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PORTACOUNT® Plus Model 8020 Technical Addendum

(includes the N95-Companion™ Model 8095)

INTRODUCTION

This document is a addendum to the *PortaCount Plus® Model 8020 Operation and Service Manual* (TSI p/n 1980092). It contains detailed technical information that is not normally needed by persons using the PortaCount Plus for respirator fit testing. Persons who will find this document of interest include respirator manufacturers, respiratory protection researchers, and persons conducting general ultrafine particle studies not related to respirator fit testing.

The most recent version of this document as well as the *PortaCount Plus Model 8020 Operation and Service Manual* can be obtained from the TSI Web site www.tsi.com.

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DIP SWITCH SETTINGS

LASER CAUTION
This instrument is a Class I laser device. Adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

There is a bank of 8 DIP switches located inside the PortaCount Plus. To gain access to the switches you must separate the top and bottom halves of the enclosure. Follow the instructions below:

1.   Turn the PortaCount Plus off.

2.   Turn the PortaCount Plus over so that it is face down and locate the four screws on the bottom that hold the two halves of the enclosure together. Remove all four screws.

3.   Turn the PortaCount Plus right side up while holding the two halves of the enclosure together so they do not separate.

4.   Gently lift the top half of the case and set it down just to the left of the unit. Notice that there is a ribbon cable connecting the top and bottom half together. Try not to pull on the ribbon cable. You do not need to disconnect the ribbon cable from the circuit board.
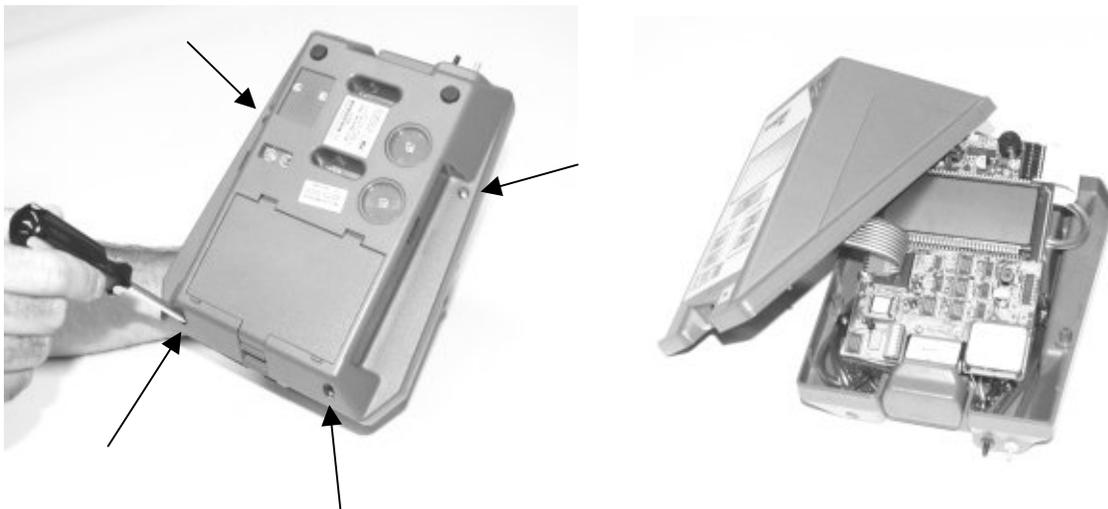
5.   The DIP switches are located towards the bottom of the circuit board just to the left of center. **Make sure the PORTACOUNT Plus is always off when changing DIP switch settings.**

There are 8 DIP switches. The top switch is number 1 and the bottom switch is number 8. A switch is considered to be "ON" when the right side is pushed down and "OFF" when the left side is down.

As shipped from the factory, the DIP switches are set as follows:

Switch Number	Factory Setting
1	ON
2	OFF
3	ON
4	ON
5	ON
6	ON
7	ON
8	ON

The function of each of the DIP Switches is as follows. Factory settings are shown in **BOLD** type:

DIP Switches 1, 2 and 3: Baud Rate
Switches 1, 2 and 3 control the Baud rate used by the RS-232C Data Port. The factory setting is for 1200 Baud. If you change the Baud rate of the PORTACOUNT Plus, you must also change the Baud rate of devices that communicate with the instrument such as a printer or computer. You should leave the Baud rate set at 1200 unless you have a good reason to change it. The switch settings for various Baud rates are:

Baud Rate	Switch 1	Switch 2	Switch 3
300	ON	ON	ON
600	OFF	ON	ON
1200	**ON**	**OFF**	**ON**
2400	OFF	OFF	ON
9600	OFF	ON	OFF

All Baud rates use 8 data bits, no parity, 1 stop bit. Switch combinations not shown are undefined.

DIP Switch 4: Memory Lock
Switch 4 allows you to lock the PᴏʀᴛᴀCᴏᴜɴᴛ Plus memory so that the internal settings for the sampling times, fit factor pass level and number of exercises cannot be changed from the PᴏʀᴛᴀCᴏᴜɴᴛ Plus Keypad or by using the MODIFY program software supplied with the instrument. The reason you might want to lock memory is to prevent unauthorized persons from altering the fit test protocol. The factory setting for switch 4 is ON which means that memory lock feature is OFF and the internal settings can be changed using the Keypad or software. The FitPlus software is not affected by DIP switch 4.

