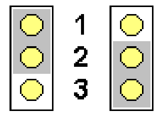
1. Detector control card expansion Slots	2. Additional heat control jumpers
3. Mother board	

Figure D-5. Detector Control Card Expansion Slots

2. Verify that the jumper (marked *J6, J7,* or *J8*) adjacent to the defined detector control card connector on the mother board, is positioned between the pins 2 and 3. Refer to the following table.

Expansion slot	Corresponding Jumper
A	J8
B	J7
C	J6

Jumper Positioning



Pins 1-2 = additional heat control **enabled**

Pins 2-3 = additional heat control **not enabled**

WARNING! The jumper (marked J6, J7, J8) must be positioned between the pins 2 and 3.

3. Plug the detector control card into the selected expansion slot on the mother board.

4. Fix the control card by using the same screw previously removed at point 1.

Mounting the PID on the GC

This operation allows the correct installation of the PID on your TRACE GC 2000.

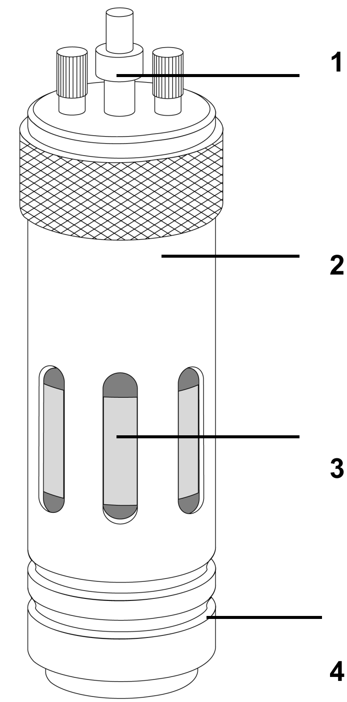
Materials needed:

- UV Lamp
- Fixing Tool

The PID consists of four main sub units. Refer to Figures D-6 and D-7 to identify the parts constituiting the PID.

- *Cell Block*
  It includes the detector cell assembly, the stainless steel bell and the insulation jacket.
- *Lamp Housing*
  It includes the detector cell assembly, the stainless steel bell and the insulation jacket.
- *Lamp Holder*
  It contains the UV lamp with the electrical cable for lamp ignition and operation.

- Heat Sink
  It dissipates the heat of the detector base body.



1. Lamp Holder	2. Heat Sink
3. Lamp Housing	4. Cell Block (not visible)

Figure D-6. PID General View

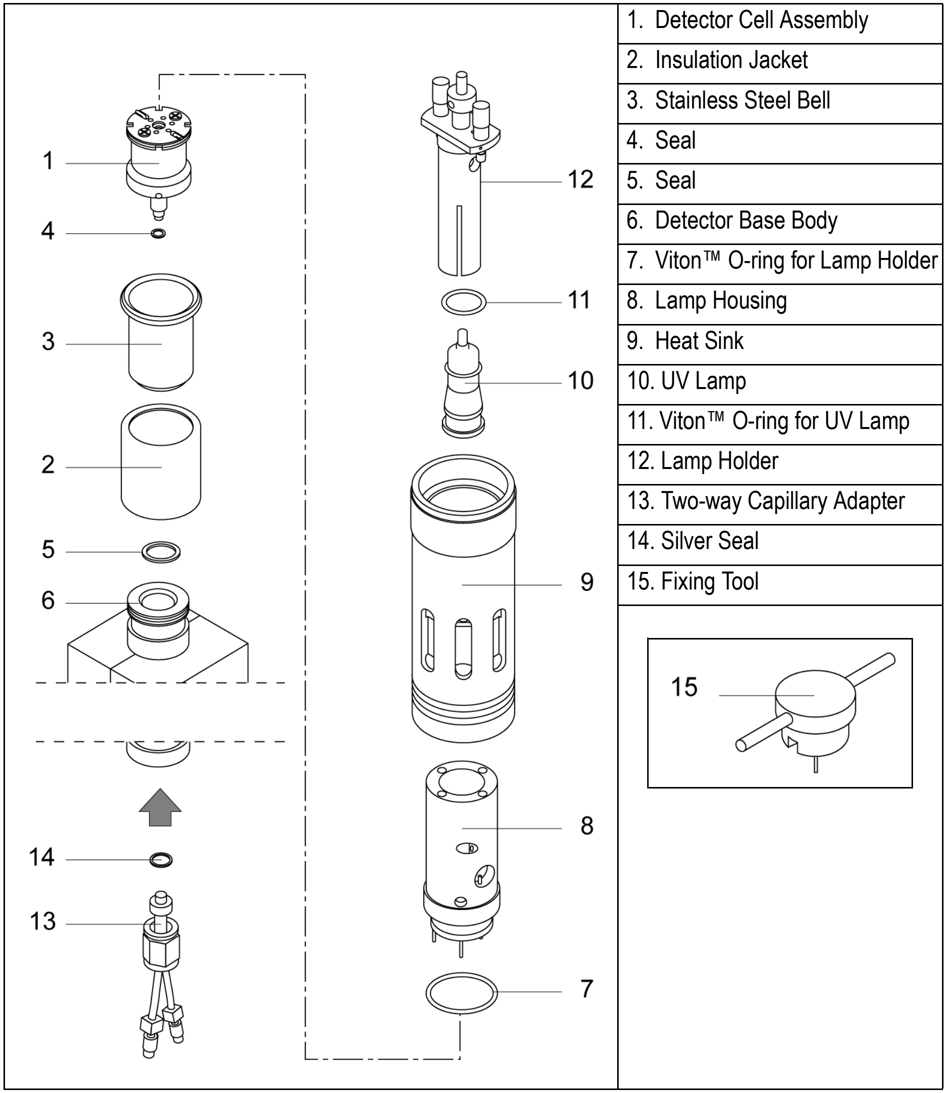


Figure D-7. Explose of the PID Components

To install the PID on the GC detector base body, follow the instruction below: Refer to Figure D-7 to identify the parts.

