Model 7300

Service Manual

Aug 27, 1999

Part Number 9226-90-00

Novametrix Medical Systems Inc.
P.O. Box 690
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Wallingford, Connecticut, U.S.A. 06492.

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Service Policy

Novametrix Medical Systems Inc. provides 24-hour a day access to technical support through its Technical Support Department in Wallingford, Connecticut, and company Service Representatives located throughout the United States. (Outside the U.S., primary technical support is handled through our qualified international sales and service distributors.)

Novametrix will provide Warranty Service support within 48 hours of receiving a request for assistance. Contact the Technical Support Department by telephone toll free at 800-243-3444, or 203-265-7701; by facsimile at 203-284-0753; or, by e-mail at techline@novametrix.com. After hours telephone support requests (before 8:00 AM and after 5:00 PM Eastern Time) will be responded to promptly by the Technical Support on-call staff. After hours facsimile and e-mail requests will be answered the next business day. It is suggested that any person calling in for technical support have the equipment available for product identification and preliminary troubleshooting.

Novametrix reserves the right to repair or replace any product found to be defective during the warranty period. Repair may be provided in the form of replacement exchange parts or accessories, on-site technical repair assistance or complete system exchanges. Repairs provided due to product abuse or misuse will be considered “non-warranty” and invoiced at the prevailing service rate. Replaced or exchanged materials are expected to be returned to Novametrix within 10 days in order to avoid (additional) charges. Return materials should be cleaned as necessary and sent directly to Novametrix using the return paperwork and shipping label(s) provided (Transferring return materials to a local sales or dealer representatives does not absolve you of your return responsibility.).

Novametrix manufactures equipment that is generally field serviceable. When repair parts are provided, the recipient can call Technical Support for parts replacement assistance and repair assurance. In the event a replacement part requires increased technical capability, Technical Support may request Biomedical assistance, provide on-site technical support or complete replacement equipment. If the customer requires the return of their original product, the exchange material will be considered “loaner material” and exchanged again after the customer equipment is repaired.

Novametrix promotes customer participation in warranty repairs, should they become necessary. A longer useful product life, and quicker, more cost-effective maintenance and repair cycles—both during and after the warranty period, are benefits of a smooth transition into self-maintenance. The Technical Support Department can provide technical product support at a level appropriate to your protocol and budget requirements.

Please contact Technical Support for information on these additional programs and services:

- Focus Series Technical Training Seminars
- Test Equipment and Test Kits
- Service Contract / Parts Insurance Plans
- On-Site Technical Support
- “Demand Services” including:
    - Flat rate parts exchange
    - Flat rate return for repair
    - Time and material,
    - Full warranty, discounted replacement sensors.

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Warranty

Equipment manufactured or distributed by Novametrix Medical Systems Inc., is fully guaranteed, covering materials and workmanship, for a period of one year from the date of shipment, except for certain disposable products and products with stated guarantees other than one year. Novametrix reserves the right to perform guarantee service(s) at its factory, at an authorized repair station, or at the customer's installation.

Novametrix' obligations under this guarantee are limited to repairs, or at Novametrix' option, replacement of any defective parts of our equipment, except fuses, batteries, and calibration gasses, without charge, if said defects occur during normal service.

Claims for damages during shipment must be filed promptly with the transportation company. All correspondence concerning the equipment must specify both the model name and number, and the serial number as it appears on the equipment.

Improper use, mishandling, tampering with, or operation of the equipment without following specific operating instructions will void this guarantee and release Novametrix from any further guarantee obligations.

Service Department

For factory repair service:
Call toll free: 1-800-243-3444
To Call Direct: (203) 265-7701
Facsimile (203) 284-0753
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techline@novametrix.com

Caution: Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.

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1 Safety

For maximum patient and operator safety, observe the following warnings, cautions and notes.

1.1 Warnings

⚠	**WARNING:** Indicates a potentially harmful condition that can lead to personal injury.

- Explosion Hazard: Do not use the NICO monitor in the presence of flammable anesthetics. Use of this instrument in such an environment may present an explosion hazard.
- Electrical Shock Hazard: Always turn the NICO monitor off before cleaning it. Do not use with a damaged external power source. Refer servicing to qualified service personnel.
- Connect the AC Mains power cord to a properly grounded hospital-grade outlet. The NICO monitor should be connected to the same electrical circuit as other equipment in use on the patient. Outlets of the same circuit can be identified by members of the hospital's engineering department.
- Failure of Operation: If the monitor fails to respond as described, do not use it until the situation has been corrected by qualified personnel.
- Reuse (disassembly, cleaning, disinfecting, resterilizing, etc.) of the NICO sensor may compromise the device functionality and system performance and cause a potential patient hazard. Performance is not guaranteed if the NCIO sensor is reused.
- Inspect the CO_2, SpO_2 and NICO sensors prior to use. Do not use if they appear to be damaged or broken.
- Do not attempt to rotate the NICO sensor in the breathing circuit by grasping the pneumatic tubes exiting the flow sensor.
- Do not apply excessive tension to any cable or the NICO sensor pneumatic tubing.
- Periodically inspect NICO sensor tubing lines for kinks.
- Replace the NICO sensor if excessive moisture or secretions are observed in the tubing.
- Do not use the NICO monitor if it is unable to properly identify the NICO sensor. If the condition persists, refer the monitor to qualified service personnel.
- The NICO sensor connector should be properly inserted into the front panel receptacle prior to connecting the NICO sensor to the breathing circuit, in order to avoid a circuit leak, or occlusion of the NICO sensor tubing.

- In the event the message **NICO SENSOR FAILURE** is displayed, remove the NICO Sensor from the patient circuit.
- Patient Safety: Care should be exercised to assure continued peripheral perfusion distal to the SpO_2 sensor site after application.
- Inspect the SpO_2 sensor site for adequate circulation at least once every four hours.
- When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.
- Do not position sensor cables or tubing in any manner that may cause entanglement or strangulation.
- The NICO monitor is not intended to be used as a primary apnea monitor.

1.2 Cautions

CAUTION:
Indicates a condition that may lead to equipment damage or malfunction.

- Use only Novametrix approved sensors and accessories with the NICO monitor.
- Do not operate the NICO monitor when it is wet due to spills or condensation.
- Do not operate the product if it appears to have been dropped or damaged.
- Never sterilize or immerse the monitor in liquids.
- Do not sterilize or immerse sensors except as directed in this manual.
- No tension should be applied to any sensor cable or tubing.
- To avoid the effects of excessive moisture in the NICO sensor, insert it in the ventilator circuit with the pneumatic tubes upright. Excessive moisture in the NICO sensor may affect the accuracy of the measurements.
- Operate the monitor at temperatures between 10 to +40° C (50 to 104° F), 10-95% R.H. non-condensing.
- Avoid storing the monitor at temperatures less than -10° C or greater than +55° C (<14° F or >131° F) 10-95% R.H. non-condensing
- Observe precautions for electrostatic discharge (ESD) and electromagnetic interference (EMI) to and from other equipment.
- Where electromagnetic devices (i.e., electrocautery) are used, patient monitoring may be interrupted due to electromagnetic interference. Electromagnetic fields up to 3 V/m will not adversely affect system performance.
- Caution: Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.

1.3 Notes

NOTE:
A point of particular interest or emphasis intended to provide more efficient or convenient operation.

- In order to ensure proper monitoring of oxygenation and ventilation:
  - The use of pulse oximetry is recommended during NICO monitoring.
  - Setting of $ETCO_2$ and SpO_2 alert limits is recommended.

- A “NO RESPIRATION” alert is not generated when both the CAPNOSTAT CO_2 sensor and the NICO sensor are disconnected from the NICO monitor.
- Be certain that the monitor is not in Demo Mode while monitoring. Demo Mode can be identified by the flashing DEMO MODE label in the General Message area of the display. To exit Demo Mode and return to normal monitoring mode, turn the power off and back on.
- The NICO monitor contains no user serviceable parts. Refer servicing to qualified service personnel.
- Do not attach an SpO_2 sensor distal to a blood pressure cuff. Valid data cannot be processed when the cuff is inflated. Attach the sensor to the limb opposite to the site used for the blood pressure cuff.
- This product and its accessories which have patient contact are free of latex.
- The NICO monitor is Year 2000 compliant.
- Data Validity: Inaccurate SpO_2 and Pulse Rate values may be caused by;
  - Incorrect application or use of a sensor
  - Significant levels of dysfunctional hemoglobin; carboxyhemoglobin or methemoglobin
  - Significant levels of indocyanine green, methylene blue, or other intravascular dyes
  - Exposure to excessive illumination such as surgical lamps—especially ones with a xenon light source, or direct sunlight
  - Excessive patient movement
  - Venous pulsations
  - Electrosurgical interference
  - Use of an IABP.
- NICO measurements will occur provided the following conditions are met:
  - The NICO sensor is properly installed in the patient’s breathing circuit.
  - Valid flow and CO_2 signals are detected with no significant signal artifact.
  - VCO_2 is greater than 20 mL/min.
  - $ETCO_2$ is between 15 and 70 mmHg (2.0 - 9.0 kPa or %)
  - The tidal volume is greater than 200ml.
  - The respiratory rate is between 3 and 60 br/min.
  - The STOP/CONTINUE REBREATHING key is not illuminated.
  - NICO is not paused by the monitor for any other reason (displayed in the C.O. message area)
- When a new CAPNOSTAT CO_2 sensor is attached to the monitor, or is moved from one monitor to another, it must be adapter zeroed before use.
- After the life cycle of the equipment and accessories has been met, disposal should be accomplished following national/local requirements.
- There is no screen indication during monitoring, except on start-up (or when the **SET ALERTS** screen is displayed), as to when the NICO alert settings are off.

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2 Introduction

2.1 About this manual

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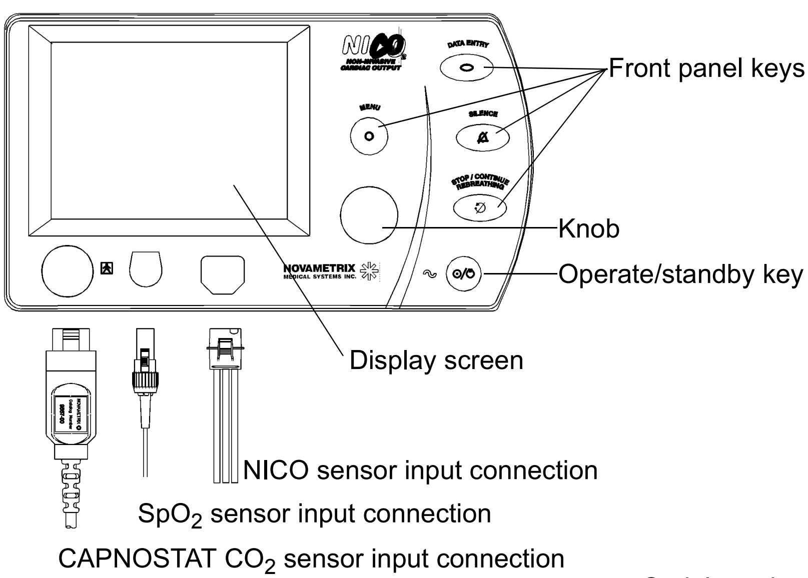
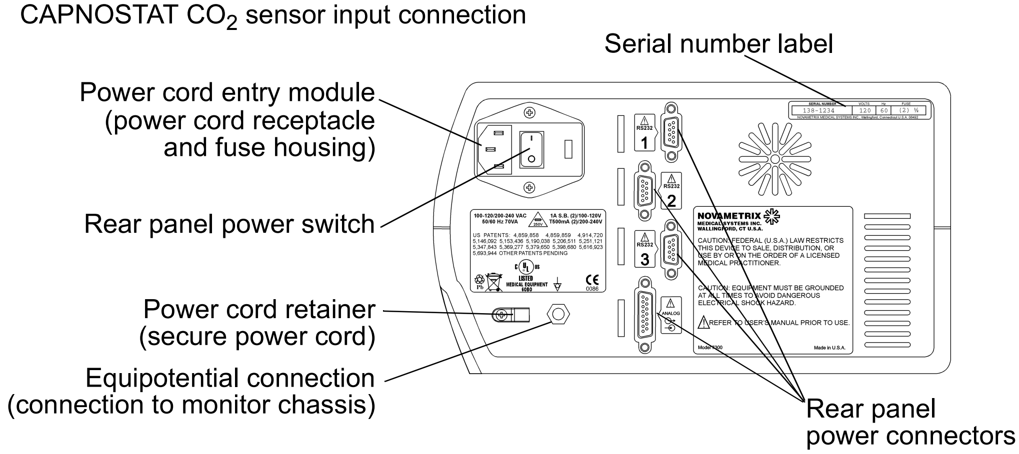
2.2 Front and Rear Illustrations





2.3 NICO Monitor Technical Description

Per requirements of IEC 601-1, the NICO monitor is classified as class II equipment, internally powered, with type BF applied part, and an enclosure protection rating of IPX0. The NICO monitor is Year 2000 compliant.

Transport/Storage: -10 to +55° C (14-131° F), 10-95% R.H. non-condensing
Operating Conditions: 10 to +40° C (50 to 104° F), 10-90% R.H. non-condensing

2.4 Manufacturing Quality & Safety

The Novametrix Medical Systems Inc. manufacturing facility is certified to both ISO 9001 and EN46001 (MDD93/42/EEC Annex II). Novametrix' products bear the "CE 0086" mark. The product is certified by Underwriter's Laboratories (UL) to bear the UL mark; and tested by TÜV Rheinland to IEC 601-1/EN60601-1.

2.5 Declaration of Conformity with European Union Directive

The Authorized Representative for Novametrix equipment is:

D.R.M. Green
European Compliance Services Limited,
Oakdene House,
Oak Road,
Watchfield
Swindon, Wilts SN6 8TD
United Kingdom

2.6 Trademarks and Patents

CAPNOSTAT CO_2 Sensor is a registered trademark (®) and NICO, $NICO_2$ and the stylized $NICO_2$ with CO2 shadow, NICO Sensor, NICO Loop and CObar (cardiac output confidence bar), SuperBright and Y-Sensor are trademarks (™) of Novametrix Medical Systems Inc. Other trademarks and registered trademarks are the property of their respective owners.

NICO and its sensors and accessories are covered by one or more of the following USA patents: 4,859,858, 4,859,859, 4,914,720, 5,146,092, 5,153,436, 5,190,038, 5,206,511, 5,251,121, 5,347,843, 5,369,277, 5,379,650, 5,398,680, 5,616,923, 5,693,944, 5,789,660. Other patents pending.

2.7 Manual Revision History

7-Aug-99 Release

3 Theory of Operation

3.1 NICO Model 7300 Non-Invasive Cardiac Output Monitor

The NICO model 7300 monitor measures cardiac output based on changes in respiratory CO_2 concentration caused by a brief period of rebreathing. The measurement of cardiac output is accomplished by interpreting data collected by proprietary sensors that measure flow, airway pressure, and CO_2 concentration, and then combining these signals to calculate CO_2 elimination. Using these variables, a technique known as Fick partial rebreathing is applied to calculate cardiac output. NICO can be used with mechanically ventilated patients in the operating room, intensive care, or emergency departments.

3.2 Digital Board 2763

3.2.1 Microprocessor

Refer to sheet 1 of the 2763-03 schematic.

The generation of the logic and control signals for the purpose of acquiring the raw physiological parameters, and management of the data needed to produce an accurate Non-Invasive Cardiac Output, are the responsibilities of microprocessor **IC1**. This device, a Motorola MC68332, is a highly integrated 32-bit microcontroller that combines high-performance data manipulation capabilities with powerful peripheral subsystems. These subsystems include circuitry for timing generation, peripheral chip selection and data control, interrupt generation, as well as synchronous and asynchronous serial communication. Also included is a sophisticated timing co-processor, the TPU (Time Processor Unit), that can generate complex timing waveforms independent of the main processor. In general, the signals for subsystems are functionally grouped into ports which can be independently programmed by software to be a pre-defined port function or discrete I/O. Additionally, the functionality for several ports (Ports C, E and F) can be pre-defined by the state of specific data bus lines on system power-up. Included is a special “background mode” port that allows the device to be externally controlled, facilitating system debugging and testing. Also integrated on-chip are several activity monitors as well as a software watchdog to ensure proper device and system operation. Refer to table 1.

Port	Defined Function	Functionality & Power-up Control
TPU 16 Channels	Timing Signal Generation	Each channel independently user programmable as TPU function or as Discrete I/O

Table 1: CPU Port Functions

QSM 4 Synchronous Serial Chip Selects & one asynchronous serial channel	Serial Communications Port: QSPI: Queued Serial Peripheral Interface SCI: Serial Communications Interface	QSPI chip selects independently user programmable, can be used as Discrete I/O or decoded to create up to 16 chip selects. SCI transmit can be programmed as Discrete I/O
Background Mode	System debugging	Allows an appropriate external device to control the microprocessor and system
C	Chip Selects	D0: CSBOOT* Data Width, 8 or 16-bit D1: CS1*-CS3* or BR*,BG*,BGACK* D2: CS3*-CS5* or FC0-FC2 D3-D7: CS6*-CS10* or A19-A23
E	Bus Control	D8: Control Signals or Discrete I/O
F	MODCK and Interrupts	D9: MODCK & IRQ or Discrete I/O

Table 1: CPU Port Functions

The operating frequency of the system clock in the *NICO* system is 24.117 MHz. It is generated by an internal VCO (Voltage Controlled Oscillator) derived from **Y1**, a 32.768KHz watch crystal, and is software programmable. The Timing Processor Unit (TPU) co-processor of the MC68332 provides complex timing functions generated from the system clock. This feature is utilized to control the precise timing required for the acquisition of the End Tidal Carbon Dioxide (etCO_2) and saturation (SpO_2) signals. The TPU is also used to generate the PWM (Pulse Width Modulation) control for the Capnostat Case and Detector heaters, and to provide the frequency generation for the audio tones. See Tables 2 and 3

Signal	Name	Function / Timing
CO2AZ	Auto Zero	Clears the Sample/Hold circuitry prior to data acquisition. Active High, 90 us
CO2PWENB	Pulse Width Enable	Defines the active time for both phases of the bipolar source pulse, used for pulse width protection circuitry. Active High, 810 us
SRCDRV0	Source Drive 0	First source drive signal. Active High, 405 us
CO2CSHL	Current Sample/Hold	Enables circuitry for source current measurement. Sample is taken when SRCDRV0 is active. Low = Sample, 90 us, High = Hold
SRCDRV1	Source Drive 1	Second source drive signal delayed for 10 microseconds after SRCDRV0 ends. Active High, 395 us
CO2SSH	Signal Sample/Hold	Enables circuitry for CO_2 and Reference channel data acquisition. Low = Sample, 90 us, High = Hold
CASEPWM	Case Heater PWM	PWM control for the case heater servo

Table 2: TPU Timing Generation for the etCO_2 subsystem

DETPWM	Detector Heater PWM	PWM control for the detector heater servo
TOUT1, TOUT2	Tone Generation	Variable frequency outputs to generate system audio

Table 2: TPU Timing Generation for the $etCO_2$ subsystem

Signal	Name	Function / Timing
ASAMPL	Auto Zero	Clears the Sample/Hold circuitry prior to data acquisition. Active Low
RDLEDL	Red Channel LED control pulse	Defines the active time for the Red LED. Active Low
IRLEDL	Infra-Red Channel LED control pulse	Defines the active time for the Infra-Red LED. Active Low
RSAMPL	Red Channel Sample/Hold	Enables circuitry for the Red Channel signal measurement. Sample is taken when SRCDRV0 is active. Low = Sample, 90 us, High = Hold
ISAMPL	Infra-Red Channel Sample/Hold	Enables circuitry for the InfraRed Channel signal measurement. Sample is taken when SRCDRV0 is active. Low = Sample, 90 us, High = Hold

Table 3: TPU Timing Generation for the SpO_2 subsystem

To help reduce and suppress the radiation of electromagnetic interference, ferrite filters (**L1-L11)** have been placed on clock signals with fast rise and fall times. Other digital signals, including address and data lines, are rise-time limited by the addition of small valued resistors and / or capacitors. In addition, good EMI/EMC design techniques have been incorporated in the component layout and printed circuit board manufacture.