Memory	Switch 4
Unlocked	**ON**
Locked	OFF

DIP Switch 5: Factory Checkout
Switch 5 is used by TSI when performing factory checkout of the PᴏʀᴛᴀCᴏᴜɴᴛ Plus and should always be in the ON position for normal use.

Mode	Switch 5
Checkout	OFF
Normal	**ON**

DIP Switch 6: Reset Factory Settings on Power Up
Switch 6 should always be left ON unless you want to reset all the internal settings back to the way they were when the PᴏʀᴛᴀCᴏᴜɴᴛ Plus was new.

When switch 6 is OFF, the PᴏʀᴛᴀCᴏᴜɴᴛ Plus will reset back to the factory settings when the power is turned on. Once the power is turned back on, you will be able to change the internal settings (unless switch 4 is OFF), but they will be reset to the factory values the next time the power is turned off and then on again.

If you want to reset the internal settings back to the factory values, move switch 6 to the OFF position and then start the PᴏʀᴛᴀCᴏᴜɴᴛ Plus. Now turn the PᴏʀᴛᴀCᴏᴜɴᴛ Plus off and change switch 6 back to the ON position. The instrument will be reset and you will be able to permanently change the internal settings. The factory settings are:

Fit Factor Pass Level:	100
Number of exercises:	8
Ambient Purge Time	4 sec
Ambient Sample Time	5 sec
Mask Purge Time	11 sec
Mask Sample Time, All exercises:	40 sec

DIP Switch 7: Reserved
Switch 7 must always be left ON.

DIP Switch 8: Use CTS
When switch 8 is on (the factory setting), the PᴏʀᴛᴀCᴏᴜɴᴛ Plus will not require a Clear To Send (CTS) signal in order to send data through the RS-232C Data Port to a

peripheral device. When switch 8 is OFF, the CTS signal will be required. The CTS signal is always required when the PORTACOUNT Plus is in External Control Mode regardless of the position of switch 8.

CTS Signal	Switch 8
Not required	**ON**
Required	OFF

SERIAL INTERFACE OUTPUT

Output in Fit Test Mode

An example of the printout from a eight exercise fit test is shown below. All characters are ASCII. Each line is terminated with both carriage return (0D hex) and line feed (0A hex) characters. The comments to the right side do not print.

```
                                      COMMENTS
          NEW TEST   PASS = 100 Start of new test
          Ambient    4750 #/cc      Ambient concentration
          Mask      11.30 #/cc      Mask concentration
          Ambient    4800 #/cc      Ambient concentration
          FF    1     422 PASS      Fit factor exercise 1
          Mask       5.20 #/cc
          Ambient    4700 #/cc
          FF    2     894 PASS      Fit factor exercise 2
          Mask       9.80 #/cc
          Ambient    5000 #/cc
          FF    3     505 PASS      Fit factor exercise 3
          Mask       4.10 #/cc
          Ambient    5100 #/cc
          FF    4    1231 PASS      Fit factor exercise 4
          Mask       7.90 #/cc
          Ambient    4900 #/cc
          FF    5     610 PASS      Fit factor exercise 5
          Mask      13.50 #/cc
          Ambient    4800 #/cc
          FF    6     359 PASS      Fit factor exercise 6
          Mask       9.80 #/cc
          Ambient    5000 #/cc
          FF    7     505 PASS      Fit factor exercise 7
          Mask      11.30 #/cc
          Ambient    4800 #/cc
          FF    8     422 PASS      Fit factor exercise 8
          Overall FF  612 PASS      Overall fit factor
```

Output in Count Mode

The PORTACOUNT Plus sends ASCII characters through the Data Port in the following format while in 1-Second Count Mode. Each line is terminated with both carriage return (0D hex) and line feed (0A hex) characters. A line of data is transmitted every 2-seconds instead of every second to accommodate slow printers. When in 1-Second Count Mode the Display show 1-second averages updated every second. The Data Port transmits 2-second averages updated every 2-seconds.

```
          Conc.        xxxxxx #/cc
```

In 15-Second Count Mode, the ASCII output is in the following format. Each line is terminated with both carriage return (0D hex) and line feed (0A hex) characters. A line of data is transmitted every 15-seconds.

```
Ave. Conc.    xxxxxx #/cc
```

The "xxxxxx" is the numeric particle concentration in particles per cubic centimeter. Concentrations from 100 up to 999999 are formatted as integers, values below 100 have two decimal places. For example, a concentration of 87 would be transmitted as:

```
Conc.          87.00 #/cc
```

Output During the 60-Second Warm-up
During the initial 60-second warm-up period, the PORTACOUNT Plus automatically transmits status information that shows the internal memory settings. The settings reflect how the PORTACOUNT Plus memory is set at the moment and can be changed. For example, when all settings are at the factory settings, the data will transmit as follows:

NOTE: If the optional Model 8095 N95-Companion is attached and active, the printout will show the timing used with the N95-Companion. These settings are different than those used by the PORTACOUNT alone.

```
PORTACOUNT PLUS PROM Vx.x
COPYRIGHT(c)1991 TSI INC
ALL RIGHTS RESERVED
Serial Number    xxxxx
FF pass level    =  100
No. of exercises =  6
Ambient purge    =  4 sec.
Ambient sample   =  5 sec.
Mask purge       = 11 sec.
Mask sample    1 = 40 sec.
Mask sample    2 = 40 sec.
Mask sample    3 = 40 sec.
Mask sample    4 = 40 sec.
Mask sample    5 = 40 sec.
Mask sample    6 = 40 sec.
Mask sample    7 = 40 sec.
Mask sample    8 = 40 sec.
DIP switch       = 10111111
```

- Each line is terminated with both carriage return (0D hex) and line feed (0A hex) characters.