1. Place the insulation jacket (**2**) on the stainless steel bell (**3**).

2. Put the detector cell assembly (**1**) into the stainless steel bell (**3**) passing the lower threaded section of the cell assembly through the bottom hole of the bell.

3. Install the seal (**5**) on the detector base body surface (**6**) and the seal (**4**) on the threaded section of the cell that goes out from the hole of the bell.

4. Screw the cell block (detector cell assembly + stainless steel bell + insulation jacket) on the detector base body, without overtighten, by using the fixing tool (**15**) provided.

5. Make sure that the Viton™ O-ring (**8**) is correctly positioned on the lower part of the lamp housing (**7**).

6. Pull the electrical cables of the lamp housing (**7**) through the heat sink (**9**) pay attention that the external knurled area of the heat sink is oriented upwards and the internal threaded section must be turned towards the detector base body.

7. Put the lamp housing on the cell block paying attention to the proper insertion of the two orientation pins into the corresponding slots of the cell block.

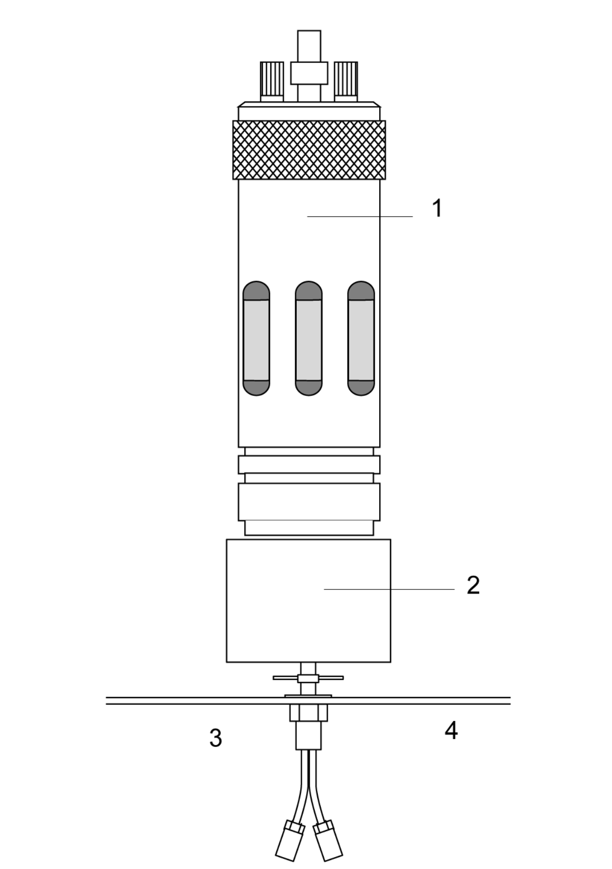
8. Mount the heat sink (**9**) on the lamp housing (**7**), then screw manually the heat sink on the stainless steel bell.

9. Install the UV lamp (**10**), with the Viton ™ O-ring (**11**) on its flange, into the lamp holder (**12**).

WARNING! Never install the UV lamp without the o-ring.

10. Install the lamp assembly (UV lamp + lamp holder) into the lamp housing and ensure screwing the two knurled screws. Refer to *Chapter 12* of the T*RACE GC 2000 Maintenance and Troubleshooting Manual*.

11. Mount the two-way capillary adapter (**13**) to the lower part of the detector base body, inside the GC column oven, interposing the seal (**14**).
The result of the operation is shown in Figure D-8.

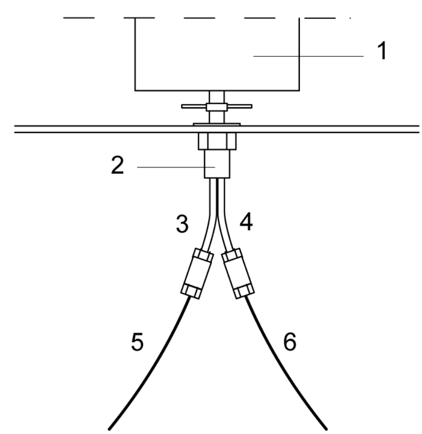


1. PID Assembly	2. Detector Base Body
3. Two-way Capillary Adapter	4. GC Column Oven

Figure D-8. PID Installation Result

Connecting Capillary Column and Exit Line

1. Connect capillary column and exit line to the PID as described in *Chapter 14* (on page 237) of the *TRACE GC 2000 Operating Manual*. The result of the operation is shown in Figure D-9.



1. Detector Base Body	2. Two-way Capillary Adapter
3. Inlet Line	4. Exit Line
5. Capillary Column	6. Exit Line Fused Silica Tubing

Figure D-9. Capillary Column and Exit Line Connections

Reinstall the GC Panels

This operation allows to reinstall the GC panels

Materials needed:

- 3-mm Allen wrench

1. Reconnect the chassis ground wire to the GC rear oven terminal.

2. Reinstall all the GC panels proceeding in the reverse order of their removal (refer to *Removing the GC Panels* on page 404) being sure to reconnect the rear panel cooling fan.

Restarting the GC

1. Verify that the connections of the detector gases has been correctly performed.
2. Open the gas supplies.
3. Reconnect the main power.
4. Turn on main power.

Configuration

This paragraph contains the instructions to configure your GC to operate with PID.

You configure the detector and make-up gas in the **`CONFIGURE`** menu. Refer to *Chapter 15* of the *TRACE GC 2000 Operating manual*.

Configuring Detector and Make-up Gas

1. Press **CONFIG** then scroll to `Left detector` or `Right detector` depending on the location of the detector to configure. Press **ENTER** to open the detector gas menu.

`LEFT DETECTOR`
`Detector type                <`
Makeup gas[1]

1. This line appears only if the DGFC module is present. Refer to note.

2. Select `Detector type`. This line indicates the type of detector mounted and the slot (A, B or C) of the relevant control board. Press **ENTER** to display the submenu.