Table 4 lists the chip select, control and discrete I/O functions for the *NICO* system module. On power-up, Ports E and F are programmed as discrete inputs by pulling down their controlling data lines, DB8 and DB9. After power-up, the software sets up each pin function individually and performs a series of self-tests to check the integrity of the system. During this period, the MPU holds the SYSUP line low which keeps the system in the initialization state. The state of configuration inputs on Port E (CNFG0, CNFG1 and CNFG2) and on data input buffer **IC10** (see sheet 2 on 2763-03 schematic) (JP1, JP2, JP2, JP4, TP4, TP5 and TP6) are read. These inputs allow the software to identify different operating conditions, such as Manufacturing Diagnostic Mode, or to recognize different hardware configurations. After the initialization period is complete and all system functions have been set, the MPU brings the status signal SYSUP high, indicating that the system is ready for patient monitoring operation.

Port	Pin Functions	System Signal Name[1]	I/O	Comments

Table 4: Chip Select, Control and Discrete I/O

C	DATA0 thru DATA7		O	D0-D7 pulled high, Pins are Chip Select on power-up
	CSBOOT*	ROMOEL	O	Program PROM Chip Select Word (16-bits) wide mode, D0 = HIGH
	CS0* / BR*	UBRAMWRL	O	Upper Byte SRAM Write Enable Allows for byte (8-bit) or word writes
	CS1*/ BG*	LBRAMWRL	O	Lower Byte SRAM Write Enable Allows for byte (8-bit) or word writes
	CS2* / BGACK*	SRAMOEL	O	SRAM Read Enable, Word
	CS3* / PC0 / FC0	ROMWRL	O	FLASH PROM Write Enable, Word
	CS4* / PC1 / FC1	UARTCSL	O	High Speed quad UART Chip Select
	CS5* / PC2 / FC2	BOOTWE	O	Port C Discrete Output, prevents unintentional writes to FLASH EPROM. This signal must be asserted before ROMWR* in order to overwrite the FLASH
	CS6* / PC3 / A19	A19	O	High Address line A19
	CS7* / PC4 / A20	RTCCSL	O	Real Time Clock Chip Select
	CS8* / PC5 / A21	DISPCSL	O	EL Display Chip Select
	CS9* / PC6 / A22	VRAMCSL	O	Video Memory Chip Select
	CS10* / ECLK / A23	CASCADEL	O	Cascaded Chip Select for Additional Parallel Peripherals
E	DATA8		O	D8 pulled low, Discrete I/O on power-up
	DSACK0* / PE0	CNFG2	I	Configuration Switch 2
	DSACK1* / PE1	DS1L	I	Data and Size Acknowledge 1*
	AVC* / PE2	CNFG0	I	Configuration Switch 0
	RMC* / PE3	CNFG1	I	Configuration Switch 1
	DS* / PE4	DSL	O	Data Strobe
	AS* / PE5	ASL	O	Address Strobe
	SIZ0* / PE6	SIZ0	O	Signifies current operation is 8-bit data
	SIZ1* / PE7	CNFG2	I	Configuration Switch 2
	R/W*	RDL	O	Data Read Strode
		WRL	O	Data Write Strobe

Table 4: Chip Select, Control and Discrete I/O

F	DATA9		O	D9 pulled low, Discrete I/O on power-up
	MODCLK / PF0	LED	O	LED CPU Activity Indicator
	IRQ1* / PF1	SYSUP	O	System Initialization Complete
	IRQ2* / PF2	CSOFTOT	O	Case Heater Over Temperature Shut Down
	IRQ3* / PF3	DSOFTOT	O	Detector Heater Over Temperature Shut Down
	IRQ4* / PF4	UARTIRQL	I	External UART Interrupt
	IRQ5* / PF5	EXTDCIN	I	Indicates external AC MAINS power operation
	IRQ6* / PF6	PWRDWN	O	System power down enable
	IRQ7* / PF7	NMIL	I	Non-Maskable Interrupt

Table 4: Chip Select, Control and Discrete I/O

1.Signal names with an “L” suffix are active low signals.

3.2.2 Background Mode Debugging and Application Development

Refer to sheet 1 on 2763-03 schematic.

Background debugging of the system during applications development or during system testing is possible by connecting an appropriate external device (emulator or debugger) to header **J1**. The signals present on this header enable an external device to halt the current microprocessor bus activity. This turns control of the microprocessor system over to the external device, placing the microcontroller into Background Debugging Mode. In this mode, the internal MPU registers can be viewed and altered, special test features can be invoked and the system’s memory, and peripherals can be read and written to.

Refer to sheet 2 on 2763-03 schematic.

In addition to the inherent debugging capabilities of the microprocessor, the digital board also contains circuitry to monitor events during application development. Output latches **IC15** and **IC17** along with Profiling header **J4** are used to determine CPU utilization during system development, latching various status bits out on the header.

3.2.3 System Memory

Refer to sheet 1 on 2763-03 schematic.

A 16-bit wide data path is used for FLASH PROM and SRAM transfers to maximize system throughput. Non-volatile memory, used for the storage of the boot-up and main program code, is contained in **IC4**, a 1024K x 8-bit, 5V FLASH ROM. To initiate the data transfer process, the MPU brings the ROMOEL output signal LOW, causing a word of program data stored in the FLASH ROM to be sent out on the data bus from the appropriate memory address. Program data may be updated by commanding the device to erase a block of its present programmed data then using the ROMWRL signal to place new program data into the address specified by the MPU. The FLASH ROM is internally protected from unintentional overwrites of the boot code by requiring an independent signal, BOOTWE, going active in addition to ROMWRL. The BOOTWE line must be high prior to writing new boot code into the FLASH device. Two 128K x 8-bit Static RAMs (**IC3 and IC6**) contain volatile data storage for use as a temporary data scratch pad during system operation and for recording patient trend information. To retain patient trending data during periods of power down, the SRAMs are battery backed to retain their contents. A 2.5 Volt level VBACK generated from the main battery via IC30 on the 2764 Power Board, is supplied when the system is turned off and removed from the AC MAINS. During this battery backed-up state, transistor **Q1** keeps the chip enable control line of the SRAMs high and in a low power, inactive state. This forces the SRAMs data bus to a high impedance state, isolating the parts from the rest of the system. True non-volatile storage for system parameters is provided by a serial EEPROM (**IC8**), which has the ability to retain programmed information in the absence of power.

3.2.4 User Interface Control Circuitry

Refer to sheet 3 on 2763-03 schematic.

The user interface features a high contrast, 320 row by 240 column Electroluminescent Display module. Patient and system information is presented in both graphical and textual formats organized into several screen configurations. An integrated display controller, **IC19**, works in conjunction with the MC68332 MPU, and provides the necessary timing signal generation and housekeeping functions to display the visual information generated by the system. Programmable logic device **IC2** is designed to condition the logic signals between the MPU and display controller, making sure that the critical timing specifications of the two devices are met. SRAMS **IC18** and **IC22** provide video RAM storage for the display system. In addition to buffering the signals for the display interface, CPLD **IC2** also decodes chip selects for the system input buffers and output latches off of CASCADEL. If required, **IC2** can be reprogrammed in-circuit using header **J9**.

A 5-switch silicon keypanel and multifunctional rotary encoder provide operator control of screen selection, patient data entry, and user selectable input. The keypanel also contains several LEDs which represent various system conditions such as input power status (AC or Battery) and alarm state. Control of the user interface is generated from the CASCADEL chip select signal along with the appropriate address line state and WRL signals from the microprocessor. **IC10** and **IC13** (sheet 2 on schematic) are input buffers, which read in the present state of the keypanel and rotary encoder. Depressing a key or activation of the encoder causes the signal line associated to be pulled low, in contrast to its normally high state. Input buffer **IC14** provides a latched output for controlling the front panel LEDs as well as several other latched control outputs.

To supplement the visual indicators associated with the membrane keypanel and display, an audio output signal is generated to provide an additional mode to convey information to the user. The TPU processor of the MC68332 (TOUT1 and TOUT2) can generate two-tone frequencies. These signals are fed into separate reference inputs of the Quad 8-bit DAC, **IC20**, providing a means for independently attenuating each signal under CPU control. From the DAC, the individual signals are summed together by **IC21B** and filtered by **L11** and **C50**. Audio amplifier **IC23** drives the system speaker to produce system audio. Inverter **IC7F**, controlled by the SYSUP signal from the MPU, disables the audio amplifier until system initialization has been completed. DAC **IC23** also supplies an output voltage level SPO2VLED to set the current gain of the saturation drive circuit which is found on the *NICO* Power PCB, 2764-01. The circuitry associated with the DACB output (including **IC21A**, **Q3** and **J6**) is presently not used.

3.2.5 Real Time Clock, Power on RESET Generation and Glue Logic

Refer to sheet 2 on 2763-03 schematic.

Time keeping for date and time stamping of patient trend information is provided by Real Time Clock **IC16**. This device contains a built in crystal for precise time and date measurement. The *NICO* system has been designed and tested for Y2K compliance. In the absence of digital power, the time keeping function is maintained by the battery backed-up supply, VBACK.

On power-up, the system is forced into a RESET state by **IC9** (sheet 1 on schematic). This chip creates the master active low system reset signal SRST*, holding up system initialization until a stable 5 VDC logic level is maintained. An inverter is used to generate RESET for devices that require an active high reset signal.

3.3 Power Supply 2764 (Power Supply and Communications)

3.3.1 Serial Communications UART

Refer to sheet 3 on 2764-03 schematic.

To enable serial communication with up to three external devices simultaneously, a Quad UART (Universal Asynchronous Receiver/Transmitter), **IC14**, is provided for buffered high-speed data communication. The connection to external, non-patient contact-type devices is electrically isolated from the patient applied sections by optical data couplers (**IC16, IC17, IC21, IC23, IC26**) and isolated winding off of the power supply flyback transformer, **T1**. Transceiver **IC13**, located on the patient-isolated circuit, provides signal translation between the system's TTL logic level and the RS-232 level requirements. Serial Ports A and C (**J1** and **J3**) are configured for a simple 3-wire (Transmit, Receive and Ground) connection, while Serial Port B (**J2**) has additional hardware handshaking capabilities. Connection to an external device is through a null-modem type of interface cable. The fourth UART channel is available on internal connector J5 for future product expansion. In addition, the system is capable of outputting four channels of analog output data through **IC22** and receiving four channels of analog input through buffer amplifiers **IC18** and A/D Converter **IC20** on connector **J4**. Voltage reference **IC19** supplies the analog I/O circuitry with a stable voltage level. Connector **J4** allows sensing of external cable connection by shorting pin 15 (IOSNSE) of the external cable to ground. Refer to Tables 5 to 8 for the pinout and signals of interface connectors.

J1		
Pin Number	**Signal**	**Function**
1	NC	No Connection
2	RxC	Serial Channel A Receive
3	TxC	Serial Channel A Transmit
4	NC	No Connection
5	Isolated Ground	Non-Patient Signal Ground
6	NC	No Connection
7	NC	No Connection
8	NC	No Connection
9	NC	No Connection

Table 5: Serial Channel A, 9-pin D-subminiature connector located on the rear panel

J2		
Pin Number	**Signal**	**Function**
1	NC	No Connection
2	RxB	Serial Channel B Receive
3	TxB	Serial Channel B Transmit
4	NC	No Connection
5	Isolated Ground	Non-Patient Signal Ground
6	NC	No Connection
7	RTSB	Request to Send Channel B, Hardware Handshake Output
8	CTSB	Clear to Send Channel C, Hardware Handshake Input
9	Isolated Power	Power

Table 6: Serial Channel B, 9-pin D-subminiature connector located on the rear panel

J3		
Pin Number	**Signal**	**Function**
1	NC	No Connection
2	RxA	Serial Channel C Receive
3	TxA	Serial Channel C Transmit
4	NC	No Connection
5	Isolated Ground	Non-Patient Signal Ground
6	NC	No Connection
7	NC	No Connection
8	NC	No Connection
9	NC	No Connection

Table 7: Serial Channel C, 9-pin D-subminiature connector located on the rear panel

J4		
Pin Number	**Signal**	**Function**
1	Isolated Ground	Non-Patient Signal Ground
2	ADCIN0	ADC Input Channel 0

Table 8: Analog Connector, 15-pin D-subminiature connector located on the rear panel

3	ADCIN1	ADC Input Channel 1
4	ADCIN2	ADC Input Channel 2
5	ADCIN3	ADC Input Channel 3
6	Isolated Ground	Non-Patient Signal Ground
7	Isolated Ground	Non-Patient Signal Ground
8	Isolated Ground	Non-Patient Signal Ground
9	Isolated Ground	Non-Patient Signal Ground
10	Isolated Ground	Non-Patient Signal Ground
11	DACOUT0	DAC Output Channel 0
12	DACOUT1	DAC Output Channel 1
13	DACOUT2	DAC Output Channel 2
14	DACOUT3	DAC Output Channel 3
15	IOSNSE	Cable connect sense input

Table 8: Analog Connector, 15-pin D-subminiature connector located on the rear panel

3.3.2 CO_2 Pulser Source Drive

The source drive circuitry is designed to drive the source with a bipolar signal to prevent the migration of charges within the source that may result from unidirectional electrical fields. The resistance of the source is monitored constantly to ensure the integrity of the system by sampling the current through the source while it is active.

Refer to sheet 1 on 2764-03 schematic.

The TPU co-processor in the MC68332 generates the timing signals that drive the power to the broadband infrared source located in the CAPNOSTAT CO_2 sensor. The SRCDRV0 and SRCDRV1 lines are used to control the direction of the current flow through the source. On the falling edge of CO2AZ (Auto Zero) and the rising edge of CO2PWENB (Pulse Width Enable), the SRCDRV0 signal goes High, enabling drivers **IC1A** and **IC2B** to turn on one half of the MOSFET H-Bridge formed by **Q1** and **Q2**. This causes current to flow through the P-Channel half of MOSFET **Q1**, through the CAPNOSTAT source, through the N-Channel half of MOSFET **Q2** and finally through **R23** to the negative supply rail, completing the first part of the Source Pulse cycle. The duration of SRCDRV0 is 405 us (microseconds). After the SRCDRV0 line goes Low, there is a 20 us software delay until the SCRDRV1 line goes High, enabling drivers **IC1B** and **IC2A** to turn on the other half of the MOSFET Bridge formed by the P-Channel half of **Q2** and the N-Channel half of **Q1**. This drives the current through the source in the opposite direction. The 20us software delay between the SRCDRV0 and SRCDRV1 signals is to prevent the possibility of both halves of the MOSFET bridge being active at the same time, thus creating a low impedance path between the two power supply rails.

When current flows through the source, it will also flow through current sensing resistor **R23**, creating a differential voltage proportional to the source current. This voltage is measured during the last part of the SCRDRV0 period by differential amplifier **IC3A**, and is inputted to **IC9** (see sheet 2 on schematic), a 12-bit, 11-channel A/D Converter after being conditioned by the sample / hold circuit consisting of **IC4**, **IC5** and **C11**. The converter output of the sample / hold is processed in software to represent the current flowing through the CAPNOSTAT source:

$V_{SRC} = (V_{SR} / R_{SR}) * R_S * A_{V(DA)}$ where

V_{SRC}	=	voltage out of difference amplifier proportional to current through the source element
	=	24V +/- 0.625V
V_{SR}	=	differential voltage across the source element
R_{SR}	=	resistance of the source element
R_S	=	resistance of the current sensing resistor
	=	1 ohm
$A_{V(DA)}$	=	difference amplifier gain
	=	5
V_{SRC}	=	[120 (Volts*Ohms) / R_{SR} (Ohms)]

For compatibility with present Novametrix monitors, the software displays the source current scaled by (1.1Vsrc) +17mV. In addition to monitoring the source current, the A/D Converter **IC9** also digitizes the feedback signals from the Saturation sensor and Power Supply.

In order to prevent the source from being driven until the system is up and ready, there is protection circuitry that inhibits the source drive until enabled. During system power-up, the RESET line keeps **Q3** on, preventing source pulses by pulling down SRCDRV0 and SCRDRV1 through **D3**. Protection circuitry also guards against extended pulse width as well as shortened duty cycle. On the rising edge of CO2PWENB, the trip point of **IC6B** is exceeded, bringing the output of **IC6B** high as **C12** charges through diode **D4**. This allows capacitor **C8** to charge up through **R22**. If the CO2PWENB signal does not turn the Source Pulser off within 200 us after the 810 us pulse period, the voltage across **C8** will exceed the trip point for **IC6A**, pulling the CO2INH line low and turning the Pulser off. After the CO2PWENB signal returns Low, capacitor **C12** is allowed to discharge through **R26**, keeping the output of comparator **IC6B** at the voltage acquired during the period when CO2PWENB was High. After approximately 7.2ms, **C12** will have discharged below comparator **IC6B**'s trip point. The comparator output goes low, discharging **C8** and the circuit is ready for the next source pulse cycle.

3.3.3 CAPNOSTAT Case and Detector Heater Control

Refer to sheet 2 on 2764-03 schematic.