- The mask sample times are transmitted only for the number of exercises set.

- DIP Switches are considered ON if set to 1 and OFF if set to 0. DIP Switches are numbered 1 - 8 from left to right on the printout and 1 - 8 from top to bottom on the circuit board.

Output When a Battery Runs Low

The PORTACOUNT Plus will turn itself off when a battery runs out of power. Just before it turns off the following message is transmitted:

```
Low Battery
```

DATA and ACCESSORY PORT PIN ASSIGNMENTS

The PORTACOUNT Plus features bi-directional RS-232C communications through the Data Port. The Accessory Port is used to interface with the N95-Companion accessory.

ACCY Port   Data Port

The PORTACOUNT Plus Data Port uses a modular RJ-45 connector with 8 contacts. The contacts are numbered 1 through 8 from left to right when viewed as shown.
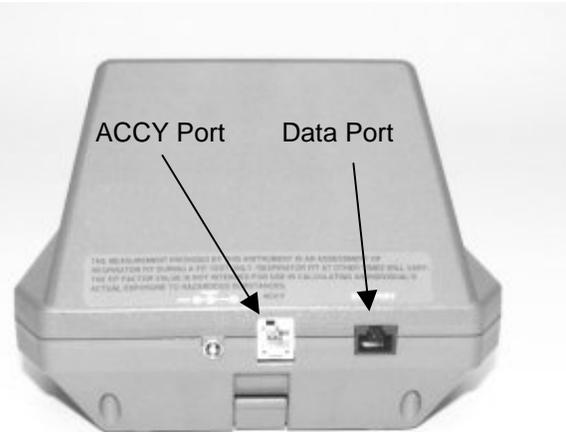
The PORTACOUNT Plus Accessory Port "ACCY" is a 6-pin MMJ modified modular connector. Contact 1 is on the left when viewed as shown.

Data Port Pin Assignments

Contact Number	Function	Direction
1	Not used	
2	Ready (DTR)	From PORTACOUNT Plus
3	Receive data (Rx)	To PORTACOUNT Plus
4	Not Used	
5	Transmit data (Tx)	From PORTACOUNT Plus
6	Not Used	
7	Signal Ground (G)	
8	Clear to send (CTS)	To PORTACOUNT Plus

PortaCount Accessory Port Pin Assignments (use TSI cable 1303522)

Contact Number	Function	Comment
1	Ground (-)	
2	+ 5 VDC	Supply voltage for all circuits except solenoid valve
3	N95 Attach Sense	Pull to ground to signal that N95-Companion is attached
4	+ 5 VDC Solenoid valve voltage feed	High current supply for solenoid valve only
5	Solenoid valve control	0.0 VDC = sample from sample tube 5.0 VDC = sample from ambient tube
6	Not used	

COMPUTER INTERFACE CABLES

The diagrams below show how to connect an IBM-PC compatible RS-232C serial interface to the PORTACOUNT Plus Data Port. The computer end of these cables are always female. Serial interface connectors on the back of the computer are always male. Pin 1 on the PORTACOUNT plus Data Port is on the left as you look at the Data Port connector.

The PORTACOUNT Plus Data Port uses a standard RJ-45 Modular Connector.

For 25 pin RS-232 connectors

PORTACOUNT Plus Data Port Pin	Computer 25 Pin Connector
1	8
2	5
3	2
4	6
5	3
6	22
7	7
8	20

For 9 pin RS-232 connectors

PORTACOUNT Plus Data Port Pin	Computer 9 Pin Connector
1	1
2	8
3	3
4	6
5	2
6	9
7	5
8	4

REMOTE CONTROL via COMPUTER

This section describes in detail, how to operate the PORTACOUNT Plus in External Control Mode through the Data Port. This information will be useful to those who want to write their own control program.

The following nomenclature is used in this section:

>x Single character ASCII numeral (0 - 9)
>v Single character ASCII numeral (0 - 9)
><cr> ASCII carriage return character (0D hex or 13 decimal)
><lf> ASCII line feed character (0A hex or 10 decimal)

Notes on External Control Mode

- All characters sent to the PORTACOUNT Plus and all characters returned by the PORTACOUNT Plus are ASCII.

- Commands are case sensitive. Be sure to use only uppercase as specified.

- All commands sent to the PORTACOUNT Plus must be terminated with an ASCII carriage return <cr> character.

- All responses returned by the PORTACOUNT Plus will be terminated with both an ASCII carriage return <cr> and a line feed <lf> character.

- When the PORTACOUNT Plus receives a command that is not understood or has values that are outside the allowable range, an ASCII E (for Error) is returned followed by and echo of the misunderstood command.

  For example, if a command is sent to the PORTACOUNT Plus that attempts to change the ambient purge time to an out of range value such as 3 seconds with the command:

      PTPA003<cr>

  The PORTACOUNT Plus will respond as follows, without changing the ambient purge time:

      EPTPA003<cr><lf>

- When the PORTACOUNT Plus receives a command that attempts to alter a setting that is locked because DIP switch 4 is OFF, it will return an ASCII W (for Write protected) followed by an echo of the illegal command. See the Appendix on DIP switch settings for details on locking memory with DIP switch 4.