3. To change detector type, scroll to the desired detector and press **ENTER** to confirm the selection. An asterisk appears beside the detector selected.

4. When the DGFC Module is present scroll to `Makeup gas` and press **ENTER**. The gases applicable to the detector in use are displayed in the submenu. An asterisk appears beside the currently active make-up gas is also displayed in parentheses in the title bar.

5. To change the make-up gas, scroll to the desired gas and press **ENTER** to confirm the selection. An asterisk appears beside the make-up gas selected.

Set PID Parameters

To set PID parameters, it is necessary to open the PID menu and the PID Signal menu.

- The **`DETECTOR (PID)`** menu contains the detector control parameters. To set parameters, refer to the Chapter 16 of the TRACE GC 2000 Operating Manual.
- The **`DETECTOR SIGNAL`** menu contains the parameters that control the detector signal. To set parameters, refer to the Chapter 15 of the TRACE GC 2000 Operating Manual.

NOTE To verify the correct installation of the detector on your GC, perform the PID Checkout as described in Section VI of the TRACE GC 2000 Standard Operating Procedures manual PN 31709200.

Parameters Setting

1. To open PID menu, press **LEFT DETECTOR** or **RIGHT DETECTOR** depending on the location of the detector. The following menu is displayed:

`LEFT DETECTOR (PID)`[1]		
`Lamp`		`Off`
Base temp	300 300	
High current	N <	
Signal pA	(15.4)	
Mkup N2[2]	7.0 7.0	
Sheath Gas[2]	40 40	

1. These settings could also be for a right detector.

2. If you have a non-DGFC module, the actual value are not displayed, and you can only turn

the flows on and off.

2. To open PID Signal menu, press **LEFT SIGNAL** or **RIGHT SIGNAL** according to the location of the detector. The following menu is displayed:

```
LEFT SIGNAL (PID)[1]
 Output                     (1000)
Offset          100
Autozero?         Y/N
Range 10^(0..3)      0<
Analog filter     Off
```

1. These settings could also be for a right signal

E

Electron Capture Detector

This appendix contains the manual **ECD Installation Instructions** (PN M 317 09 335) which provides the instructions to install and configure the Electron Capture Detector on your TRACE GC 2000.

Guide at a Glance...

Operating Procedures

About This Guide

It provides the instructions to install and configure the Electron Capture Detector on your TRACE GC™ 2000.

WARNING! **The Electron Capture Detector (ECD) contains a ^{63}Ni beta-emitting eadioactive source of 370 MBq (10 mCi).**

NOTE For Conventions, Symbols, Safety Information, Wipe Test and Costumer Communications, please refer to the TRACE GC 2000 Operating Manual.

Introduction

The upgrade kit contains all the material required to install the Electron Capture Detector on your TRACE GC 2000:

- ECD Assembly for TRACE
- ECD Control Card
- ECD Standard Outfit
- Wipe Test

CAUTION **The detector gas control module is not part of this kit.**

Who Performs the Installation of the Kit

If, for any reason, the kit is not installed by ThermoQuest technical personnel, you must carefully adhere to the following instructions.

Detector Gases Requirements

The ECD commonly uses nitrogen or argon/methane as make-up gas. According to the required gases, the DGFC or the Non-DGFC module may be:

- Type AA, AB, AC or AD for the control of make-up gas.

1. Verify that the detector gas control module installed on your GC is compatible with the ECD gas requirements.

2. The connections of the detector gases must be performed as described in the following table:

Installed Module	Connect Hydrogen to	Connect Air to	Connect Make-up Gas to
AA	—	—	Gas 3
AB	—	—	Gas 2

Installed Module	Connect Hydrogen to	Connect Air to	Connect Make-up Gas to
AC	—	—	Gas 3
AD	—	—	Gas 3

For further details, refer to *Chapters 15* and *Chapter 16* of the TRACE GC 2000 Operating Manual.

Getting Started

This paragraph contains the instruction to install the ECD on your GC.
To properly install the ECD upgrade kit, the following sequential operations must be performed:

- Remove the top and right side panels of the GC.
- Install the detector control card into the GC electronic compartment (control unit).
- Mount the ECD on the GC.
- Remount GC panels.
- Restart the GC.
- Configure the detector.

Before starting, the following preliminary operations must be carried out:

1. Cool the oven and detector base body to room temperature.
2. Make sure that the detector base body is leak free.
3. Close the gas supplies.
4. Turn off the main power on the rear panel of the GC.
5. Disconnect the main power cable from the rear of the GC.

Installing ECD Upgrade Kit

Follow this instruction to properly install the ECD Upgrade Kit.

1. Injector and detector cassette	2. Column oven door
3. Upper cover	4. Right hand-side panel

Figure E-1. TRACE GC 2000

Removing the GC Panels

This operation allows to access the GC upper parts and the electronic compartment.

Materials needed:

- 2-mm Allen wrench
- 3-mm Allen wrench

Remove the GC Top Cover

1. Lift the detector cover off the GC top cover.

2. Open the oven door and unscrew the two top cover fastening screws.

3. Push the cover back about 1 cm and lift it up and off the GC.

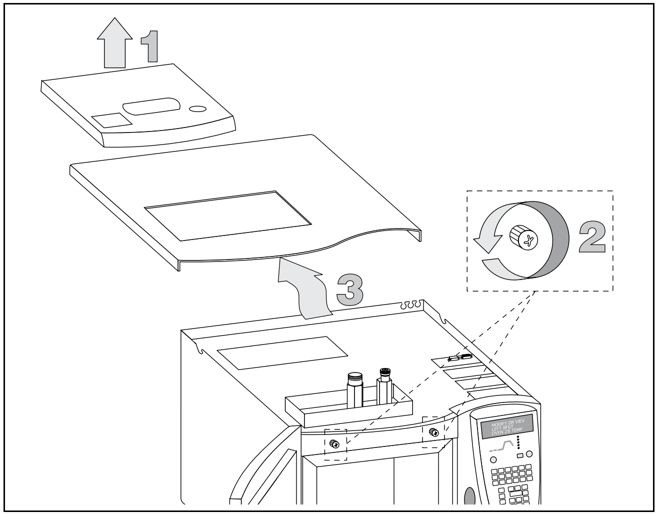


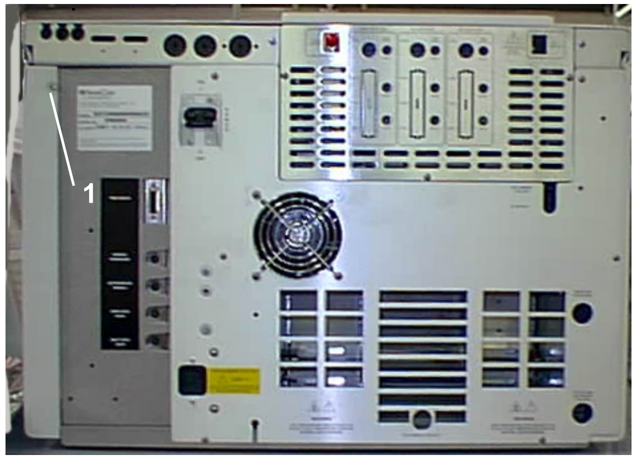
Figure E-2. TRACE GC 2000 Top Cover

Remove the GC Right Side Panel

1. Loosen and remove the screw that secures the right side panel to the right upper rear corner of the GC by using the 3-mm Allen wrench. Refer to Figure E-3.

2. Slide the side panel towards the back of the GC and then tilt the top of the side panel outwards. Continue to slide the panel towards the rear of the GC.

3. Hold the side panel parallel to the GC, and pull the lower edge of the panel away from the GC.



1. Right Panel Securing Screw

Figure E-3. TRACE GC 2000 Rear Panel

Installing the ECD Control Card

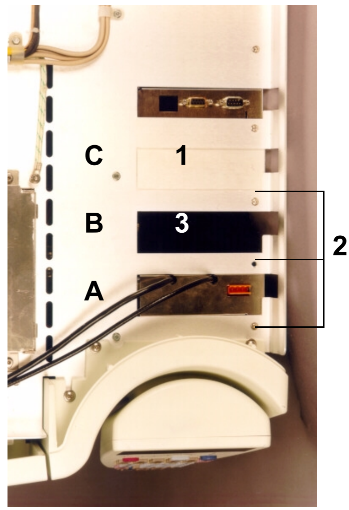
The ECD control card must be installed into the proper expansion slot marked A, B or C located on the left part of the GC mother board in the electronic compartment. Refer to Figures E-4 and E-5.

NOTE

In the case all the expansion slots are occupied, it is necessary to remove one of the three detector control card currently installed and replace it with the ECD control card.

Materials needed:

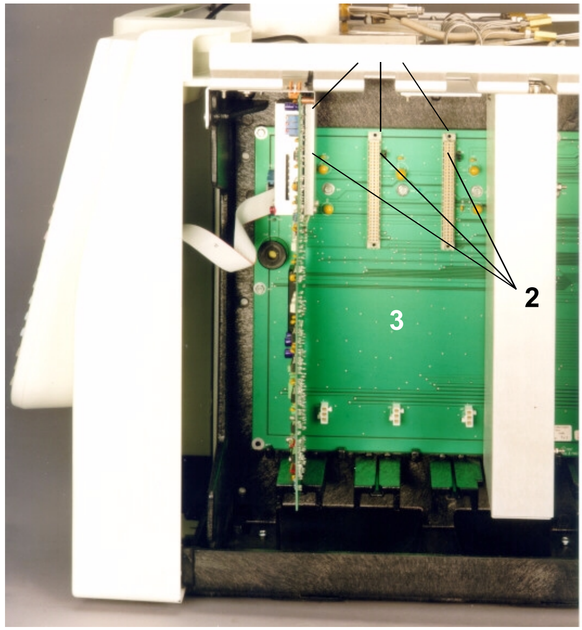
- 3-mm Allen wrench



1. Slot cover plate	2. Cover plates fixing screw
3. Free slot	A B C. Extension slot position

Figure E-4. Extension Slots Top View

1. Loosen the fixing screw of the slot cover plate that corresponds to the selected A, B or C expansion slot on the mother board.



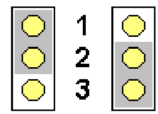
1. Detector control card expansion Slots	2. Additional heat control jumpers
3. Mother board	

Figure E-5. Detector Control Card Expansion Slots

2. Verify that the jumper (marked *J6, J7,* or *J8*) adjacent to the defined detector control card connector on the mother board, is positioned between the pins 1 and 2. Refer to the following table.

Expansion slot	Corresponding Jumper
A	J8
B	J7
C	J6

Jumper Positioning



Pins 1-2 = additional heat control **enabled**

Pins 2-3 = additional heat control **not enabled**

WARNING! The jumper (marked J6, J7, J8) must be positioned between the pins 1 and 2.