The temperature of the CAPNOSTAT sensor system directly affects its ability to accurately measure CO_2. Two separate heaters and control circuits are used to maintain the sensor temperature at a precise value. One heater regulates the temperature of the detectors that detect the amount of infrared energy passing through the sample chamber; the other regulates the temperature of the transducer case (and loosely maintains the temperature of the airway adapter). While the purpose of the detector heater is to keep the detectors' sensitivity to infrared radiation constant, the function of the case heater is to keep condensation from forming on the airway windows by elevating the window temperature above the ambient airway temperature. Both heaters use an efficient Pulse-Width Modulation scheme designed to decrease power consumption, with the PWM timing generated by the TPU under microprocessor control. The MPU senses the voltage output from the CAPNOSTAT case and detector thermistors (circuit described in the Analog 2754-01 PCB discussion) and regulates the output pulses from the TPU, creating a pulse duty cycle that is proportional to the amount of energy required to maintain the heater temperature. Dual MOSFET Driver **IC10** buffers the TPU signals to drive the gates of Dual P-Channel MOSFET **Q7**. These drive signals are AC coupled by capacitors **C24** & **C31** to ensure that if PWM pulses are lost for any reason, the MOSFET gates will be pulled up by resistors **R40** and **R47** which will turn the MOSFETs Off, removing power to the Capnostat heaters. Dual MOSFET **Q4** also controls power to the heaters, allowing independent over-temperature cut-off of each heater by both software and hardware watchdogs. **D6**, **L1** and **C25** help turn the pulses for the Case Heater from **Q7A** into a steady DC output, while **D8**, **L2** and **C32** smooth out the Detector Heater output from **Q7B**. Since the TPU-generated PWM signal is based on the system clock, it is synchronized with the generation of the source pulse timing. This minimizes the effect of any random disturbance caused by the heater circuit on the detection of the CO_2 Data and Reference signals.

3.3.4 Saturation LED Power Generation and LED Drive

Refer to sheet 2 on 2764-03 schematic.

Adjustable voltage regulator **IC11** is configured as a constant current supply for the Red and InfraRed (IR) saturation sensor LEDs. **R50** limits the current to Vref/R {1.25V/26.7 ohms} or 50mA, while Zener diode **D9** sets the maximum output voltage at 7.5 Volts. Capacitors **C36** and **C37** provide a reservoir for providing the instantaneous current demanded when the LEDs are turned on. Transistor **Q11** allows shutting down the power to the sensor LEDs by the microprocessor.

Connector **J4** on the *NICO* 2765-01 Analog Board connects the saturation sensor to the monitor. Both of the saturation sensor LEDs are controlled by an amplifier configured as a constant current driver. The voltage control for the constant current drive, SPO2VLED, comes from DAC **IC20** on the *NICO* Digital Board, 2763-01. The cathode of the Red LED channel is tied to the driver consisting of amplifier **IC12A**, MOSFET **Q10** and resistor **R57**. Since the amplifier is connected as a non-inverting amplifier, the voltage appearing at the positive terminal will also appear at the negative terminal and across **R57**. This voltage, nominally 0.74V, creates a current through **R50** of 225mA {0.74V/3.3 ohms} when the RDLED* signal is asserted which also flows through the Red LED of the Saturation sensor via **Q10**. The driver for the IR LED (**IC12B**, **Q13** and **R64**) creates a constant current source of 111mA across **R64** and is controlled by asserting the IRLED* signal. The two control signals operate at 33 kHz with a 10% duty cycle and are staggered so that one LED is on during the middle of the other LED’s off time.

3.3.5 Power Supply and Voltage Reference Generation

The monitor operates either on isolated AC Mains power or on the internal 12-Volt Lead-Acid Battery. To provide isolation from the MAINS lines as well as AC/DC voltage conversion, the *NICO* monitor utilizes a Medical Grade, universal input off-line switching power supply. The DC output of this supply is 15 VDC at 40 Watts, and is brought to the Power board on connector **J6** (sheet 5 on schematic). The heart of the power supply design for the system is a 100 kHz switching regulator, **IC34** (sheet 4 on schematic), which utilizes a flyback transformer configuration to generate the DC supply voltages and provide the required isolation between the primary, secondary and isolated power planes. Power On / Off control is achieved by sensing the state of the power switch located on the front panel. A high to low transition on the PWRSW line is debounced by **C85** and **IC31A**, and clocked into Flip-flop **IC32A**, which causes the Flip-flop output to toggle its present state. A high output causes switching regulator **IC34** to be turned on, supplying power to the system. Flip-flop **IC32B** provides control over the state of the system when the user turns the system “Off”. When the monitor is operated from an AC MAINS power source the green AC ON indicator on the front panel is lit. If the monitor is on, pressing the power key on the front membrane keypanel will not power the monitor down. Instead, the monitor is placed in a standby operating mode. The display and other non-essential control functions are inactivated by the software, giving the monitor the appearance of power down. While in standby, however, the core system continues to operate, keeping the Capnostat heaters within temperature regulation. This reduces the time required to bring the system up to full operating specifications during the following power-up cycle. While on battery operation, depressing the Power Key on the front keypanel will turn off the switching regulator, thus powering down the system. Stand by mode is disabled and power to the system is turned off. The monitor enters a low power mode where only circuitry required for SRAM and real-time clock battery back-up and Power Key sensing is kept supplied. Power for the SRAM and Real-time clock, VBACK, is determined by the state of VDD. When VDD is available and transistor **Q23** is turned on, VDD is supplied through transistor **Q21**. In the absence of VDD, VBACK drops down to a low power level supplied through diode **D36**.

During system initialization, the switching frequency is synchronized to the main system clock by the components associated with **Q17** to reduce system data acquisition errors due to power supply interference. The nominal synchronized frequency is 156 kHz. The primary of transformer **T1** is designed to accept 10 to 24 V DC input and provides secondary outputs of nominally 5 VDC, +14 VDC, and -14 VDC. An additional winding pair is isolated by 2KV from the other transformer windings to provides 9VDC output for the earth connected and patient isolated serial and analog input and output circuitry. The 5VDC supply (VDD) provides feedback to the switching regulator by resistor divider **R108** and **R112**. The other windings are loosely regulated by the requirements of the 5 VDC supply by the ratio of the transformer windings, creating semi-regulated secondary voltages for the analog supplies of approximately +\-14VDC. The 5V supply is L-C filtered to provide clean logic supplies for both the digital logic (VDD) and the analog sections of the Digital and Power Boards (DVDD). Another filter isolates the 5-Volt supply for the Flow Pneumatics (VVDD) from the rest of the system. Regulators **IC33** and **IC36** are designed as a tracking regulator pair to provide a 24VDC differential voltage for powering the Capnostat source (+VSRC, -VSRC). The voltage level of the +VA supply is monitored by **IC35B** to ensure that a tight voltage range is maintained and not exceeded in the event that the +5 VDC feedback to the switching regulator, **IC34**, is lost. Linear regulator **IC27** provides the logic and analog supply for the patient-isolated circuits.

Power for the CAPNOSTAT heaters and the display are derived off of the main 15 Volt input from the offline switching regulator during connection to an AC MAINS power source. During AC operation, the signal LINEST is High, indicating the presence of AC MAINS. **IC37**, also a switching voltage regulator, and its associated circuitry provide these functions with a well-regulated 12 VDC supply. When the monitor is operating off of the internal battery, LINEST is Low, disabling the switching regulator and turning on MOSFET **Q19A** which is controlled by voltage comparator **IC35C**. In this mode, the heaters and display are supplied directly with battery power, minimizing power losses that occur during the conversion of one voltage level to another. The output from comparator **IC35C** also controls the Reset input to Flip-flop **IC32B**, determining whether the monitor is in AC stand-by or DC Power Down operating mode.

Charging the battery takes place as long as the unit is connected into a viable source of AC MAINS power and the power entry module switch is in the “On” position. In order to charge the battery as quickly and efficiently as possible, a two-step charging process is employed. Assuming the battery is in a depleted charge state, feedback to the low drop-out linear regulator, **IC39**, sets the voltage output at a fast-charge level of approximately 14 VDC. Sensing the voltage drop across **R144**, comparator **IC40A** monitors the current draw of the battery, limiting it to approximately 250mA for a maximum charge rate of C/10. If the battery tries to draw current in excess of the amount allowed, **IC40A** turns off the regulator, thus limiting the charging current. As the battery reaches a fully charged state and the current draw decreases to approximately 50mA, **IC40B** turns transistor **Q27** off which causes the regulator to change its output to a float charge voltage of approximately 13.2 VDC, which maintains the battery in a constant state of readiness.

If AC power is lost or is not available, the monitor automatically operates from its internal battery without interruption. The AC ON indicator is extinguished and a BATTERY ICON appears on the display, indicating the current power level of the battery. While on internal DC power, the current state of the battery is monitored by both software and hardware (**IC29**, **IC28A** and **IC35A**). Should the battery power level get critically low, the monitor software, which monitors the VBATTADC signal into A/D Converter **IC9** (sheet 2 on schematic), alerts the user. If the monitor is not placed on AC MAINS power within approximately ten minutes, the software will turn the unit off. Should the software fail to turn the monitor off, the hardware cutoff, controlled by comparator **IC35A**, activates, turning the unit off.

Stable reference voltages for the analog circuitry are derived from **IC7** (sheet 1 on schematic), a precision 2.5V with low drift. Five Volt and 2.5 Volt references are generated by **IC8**.

Refer to Table 9.

Signal	Supply	Description
VDCIN	+10 - +15 VDC	Main DC input generated from offline switcher or internal battery
VBATT	+10 - +12.5VDC	Internal Battery DC input
VBACK	+2.5VDC or +5VDC	Supply for SRAMs, either VDD or 2.5V to maintain SRAM data during power down
VHTR	+12V or VBATT	Supply for the Capnostat Case and Detector heaters and Fan, regulated at 12V when MAINS power available or from VBATT when unit is on battery power
DISPVA	+12V or VBATT	Supply for the EL Display, regulated at 12V when MAINS power available or from VBATT when unit is on battery power
VDD	+5VDC	Regulated digital logic supply
VVDD	+5VDC	Regulated and filtered supply for the valves
CVDD	+5VDC	Regulated and filtered logic supply for CO_2 analog sub-system
DVDD	+5VDC	Regulated and filtered logic supply for general analog sub-systems
ADCVDD	+2.14VDC	ADC input for monitoring VDD
+VA	+14VDC (nominal)	Loosely regulated off of the 5VDC feedback line

Table 9: Power Supply Outputs

+VSRC	+12VDC	Linearly Regulated and filtered positive supply for the Capnostat Source. Tracks -VSRC to provide a 24V +/- 2.5% differential voltage across the source
ADCPVSRC	+0.85VDC	ADC input for monitoring +VSRC
-VSRC	-12VDC	Linearly Regulated and filtered negative supply for the Capnostat Source. Tracked by +VSRC to provide a 24V +/- 2.5% differential voltage across the source
ADCNVSRC	+0.75VDC	ADC input for monitoring -VSRC
-VA	-14VDC (nominal)	Loosely regulated off of the 5VDC feedback line
IRAW	+7.5VDC (nominal)	Loosely regulated off of the 5VDC feedback line, isolated from the other transformer windings
IVDD	+5VDC	Linearly Regulated to provide an isolated digital and analog power source

Table 9: Power Supply Outputs

3.3.6 Logic and Input / Output Signal Control

Refer to sheet 6 on 2764-03 schematic.

Chip selection for the serial peripherals are provided by decoders **IC43** and **IC46** and by the inverters **IC47**, **IC45E** and **IC45F**. Latch **IC41** is used mainly to control the system pneumatics, with Latch **IC42** providing additional control signals for the *NICO* 2765-01 Analog Board. Input buffer **IC44** allows the digital system to read various status signals from the Analog Board.

3.4 Analog Board 2765-01

3.4.1 CAPNOSTAT Interface

Refer to sheet 1 on 2765-03 schematic.

A twenty pin connector, **J2**, interfaces the CAPNOSTAT with the system electronics. Ferrite filters have been placed on all lines to suppress radiated EMI and reduce susceptibility from high frequency external sources of interference.

Stable reference voltages for the sensors and analog circuitry are derived from **IC1**, a precision 2.5V reference with low drift. Five Volt and 2.5 Volt references for the CO_2 and Saturation circuits are generated by **IC2**. Positive and negative supply rails for the analog circuitry are derived from linear regulators **IC6**, **IC7** and **IC50**, while regulators **IC3** and **IC49** and provide regulated voltage supplies for the CAPNOSTAT itself.

3.4.2 CO_2 Input Signal Path

Refer to sheet 2 on 2765-03 schematic.

The signals from the sensor CO2DATAIN (CO_2 Data) and CO2REFIN (Reference Signal) have similar signal paths. The CO2DATAIN passes through a high pass filter with a gain of 7.65 consisting of **C60**, **R68** and buffer amplifier **IC15B**. The signal is fed to a Butterworth low pass filter **IC15A** and associated components. This filter has a gain of 2 with a corner frequency of 1.5 kHz. The output from the low pass filter is fed to a 12-bit Digital to Analog converter **IC14**. The signal, CO2DFB comes into the feedback pin of the DAC, which acts as a programmable gain stage. Here, under processor control, the signal's gain is adjusted to an acceptable level for conversion. The gain setting is adjusted using the digitized signal out of A/D Converter **IC4** (sheet 1 on schematic) as part of the feedback loop. Similarly, CO2REFIN is conditioned by high pass filter **IC16B** with a gain of 3.5 and low pass filter **IC16A** with a gain of 2. The equivalent fixed gains for the two input signals are not equal in order to compensate for differences in the output signal levels of the infra-red detectors in the CAPNOSTAT.

The output from DAC **IC14** corresponding to signal CO2DATAIN is buffered by **IC12A** and AC coupled through **C49** to **IC11A**. The CO2DATA signal received from the CAPNOSTAT is AC coupled prior to the high pass filter to remove any DC bias by **C60**. Prior to sampling a CO_2 signal, the CO2AZ (Auto Zero) pulse turns **Q1** on causing any residual charge on **C49** to discharge to ground. At the start of the source pulse, the CO2AZ pulse goes Low and the CO_2 signal from the sensor is acquired. The signal is buffered by **IC11A** before appearing at the input of the sample and hold amplifier, **IC13A**. Near the end of the source pulse, the CO2SSH (CO_2 Sample and Hold) goes Low and the peak signal is acquired on the internal sample and hold capacitor. CO2SSH returns high at the end of the cycle, and the CO_2 signal on the sample capacitor is held at the peak value. The signal then passes through a low pass filter and resistive divider network consisting of **R51**, **R53** and **C51** before being converted by the A/D Converter **IC4** into digital data and analyzed by the processor. The signal CO2REF follows an identical zeroing and acquisition path.

3.4.3 CO_2 Case and Detector Heater Regulation

Refer to sheet 2 on 2765-03 schematic.

For the purpose of describing the regulation loop, the case heater circuitry will be considered. The detector and case heater circuitry are identical.

Inside the CAPNOSTAT, a sensing thermistor is thermally connected to the heater module. Initially, the CAPNOSTAT is at ambient temperature and the resistance of the thermistor is large. A small current flows through the signal path CASETHERM and only a small voltage is developed across **R47**. The microprocessor programs the TPU to allow an initial maximum duty cycle of 70% to power the PWM heater circuitry. This causes the heater control MOSFET on the *NICO* 2764-01 Power Board to be pulsed on and off with a duty cycle that is under direct control of the program software. As the heater warms up the case, the thermistor's resistance decreases, raising the voltage appearing at the input of the control loop. As described below, the MPU looks at this output voltage and decreases the duty cycle of the PWM control circuitry, gradually reducing the power output into the heater. When the desired temperature set point is reached, a balance is struck between the energy delivered into the system and the heat flow out of the system.

The case thermistor is sensed by amplifier **IC9B**. The difference between the signal at the non-inverting input and the reference appearing at the inverting terminal generates an error voltage proportional to the sensed temperature at the amplifier's output:

e_o (V) = [83.133V / (R_{th}+3.32K)] - 10.2V where e_o = amplifier output voltage
R_{th} = resistance of the thermistor
= 4.36933K at 45°C

Temp (°C) = 4.1288 (°C/V) * $e_{o\,(T)}$ V + 41.7321°C
where e_o = amplifier output voltage at temperature T

This error voltage is low pass filtered by amplifier **IC8B**, sent to the ADC and processed by the CPU to regulate the output pulses from the TPU. The error voltage out of amplifier **IC9B** also appears at the temperature watchdog comparator **IC10A**. If the error voltage reaches approximately 56 degrees Celsius, the comparator trips, causing the output to go Low and turning off the heater supply on the Power Board.

3.4.4 *Flow Zeroing and Patient Line Purging*

Refer to sheet 5 on 2765-03 schematic.

The zero process begins when the CPU brings the VALVE1, VALVE2, VALVE3 VALVE4and VALVE6 lines high, energizing valves **V1**, **V2**, **V3, V4** and **V6**. This action disconnects the differential pressure transducer **IC18** (via **V1** and **V2)** and the absolute pressure transducer **IC29** (via **V2**) from the patient airway, shunts the differential pressure sensor ports (**V4**), and opens all pressure transducer ports to atmosphere through **V3**. Valve **V6** switches the pump output from the external *NICO* Valve to the internal patient tubing and flow sensor. The differential pressure transducer is “zeroed” by capturing the digital output of the 20-bit sigma delta A/D Converter, **IC25** (sheet 3 on schematic), during this zero flow condition, and using this value to set the software. The patient airway pressure transducer is "zeroed" by adjusting the output of the DAC, **IC26** pin 10 (sheet 3 on schematic), until the Airway Pressure signal into the ADC, **IC4**, reads mid-scale. The barometric (ambient) pressure, as sensed by **IC28** (sheet 3 on schematic), is recorded after the airway pressure zero is completed. IC30 acts to filter the signals from the barometric pressure and airway pressure channels. After the result from each channel is stored in SRAM to be used as an offset in the flow and pressure calculations, valves **V1**, **V2**, **V3, V4** and **V6** are then de-energized, reconnecting the pressure transducers with the patient airway.

If patient line purging is enabled by the software, the system turns on the pump by bringing the PURGE line high after the zero values are recorded. A slight pressure is allowed to build in the pump tubing line that will aid in flushing out the patient airway tubing. To purge patient line 1, the CPU brings the VALVE1 and VALVE4 signals high, energizing Valves **V1** and **V4**. **V1** connects the pump with the P1 patient line, flushing out the patient P1 line while **V4** shunts across the differential pressure transducer, preventing a differential pressure from appearing across the transducer. During purging, the system is able to monitor the pressure that is present in the selected patient line by reading the AWPRESS signal. VALVE1 is brought low and **V1** is the de-energized, once again isolating the pump from the patient airway and allowing a pressure head to build once more. The VALVE2 line is then brought high and valve **V2** is then energized, flushing out the patient P2 line. After all lines have been flushed out, **V1** and **V3** are re-engerized allowing any residual pressure to be vented to atmosphere. All valves are then de-engerized and the PURGE signal is brought low, turning the pump off. The purging process is complete and normal patient monitoring continues.