  For example, if DIP switch 4 is OFF and an attempt is made to change the mask sample time for exercise 3 to 30 seconds with the command:

```
PTM0330<cr>
```

The PORTACOUNT Plus will respond as follows, without changing the mask sample time:

```
WPTM0330<cr><lf>
```

- If a low battery condition occurs while the PORTACOUNT Plus is in External Control Mode, the following characters are transmitted just before the unit turns itself off:

```
Low Battery<cr><lf>
```

The following table describes each of the available external commands and responses in detail.

COMMAND	DESCRIPTION
J<cr>	**Invoke External Control** This command puts the PORTACOUNT Plus into External Control Mode. All characters sent are ignored until the first J<cr> is received. Response from PORTACOUNT Plus: OK<cr><lf> When External Control Mode is invoked, certain parameters are automatically set as follows: • The internal valve is set to OFF. This position forces air to be drawn through the Sample Tube. • The PORTACOUNT Plus Display is cleared. • The External Control indicator on the Keypad is turned ON. • Count Mode and Fit Test Mode indicators are turned OFF. • Continuous transmission of concentration data is enabled as if the ZE<cr> command had been received.
G<cr>	**Release from External Control** This command puts the PORTACOUNT Plus back into Local Mode so it can be operated from the keypad. Response from PORTACOUNT Plus: G<cr><lf>
Q<cr>	**Test to see if N95-Companion is attached** QN<cr><lf> (Response if N95-Companion IS NOT attached) QY<cr><lf> Response if N95-Companion IS attached:

COMMAND	DESCRIPTION
VN<cr>	**Switch Valve ON** (sample through Ambient Tube) This command switches the internal valve to the ON position which forces the sampled air to be drawn through the Ambient Tube. The valve is automatically set to OFF when the External Control Mode is first invoked. Response from PORTACOUNT Plus: VN<cr><lf>
VF<cr>	**Switch Valve OFF** (sample through Sample Tube) This command switches the internal valve to the OFF position which forces the sampled air to be drawn through the Sample Tube. The valve is automatically set to OFF when External Control Mode is first invoked. Response from PORTACOUNT Plus: VO<cr><lf>
ZD<cr>	**Disable Continuous Data Transmission** This command tells the PORTACOUNT Plus to stop sending continuous particle concentration data. Response from PORTACOUNT Plus: ZD<cr><lf>
ZE<cr>	**Enable Continuous Data Transmission** This command tells the PORTACOUNT Plus to continuously transmit particle concentration data in 1-second intervals. Response from PORTACOUNT Plus is to echo: ZE<cr><lf> and then begin sending concentration data in units of particles per cubic centimeter. The data values are in the format: xxxxxx.xx<cr><lf> All values are right justified with leading zeros as needed to send 9 characters including the decimal point. **Example:**

<table>
<tr><td>Concentration</td><td>Transmitted</td></tr>
<tr><td>Particles/cm^3</td><td>Characters</td></tr>
<tr><td>0.60</td><td>000000.60<cr><lf></td></tr>
<tr><td>100</td><td>000100.00<cr><lf></td></tr>
<tr><td>4756.5</td><td>004756.50<cr><lf></td></tr>
<tr><td>23941</td><td>023941.00<cr><lf></td></tr>
<tr><td>496720</td><td>496720.00<cr><lf></td></tr>
</table>

COMMAND	DESCRIPTION
R<cr>	**Request Runtime Status of Battery and Signal Pulse** This command forces the PORTACOUNT Plus to report the battery condition and the sensor pulse condition. Three characters are returned by the PORTACOUNT Plus. The first character is always an R. The second character is the battery condition and the third is the sensor pulse condition. When the AC Adapter is in use, the first character indicates the condition of the power supply voltage rather than a battery. Possible responses from PORTACOUNT Plus RGG<cr><lf> Battery Good, Pulse Good RGB<cr><lf> Battery Good, Pulse Bad RBG<cr><lf> Battery Bad, Pulse Good RBB<cr><lf> Battery Bad, Pulse Bad
S<cr>	**Request Settings** This command forces the PORTACOUNT Plus to transmit all current settings for sample times, fit factor pass level, serial number, Hours of operation and date last serviced. Each item is described below in the order it is transmitted. **Ambient Purge Time** STPA 000vv<cr><lf> vv is the ambient purge time in seconds. The value will be in the range from 04 to 25. All exercises use the same ambient purge time. **Ambient Sample Time** STA 000vv<cr><lf> vv is the ambient sample time in seconds. The value will be in the range from 05 to 99. All exercises use the same ambient sample time. There are 2 spaced after the STA. **Mask Sample Purge Time** STPM 000vv<cr><lf> vv is the mask sample purge time in seconds. The value will be in the range from 11 to 99. All exercises use the same mask sample purge time. There is one space after the STPM. **Mask Sample Times** STMxx000vv<cr><lf> (continued on next page)