3. Guide through the slot mentioned at point 1 the signal and excitation cables coming from the top of the card.

4. Plug the detector control card into the selected expansion slot on the mother board.

5. Fix the control card by using the same screw previously removed at point 1.

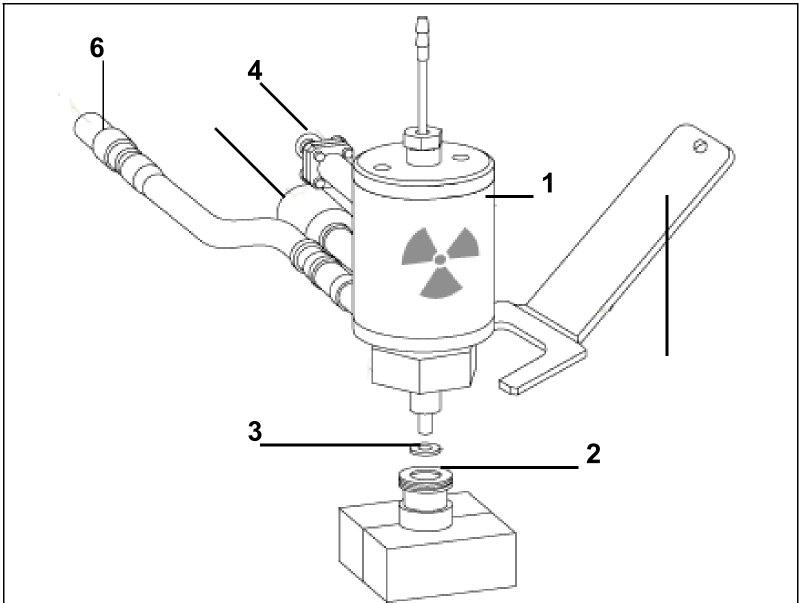
6. Connect the temperature sensor/heater cable to the connector located on the top of the detector control card.

Mounting the ECD on the GC

This operation allows the correct installation of the ECD on your TRACE GC 2000. Refer to Figure E-6.

Materials needed:

- ECD Fixing Tool



1. ECD	2. Detector Base Body
3. Lower Seal	4. Signal connector
5. Excitation Connector	6. Temperature sensor/heater Connector
7. ECD Fixing Tool	

Figure E-6. Installation of the ECD

1. Install the ECD on the detector base body interposing the lower seal. Secure the detector by using the ECD fixing tool

2. Carefully, connect the signal, excitation and temperature sensor/heater extension cables coming from the detector control card, to the detector cell.

Reinstall the GC Panels

This operation allows to reinstall the GC panels

Materials needed:

- 3-mm Allen wrench

1. Reconnect the chassis ground wire to the GC rear oven terminal.
2. Reinstall all the GC panels proceeding in the reverse order of their removal (refer to *Removing the GC Panels* on page 424) being sure to reconnect the rear panel cooling fan.

Restarting the GC

1. Verify that the connections of the detector gases has been correctly performed.
2. Open the gas supplies.
3. Reconnect the main power.
4. Turn on main power.

Configuration

This paragraph contains the instructions to configure your GC to operate with ECD.

You configure the detector and make-up gas in the **CONFIGURE** menu. Refer to *Chapter 15* of the TRACE GC 2000 Operating manual.

Configuring Detector and Make-up Gas

1. Press **CONFIG** then scroll to `Left detector` or `Right detector` depending on the location of the detector to configure. Press **ENTER** to open the detector gas menu.

LEFT DETECTOR
Detector type <
Makeup gas[1]

1. This line appears only if the DGFC module is present. Refer to note.

2. Select `Detector type`. This line indicates the type of detector mounted and the slot (A, B or C) of the relevant control board. Press **ENTER** to display the submenu.

3. To change detector type, scroll to the desired detector and press **ENTER** to confirm the selection. An asterisk appears beside the detector selected.

4. When the DGFC Module is present scroll to `Makeup gas` and press **ENTER**. The gases applicable to the detector in use are displayed in the submenu. An asterisk appears beside the currently active make-up gas is also displayed in parentheses in the title bar.

5. To change the make-up gas, scroll to the desired gas and press **ENTER** to confirm the selection. An asterisk appears beside the make-up gas selected.

Set ECD Parameters

To set ECD parameters, it is necessary to open the ECD menu and the ECD Signal menu.

- The **`DETECTOR (ECD)`** menu contains the detector control parameters. To set parameters, refer to the Chapter 16 of the TRACE GC 2000 Operating Manual.
- The **`DETECTOR SIGNAL`** menu contains the parameters that control the detector signal. To set parameters, refer to the Chapter 15 of the TRACE GC 2000 Operating Manual.

NOTE To verify the correct installation of the detector on your GC, perform the ECD Checkout as described in Section III of the TRACE GC 2000 Standard Operating Procedures manual PN 31709200.

Parameters Setting

1. To open ECD menu, press **LEFT DETECTOR** or **RIGHT DETECTOR** depending on the location of the detector. The following menu is displayed:

`LEFT DETECTOR (ECD)`[1]		
Base temp	250	250
ECD Temp	300	300
Ref current nA	1.0	
Freq kHz	(2.20)	
Pulse amp V	50	
Pulse width us	1.0	
Mkup (N2)[2]	30	30<

1. These settings could also be for a right detector.

2. If you have a non-DGFC module, the actual value are not displayed, and you can only turn the flows on and off.

2. To open ECD Signal menu, press **LEFT SIGNAL** or **RIGHT SIGNAL** according to the location of the detector. The following menu is displayed:

```
LEFT SIGNAL (ECD)[1]
 Output                (1000)
Offset          100
Auto zero?        Y/N <
```

1. These settings could also be for a right signal

F

Transformer Installation

This appendix contains the manual **Transformer Installation** which provides the instructions to install and configure a transformer on your TRACE ™ GC 2000.

Guide at a Glance...

Operating Procedures

Transformer Overview

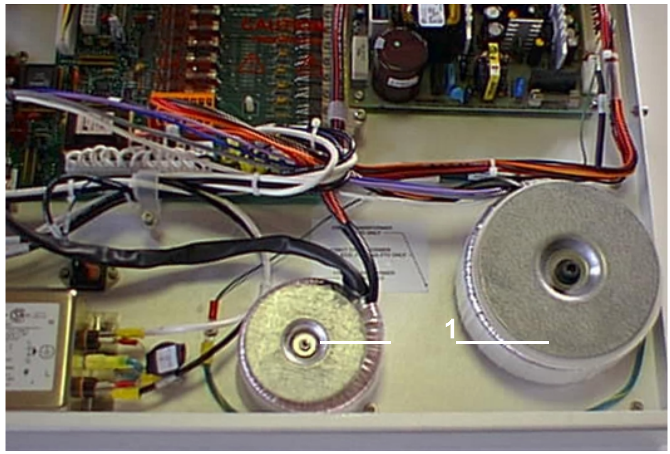
All the GC's are equipped with a proper toroidal transformer already factory installed according to the type of the detector in use. Refer to TableF-1.