A hardware watchdog, consisting of **IC44A** and the surrounding circuitry, limits the maximum pump-on time, preventing overpressure from building in the patient lines.

3.4.5 *Flow Circuitry*

Refer to sheet 3 on 2765-03 schematic.

Differential Pressure Transducer, **IC18**, is a silicon based, piezoresistive bridge with four active elements. When a pressure is applied between transducer ports P1 and P2, a differential output voltage proportional to the applied pressure is produced. The full-scale output range for the transducer is 0 to 10 inches of water (P1>P2). By setting the 0 differential pressure (no-flow) point to mid-scale (during the zeroing process described earlier), negative pressure readings (P2>P1) are also available. The transducer is temperature compensated at 25 degrees Celsius and designed to be driven by a constant voltage source.

In the normal system operating mode, all valves are de-engerized and the pump is inactive. Transducer ports P1 and P2 are connected to the patient airway. As air flows through the airway adapter pneumotach, a pressure difference between P1 and P2 is created. This signal is dependent on both the magnitude and the direction of the airflow. The greater the flow volume, the larger the pressure difference created between the two transducer ports. The transducer senses an inspired flow as a positive pressure difference (P1>P2), while an expiratory flow is seen as a negative pressure (P2>P1). With a supply voltage of 2.5V, the sensor transforms this pressure difference into an electrical signal with a nominal absolute magnitude of 23 mV Full-scale Output. This signal is conditioned and amplified by **IC23**, which is a monolithic Instrumentation Amplifier (IA). A positive pressure difference (inspiratory flow) creates a signal above the no-flow zero baseline obtained during the zeroing process. A negative pressure difference (expiratory flow) is below the set baseline. The nominal gain of **IC23** is set by fixed resistors **R85**, **R83** and variable resistor **VR1**. The output for the transducer is adjusted using **VR1** and a known pressure input as a calibration reference. With an input differential pressure of 20 cmH_2O, the gain of the amplifier is set to give an ADC count of 412160.

The signal out of the flow IA is taken through a two-pole low pass filter **IC22A** with a 31 Hz cutoff frequency to remove unwanted high frequency electronic noise. It is then passed on to the 20-bit sigma delta ADC, where it is transformed from an analog voltage into a digital code for processing by the CPU, located on the 2763-01 Digital Board.

3.4.6 *Barometric and Airway Pressure*

Refer to sheet 3 on 2765-03 schematic.

IC29 is a piezoresistive differential pressure transducer with port P2 held at zero psi. It measures the absolute pressure difference at port P1 relative to the vacuum at port P2. The transducer is calibrated for a full scale output of 0 to 15 psi, has internal temperature compensation, and is designed to be driven by a constant voltage source. Instrumentation amplifier (IA) **IC28** conditions this signal to correspond to the current barometric pressure, which is set by adjusting **VR3**. The nominal gain of this amplifier is 67, which corresponds to a 12-bit ADC count of 4012 at 760 mmHg. The output signal from **IC28** is low pass filtered by **IC30B** and appears as an input to both the 12-bit ADC and a second IA, **IC27**. **IC27** provides gain adjustment via **VR2** and offsets the output signal from the barometric amplifier to mid-scale during the zeroing state. The nominal gain of the airway pressure amplifier is 5. This signal connects to the P1 (proximal to the patient) side of the differential pressure transducer during monitoring and provides patient airway pressure sensing.

3.4.7 *Patient Airway Adapter Type Sensing*

Refer to sheet 5 on 2765-03 schematic.

Given a specific flow sensor type (i.e., Adult), the physical characteristics of the sensor will be consistent from one adapter to another. However, due to the differences in the physical size and geometry of the various flow sensor types, each type (i.e., Adult, Adult Combo) requires different coefficients be used in the calculation of flow. Each flow sensor type has a unique 4-bit code associated with it. This pattern molded into the connector body can be optically reflective or non-reflective and is read by the system. A pulse is generated by the CPU that turns on the LED component of a opto-coupler mounted directly beneath each pattern segment. If the pattern segment associated with that opto-coupler is reflective, the LED's light will cause its photodetector mate to be turned on, which generates a signal that is sensed by the system and relayed back to the CPU. If the segment is non-reflective, no signal is returned to the sensing circuitry.

A four-bit code can generate 16 unique pattern combinations. One code condition, all zeros (no reflection), is reserved for detecting when the sensor unplugged. The circuitry to decode the flow sensor type consists chiefly of connector J5 and comparator IC40.

3.4.8 NICO Sensor Rebreathing Valve Control

Refer to sheets 3 and 5 on 2765-03 schematic.

To initiate a *NICO* cycle and switch the external *NICO* Valve from non-rebreathing to rebreathing mode, valve **V5** is energized, which switches the tubing to the external valve from atmosphere to the pump. The pump is turned on, causing the diaphragm in the *NICO* valve to switch to rebreathing mode. The pressure in the airline is monitored by pressure transducer **IC32** and IA **IC31**. When adequate pressure to switch the valve is reached, the pump turns off and the software continues to monitor the airline pressure to ensure pressure is maintained. Valve **V6** has a time-out watchdog, **IC44B**, to ensure that software control over the external *NICO* valve is maintained.

3.4.9 Saturation Input Signal Path and Signal Conversion

Refer to sheet 4 on 2765-03 schematic.

On power up, the system performs a self-calibration cycle to establish the level of background circuit offset. Calibration is performed by coordinating the control signals SPO2CAL, SPO2SC1, ASAMPL, RSAMPL, ISAMPL, SIGNDL and INSIGL. Once the system baseline has been acquired, the Red and Infrared ADCs, **IC33** and **IC37**, adjust their output to compensate for any system offsets found. Since the LED drives are staggered, a single detector is used to multiplex the individual signals on a common signal input line. Amplifier **IC36B** performs a current to voltage conversion on the input signal, and analog switch **IC35** steers the signal to the proper 20-bit ADC based upon the LED channel (Red or Infrared) that is currently active. A sample and hold circuit for each channel made up of **IC35** and **IC34** transform the pulsed input signal into a constant voltage level for signal conversion. The main timing signal generation for saturation signal acquisition is generated by the TPU. Amplifier **IC38A** generates an analog signal, SPO2PROB, that varies with the saturation probe type. SPO2PROB is converted to digital form by ADC **IC9** on the *NICO* 2763-01 Digital Board Schematic.

4 Functional Testing

The functional Testing verifies overall functional integrity of the monitor and sensor. If the Model 7300 does not pass these tests, remove from use and contact the Novametrix Service Department for repair/replacement assistance. Refer to the Accuracy Tests for testing the rear panel connectors.

This procedure assumes the technician performs each step as indicated - leaving the monitor in a known state prior to performing the next step. If steps are omitted or performed out of order, be sure that the monitor is set to the correct state before continuing.

4.1 Equipment Required

1. CAPNOSTAT CO_2 Sensor, PN: 9567-00
2. NICO sensor, PN: 8951-01
3. SpO_2 Finger Sensor, PN: 8776-00
4. 500ml Calibration syringe, Hans Rudolph Model 5550 or equivalent
5. Model 1298 Gas Calibrator, PN: 6081-00
   Low point calibration gas, PN: 8364
   Adult airway adapter PN: 7007-01 Qty. 3

4.2 Functional Test

In this procedure the term “select” refers to highlighting a selection on the screen by turning the knob, then pressing it in to select the highlighted option.

1. Connect the monitor to the AC line. Set the rear panel power entry module switch ON. Verify the AC LED turns on.
2. Press the power switch. Verify the display shows the NICO start up routine followed by the main display screen (reference the Users Manual for display appearance).
3. Connect the NICO sensor to the monitor. Verify an ADULT NICO ADAPTER IDENTIFIED message is momentarily displayed.
4. Connect the CAPNOSTAT CO_2 sensor to the monitor. Verify the CO_2 SENSOR? message is replaced by a WARMUP message.
5. Place the CAPNOSTAT CO_2 sensor on the NICO sensor airway adapter.
6. Press the MENU button. Verify the SELECT A SCREEN menu is displayed.
7. Select the SETUP screen.
8. Select CO_2 ZERO NOW. Follow the screen prompts to perform a zero calibration. When the zero calibration is complete, select EXIT.

NOTE: The CAPNOSTAT CO_2 sensor must reach operating temperature before zeroing.

9. Connect the low point calibration gas to the Model 1298 Gas Calibrator. Refer to the instructions supplied with the gas calibrator for further instructions.
10. Connect the Model 1298 Gas Calibrator with low point calibration gas to the NICO sensor via the airway adapter stack (see instructions with Model 1298 Gas Calibrator).
11. Press and hold the MENU and DATA ENTRY keys simultaneously until the CONFIGURATION MENU appears. Select DIAGNOSTIC SCREENS, then select CO_2.
12. Flow gas for thirty seconds. Verify the CO_2 value is 41 ± 2.
13. Turn the calibration gas off. Select EXIT and remove the Model 1298 Gas Calibrator.
14. Select CO_2/SpO_2.
15. Breathe into the NICO sensor, verify both $ETCO_2$ and RR values.
16. Stop breathing into the NICO sensor. Wait for 20 seconds, verify that an alert is generated and NO RESP: X:XX is displayed where X:XX starts at 0:20 and counts up in seconds. Press SILENCE to reset any audible alerts.
17. Turn the knob until the FLOW/PAW screen is displayed.
18. Connect the 500 ml calibration syringe to the NICO sensor. Pump the syringe back and forth at a rate of 15 cycles per minute. Verify a Vti and Vte of 500ml ± 25.
19. Remove the calibration syringe.
20. Press the MENU button. Select SET ALERTS. Verify the SET ALERTS screen is displayed.
21. Select the low pulse (bpm) alert. Verify the ENTER LOW PULSE LIMIT screen is displayed.
22. Record the current value of the low pulse limit. Follow the screen instructions and set the low pulse limit to 99. Verify that the bell icon next to the limit is active (does not have a line through it). If not select it to enable audible alerts.
23. Select the AUDIO. Follow the screen instructions and scroll through the audio levels. Verify the audio increments with each audio level. Set the audio level to 5.
24. EXIT the SET ALERTS screen.
25. Turn the knob until the CO_2/PLETH screen is displayed.
26. Connect the finger sensor to the monitor. Verify the SPO_2 PROBE? message is replaced by a PULSE SEARCH message.
27. Place the SpO_2 finger sensor on your finger. Verify an SpO_2, pulse rate and pleth waveform are present. Verify the pulse value is blinking, LOW PULSE is displayed, and an audio alert is heard.
    Note:If your pulse is not below 99 you will not get the error.
28. Press the SILENCE button. Verify the audio alert is silenced and the SILENCE button is flashing between yellow and red.
29. Remove the finger sensor from your finger. Verify a PULSE SEARCH message is displayed.
30. Follow steps 20. 21. and 22. to return the low pulse limit to the previous value.

31. Press the MENU button, select SETUP. Verify the SETUP screen is displayed.
32. Select SET TIME & DATE. Verify the time and date are correct.
33. Exit the SET TIME & DATE screen then EXIT the SETUP screen.
34. Set the power entry module switch on the rear panel to the OFF position. Verify the AC indicator turns off, a battery icon is displayed and the monitor continues to operate. Set the power entry module switch back ON.
35. The test is complete. Disconnect the sensors from the monitor and turn it off.

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5 Accuracy Tests

The Accuracy Tests verifies the performance accuracy of the Model 7300. This test is typically performed in conjunction with (after) the Functional Tests. If the monitor does not pass the Accuracy Tests, remove from use and contact the Novametrix Service Department for repair/replacement assistance.

This procedure assumes the technician performs each step as indicated - leaving the monitor in a known state prior to performing the next step. If steps are omitted or performed out of order, be sure that the monitor is set to the correct state before continuing.

5.1 Equipment Required

1. Leak test adapter, PN: 9695-48
2. Calibrated barometer
3. Capnostat CO_2 Sensor, PN: 9567-00
4. Model 1298 Gas Calibrator Catalog No. 6081-00
   Low point calibration gas, Catalog No. 8364
   Adult airway adapter PN: 7007-01 Qty. 3
5. TB500B Saturation simulator, PN: 5530-00
   This is the same device used by the factory technicians to calibrate the monitor prior to shipping. The TB500B is an updated version of the TB500A Test Box. The TB500A, used in conjunction with adapter cable (Cat. No. 5453-00), may be substituted for the TB500B in most parts of this test.
6. SpO_2 Finger Sensor, PN: 8776-00
7. NICO sensor, PN: 8951-01
8. 500ml Calibration syringe, Hans Rudolph Model 5550 or equivalent

5.2 CO_2 Testing

In this procedure the term “select” refers to highlighting a selection on the screen by turning the knob, then pressing it in to select the highlighted option.

1. Connect the monitor to the AC line. Set the rear panel power entry module switch ON. Verify the AC LED turns on.
2. Press the power switch. Verify the display shows the NICO start up routine followed by the main display screen (reference the Users Manual for display appearance).
3. Connect the NICO sensor to the monitor. Verify an ADULT NICO ADAPTER IDENTIFIED message is momentarily displayed.

4. Connect the CAPNOSTAT CO_2 sensor to the monitor. Verify the CO_2 SENSOR? message is replaced by a WARMUP message.
5. Place the CAPNOSTAT CO_2 sensor on the NICO sensor airway adapter.
6. Press the MENU button. Verify the SELECT A SCREEN menu is displayed.
7. Select the SETUP screen.
8. Select CO_2 ZERO NOW. Follow the screen prompts to perform a zero calibration. When the zero calibration is complete, select EXIT.
   NOTE: The CAPNOSTAT CO_2 sensor must reach operating temperature before zeroing.
9. Connect the Model 1298 Gas Calibrator with low point calibration gas to the NICO sensor via the airway adapter stack (see instructions with Model 1298 Gas Calibrator).
10. Press and hold the MENU and DATA ENTRY keys simultaneously until the CONFIGURATION MENU appears. Select DIAGNOSTIC SCREENS, then select CO2.
11. Flow gas for thirty seconds. Verify a CO_2 reading of 41 ± 2.
12. Shut the gas flow off. Remove the Model 1298 Gas Calibrator.
13. Verify the following displayed parameters:

SRC CUR	180-300
DET T	45.00 ± 0.2
CASE T	45.00 ± 0.2
DATA CHAN	3400 ± 200
REF CHAN	3400 ± 200

5.3 SpO$_2$ Testing

14. Select SPO$_2$ from the CO2 DIAGNOSTIC SCREEN.
15. Verify the STATUS: is “9 Probe Xconnect”.
16. Set the controls on the TB500B as follows:
    SENSOR TYPE: 87XX
    SIGNAL ATTENUATION:3
    SATURATION SETTING:100
    POWER:ON
17. Connect the TB500B to the monitor.
18. Set the saturation switch on the TB500B to “0”. Verify the status is “2 Low Signal”.
19. Set the saturation switch on the TB500B to “100”. Verify the status returns to “0”.
20. Turn the TB500B OFF. Verify the status line reads “3 Low Light”.
21. Turn the TB500B ON. Verify the status returns to “0”.
22. Press and hold the RED open test button on the TB500B. Verify the status is “13 IR LED FAIL”.
23. Release the RED open test button. Verify the status returns to “0”.

24. Press and hold the INFRARED open test button on the TB500B. Verify the status is “12 Probe Error”.
25. Release the INFRARED open test button. Verify the status returns to “0”.
26. EXIT the diagnostic screen.
27. Select CO_2/SpO_2 in the SELECT A SCREEN menu.
28. Verify the Saturation and Pulse values for the following TB500B Saturation settings. Verify the pleth waveform is consistent and free of noise.

Test Box Switch Settings		Saturation
Saturation Setting	Signal Attenuation	Tolerance Range
100	3	98 - 100
82	3	80 - 84
62	3	60 - 64
72	7	68 - 76
92	7	88 - 96

Verify Pulse rate is 60 ± 1 for all settings

29. Disconnect the TB500B from the unit and turn it OFF.

5.4 Flow Testing

30. Turn the knob until the FLOW/PAW screen is displayed.
31. Connect the 500ml calibration syringe to the NICO sensor.
32. Pump the calibration syringe back and forth with a steady motion at a rate of 20 cycles per minute. Verify the Vte and Vti are 500 ± 25.
33. Disconnect the 500ml calibration syringe from the NICO sensor.
34. Press and hold the MENU and DATA ENTRY keys simultaneously until the CONFIGURATION MENU appears. Select DIAGNOSTIC SCREENS, then select FLOW.
35. Connect the 9695-48 Leak Test Adapter to the unit.
36. Pull the syringe back.
37. Set the stop cock open.
38. Push in the syringe until the airway pressure (Paw) reads 100cmH_2O.
39. Close the stop cock.
40. Verify the pressure remains above 90 mmH_2O after 30 seconds.

5.5 Time / Date Setting

41. Press the Menu button. Verify the select a screen menu is displayed.
42. Select the setup screen. Verify the setup screen is displayed.
43. Select SET TIME & DATE option. Follow the instructions and set the correct time and date. Exit the SET TIME & DATE screen then exit the setup screen.

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6 Electronic Tests

The Electronic Tests verify the calibration and operation of the electronic circuits within the Model 7300. These tests DO NOT need to be performed on a regular (preventative) basis. Perform these tests only if the monitor fails to operate as expected or fails the Accuracy Tests or the Functional Tests. The Electronic Tests should be performed only by qualified service personnel.

The Electronic Tests require access to the internal components of the monitor. Refer to the Maintenance section for disassembly instructions.

CAUTION: The Model 7300 contains static sensitive devices. Be sure to follow proper grounding procedures when handling the internal components to avoid damage from static discharge.

This procedure assumes the technician performs each step as indicated - leaving the monitor in a known state prior to performing the next step. If steps are omitted or performed out of order, be sure that the monitor is set to the correct state before continuing.