COMMAND	DESCRIPTION
S<cr> (continued)	(continued from previous page) 13 lines will be transmitted, one for each exercise. xx is the exercise number (01 to 13) and vv is the mask sample time in seconds. Mask sample times will be in the range from 10 to 99 seconds. The 13th line is the mask sample time (60 seconds) used when the number of exercises is set to zero (8010 Mode). The 13th mask sample time cannot be changed. **Fit Factor Pass Levels** SP xxvvvvv<cr><lf> 12 lines will be transmitted, one for each of the fit factor pass levels stored in memory. The PORTACOUNT Plus stores 12 fit factor pass levels in memory and allows an operator to scroll through the list using the Keypad. Xx is the memory location between 01 and 12. Vvvvv is the fit factor pass level contained in that memory location. The maximum value allowed for the fit factor pass level is 64000. There is one space after the SP. **Serial Number** The PORTACOUNT Plus serial number is transmitted in the format: SS vvvvv<cr><lf> vvvvv is the serial number. There are three spaces after the SS. **Run Time Since Last Serviced at the Factory** The run time since the last time factory service was provided is transmitted in the format: SR vvvvv<cr><lf> vvvvv is the run time in 10 minute increments. There are three spaces after the SR. For example: SR 05370<cr><lf> indicates that the unit has run for 53700 minutes or 895 hours since last serviced. The timer is reset at the factory when service is performed. **Date Last Serviced** The date when the PORTACOUNT Plus was last serviced at the factory is transmitted in the format: SD 0MMYY<cr><lf> Where MM is the month number (01 to 12) and YY is the last 2 digits of the year (91 = 1991, 93 = 1993, 00 = 2000 etc.). The character before the month number (MM) is always a zero. There are three spaces after the SD.

COMMAND	DESCRIPTION
Y<cr>	**Turn Power OFF** This command turns the PORTACOUNT Plus OFF. It must be turned ON using the Keypad. There is no way to turn the PORTACOUNT Plus ON using an external computer. When first turned ON the PORTACOUNT Plus is always operable using the Keypad. Response from PORTACOUNT Plus just before it turns off: Y<cr><lf>
PTMxxvv<cr>	**Set Mask Sample Time** Each exercise has its own independent mask sample time. xx is the exercise number between 01 and 12. vv is the mask sample time in seconds between 10 and 99. For example, to set the mask sample time for exercise 4 to 40 seconds, send the command: PTM0440<cr> The PORTACOUNT Plus will respond with an echo of the same command: PTM0440<cr><lf>
PTA00vv<cr>	**Set Ambient Sample Time** This command sets the ambient sample time for exercises 1 through 12. vv is the ambient sample time in seconds and must be in the range from 05 to 99. For example, to set the ambient sample time to 10 seconds, send the command: PTA0010<cr> The PORTACOUNT Plus will respond with an echo of the same command: PTA0010<cr><lf>
PTPM0vv<cr>	**Set Mask Sample Purge Time** This command sets the mask sample purge time for exercises 1 through 12. vv is the mask sample purge time in seconds and must be in the range from 11 to 25. For example, to set the mask sample purge time to 15 seconds, send the command: PTPM015<cr> The PORTACOUNT Plus will respond with an echo of the same command: PTPM015<cr><lf>

COMMAND	DESCRIPTION
PTPA0vv<cr>	**Set Ambient Sample Purge Time** This command sets the ambient sample purge time for exercises 1 through 12. vv is the ambient sample purge time in seconds and must be in the range from 04 to 25. For example, to set the ambient sample purge time to 8 seconds, send the command: PTPA008<cr> The PORTACOUNT Plus will respond with an echo of the same command: PTPA008<cr><lf>
PPxxvvvvv<cr>	**Set Fit Factor Pass Level** The PORTACOUNT Plus stores a set of 12 fit factor pass levels in memory. The operator is allowed to scroll through and select one of these values as the current fit factor pass level using the PORTACOUNT Plus Keypad. This command allows any of the 12 fit factor pass levels stored in the PORTACOUNT Plus to be permanently changed. xx is the memory location from 01 to 12. vvvvv is the new fit factor pass level between 00000 and 64000. All fit factor pass levels must have 5 characters. Use leading zeros when necessary, such as 000350 for 350 and 02000 for 2000. For example, to change the 3rd of 12 fit factor pass levels to 350, send the command: PP0300350<cr> The PORTACOUNT Plus will respond with an echo of the same command: PP0300350<cr><lf>

COMMAND	DESCRIPTION
Dxxxxxx.xx<cr>	**Display Concentration on PORTACOUNT Plus** This command clears the entire Display and then displays a concentration value. The PARTICLE/cm^3 message is turned ON. xxxxxx.xx is the concentration to display and can be any number from 000000.00 to 999999.99. The concentration value must be 9 characters long including the decimal point so add zeros as needed on the left. Characters to the right of the decimal point are not displayed if the value to the left of the decimal point is above 100, however, they must be included in this command even if they are both zeros. For example, to display a concentration of 5375 send the command: D005375.00<cr> The PORTACOUNT Plus responds by echoing: D005375.00<cr><lf>
Lxxxxxx<cr>	**Display Fit Factor Pass Level on PORTACOUNT Plus** This command clears the Display and then displays a fit factor pass level. The FIT FACTOR PASS LEVEL message is turned ON. xxxxxx is the fit factor pass level to display and can be in the range from 000000 to 999999. The value to display must have 6 characters so add zeros on the left as needed. For example, to display a fit factor pass level of 1000, send the command: L001000<cr> The PORTACOUNT Plus responds by echoing: L001000<cr><lf>
Fxxxxxx.x<cr>	**Display Fit Factor on PORTACOUNT Plus** This command clears the entire Display and then displays a fit factor value. The FIT FACTOR message is turned ON. xxxxxx.x is the fit factor to display and can be any number from 000000.0 to 999999.9. The fit factor value must be 8 characters long including the decimal point so add zeros as needed on the left. The character to the right of the decimal point is not displayed if the value to the left of the decimal point is above 10, however, it must be included in this command even if it is zero. For example, to display a fit factor of 6240 send the command: F006240.0<cr> The PORTACOUNT Plus responds by echoing: F006240.0<cr><lf>