Table H-1. Transformer Types

Transformer	Description
Standard	It supports the detectors FID, ECD, PID, FPD, TCD and the PTV Injector.
For NPD	It supports the NPD only. It is already factory installed when the GC is equipped with a NPD. - In the case the GC, equipped with a detector different than NPD, is upgraded with a NPD, the transformer must be installed on the GC Power Control Module. - When the GC is upgraded with a second NPD, this transformer supports both.

NOTE An obsoleted FID transformer is present in TRACE™ GC 2000 with FID having serial number below than 983808 (Milan) or TR101089 (Austin).
This transformer must be replaced with the standard one when the GC is upgraded with a detector different than FID.
In the case the GC is upgraded with a second FID, the transformer already present may be used to supply a second FID.

Figures F-1 shows the positions on the GC Power Control Module where the detector trasformer must be installed.



1. NPD Transformer	2. Standard Transformer

Figure F-1. Standard and NPD Transformers

To install or replace the required transformer into the GC, refer to the Operating Sequence *Installing the Transformer* on page 438.

Getting Started

This paragraph contains the instruction to install or replace the transformer on your GC.

WARNING! This operation must be carried out by authorized ThermoQuest technical personnel.

To properly install or replace the transformer, the following sequential operations must be performed:

- Remove the top, right side and rear panels of the GC.
- Remove the GC Power Control Module
- Mount the transformer.
- Remount GC panels.
- Restart the GC.
- Configure the transformer.

Before starting, the following preliminary operations must be carried out:

1. Cool the oven and detector base body to room temperature.
2. Close the gas supplies.
3. Turn off the main power on the rear panel of the GC.

Disconnect the main power cable from the rear of the GC.

Installing the Transformer

This operation allows to install or replace the toroidal transformer.

WARNING! This operation must be carried out by authorized ThermoQuest technical personnel.

Removing the GC Panels

This operation allows to access the GC electronic compartment.

Materials needed:

- 2-mm Allen wrench
- 3-mm Allen wrench

1. Right hand-side panel

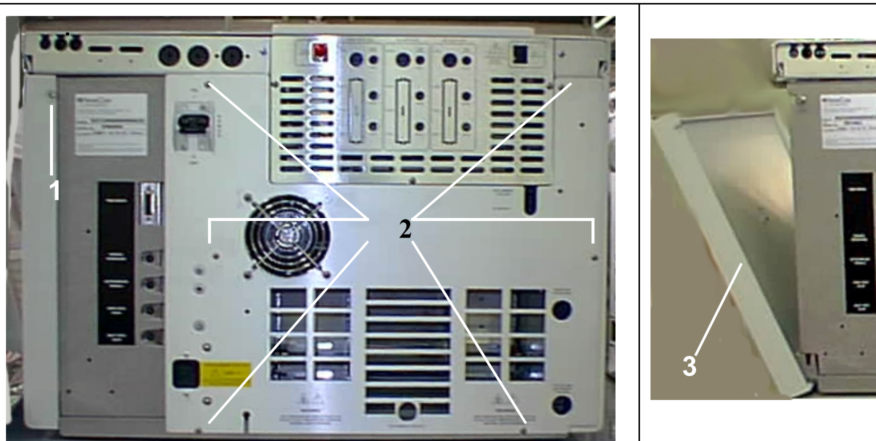
Figure F-2. TRACE GC 2000 View

Remove the GC Right Side Panel

1. Loosen and remove the screw **1** that secures the right side panel to the right upper rear corner of the GC by using the 3-mm Allen wrench.

2. Slide the side panel towards the back of the GC and then tilt the top of the side panel outwards. Continue to slide the panel towards the rear of the GC.

3. Hold the side panel parallel to the GC, and pull the lower edge of the panel away from the GC.



1. Right Panel Securing Screw	2. Reap Panel Fixing Screws	3. GC Right Side Panel

Figure F-3. TRACE GC 2000 Rear Panel

Remove the GC Rear Panel

1. Locate the six Allen screws that secure the rear panel to the GC. Remove these screws using the 2-mm Allen wrench. See Figure F-F-3.

2. Carefully remove the rear panel of the GC. Be aware that the cooling fan is attached to the rear panel.

Pay attention to the positioning of the cooling fan plug, so it can be reconnected in the same way it was removed.

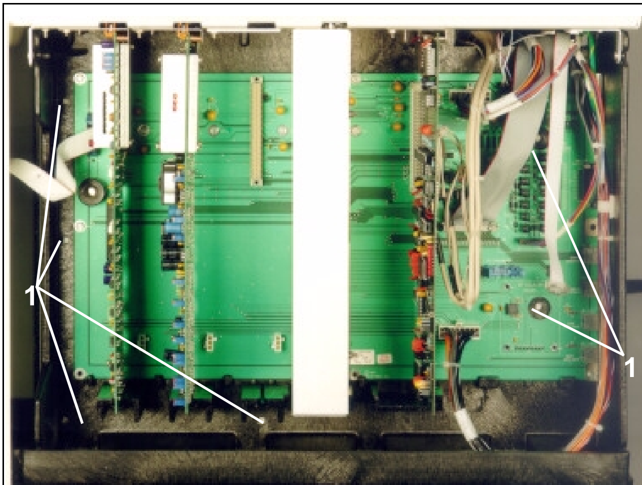
Remove the Power Control Module

Materials needed:

- Phillips screwdriver

Six screws fix the Power Control Module. Two large Phillips screws are located in the rear of the right hand-side of the GC, while the remaining four screws are located just behind the front panel of the GC.