6.1 Equipment Required

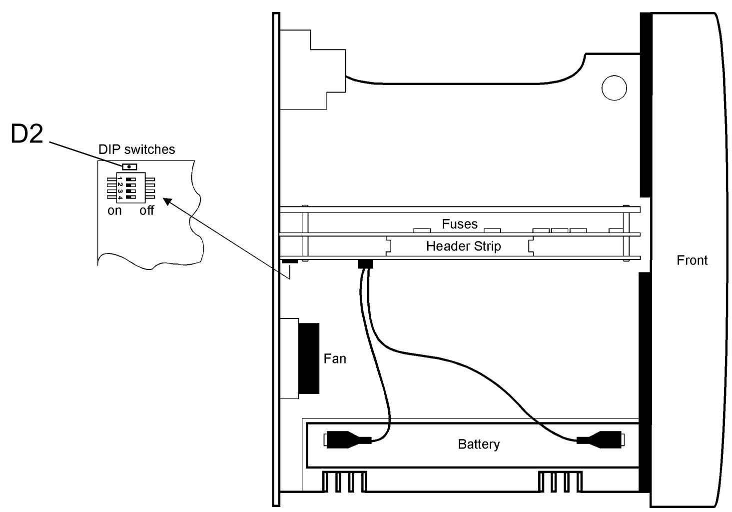
1. TB1265 Sensor Simulator, PN: 5776-00
   The Novametrix TB1265 Sensor Simulator emulates a functioning CAPNOSTAT CO_2 Sensor, and can be used in place of the CAPNOSTAT CO_2 Sensor for monitor test purposes. The TB1265 will verify the functionality of the monitor's CO_2 front end circuitry. Certain error conditions can be simulated to verify responses from the monitor under test.
   The TB1265 is an optional test device and is not mandatory for testing the Model 7300. Its purpose is to increase test efficiency by simulating a working CAPNOSTAT. The TB1265 Sensor Simulator is available from Novametrix Service Department.
2. TB1265 Adapter cable, PN: 5776-48
3. Current limit test jack, PN: 5693-48
4. TB500B Saturation simulator, PN: 5530-00
   This is the same device used by the factory technicians to calibrate the monitor prior to shipping. The TB500B is an updated version of the TB500A Test Box. The TB500A, used in conjunction with adapter cable (Cat. No. 5453-00), may be substituted for the TB500B in most parts of this test.
5. Optical encoder "5" test jack, PN: 9635-48
6. Optical encoder "A" test jack, PN: 9635-14
7. Pressure source, Penwalt pneumatic calibrator model 65-120 or equivalent
8. Common mode test jack, PN: 9638-48

9. Differential test jack, PN: 9636-48
10. Plug test fixture, PN: 9645-48
11. Shorted saturation test jack, PN: 6573-48
12. Oscilloscope
13. 30 ohm 10 watt resistor
14. 100 ohm 2 watt resistor
15. Digital Volt Meter (DVM)
16. Leakage Tester

6.2 Power Supply

In this procedure the term “select” refers to highlighting a selection on the screen by turning the knob, then pressing it in to select the highlighted option.

1. Connect the monitor to the AC line. Set the rear panel power entry module switch ON. Verify the AC LED turns on.
2. Press the power switch. Verify the display shows the NICO start up routine followed by the main display screen.
3. Set switches 2 and 3 on S1 on the 2763-01 board to the “ON” position. Verify the red LED (D2) flashes.



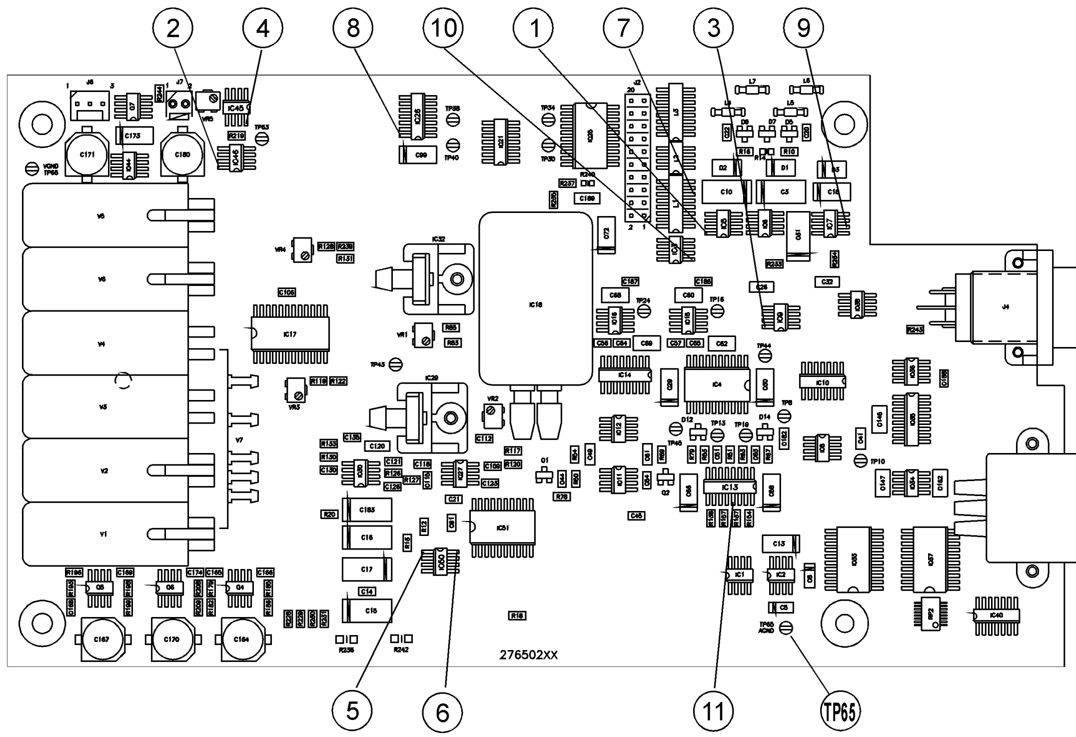
4. Using a DVM, measure the power supply voltage at J6 pin 1 on the 2764-01 board (Use TP1 on the 2763-01 board for ground reference). Verify 15.00V ± 1V.
5. Disconnect the connectors battery from the battery terminals. Measure the voltage at the positive battery terminal connector. Verify 12.6V ± 500mV.
6. Connect the 100 ohm resistor across the battery terminal connectors from J7. Measure the voltage and verify 13.77V ± 500mV. Remove the resistor.
7. Connect the 30 ohm resistor across the battery terminal connectors from J7. Using an oscilloscope, verify pulses present, the peak of the pulses should not be higher than 13.77V ± 500mV.

8. Disconnect the resistor. Position the battery cables from J7 in such a manner so that they do not short against anything.

6.3 Voltage Checks

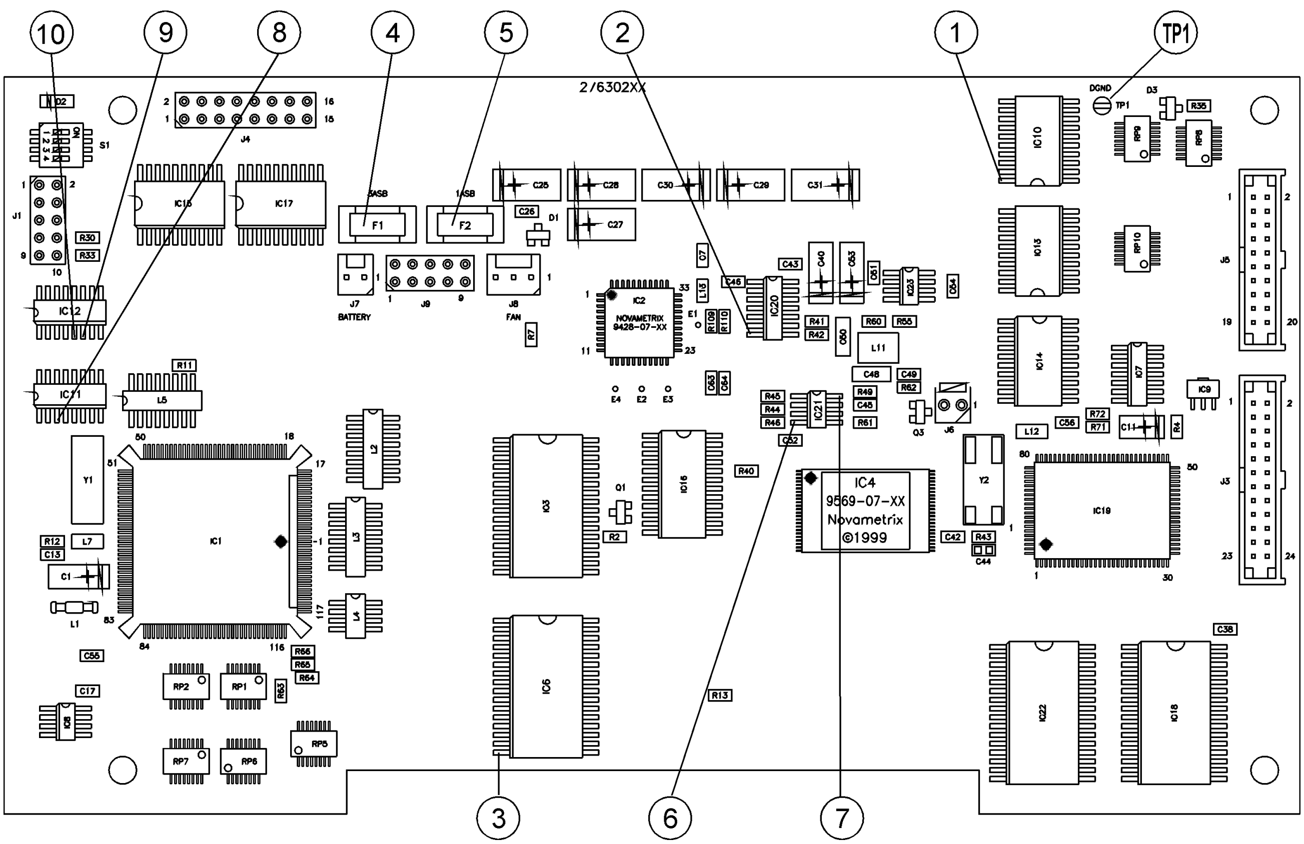
9. Use TP65 on the 2765 board as ground reference for all measurements unless otherwise specified. Measure the following power supply voltages using a DVM:

	Supply Name	Location	Voltage Range
1	VDD	IC5 pin 8	5.00V ± 150mV
2	VVDD	IC46 pin 8	5.00V ± 150mV
3	CVDD	IC9 pin 8	5.00V ± 150mV
4	DISPVA	IC45 pin 8	12.15V ± 500mV
5	AVCCIN	IC50 pin 8	16.00V ± 2.50V
6	AVCC	IC50 pin 1	12.00V ± 500mV
7	VCAPNO	L1 pin 6	12.00V ± 500mV
8	FVDD	IC26 pin 14	5.00V ± 200mV
9	-VA	IC7 pin 2	-16.00V ± 2.50V
10	-VCAPNO	IC3 pin 1	-12.00V ± 500mV
11	-AVCC	IC13 pin 13	-5.00V ± 250mV



10. Measure the following voltages on the 2763 board with a DVM, use TP1 as ground reference.

	Supply Name	Location	Voltage Range
1	VDD	IC10 pin 20	5.00V ± 150mV
2	DVDD	IC20 pin 14	5.00V ± 150mV
3	VBACK	IC6 pin 32	4.50V ± 250mV
4	VBATT	F1	12.60V ± 500mV
5	VHTR	F2	12.15V ± 500mV
6	+VA	IC21 pin 8	16.50V ± 2.50V
7	-VA	IC21 pin 4	-16.50V ± 2.50V



6.4 CO_2 Testing

11. Set the TB1265 switches as follows:
    INSPIRED CO2: OFF
    %CO2: 0
    SENSOR LOCATION: A/A
    SOURCE CURRENT: NORMAL
    CO2 MODE: CONTINUOUS
    TEMPERATURE: NORMAL
12. Connect the TB1265 to the monitor using the TB1265 adapter cable.
13. Press the MENU key, then select SETUP.
14. Select CO_2 ZERO NOW. Follow the screen prompts to perform a zero calibration. When the zero calibration is complete, select EXIT.
    NOTE: The CAPNOSTAT CO_2 sensor must reach operating temperature before zeroing.
15. Set the TB1265 simulator controls as follows:
    CO2 MODE: RESPIRATION
    %CO2: 5%
16. Turn the knob to display the CO_2/PLETH screen and verify an $ETCO_2$ value of 41 ± 2 and a RR (respiration rate) of 20 ± 2.
17. Press and hold the MENU and DATA ENTRY keys simultaneously until the CONFIGURATION MENU appears. Select DIAGNOSTIC SCREENS, then select CO2.
18. Verify DET T and CASE T stabilize at 45.00 ± 0.2.
19. Use TP65 as reference and monitor L5 on the 2765 board. Set the TB1265 TEMPERATURE to CASE OVERTEMP. Verify the voltage is at zero volts and CASE T is >50.00 and DET T remains at 45.00 ± 0.2
20. Set the TEMPERATURE back to NORMAL. Verify CASE T stabilizes at 45.00 ± 0.2 within 2 minutes.
21. Monitor L4 on the 2765 board. Set the TB1265 TEMPERATURE to DETECTOR OVERTEMP. Verify the voltage is at zero volts and DET T is > 50.00 and CASE T remains at 45.00 ± 0.2.
22. Set the TEMPERATURE back to NORMAL. Verify DET T stabilizes at 45.00 ± 0.2 within 2 minutes.
23. Verify the SRC CUR is between 220 and 260.
24. Set the TB1265 SOURCE CURRENT to HIGH. Verify the SRC CUR slowly increases to a value between 340 and 380 and the CASE T and DET T are < 42.00.
25. Set the SOURCE CURRENT back to NORMAL. Verify SRC CUR is between 220 and 260 and CASE T and DET T slowly rise and stabilize at 45.00 ± 0.20 within two minutes.
26. Disconnect the TB1265 from the monitor.

6.5 SpO_2 Testing

27. Select SpO_2 from the CO2 DIAGNOSTIC SCREEN.

28. Connect the current limit test jack to the monitor. Verify the LED n the fixture is on.
29. Press the switch on the current limit test jack. Verify the red LED turns off.
30. Remove the current limit test jack.
31. Verify the STATUS is “9 Probe Xconnect”.
32. Set the controls on the TB500B as follows:
    SENSOR TYPE: 87XX
    SIGNAL ATTENUATION: 3
    SATURATION SETTING: 100
    POWER: ON
33. Connect the TB500B to the monitor.
34. Set the saturation switch on the TB500B to “0”. Verify the status is “2 Low Signal”.
35. Set the saturation switch on the TB500B to “100”. Verify the status returns to “0”.
36. Turn the TB500B OFF. Verify the status line reads “3 Low Light”.
37. Turn the TB500B ON. Verify the status returns to “0”.
38. Press and hold the RED open test button on the TB500B. Verify the status is “13 IR LED FAIL”.
39. Release the RED open test button. Verify the status returns to “0”.
40. Press and hold the INFRARED open test button on the TB500B. Verify the status is “12 Probe Error”.
41. Release the INFRARED open test button. Verify the status returns to “0”.
42. EXIT the diagnostic screen.
43. Select CO_2/SpO_2 in the SELECT A SCREEN menu.
44. Verify the Saturation and Pulse values for the following TB500B Saturation settings. Verify the pleth waveform is consistent and free of noise.

Test Box Switch Settings		Saturation
Saturation Setting	Signal Attenuation	Tolerance Range
100	3	98 - 100
82	3	80 - 84
62	3	60 - 64
72	7	68 - 76
92	7	88 - 96

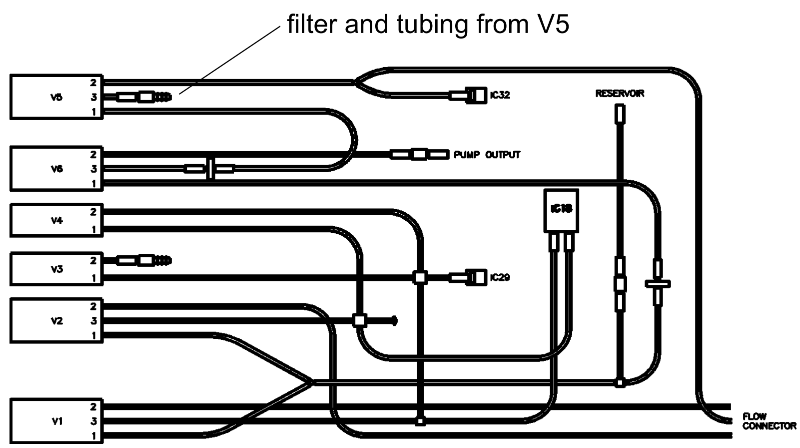
    Verify Pulse rate is 60 ± 1 for all settings

45. Disconnect the TB500B from the unit and set POWER: OFF.

6.6 Flow, Barometric Pressure and Rebreathe Valve Testing

46. Press and hold the MENU and DATA ENTRY keys simultaneously until the CONFIGURATION MENU appears. Select DIAGNOSTIC SCREENS, then select FLOW.
47. Verify SENSOR is “(0) NONE”.
48. Connect the “5” test jack to the monitor. Verify “(5) Unknown” is displayed.
49. Connect the “A” test jack to the monitor. Verify “(10) Unknown” is displayed.
50. Record the current barometric pressure from the calibrated barometer.

51. Adjust VR3 on the 2765 board if necessary until the TOT PRESS equals the current barometric pressure.
52. Select ZERO. Verify the BARO PRESS equals the value from the previous step. Readjust VR3 if necessary.
53. Connect the differential test fixture to the monitor.
54. Set the pneumatic calibrator for an output pressure of 20 cmH_2O. Connect the pneumatic calibrator output to the left port of the differential test fixture.
55. Adjust VR1 on the 2765 board for a 20b ADC value of 412160 counts ± 1280 counts.
56. Switch the pneumatic calibrator from the left port to the right port on the differential test fixture.
57. Verify a 20b ADC value of 412160 counts ± 12800.
58. Disconnect the differential test fixture.
59. Set the pneumatic calibrator for an output pressure of 80 cmH_2O. Connect the common mode test fixture. Connect the pneumatic calibrator output to the common mode test fixture.
60. Adjust VR2 on the 2765 board for an PAW of 80.00 cmH_2O ± 0.1 cmH_2O.
61. Remove the filter and tubing from V5 on the 2765 board. Replace with the plug test fixture.



62. Set the pneumatic calibrator for an output pressure of 120 cmH_2O. Connect the pneumatic calibrator to the NICO port on the common mode test fixture.
63. Adjust VR4 on the 2765 board for a PRESS2 ADC value of 120 cmH_2O ± 1.0 cmH_2O.
64. Disconnect the common mode test fixture and the plug test fixture.
65. Reconnect the filter and tubing to V5 on the 2765 board.
66. Connect the NICO sensor to the monitor. Select REBREATHE.
67. Verify the pump starts and the PRESS2 ADC rises above 120. Select REBREATHE again, verify the PRESS2 ADC drops to 0.
68. Disconnect the NICO sensor.