COMMAND	DESCRIPTION
Axxxxxx.x<cr>	**Display Overall Fit Factor on PORTACOUNT Plus** This command clears the entire Display and then displays an overall fit factor value. The OVERALL FIT FACTOR message is turned ON. xxxxxx.x is the overall fit factor to display and can be any number from 000000.0 to 999999.9. The overall fit factor value must be 8 characters long including the decimal point so add zeros as needed on the left. The character to the right of the decimal point is not displayed if the value to the left of the decimal point is above 10, however, it must be included in this command even if it is zero. For example, to display an overall fit factor of 740 send the command: A000740.0<cr> The PORTACOUNT Plus responds by echoing: A000740.0<cr><lf>
Nxx<cr>	**Display Exercise Number on PORTACOUNT Plus** This command displays an exercise number on the PORTACOUNT Plus Display. xx is the number to display and must be in the range from 00 to 19. For example, to display the exercise number 5 on the PORTACOUNT Plus send the command: N05<cr> The PORTACOUNT Plus will respond with an echo of the same command: N05<cr><lf>
Ixxxxxxxx<cr>	**Display Indicator Message on PORTACOUNT Plus** This command causes selected indicator messages to turn ON or OFF on the PORTACOUNT Plus Display. xxxxxxxx represents an eight-place binary value. Each bit corresponds to a particular indicator message. 1 means ON and 0 means OFF. The left most bit is bit 1 and the bit furthest to the right is bit 8. Each of the 8 bits controls a certain indicator message as described below. **Bit 1: Not Used** Bit one is not used and is ignored by the PORTACOUNT Plus. For simplicity, a zero (0) will always be used for bit 1. **Bit 2: IN PROGRESS Message** 1 = Turn IN PROGRESS message ON (it will flash) 0 = Turn IN PROGRESS message OFF (continued on next page)

COMMAND	DESCRIPTION
`Ixxxxxxxx<cr>` (continued)	(continued from previous page) **Bit 3: FIT FACTOR Message** 1 = Turn FIT FACTOR message ON 0 = Turn FIT FACTOR message OFF **Bit 4: SERVICE Message** 1 = Turn SERVICE message ON 0 = Turn SERVICE message OFF **Bit 5: LOW PARTICLE Message** 1 = Turn LOW PARTICLE message ON 0 = Turn LOW PARTICLE message OFF **Bit 6: LOW BATTERY Message** 1 = Turn LOW BATTERY message ON 0 = Turn LOW BATTERY message OFF The LOW BATTERY message will flash when it is ON. **Bit 7: FAIL Message** 1 = Turn FAIL message ON 0 = Turn FAIL message OFF **Bit 8: PASS Message** 1 = Turn PASS message ON 0 = Turn PASS message OFF For example, to turn all messages OFF, all bits would be zero so send the command: I00000000<cr> The PORTACOUNT Plus will respond: I00000000<cr><lf> (continued on next page)

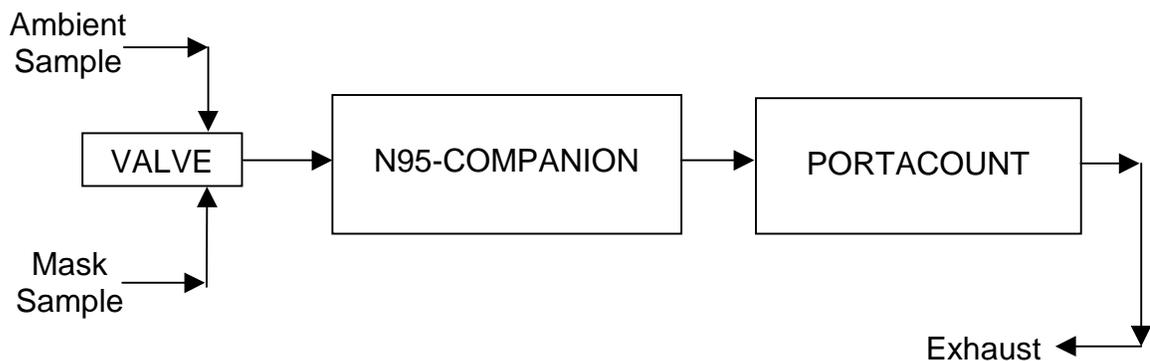| COMMAND	DESCRIPTION
Ixxxxxxxx<cr> (continued)	(continued from previous page) To turn the FAIL message on only, bit 7 must be a 1, send the command: I00000010<cr> The PORTACOUNT Plus will respond: (continued on next page) (continued from previous page) I00000010<cr><lf> To turn the FAIL message OFF and the PASS message ON with one command, bit 7 must be a zero and bit 8 must be a 1, send: I00000001<cr> The PORTACOUNT Plus responds: I00000001<cr><lf> To turn the FIT FACTOR message and the PASS message ON at the same time bit 3 must be a 1 and bit 8 must be a 1, send: I00100001<cr> The PORTACOUNT Plus responds: I00100001<cr><lf>
K<cr>	**Clear Display on PORTACOUNT Plus** This command clears the entire PORTACOUNT Plus Display. Send the command: Response from PORTACOUNT Plus: K<cr><lf>
Bxx<cr>	**Sound Beeper inside the PORTACOUNT Plus** This command causes the internal beeper to sound. Xx is the duration of the beep in 1/10 seconds in the range from 01 to 99 (0.1 to 9.9 seconds). For example, to sound a 5/10 (= 1/2) second beep, send the command: B05<cr> The PORTACOUNT Plus beeps for the specified time interval and responds: B05<cr><lf>