1. Remove the six screws. Refer to Figure H-F-4.

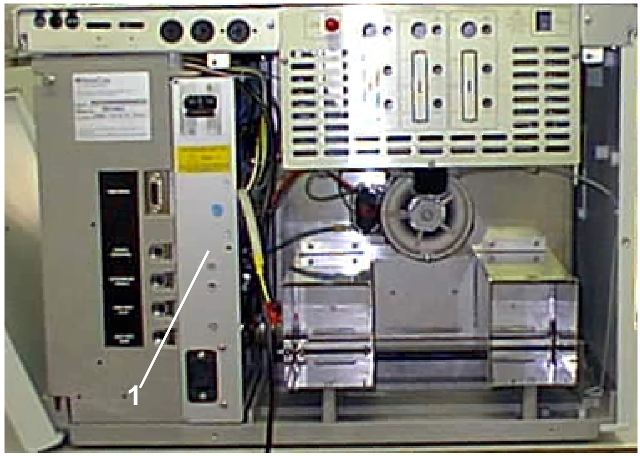


1. Large Phillips Screws

Figure F-4. TRACE GC 2000 Right Side View

2. Slide the Power Control Module very slowly and gently outward towards the rear of the GC.

CAUTION **This operation requires particular attention because several cables are connected to the Power Control Module. It must be removed gradually paying attention to disconnect step by step all the cables available until the power control module is completely free. Be very careful not to damage any wire during this operation.**



1. Power Control Module

Figure F-5. TRACE GC 2000 Rear View

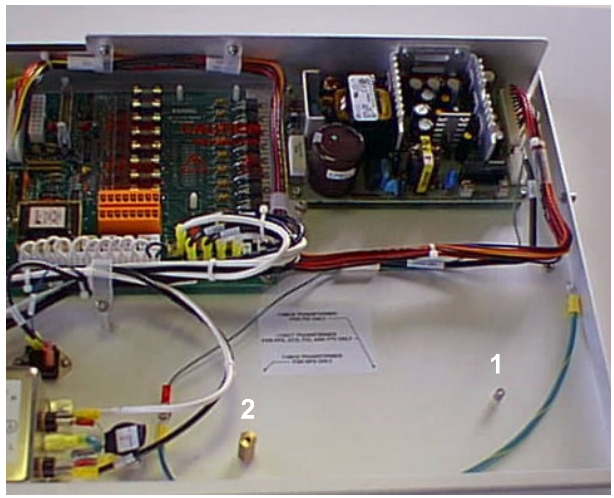
3. As the Power Control Module is being removed, disconnection of the parts must be carried out in the following order:

- J1, 16-pin white connector.
- J8, 2-pin connector.
- J11, 16-pin white connector located in the upper rear quadrant of the chassis.
- J13, ribbon cable.
- Oven heater wire connected to the oven heater triac.
- TB1 and TB2, orange terminal strips for the heater wire connections.
- J17, oven blower motor.
- J8, second oven heater wire.
- Chassis ground wire from the GC rear oven terminal.

4. Place the Power Control Module on a free working table.

Install the Transformer for Detector

Figure F-6 shows the positions on the GC Power Control Module where the detector trasformer must be installed.



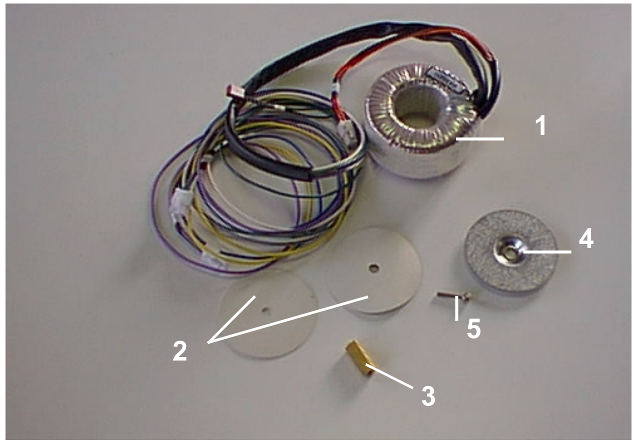
1. Transformer for FID, ECD, PID, FPD , TCD and PTV Injector	2. Transformer for NPD

Figure F-6. Transformer Installation

Install the transformer proceeding as follows. Refer to Figure F-7.

1. Screw the spacer on the threaded pin.
2. Insert the first protection disk on the spacer.
3. Place the transformer over the protection disk.
4. Place the second protection disk over the transformer.
5. Place the metal plate over the assembly.
6. Insert the fixing screw in the spacer passing through the metal plate.

7. Screw until the transformer assembly is blocked.



1. Transformer	2. Protection disks
3. Spacer	4. Metal Plate
5. Fixing Screw	

Figure F-7. Transformer Assembly Identification Parts

The transformer has three cables and three female connectors marked "**Px**"[1]. Connect the female connectors to the corresponding male connectors on the power control module PCB marked "**Jx**"[1].

1. "**x**" is equal to a number defined by the table below.

Transformer	Cable Connector	Connect To...
Standard	P14	J14
	P5	J5
	P6	J6
For NPD	P15	J15
	P4	J4
	P35/36	J35/36
	P36/37	J36/37

Reinstall the Power Control Module

CAUTION **This operation requires particular attention because several cables must be reconnected to the Power Control Module. It must be gradually reinserted paying attention to reconnect step by step all the cables until the power control module is completely reinstalled into the GC.**

1. Reconnect the previous disconnected connections in the reverse order of their removal.
2. Secure the six Phillips screws that fix the Power Control Module in place.
3. Reconnect the chassis ground wire to the GC rear oven terminal.

Reinstall the GC Panels

This operation allows to reinstall the GC panels

Materials needed:

- 3-mm Allen wrench

1. Reconnect the chassis ground wire to the GC rear oven terminal.
2. Reinstall all the GC panels proceeding in the reverse order of their removal (refer to *Removing the GC Panels* on page 438) being sure to reconnect the rear panel cooling fan.

Restarting the GC

1. Verify that the connections of the detector gases has been correctly performed.
2. Open the gas supplies.
3. Reconnect the main power.
4. Turn on main power.

Configuration

This paragraph contains the instructions to configure your GC to operate with the new transformer.