6.7 Serial / Analog Testing

69. Verify switches 2 and 3 of S1 are “ON”, verify LED D2 is blinking on the 2763 board.
70. From the DIAGNOSTIC SCREENS select SYSTEM, verify the Analog Connected status is “NO”.
71. Connect pins 8 and 15 together on the rear panel ANALOG connector. Verify the Analog Connected status is “Yes”.
72. Connect pins 2 and 11 together on the rear panel ANALOG connector. Select ANALOG from the SYSTEM DIAGNOSTIC SCREEN. Press the knob in to cycle through the different Output values listed, verify the Input values below:

Output	Input
0	0 +5
128	128 ± 5
255	255 ± 5

73. Repeat for the following pin combinations; pins 3 and 12, pins 4 and 13, pins 5 and 14.
74. Connect pins 2 and 3 together on the RS232 “1” connector. Select SERIAL 1, verify TESTING-Ch1 appears followed by PASS-Ch1.
75. Connect pins 2 and 3 together on the RS232 “2” connector. Select SERIAL 2, verify TESTING-Ch2 appears followed by PASS-Ch2.
76. Connect pins 2 and 3 together on the RS232 “3” connector. Select SERIAL 3, verify TESTING-Ch3 appears followed by PASS-Ch3.
77. Select EXIT to leave the DIAGNOSTIC SCREENS.
78. Set switches 2 and 3 on S1 on the 2763-01 board to the “OFF” position. Verify the red LED (D2) stops flashing.
79. Turn the monitor OFF. Reconnect the battery, ensure proper polarity hookup.

6.8 Safety Testing

80. Assemble the unit completely. Ensure there is no loose hardware inside.
81. Measure the monitor leakage current as follows. Verify a leakage current less than 25uA.
    - Monitor grounded
    - Monitor ungrounded
    - Monitor ungrounded with polarity reversed
82. Measure the monitor AC leakage from the shorted saturation test jack to the hot side of the AC line. Verify a leakage current less than 25uA.

7 Maintenance

7.1 General

This section presents information on general maintenance, such as battery and fuse replacement, disassembly and assembly instructions, and system software updates for the Model 7300.

7.2 Maintenance Schedules

The electronic circuits within the Novametrix Model 7300 monitor do not require scheduled calibration or service[1]. However, in order to maximize battery life, the monitor's internal battery should be tested monthly.

7.3 Cleaning and Sterilization

Follow the cleaning and sterilization instructions listed below to clean and/or sterilize the monitor and its accessories.

7.3.1 Monitor

- Turn the monitor off and unplug the line cord from the AC line before cleaning.
- The monitor can be cleaned and disinfected with solutions such as a 70% isopropyl alcohol, 2% glutheralhyde, or 10% bleach solution. Then wipe down with a water-dampened clean cloth to rinse. Dry before use.
- Do not immerse the monitor.
- Do not attempt to sterilize the monitor.

7.3.2 SpO_2 Finger Sensor

- The sensor can be cleaned and disinfected with solutions such as a 70% isopropyl alcohol, 2% glutheralhyde, or 10% bleach solution. Then wipe down with a water-dampened clean cloth to rinse. Dry before use.
- Make certain that the finger sensor windows are clean and dry before reuse.
- Do not immerse the finger sensor.
- Do not attempt to sterilize the finger sensor.
- After cleaning the finger sensor, verify that the sensor is physically intact, with no broken or frayed wires or damaged parts. Make certain that the connectors are clean and dry, with no signs of contamination or corrosion. Do not use a broken or damaged sensor or one with wet, contaminated or corroded connectors.

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1. At the customer's request, Novametrix will provide repair and calibration services under terms of a Service Contract. Contact the Novametrix Service Department for contract details.

7.3.3 SpO_2 Y-Sensor

- Do not immerse connector on the Y-Sensor.
- The Y-Sensor may be immersed—up to, but not including, the connector, in a 2% glutheralhyde solution, or 10% bleach solution. Refer to manufacturer's instructions and standard hospital protocols to determine recommended times for disinfection and sterilization.
- Rinse thoroughly with water and dry before use (do not rinse the connector).
- Do not attempt to sterilize Y-Sensor except as stated above.
- After cleaning or sterilizing the Y-Sensor, verify that the sensor is physically intact, with no broken or frayed wires or damaged parts. Make certain that the connectors are clean and dry, with no signs of contamination or corrosion. Do not use a broken or damaged sensor or one with wet, contaminated, or corroded connectors.

7.3.4 SpO_2 Y-Strip Tapes and Foam Wraps

- Treat Y-Strip Tapes and foam wraps in accordance with hospital protocol for single-patient use items.

7.3.5 Ear Clip

- Clean the ear clip with a cloth dampened with 70% isopropyl alcohol. After cleaning, wipe the ear clip down thoroughly with a clean water-dampened cloth to rinse.

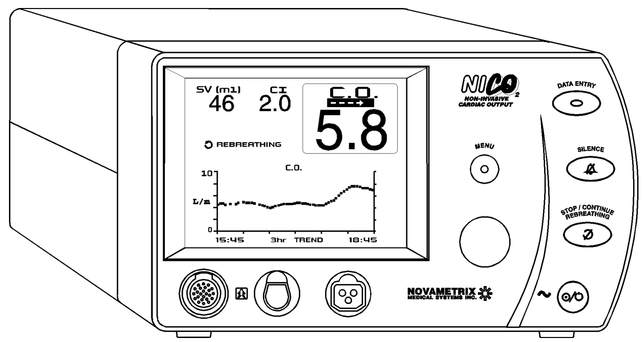
7.3.6 NICO Sensors

- Treat the NICO sensor in accordance with hospital protocol for single-patient use items.
- Do not attempt to reuse, clean or sterilize the NICO sensor.

7.3.7 CAPNOSTAT CO_2 Sensor

- Clean the sensor surface with a damp cloth.
- Make certain that the sensor windows are clean and dry.
- Do not immerse the CAPNOSTAT CO_2 sensor.
- Do not attempt to sterilize the CAPNOSTAT CO_2 sensor.

7.4 Disassembly



CAUTION:

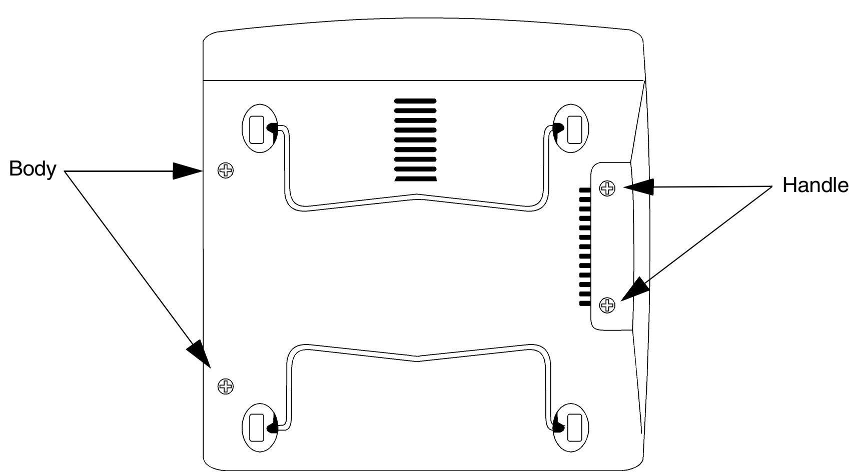
The Model 7300 contains static sensitive devices. Be sure to follow proper grounding procedures when handling the internal components to avoid damage from static discharge.

7.4.1 Equipment Required

- Phillips screwdriver
- Small flat-blade screwdriver

7.4.2 Disassembling Unit

1. Check that the monitor is OFF.
2. Set the rear panel power entry module switch to OFF ("O"). Remove the line cord from the power entry module (if connected).
3. Turn the unit over to expose the bottom; remove two screws from the body of the unit and two more from the handle. NOTE: Body screws are long.



4. Holding the unit together with both hands, turn it right-side up; then slide the top cover off by pulling gently straight up.

5. Place the top cover and screws aside.
6. If necessary the bottom cover can be removed to access to the analog board. It is not recommended to disassemble the unit any further as damage may result.

7.5 Reassembling Unit

1. Check that the line cord is not connected. Verify proper connections on the internal battery.
2. Check that there is no loose hardware or objects within the chassis assembly. Verify all wires and cables are properly secured.
3. Align the top cover with the unit and push down to seat.
4. Holding the unit together with both hands, turn it bottom-side up.
5. Replace two screws in the body of the unit and two more in the handle.
   NOTE: Body screws are longer.

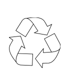
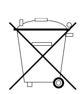
7.6 Battery Maintenance

If the monitor has not been used or powered by AC for an extended time[2] (3 months or more) allow the battery to charge for 12 hours before use. The monitor may not power up on battery power if the battery is not sufficiently charged.

To charge the battery, connect the power cord (see below) and set the rear panel power switch ON (“|”). Check that the front panel AC LED is on. Allow the battery to charge for 12 hours to ensure a fully charged battery in the event that battery power is required.

The AC power line cord shipped with monitors for North America is a Hospital Grade, SJT style cord with a 120 VAC plug. All power line cords shipped with monitors for Europe are the European style with a 220-240 VAC plug. All other style power line cords, as required by the country of destination, are provided by the distributor for that country.

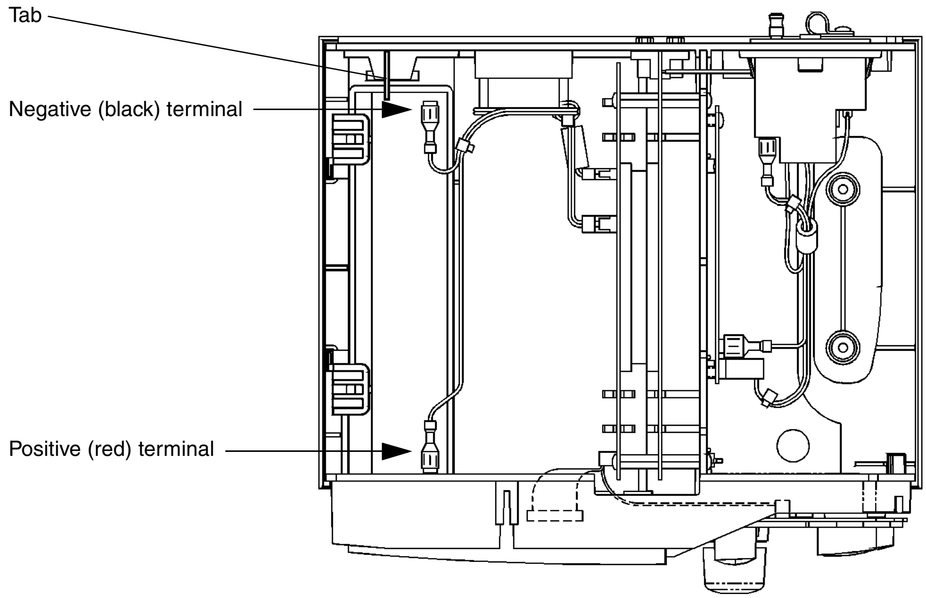
7.7 Replacing the Internal Battery

	Recyclable item. After the life cycle of the item has been met, disposal should be accomplished following national/local requirements.
	Separate collection. Appropriate steps must be taken to ensure that spent batteries are collected separately when disposed of. This symbol is found on the internal battery.
Pb	Indicates heavy metal content, specifically lead. This symbol is found on the internal battery and the monitor enclosure.

1. Remove the line cord from the unit (if installed).

2. The internal battery will slowly discharge over long periods of non-use.

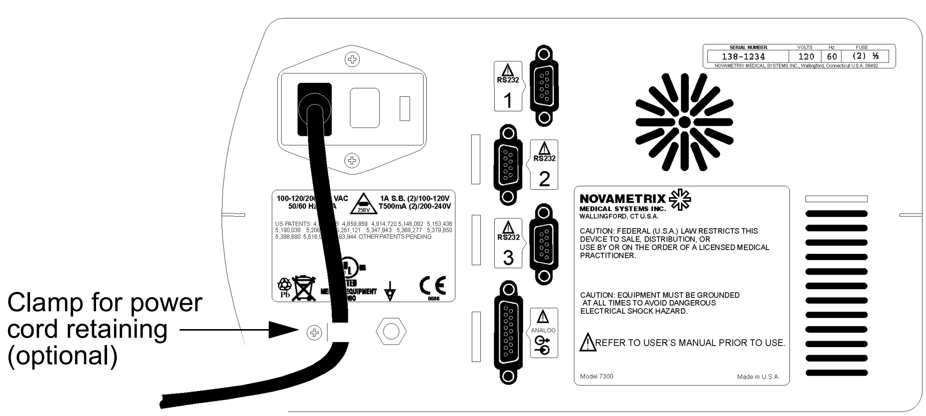
2. With the top cover removed, disconnect the positive then the negative lead from the battery terminals.



3. Newer units will have a tab that extends from the rear panel to the rear edge of the battery. To remove the battery on these units, carefully flex the tab to the left and tilt the battery to the right and pull the battery out. For other units simply slide the battery out by tilting the back up slightly to clear the front edge of the monitor and pulling straight up.
4. Replace the battery and reconnect the negative lead first, being careful to connect the negative (black) lead to the negative (black) terminal on the battery.
5. Connect the positive (red) lead to the positive (red) terminal. The unit may turn on when the positive lead is connected, simply press the power key to turn the unit off.

7.8 Mains Voltage Configuration

The rear panel indicates the mains voltage setting for the monitor. Check that the voltage is correct before attaching the line cord and powering the monitor. The Model 7300 can operate from 100-120 VAC 50/60Hz or 200-240VAC 50/60Hz.



Refer to the following section for fuse replacement.

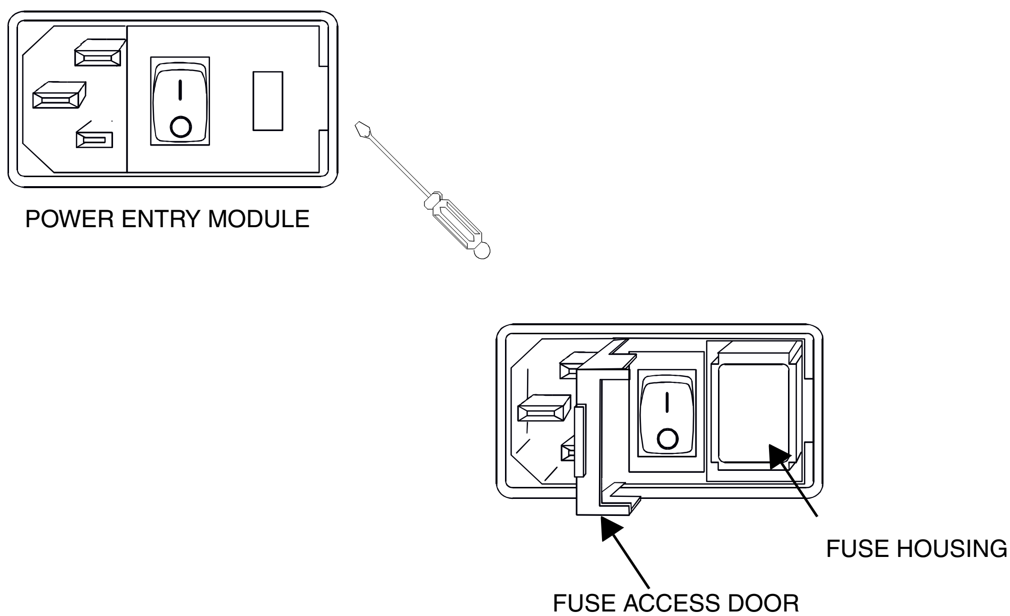
7.8.1 Fuse Replacement

CAUTION:

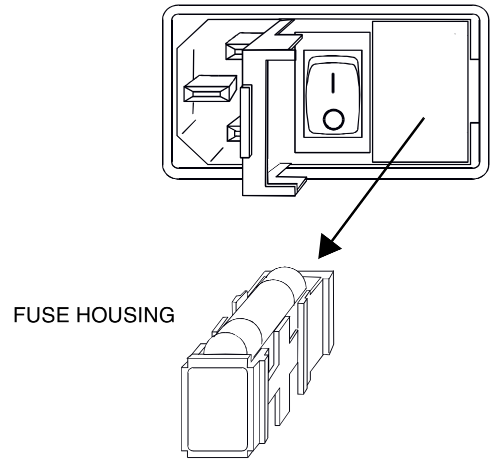
Replace fuses with same type and rating. Verify proper fuse value for mains voltage setting (see table below).

Mains Voltage	Fuses (Slo Blo)	Part No.
100-120 VAC	1.0 A 250V	515005
200-240 VAC	500mA 250V	515095

1. Check that the monitor is OFF.
2. Set the rear panel power entry module switch to OFF (“O”). Remove the line cord from the power entry module (if connected).
3. Using a flat blade screwdriver, pry the fuse access door open to expose the fuse housing.



4. Pry the fuse housing out from the power entry module.



5. Replace the blown fuse(s) with the proper type and rating.
6. Re-install the fuse housing. When positioning the housing into the power entry module ensure that it is oriented correctly. Press the fuse housing back into the power entry module.
7. Close the fuse access door.

7.9 Software Update Instructions

The following procedure is for updating the monitor's software from the supplied *NICO* Software Update Kit using an IBM compatible computer.

7.9.1 Equipment Required

1. IBM compatible computer with an unused serial port (COM1 or COM2)
2. DB-9 male to DB-9 female serial communications cable (Cat. No. 600073)
3. Update diskette PN: 9571-07-XX (XX = new firmware version)
4. Reply card

7.9.2 Setup

1. Connect the serial cable to the rear panel 9 pin connector marked "1" on the *NICO* (see FIG. A).

2. Connect the other end of the cable to the computer's COM[3] (serial) port (see FIG. A). The update software allows use of either COM1 or COM2, the program will request which COM port to use before updating the software.

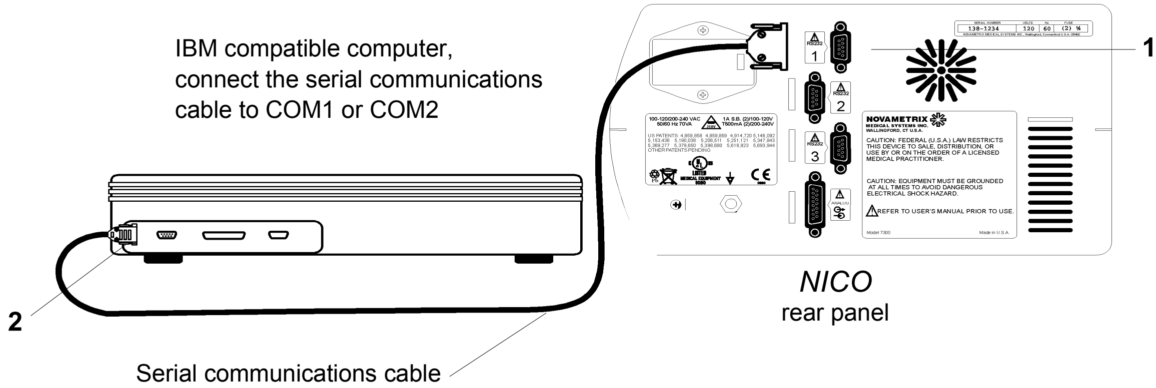


FIG. A

3. Turn the *NICO* on.

7.9.3 Procedure

1. Insert the update diskette into the computer's floppy drive (typically drive A).
2. From DOS: Type A: ↵ (where A is the drive letter where the update diskette is loaded). At the "A:" prompt type UPDATE then press ↵ .