N95-Companion Model 8095

The N95-Companion is an accessory for the PortaCount Plus that permits the PortaCount to perform quantitative fit testing on low efficiency disposable respirators such as class-95 (USA) and class-P1/P2 (other countries). The N95-Companion is essentially an electrostatic particle classifier (a.k.a. Differential Mobility Analyzer or DMA) that strips off all particle sizes above and below the target particle size of approximately 0.04 micrometers. The target particle size is fixed and cannot be adjusted. Refer to the *N95-Companion Operation and Service Manual* (TSI part no. 1980308) for operation and maintenance instruction. Visit www.tsi.com to obtain a copy.

To operate with the N95-Companion the PortaCount Plus must have the revision A modifications. The tag on the bottom of the PortaCount Plus will show MODEL 8020A if it is "N95-Companion ready." Revision A modifications can be added to older PortaCounts via factory service.

Sampling Pendant

N95-Companion Theory of Operation

The fundamental assumption made when fit testing with the PortaCount is that any particles sampled from inside the respirator must have entered through a leak since they cannot pass through the filter. This assumption is always true for high efficiency filters, but fails for low efficiency filters. There are enough particle passing through low efficiency media to bias the fit test and cause very low fit factors even when the face seal is perfect. The PortaCount does not know the difference between a particle that entered via a face seal leak and one that passed through the filter media.

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Ambient
Sample
                VALVE  →  N95-COMPANION  →  PORTACOUNT  →
Mask                                                        Exhaust
Sample
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The N95-Companion is used as a particle conditioner in between the respirator and the PortaCount. The 0.04 micrometer particles that are allowed to pass through to the PortaCount are in the size range that is effectively stopped by low efficiency filter media as well as high efficiency media. By only allowing the PortaCount to "see" particles that can only enter the respirator via a face seal leak, the N95-Companion makes low efficiency media look like high efficiency media to the PortaCount. Since both the ambient and respirator sample pass through the N95-Companion, the ratio of outside concentration vs. inside concentration (fit factor) is valid.

For more information visit the www.tsi.com and review the following documents:

Mechanisms of Filtration for High Efficiency Fibrous Filters (Application Note ITI-041)

PortaCount Theory of Operation (Application Note ITI-048)

N95-Companion Model 8095 Theory of Operation (Application Note ITI-053)

Penetration of Ambient Aerosols Through Respirator Faceseal Leaks (Application Note ITI-055)

Fit Testing Using Size-Selected Aerosol (Application Note ITI-062)

PortaCount Internal Program Configuration

When the PortaCount Plus senses the presence of the N95-Companion it automatically resets itself and runs with special configuration parameters designed to function with the N95-Companion. The changes include:

- Sample timing changes to accommodate the longer N95-Companion sampling requirements.

> Ambient purge = 6 seconds
> Ambient sample = 15 sec
> Mask purge = 15 sec
> Mask sample 50 sec,

- The maximum fit factor that can be displayed is 200. Any fit factor measured to be above 200 is displayed as 200 with the words "Fit Factor" flashing. The 200 limit was necessary because the particle concentrations output by the N95-Companion are too low to allow accurate fit factor measurements at higher levels.

- The pump inside the N95-Companion runs in addition to the pump inside the PortaCount.
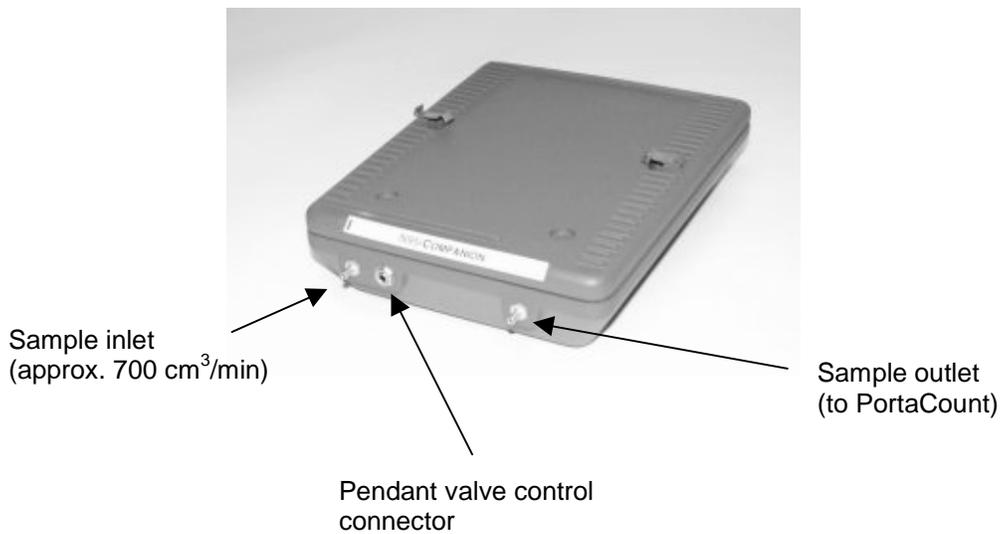
- The valve inside the PortaCount is no longer used and is left un-energized (sample tube open). The valve control is automatically re-routed to the N-95-Companion valve located inside the Sampling Pendant.