Hardware Configuration

This operation must be performed to verify if the GC has recognized the presence of the transformer previously installed.

1. Press **INFO/DIAG** twice to open **`Diagnostics`** menu.
2. Scroll to `Hardware Config` and press **ENTER**.
3. Address the hardware configuration menu. Scroll down until the type of transformer installed in the system is displayed.
4. If not, verify the transformer connections.

G

Reagent Safety Information

Material Safety Data Sheets for the chemicals mentioned in the procedures contained in this manual should be requested from the respective manufacturers, in compliance with the relevant legislation in the country of use.

Chemical safety information is also available from the Internet. For example, International Chemical Safety Cards can be found at http://www.cdc.gov/niosh/ipcs/ipcsname.html.

The following are the chemical references for the solvents mentioned in this manual.

ACETONE

ACETONE
2-Propanone
Dimethyl ketone
$C_3H_6O/CH_3\text{-}CO\text{-}CH_3$

Molecular mass: 58.1

CAS # 67-64-1
RTECS # AL3150000
ICSC # 0087
UN # 1090
EC # 606-001-00-8

METHANOL

METHANOL
Methyl alcohol
Carbinol Wood alcohol
CH_4O/CH_3OH

Molecular mass: 32.0

CAS # 67-56-1
RTECS # PC1400000
ICSC # 0057
UN # 1230
EC # 603-001-00-X

TOLUENE

TOLUENE
Methylbenzene
Toluol
$C_6H_5CH_3/C_7H_8$

Molecular mass: 92.1

CAS # 108-88-3
RTECS # XS5250000
ICSC # 0078
UN # 1294
EC # 601-021-00-3

H

Customer Communication

This appendix contains contact information for ThermoQuest offices worldwide. This appendix also contains a one-page *Reader Survey*. Use this survey to give us feedback on this manual and help us improve the quality of our documentation.

How To Contact Us and Order Spare Parts

ThermoQuest provides comprehensive technical assistance worldwide and is dedicated to the quality of our customer relationships and services. Use this list to contact your local ThermoQuest office or affiliate. Please fax any spare parts orders to the fax number corresponding to your country of residence.

AUSTRALIA
ThermoQuest Australia
PO Box 239, Unit 20, 38-46 South Street
Rydalmere, NSW 2116
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Fax: 2 684 4244

AUSTRIA
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Wehlistrasse 27 b, A-1200, Wien
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Reader Survey

Product: TRACE GC 2000
Manual: Service Manual
Part No.: M 317 09 270, Rev. B

Please help us improve the quality of our documentation by completing and returning this survey.

Circle one number for each of the statements below.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The manual is well organized.	1	2	3	4	5
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If you would like to make additional comments, please do. (Attach additional sheets if necessary.)

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Glossary

This section contains an alphabetical list and descriptions of terms used in this guide and the help diskette. This also includes abbreviations, acronyms, metric prefixes, and symbols.

A

A	ampere
ac	alternating current
ADC	analog-to-digital converter

B

b	bit
B	byte (8 b)
baud rate	data transmission speed in events per second

C

ºC	Celsius
CIP	Carriage and Insurance Paid To
cm	centimeter
CPU	central processing unit (of a computer)
CSE	Customer Service Engineer

D

d	depth
DAC	digital-to-analog converter
dc	direct current
DET	Detector
DPFC	Digital Pressure Flow Control
DS	data system

E

ECD	Electron Capture Detector
EMC	electromagnetic compatibility
EPROM	Erasable Programmable Read-Only Memory
ESD	electrostatic discharge

F

ºF	Fahrenheit
FET	field effect transistor
FID	Flame Ionization Detector
FOB	Free on Board
FPD	Flame Photometric Detector
ft.	foot

G

g	gram
GC	gas chromatograph
GFC	Gas Flow Control
GND	electrical ground
GSV	gas sampling valves

H

h	height
h	hour
harmonic distortion	A high-frequency disturbance that appears as distortion of the fundamental sine wave.
HV	high voltage
HW	hardware
Hz	hertz (cycles per second)

I

ID	identification code or inside diameter
IEC	International Electrotechnical Commission
impulse	See *transient*
in.	inch
INJ	injector
I/O	input/output

K

k	kilo (10^3 or 1024)
K	Kelvin

kg	kilogram
kPa	kilopascal

L

l	length
l	liter
lb.	pound
LED	light-emitting diode

M

m	meter (or milli [10^{-3}])
M	mega (10^{6})
µ	micro (10^{-6})
min	minute
mA	milliampere
mL	milliliter
mm	millimeter
m/z	mass-to-charge ratio

N

n	nano (10^{-9})
NPD	Nitrogen Phosphorous Detector

O

OC	on-column
Ω	ohm

P

p	pico (10^{-12})
Pa	pascal
PCB	printed circuit board
PCKD	packed
PCM	power control module
PID	Photo Ionization Detector
PLD	programmable logic device
PN	part number

psi	pounds per square inch
PTV	programmable temperature vaporizing
R	platinum temperature sensor
RAM	random access memory; read and write memory
RF	radio frequency
ROM	read-only memory
RS-232	industry standard for serial communications
RTD	reading temperature device
S	
s	second
sag	See *surge*
SC	wiring diagram
slow average	A gradual, long-term change in average RMS voltage level, with typical durations greater than 2 s.
SPI	serial peripheral interface
S/SL	split/splitless
SSR	solid-state-relay
surge	A sudden change in average RMS voltage level, with typical duration between 50 µs and 2 s.
SW	software
T	
TC	thermocouple
TCD	Thermal Conductivity Detector
TF & DIO	Temperature Feedback and Digital I/O
TPU	Time Processor Unit
transient	A brief voltage surge of up to several thousand volts, with a duration of less than 50 µs.
V	
V	volt
V ac	volts, alternating current
V dc	volts, direct current
VGA	Video Graphics Array

W

w	width
W	Watt
WB	wide-bore

Index

O

P

U

V