   From Windows 3.x: Boot to DOS and follow the DOS instruction above.

   From Windows 95: Select Start, Run, then type A:update ↵ (where A is the drive letter where the update diskette is loaded)
3. Follow the install program screen instructions. Verify that the firmware version shown on the computer screen is correct, then press any key to continue.
4. When the following prompt appears:

```
Select the PC's COM port the instrument is connected to
from the following choices:
    1-COM1
    2-COM2
    any other key - exit
```

   Press 1 for COM1 or 2 for COM 2. If the download does not start try selecting the other COM port.
   If you are not sure of the process, press any other key and call service or Novametrix Service Department at 1-800-243-3444, in Connecticut call collect (203) 265-7701.

3. The location and availability of the COM ports (COM1, COM2) will vary from computer to computer. Refer to the computer's documentation for more information. The update software can only communicate with the *NICO* through either COM1 or COM2.

5. When the download starts the *NICO* screen will blank and the following message will appear on the computer screen.

```
Validating File
```

then,

```
UPDATING FIRMWARE, DO NOT INTERRUPT. PERCENT DONE: xx%
```

The “xx” will count up from 0% through 100% as the update is completed.

6. The procedure is complete when the computer displays:

```
***PROGRAM COMPLETE***

F1-exit          Esc-back
```

7. Press F1 to exit the update program.
8. Check that the *NICO* restarts and returns to normal operation, if not then perform the update procedure again or call Novametrix Service Department at 1-800-243-3444, in Connecticut call collect (203) 265-7701.
9. Remove the serial communications cable from the PC and the *NICO*. Record the serial number from the *NICO* on the reply card. Fill in the remaining information and return the postage paid card to Novametrix.

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8 Specifications

8.1 General

Specifications for the Novametrix NICO Monitor, Model 7300, are listed for informational purposes only, and are subject to change without notice.

8.2 NICO

- Measurement Frequency: Rebreathing cardiac output measurement made every three minutes, rebreathing period is 50 seconds.
- Cardiac Output Range: 0-19.9 liters/minute
- Cardiac Output Resolution: 0.1 liters/minute
- Pulmonary Capillary Blood Flow (PCBF) Range: 0-19.9 L/min, Resolution: 0.1 L/min
- Cardiac Index Range: 0-9.9 L/min/meter^2, Resolution: 0.1 L/min/meter^2
- Stroke Volume Range: 0-250 ml, Resolution: 1 ml
- Rebreathing Valve/sensor:
  - Valve type: dual diaphragm, pneumatically controlled
  - Return spring: automatically returns valve to normal position
  - Resistance: 3cmH_2O/L/min maximum
  - Rebreathed volume: normal position 35ml; rebreathing position 150-450ml (large)
  - CO_2/flow sensor: integrated into valve assembly
- Parameter limits for NICO measurements:
  - VCO_2: >20 ml/min
  - RR: >3, <60
  - Vt: >200
  - $ETCO_2$: >15, <70 mmHg

8.3 CO_2

- Principle of Operation: Non-Dispersive Infrared (NDIR) absorption, dual wavelength ratiometric-single beam optics, mainstream sensor.
- Response Time: Less than 60 ms
- Gas composition effects: Operator selectable
- CAPNOSTAT® CO_2 Sensor:
  - Weight: Less than 18 g without cable
  - Sensor Size: 1.3 x 1.67 x .85 inches (3.3 x 4.2 x 2.2 cm), 8 foot cable (2.44 m)
  - Construction: Durable high performance plastic, ultra-flexible cable
    Shock Resistant: Sensor will withstand a 6 foot drop to a tile floor

- End Tidal CO_2:
  - Range: 0-150 mmHg, 0-20 kPa or %
  - Accuracy: ± 2 mmHg for 0-40 mmHg, ± 5% of reading for 41-70 mmHg, ± 8% of reading for 71-150 mmHg
- Respiratory Rate:
  - Range: 1-150 breaths/min
  - Accuracy: ± 1 breath/min

8.4 Flow Sensor

- Flow Range: 2 to 180 L/min @ Barometric Pressure 760 mmHg, room air, 35°C
- Flow Accuracy: Greater of ± 3% reading or .5 L/min
- Minute Volume Range: 2 to 60 L/min
- Tidal Volume Range: 100 to 3000 ml
- Airway Pressure Range: -120 to 120 cmH_2O

8.5 SpO_2

- Oxygen Saturation
  - Range: 0-100%
  - Accuracy: ± 2% for 80-100% (± 1 standard deviation), unspecified for 0-79%
  - Averaging Time: 2 seconds
- Pulse Rate:
  - Range: 30-250 beats per minute
  - Accuracy: ± 1% of full scale
  - Averaging Time: 8 seconds

8.6 Monitor Specifications

- Classification (IEC601-1): Class I/internal power source, type BF, continuous operating mode
- Operating Environment: 50-95° F (10-35° C), 0-90% relative humidity (non-condensing)
- Size: Height 6.5 in., Width 10.75 in., Depth 9.5 in.
- Weight: 10 pounds
- POWER: 100-240 VAC, 50-60 Hz, 40VA
- Fuse Rating: 100-240 VAC, 0.5 A 250 V Slo-Blo (x2); 200-240 VAC, T 250 mA/ 250 V (x2)
- Battery: Internal, Sealed lead-acid gel-cell, 45 minute life on full charge (on-screen life indicator), 12 hours recharge time.
- Display: 4.625 x 3.5 inch EL, 320x240 pixels
- Electromagnetic Emissions: Conforms to EMC Directive 89/336/EEC, CISPR Class A. Tested to EN55011 (1991) and CISPR11 (1990).
- Electromagnetic Immunity: Conforms to EMC Directive 89/336/EEC, EN50082-1 (1992). Tested to IEC801-3 (1984) Radiated Immunity. Conforms to Medical Device Directive 93/42/EEC EN60601-1 (1992). Tested to IEC801-2 (1991) ESD, IEC801-4 (1988) EFT, and IEC1000-4-5 (1995) Surge Immunity.

9 NICO Accessories

Catalog No.	Description
9226-00	***NICO*** **Non-Invasive Cardiac Output Monitor**, Model 7300 Includes: Monitor, *CAPNOSTAT* CO_2 Sensor, SpO_2 Sensor, Power Cord and User's Manual.
8951-00	***NICO*** **Sensors** (10 per box) **Standard size (for tidal volumes of 450 - 1400 mL)**
9567-00	***CAPNOSTAT®*** **CO_2 Sensor**
6934-00	**Cable Management Straps** for use with the CAPNOSTAT CO_2 Sensor. Organizes and holds multiple cables and tubings. (package of 5)
8751-00	***CAPNOSTAT®*** **CO_2 Sensor Cable Holding Clips** (50 per box)
8776-00	***SuperBright*™ Finger Sensor** (10 ft. sensor cable) 1 yr. warranty
8791-00	***SuperBright*™ Y-Sensor** (10 ft. sensor cable) 90 day warranty
4941-00	**Saturation Sensor Extension Cable** (4 feet)
4942-00	**Saturation Sensor Extension Cable** (6 feet)
4943-00	**Saturation Sensor Extension Cable** (10 feet)
5266-00	**Saturation Sensor Extension Cable** (25 feet)
6147-00	**Saturation Sensor Extension Cable** (50 feet)
8828-00	**20mm Wrap Style Taping System** (100 per box) **for use with Y-Sensor** Use on neonatal foot and hand, or on pediatric toe or finger, color coded blue
8829-00	**25mm Wrap Style Taping System** (100 per box) **for use with Y-Sensor** Use on neonatal foot and hand, color coded green
8831-00	**20mm Finger Style Taping System** (100 per box) **for use with Y-Sensor** Use on pediatric finger or on small adult finger, color coded blue
8832-00	**25mm Finger Style Taping System** (100 per box) **for use with Y-Sensor** Use on adult finger, color coded green
6929-00	**Adhesive Foam Wraps**, Large (25 per box) **for use with Y-Sensor**
6968-00	**Adhesive Foam Wraps**, Small (25 per box) **for use with Y-Sensor**
8836-00	**Non-Adhesive Foam Wraps**, Large (25 per box) **for use with Y-Sensor**
8943-00	**Non-Adhesive Foam Wraps**, Small (25 per box) **for use with Y-Sensor**
6131-50	**Ear Clips** (5 per box) **for use with Y-Sensor**
6131-25	**Ear Clips** (25 per box) **for use with Y-Sensor**
8700-00	**Adhesive Dots** (200 per box)
600026	**Power Cord** (included with monitor)
9226-23	***NICO*** User Manual
9226-90	***NICO*** Service Manual

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10 Parts Lists

10.1 9226-00 Non-Invasive Cardiac Output Monitor, Model 7300

Item	Part No.	Description	Quantity
001	1003-32	LABEL, SERIAL NUMBER	1
002	1217-32	REPAIR LABEL	1
003	4470-32	LABEL, CAUTION GROUNDING	1
005	9026-32	LABEL, MANUFACTURED IN USA	1
006	9226-01	MAIN ASSY	1
014	9486-32	LABEL SET, REAR PNL, 7300	1
015	9487-32	TOP COVER LABEL, 7300	1
016	9501-13	FACADE W PAD PRINT, 7300	1
027	315032	LABEL, 120VAC, 10MM X 20M	1
028	600026	LINE CORD, AC, 7 1/2 FT, 120 VAC	1

10.2 9226-01 Main Assy

Item	Part No.	Description	Quantity
001	2763-01	DIGITAL BOARD ASSY	1
002	2764-01	POWER BOARD ASSY	1
003	2765-01	ANALOG BOARD ASSY	1
004	2766-01	C02 INPUT BOARD ASSY	1
005	5760-16	LEFT FOOT, WHITE, KICKSTAND	2
006	5761-16	RIGHT FOOT, WHITE, KICKSTAND	2
007	5826-10	FOOT PAD, BOTTOM COVER	4
008	9306-27	SILICONE KEYPANEL	1
009	9335-10	GASKET, PCB, 7300 - NICO	1
010	9336-10	KICKSTAND, 7300 - NICO	2
011	9337-10	GASKET, DISPLAY, 7300 - NICO	1
012	9379-01	FAN & BTRY HARN ASSY, 7300	1
013	9392-01	PUMP W RSVR ASSY, 7300	1
014	9419-01	CABLE ASSY, PWR ENTRY MODULE	1
015	9420-01	CABLE ASSY, DC PWR, 7300	1
016	9486-16	REAR PANEL, 7300 - NICO	1
017	9487-16	TOP COVER, 7300 - NICO	1
018	9488-16	BOTTOM COVER, 7300 - NICO	1

Item	Part No.	Description	Quantity
019	9489-16	MAIN FRAME, 7300 - NICO	1
020	9490-16	BEZEL, MODEL 7300 - NICO	1
021	9492-01	KNOB ASSY, MODEL 7300	1
031	161060	EPOXY, 2 PART (5/7), GRAY	0
032	161067	TAPE, CL CELL	0
033	210157	PWR MODULE, D FUSE, ON/OFF	1
034	216074	CONNECTOR, PLUG, POT COMP	1
035	280244	STANDOFF, 1/4 HEX X 11/16	0
036	280245	STANDOFF, 1/4 HEX X 11/16	0
037	280246	STANDOFF, . I8DIA X 11/16L	0
038	161007	ADHESIVE, 414, HIGH STRENGTH	0
039	284007	SCR, 4-24 X IL, PAN HD	0
040	284008	SCR, 4-24 X 5/16L, PAN HD	0
041	284009	SCR, 4-24 X 1/4L, PAN HD	0
042	284252	#4-40 X 3/8 OVAL HEAD PHIL	0
043	284261	SCREW, 4-40 X 5/8 L, PHIL	0
044	285051	WASHER, .500 DIA X .120	0
045	286005	5CR, 6-32 X 1/4L, PAN HD	0
046	286006	SCR, 6-32 X 5/16L, PAN HD	0
047	286010	5CR, 6-32 X 4 3/4L, PAN HD	2
048	286011	SCR, 6-20 X 5/16L, PAN RD	0
049	286012	5CR, 6-32 X 3/4L, PAN HD	0
050	400024	BATTERY, 12V DC, 2.3 AMP	1
051	400056	PWR SUPPLY, 15 VOC OUT	1
052	482610	EL DISPLAY, THIN FILM	1
053	510016	SWITCH, ROTARY ENCDR	1
054	600078	RIBBON CABLE, 24 PIN, RCP	1
055	600079	RIBBON CABLE, 20 PIN, RCP	1
056	600080	RIBBON CABLE, 40 PIN, RCP	2
057	608001	CABLE TIE, .094 X 3.62L	0
058	608128	CABLE CLAMP. .312 DIA CAB	1
059	216077	TERMINAL LUG, RING, .250	1
060	515005	FUSE, LA, 250V, SLO-BLO	2

10.3 2763-01 Digital Board Assy

Part No.	Description	Quantity
486037	IC, HM628128LFP-12, 128K	2
474233	RESISTOR, 10K OHM, 1/16W	25
180034	FERRITE FILTER, 4 LIN, EMI	2
486790	IC1 TLE2022CD, DUAL OP AMP	1
180029	INDUCTOR, 50MHZ CUT-OFF	5
180030	INDUCTOR, CAP, 4700PF, 50V	1

Part No.	Description	Quantity
474242	RESISTOR, 249K OHM, 1/16W	1
486314	IC, MC74HC541DW, OCTAL BUFFER	2
486348	IC, MM74HC4040M, 12-STAGE	1
474227	RESISTOR, 1K OHM, 1/16W	5
486042	IC, AT93C66-I0SC, SERIAL	1
154112	CAPACITOR, .047UF, I6VDC	3
483019	TRANSISTOR, MMBT2907ALTI	1
474247	RESISTOR, 10M OHM, 1/16W	1
482551	LED, RED, WITH LENS, SURF	1
230024	CRYSTAL, 32.768 KHZ, SURF	1
486320	IC, SN74HCI4D, HEX SCHMIT	1
474231	RESISTOR, 4.99K OHM, 1/16	2
474240	RESISTOR, 100K OHM, 1/16W	8
481546	DIODE, SWITCHING, SURF MT	2
487094	IC, RTC-62423, REAL TIME	1
474194	RESISTOR, 2.2M OHM, 1/16W	1
180035	FERRITE FILTER, 8 LINE	3
180022	INDUCTOR, 10UH, 10%, SURF MT	1
487132	IC, TL7757CPK, SPLY V ROL	1
487114	IC, MC34119D, AUDIO AMP	1
154108	CAPACITOR, 100PF, 50VDC	4
486481	IC, TLC5620CD, QUAD 8-B	1
211213	CONNECTOR, 2 PIN, POST	1
154072	CAPACITOR, .IUF, 50V, 10%	2
154104	CAPACITOR, .01UF, 50vDC	30
154079	CAPACITOR, 10UF, 25V, 10%	3
154116	CAPACITOR, 10UF, 35V, 10%	6
474225	RESISTOR, 499 OHM, 1/16W	1
513010	SWITCH, SLIDE, SPDT, 4 SW	1
485532	TRANSISTOR, 2N7002T1	2
474236	RESISTOR, 33.2K OHM, 1/16	2
474235	RESISTOR, 24.9K OHM, 1/16	3
486323	IC, SN74HC573DW, OCTAL	3
487138	IC, GRAPHICS LCD CONT	1
486365	IC, MICROCONTROLLER	1
474313	RES PACK, 10K OHM, .1W	3
474316	RES PACK, 100K OHM, 3/4W	1
474311	RES PACK, 51 OHM, .1W	6
212543	CONNECTOR, 20 PIN, HEADER	1
486367	IC, DECADE COUNTER, HIGH	1
486055	IC, STATIC RAM, 4M BIT	2
2763-02	FAB, DIGITAL BOARD	1
2763-03	SCHEMATIC, DIGITAL BOARD	0
212610	CONN, 24 PIN, HEADER	1

Part No.	Description	Quantity
2763-04	TEST PROC, DIGITAL BD	0
210156	CONNECTOR, 96 PIN, HEADER	1
216029	TEST POINT, SPRING LOADED	1
211327	CONNECTOR, 3 PIN, HEADER	1
9428-07	PROGRAM, CPLD	1
515094	FUSE WITH FUSEHOLDER, 3A	1
9569-07	PRGM, B CODE & SYS, 7300	1
153006	CAPACITOR, 47PF, 63V	1
5150S7	FUSE w FUSEHOLDER, lA	1
154069	CAPACITOR, 4.7UF, 10V	1
154105	CAPACITOR, 47PF, 50VDC	1
180062	FERRITE BEAD, 1K OHMS	1
154106	CAPACITOR, 22PF, 50VDC	5
154106	CAPACITOR, 22PF, 50VDC	4
474222	RESISTOR, 10 OHM, 1/16w	3
474222	RESISTOR, 10 OHM, 1/16w	2
474224	RESISTOR, 100 OHM, 1/16w	44
474224	RESISTOR, 100 OHM, 1/16W	46
154119	CAP, 6.8PF, 50V, 5%, NPO	6
154119	CAP, 6.8PF, 50V, 5%, NPO	9

10.4 2764-01 Power Board Assy

Part No.	Description	Quantity
487100	IC, TCl426COA, INV DUAL	1
481557	DIODE, MBRSll00T3, SCHOTT	2
484557	VOLTAGE REGULATOR, LT1117	1
154106	CAPACITOR, 22PF, SOVOC	1
474241	RESISTOR, 150K OHM, 1/16W	3
154110	CAPACITOR, 3.3NF, SOVOC	1
486325	IC, MC14093BD, QUAD 2-IN	1
154111	CAPACITOR, .1UF, 16VOC	4
486825	IC, LMC7101BIM5X, OP AMP	2
486346	IC, TC7SOOFTE85L, 2-IN	2
152085	CAPACITOR, 1500UF, 16V	2
212307	CONN, 15 P, D-SUBMIN, RT	1
154093	CAPACITOR, 68UF, 16VOC	2
481549	DIODE, M~RS140T3, RECT	5
152096	CAPACITOR, 220UF, 35V,	12
486790	IC, TLE2022CD, DUAL OP AMP	2
486340	IC, TLC2543CDW, 12 BIT	1
515088	FUSE W FUSEHOLDER, 1/16A	1
484061	TRANSISTOR, MMBT2222ALT1	5