- The minimum ambient particle concentration necessary to allow a fit test drops from 1000 to 70 particles/cm^3.

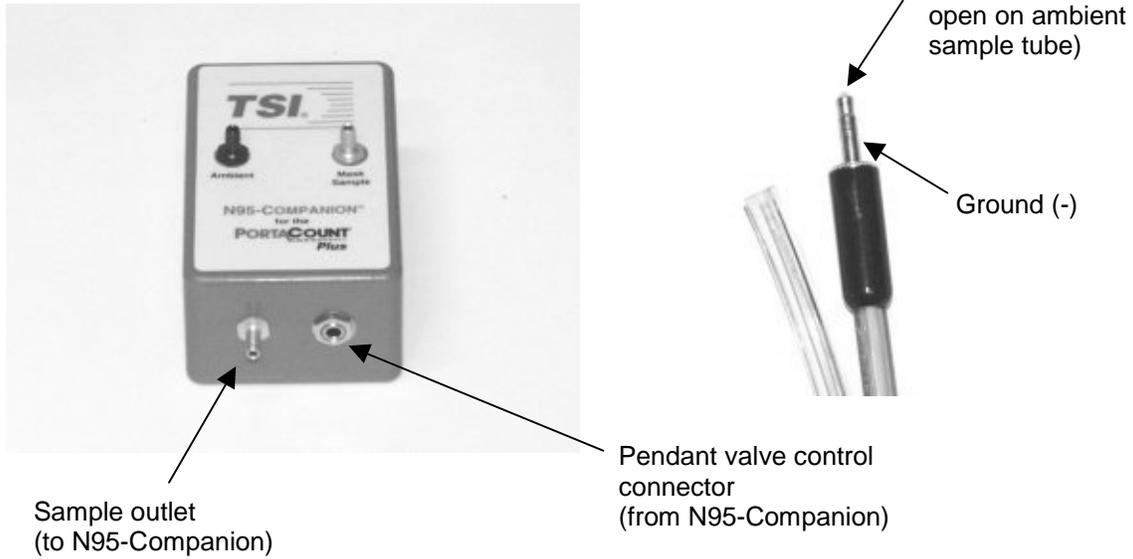- The internal pass/fail settings are reduced by a factor of 10.

Pass/Fail setting for PortaCount alone	Pass/Fail setting with N95-Companion	Comment
0	0	Pass/Fail indicator OFF
1 to 10*	1	Minimum pass/fail = 1
50*	5	
100	10	
200	20	
500	50	
1000	100	
2000 or higher	200	Maximum pass/fail = 200

 * Not a factory setting

N95-Companion Front Panel

Sample inlet
(approx. 700 cm^3/min)

Pendant valve control
connector

Sample outlet
(to PortaCount)

N95-Companion Sampling Pendant

+ 5 VDC
(to hold valve
open on ambient
sample tube)

Ground (-)

Pendant valve control
connector
(from N95-Companion)

Sample outlet
(to N95-Companion)

N95-Companion Back Panel

Factory use only

Particle Classifier
Check Button
(turns DMA off)

Control Connector
(6-pin MMJ to PortaCount)
Use TSI cable 1303522
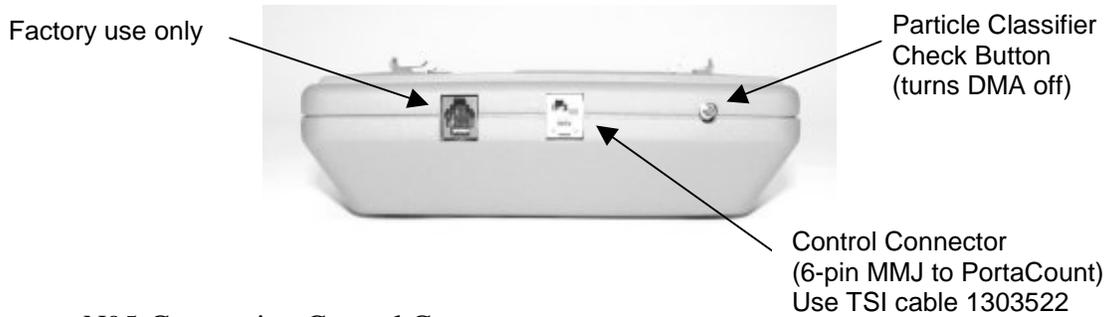
N95-Companion Control Connector

Contact Number	Function	Comment
1	Ground (-)	
2	+ 5 VDC (from PortaCount)	Supply voltage for all circuits except solenoid valve in pendant
3	N95 Attach Signal (to PortaCount)	Jumpered to ground to signal PortaCount that N95-Companion is attached
4	+ 5 VDC Solenoid valve voltage feed (from PortaCount)	High current voltage supply for solenoid valve in pendant
5	Solenoid valve control (from PortaCount)	0.0 VDC = sample from sample tube (normal position) 5.0 VDC = sample from ambient tube (maintain voltage while sampling)
6	Not used	