Part No.	Description	Quantity
474242	RESISTOR, 249K OHM, 1/16W	4
474265	RESISTOR, 1 OHM, 1/4W, 1%	1
481555	DIODE, MMBD7000LT1, DUAL	11
486314	IC, MC74HC54lDW, OCTAL BU	1
484565	IC, LTl170CQ, VOLTAGE REG	1
154081	CAPACITOR, 100PF, 100V	6
486326	IC, MCl40l3BD, DUAL D FLI	1
471400	RESISTOR, lOOM OHM, 1W	1
474238	RESISTOR, 37.4K OHM, 1/16	4
474259	RESISTOR, 15K OHM, 1/16W	1
485546	TRANSISTOR, VN0605T, N-CH	2
483019	TRANSISTOR, MMBT2907ALT1	1
487104	IC, TC4404COA, DUAL	1
484541	VOLTAGE REGULATOR, LM317L	1
485541	TRANSISTOR, SI4947DY, MOS	4
180045	INDUCTOR, 220UH, 20%	2
486796	IC, TLC2272CD, DUAL OP AM	1
474247	RESISTOR, lOM OHM, 1/16W	1
486805	IC, LM393M, DUAL VOLTAGE	2
486785	IC, LP339M, QUAD VOLTAGE	1
486320	IC, SN74HCl4D, HEX SCHMIT	2
515085	FUSE W FUSEHOLDER, 2A	2
481046	DIODE, ZENER, MMSZ5236BTl	1
474240	RESISTOR, 100K OHM, 1/16W	26
474261	RESISTOR, 7.5K OHM, 1/16W	2
154086	CAPACITOR, 4.7UF, 10VDC	2
481546	DIODE, SWITCHING, SURF MT	5
180035	FERRITE FILTER, 8 LINE	1
474197	RESISTOR, 49.9K OHM, 1/16	2
484062	TRANSISTOR, MMBT2369LT1	1
484562	IC, LT1l7SCS8-ADJ, MICRO	1
484563	IC, LTlll7CST, VOLTAGE	1
484543	VOLTAGE REGULATOR, MC78L05	1
180022	INDUCTOR, 10UH, 10%, SURF MT	3
486821	IC, AD822AR, FET-IN OP AMP	1
180047	INDUCTOR, 50 OHMS @ 100M	8
210070	CONN, 96 PIN, RCPT, STR	1
485543	TRANSISTOR, MOSFET, N-CHAN	2
153045	CAPACITOR, .47UF, 50V	1
515087	FUSE W FUSEHOLDER, lA	1
481556	DIODE, MMBD354LT1, DUAL	1
474239	RESISTOR, 75K OHM, 1/16W	1
154108	CAPACITOR, 100PF, 50vDC	3
486781	IC, TLO72CD, OP AMP, JFET	1

Part No.	Description	Quantity
486481	IC, TLC5620CD, QUAD 8-B D	1
486813	IC, TLC2274AID, QUAD FET	1
6756-10	TRANSFORMER, MAIN BOARD	1
154072	CAPACITOR, . 1UF, 50V, 10%	9
180019	INDUCTOR, 100UH, 10%, SUR	1
474193	RESISTOR, 8.87K OHM, 1/16	1
153063	CAPACITOR, 220PF, 3KV. 20	2
481548	DIODE, EGL41B, RECTIFIER	4
486828	IC, LT1460HCS3-2.5, UPOWE	2
486321	IC, SN74HC138D	2
486313	IC, MC14066BD, QUAD ANALOG	1
216029	TEST POINT, SPRING LOADED	6
154116	CAPACITOR, IOUF, 35V, 10%	16
474234	RESISTOR, 20.5K OHM, 1/16	2
474225	RESISTOR, 499 OHM, 1/16w	13
487103	IC, TC4405COA, DUAL	1
481036	DIODE, ZENER, 1N5366B	1
474243	RESISTOR, 324K OHM, 1/16W	2
474195	RESISTOR, 511K OHM, 1/16W	7
212108	CONNECTOR, 10 PIN, HEADER	1
485532	TRANSISTOR, 2N7002T1	11
474236	RESISTOR, 33.2K OHM, 1/16	5
474235	RESISTOR, 24.9K OHM, 1/16	5
486323	IC, 5N74HC573DW	2
486363	IC, QUAD UNIV ASYNCH XCVR	1
486364	IC, 8 BIT A TO D CONV	1
486831	IC, PRECISION 2.5V REF	1
154118	CAP, 33PF, 50V, 5%, NPO	1
474316	RES PACK, 100K OHM, 3/4W	3
474311	RES PACK, 51 OHM, .1W	1
474312	RES PACK, 1K OHM, .1W	2
474302	RESISTOR, 150 OHM, .33W	1
474304	RESISTOR, 470K OHM, .33W	1
474305	RESISTOR, 470 OHM, .75W	2
474306	RESISTOR, 26.7 OHM, .33W	1
474307	RESISTOR, 3.32 OHM, .33W	1
474308	RESISTOR, 5.6 OHM, .33W	1
230028	CRYSTAL, 7.3728 MHZ, 20PF	1
180057	INDUCTOR, 22UH, 20%, .05	1
486369	IC, 5V RS232 4-DRIVER	1
487145	IC, OPTOCPLR, DUAL, LOGIC	3
515094	FUSE WITH FUSEHOLDER, 3A	2
213413	CONN, 40 PIN, HEADER	2
484575	VOLT RGLTR, 1.2V-37V, 3A	1

Part No.	Description	Quantity
487146	IC, OPTOCOUPLER, 4-CH, 16	2
211411	CONNECTOR, PLUG, 4 PIN	1
474303	RESISTOR, 4.3 OHM, .75W	1
2764-02	FAB, POWER BOARD	1
481552	DIODE, MBRS340T3, SCHOTTKY	6
211924	CONN, 9 PIN, RCPT, D-SUB	3
474220	RESISTOR, ZERO OHM, 1/4W	1
474228	RESISTOR, 1.21K OHM, 1/16	1
472075	RESISTOR, 1M OHM, 1/4W	1
472030	RESISTOR, 10K OHM, 1/4W	1
152065	CAPACITOR, 10UF, 20%, 25V	2
484576	VOLT RGLTR	1
606402	WIRE, BUS, 26AWG	0
608022	TEFLON TUBING	0
474172	RESISTOR, 10 OHM, 1/8W	1
474260	RESISTOR, 121K OHM, 1/16W	2
606812	WIRE, 30AWG, SOLID, PVC 1	0
9330-01	WIRE ASSY	1
474229	RESISTOR, 2.05K OHM, 1/16	4
481547	DIODE, BAT54, HOT CARRIER	6
474245	RESISTOR, IM OHM, 1/16W	5
474245	RESISTOR, IM OHM, 1/16W	6
474233	RESISTOR, 10K OHM, 1/16W	30
474233	RESISTOR, 10K OHM, 1/16W	29
474222	RESISTOR, 10 OHM, 1/16W	5
474222	RESISTOR, 10 OHM, 1/16W	6
180030	INDUCTOR-CAP, 4700PF, 50V	4
180030	INDUCTOR-CAP, 4700PF, 50V	5
474227	RESISTOR, 1K OHM, 1/16W	27
474227	RESISTOR, 1K OHM, 1/16W	30
154105	CAPACITOR, 47PF, SOVOC	4
154105	CAPACITOR, 47PF, SOVOC	3
154103	CAPACITOR, .001UF, 50VDC	3
154103	CAPACITOR, .001UF, SOVOC	4
154112	CAPACITOR, .047UF, 16VDC	11
154112	CAPACITOR, .047UF, I6VDC	10
474230	RESISTOR, 3.32K OHM, 1/16	2
474230	RESISTOR, 3.32K OHM, 1/16	1
474224	RESISTOR, 100 OHM, 1/16W	10
474224	RESISTOR, 100 OHM, 1/16W	13
154104	CAPACITOR, .01UF, 50VDC	48
154104	CAPACITOR, .01UF, 50VDC	49
154079	CAPACITOR, IOUF, 25V, 10%	4
154079	CAPACITOR, IOUF, 25V, 10%	6

Part No.	Description	Quantity
474198	RESISTOR, 2.49K OHM, 1/16	4
474198	RESISTOR, 2.49K OHM, 1/16	5
474231	RESISTOR, 4.99K OHM, 1/16	1
474231	RESISTOR, 4.99K OHM, 1/16	2

10.5 2765-01 Analog Board Assy

Part No.	Description	Quantity
475051	POTENTIOMETER, 10K OHM	4
474245	RESISTOR, iM OHM, 1/16W	7
474241	RESISTOR, 150K OHM, 1/16W	9
154111	cAPACITOR, .1UF, l6VDC	8
486825	IC, LMC710lBIM5X, OP AMP	1
484544	VOLTAGE REGULATOR, MC79L12	1
487129	IC, CPCI5AFH, ABSOLUTE PR	1
180034	FERRITE FILTER, 4 LIN, EM	1
474222	RESISTOR, 10 OHM, 1/16W	20
152096	cAPACITOR, 220UF, 35V, 20	5
486790	IC, TLE2022CD, DUAL OP AM	4
486340	IC, TLC2543CDW, 12 BIT A	1
487115	IC, INSTR AMP, LOW POWER	4
474242	RESISTOR, 249K OHM, 1/16W	5
475042	POTENTIOMETER, 50K OHM	1
474265	RESISTOR, 1 OHM, 1/4W, 1%	1
481555	DIODE, MMBD7000LT1, DUAL	25
474227	RESISTOR, 1K OHM, 1/16W	24
474229	RESISTOR, 2.05K OHM, 1/16	1
474238	RESISTOR, 37.4K OHM, 1/16	1
474259	RESISTOR, 15K OHM, 1/16W	4
250146	VALVE, SOLENOID, 5V	4
486829	IC, bTC1590CS, DUAL 12-BI	1
484542	VOLTAGE REGULATOR	1
474228	RESISTOR, 1.21K OHM, 1/16	1
486796	IC, TLC2272CD, DUAL OP AM	4
487124	IC, ERT-3281, REFLECTIVE	4
486785	IC, LP339M, QUAD VOLTAGE	2
212501	CONNECTOR, 20 PIN, HEADER	1
486324	IC, DG444DY, QUAD SPST CM	1
474261	RESISTOR, 7.5K OHM, 1/16W	3
474251	RESISTOR, 61.9K OHM, 1/16	1
154086	cAPACITOR, 4.7UF, l0VDC	2
481546	DIODE, SWITCHING, SURF MT	1
481547	DIODE, BAT54, HOT CARRIER	5

Part No.	Description	Quantity
474194	RESISTOR, 2.2M OHM, 1/16W	2
180035	FERRITE FILTER, 8 LINE	2
484543	VOLTAGE REGULATOR	1
486821	IC, AD822AR, FET-IN OP AMP	4
486807	IC, SMP04ES, QUAD SAMPLE	1
474230	RESISTOR, 3.32K OHM, 1/16	2
481556	DIODE, MMBD354LT1, DUAL	2
474239	RESISTOR, 75K OHM, 1/16W	8
486332	IC, AD7703BR, 20-BIT A TO	2
474198	RESISTOR, 2.49K OHM, 1/16	2
154108	cAPACITOR, 100PF, 50VDC	2
486481	IC, TLC5620CD, QUAD 8-B D	1
250151	VALVE, SOLENOID, 5V	2
211213	CONNECTOR, 2 PIN	1
474224	RESISTOR, 100 OHM, 1/16W	28
474223	RESISTOR, 49.9 OHM, 1/16W	8
481548	DIODE, EGL4lB, RECTIFIER	3
154079	CAPACITOR, lOUF, 25V, 10%	11
216029	TEST POINT, SPRING LOADED	16
154116	cAPACITOR, lOUF, 35V, 10%	7
474234	RESISTOR, 20.5K OHM, 1/16	2
211327	CONNECTOR, 3 PIN, HEADER	1
474225	RESISTOR, 499 OHM, 1/16W	4
474195	RESISTORs 511K OHM, 1/16W	1
485532	TRANSISTOR, 2N7002T1	3
487078	IC, AD7121R, DUAL BIFET 0	2
474236	RESISTOR, 33.2K OHM, 1/16	2
474235	RESISTOR, 24.9K OHM, 1/16	8
487136	IC, PRESSURE XDCR, 0-5 PS	1
487137	IC, PRESSURE SENSOR, 1 IN	1
486832	IC, PRECISION 5V REF, LOW	1
486831	IC, PRECISION 2.5V REF	1
486362	IC, 20 BIT A TO D CONV	1
474316	RES PACK, 100K OHM, 3/4W	1
474310	RES PACK, 10K OHM, .1W	1
486833	IC, 4-INPUT & OUTPUT OP	1
2765-02	FAB, ANALOG BOARD	1
213414	CONN, 40 PIN, HDR, ELEV	2
9270-16	FL CONN, RCPT, 3 PT, 7300	1
9272-16	SEAL FL CONN, 7300 - NICO	1
9328-16	SUPPORT, XDUCER	2
9269-01	SPO2 CONN BRKT ASSY, 7300	1
484545	VOLTAGE REGULATOR, MC78L1	2
474157	RESISTOR, 511 OHM, 1/8W	4

Part No.	Description	Quantity
486042	IC, AT93C66-l0SC, SERIAL	1
474175	RESISTOR, 3.92K OHM, 1/8W	2
486805	IC, LM393M, DUAL VOLTAGE	1
154137	CAPACITOR, .0047uF, 50VDC	2
154138	CAPACITOR, .001uF, 50V	6
154139	CAPACITOR, .047uF, 5%	1
281211	SCREW, 2-56 X 1/4L, SELF	0
284008	SCR, 4-24 X 5/16L, PAN HD	0
484010	NPN TRANSISTOR 2N3904	2
483002	2N3906 PNP SILICON SWITCH	1
472058	RESISTOR, 100K OHM, 1/4W	1
474243	RESISTOR, 324K OHM, 1/16W	2
474271	RESISTOR, 402 OHM, 1/16W	1
486314	IC, MC74~C541DW, OCTAL BU	1
483019	TRANSISTOR, MMBT2907ALT1	1
485543	TRANSISTOR, MOSFET, N-CHA	1
486366	IC, DIGITAL POT, 10K OHM	1
154143	CAPACITOR, .01uF, 50VDC	6
484540	VOLTAGE REGULATOR, LP2951	1
250164	FITTING, PRESS-IN PLUG	1
608129	TUBING, ESTER-BASED POLY	0
250134	FITTING, Y, FOR 1/16 ID T	2
9024-10	PNEUMATIC JUNCTION BOX	2
250109	FITTING, TEE, FOR 1/16 ID	2
160030	TUBING, .062 ID X .125 OD	0
250169	FILTER, INLINE, 25 MICRON	4
250171	CHECK VALVE, NC, .7 OD	2
608022	TEFLON TUBING	0
606407	WIRE, 30AWG, SOLTD, UNINS	0
606812	WIRE, 30AWG, SOLID, PVC	0
154072	CAPACITOR, .1UF, 50V, 10%	15
154072	CAPACITOR, .1UF, 50v, 10%	14
154103	CAPACITOR, .001UF, 50VDC	3
154103	CAPACITOR, .001UF, 50VDC	9
154104	CAPACITOR, .01UF, 50vDC	76
154104	CAPACITOR, .0lUF, 50vDC	73
154105	CAPACITOR, 47PF, 50vDC	4
154105	CAPACITOR, 47P~, 50VDC	6
154106	CAPACITOR, 22PF, 50VDC	8
154106	CAPACITOR, 22PF, 50VDC	4
154112	CAPACITOR, .047UF, 16VDC	38
154112	CAPACITOR, .047UF, l6VDC	42
180030	INDUCTOR-CAP, 4700PF, 50V	4
180030	INDUCTOR-CAP, 4700PF, 50V	5

Part No.	Description	Quantity
180056	FERRITE BEAD, 120 OHMS	6
180056	FERRITE BEAD, 120 OHMS	4
474197	RESISTOR, 49.9K OHM, 1/16	12
474197	RESISTOR, 49.9K OHM, 1/16	18
474233	RESISTOR, 10K OHM, 1/16w	18
474233	RESISTOR, 10K OHM, 1/16w	19
474240	RESISTOR, 100K OHM, 1/16w	42
474240	RESISTOR, 100K OHM, 1/16w	44
474256	RESISTOR, 0 OHM, 0603 STY	6
474256	RESISTOR, 0 OHM, 0603 STY	5
484061	TRANSISTOR, MMBT2222ALTI	1
484061	TRANSISTOR, MMBT2222ALTI	2
485540	TRANSISTOR, MOSFET, DUAL	4
485540	TRANSISTOR, MOSFET, DUAL	3

10.6 2766-01 CO_2 Input Board Assy

Part No.	Description	Quantity
2766-02	FAB, CO2 INPUT BOARD	1
2766-03	SCHEMATIC, CO2 INPUT BD	0
600055	RIBBON CABLE ASSY, 20 PIN	1
212527	CONNECTOR, 20 PIN, RECEPT	1

10.7 9392-01 Pump W Rsvr Assy

Item	Part No.	Description	Quantity
001	9322-01	RESERVOIR ASSY	1
002	9397-10	MOUNTING PL, PUMP, 7300	1
006	161108	FOAM TAPE, 1/32THK x 3/4W	0
007	211328	CONNECTOR, 3 PIN, RCPT	1
008	250130	PUMP, DIAPHRAGM, 4.5V	1
009	250169	FILTER, INLINE, 25 MICRON	1
010	280192	GROMMET, RIBBED, ISODAMP	2
011	284009	5CR, 4-24 X 1/4L, PAN HD	0
012	605001	WIRE, 28AWG, RED, TINNED	0
013	605007	WIRE, 28AWG, BLACK, TINNED	0
014	608001	CABLE TIE, .094 X 3.62L	0
015	608005	TUBING, HEAT SHRINK, 1/16	0
016	608012	CABLE TIE, SELF-LKG, .094	1
017	608114	TUBING, TYGON, 3/32 IN	0

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11 *Drawings*

Number	**Title**
9226-00	Non-Invasive Cardiac Output Monitor, 7300
9226-09	Overall Wiring Diagram
9226-01	Main Assembly, Model 7300 - NICO (5 sheets)
2763-01	Digital Board Assy, Model 7300 - NICO (3 sheets)
2763-03	Schematic, Digital Bd, Model 7300, NICO (3 sheets)
2764-01	Power Board Assy, Model 7300 - NICO (3 sheets)
2764-03	Schematic, Power Board, Model 7300, NICO (6 sheets)
2765-01	Analog Board Assy, Model 7300 - NICO (4 sheets)
2765-03	Schematic, Analog Board, Model 7300, NICO (5 sheets)
2766-01	CO_2 Input Board Assy, Model 7300 - NICO
2766-03	Schematic, CO_2 Input Board

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