Back-Scatter Cloud Probe (BCP)

Operator Manual

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Warranty

The seller warrants that the equipment supplied will be free from defects in material and workmanship for a period of one year from the confirmed date of purchase of the original buyer. Service procedures and repairs are warrantied for 90 days. The equipment owner will pay for shipping to DMT, while DMT covers the return shipping expense.

Consumable components, such as tubing, filters, pump diaphragms, and Nafion humidifiers and dehumidifiers are not covered by this warranty.

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CAUTION: The requirement for the BCP to be non-intrusive to aircraft operations (i.e., no external components) dictates that there be no laser beam-stop mechanism. The laser beam will project unimpeded from the optical window. The laser is not eye-safe, so precautions must be enforced for operation on the bench or ground.

Benchtop operation: The BCP can be safely operated on the bench if certain precautions are followed. The optical block should be secured on the technician's bench and a beam-stop must be secured in such a position that the direct beam or reflections cannot be seen by the operator or others in the room.

Aircraft operation: Operators should wear protective optical glasses, preventing the 658 nm wavelength from passing. For operation on an aircraft, it is the responsibility of the system operator or power distribution system to apply 28 VDC power to the BCP only after airborne. The laser beam diverges quickly, and does become eye-safe after just several meters, so the instrument can safely be operated while airborne. It is also the operator's or power distribution system's responsibility to deactivate the BCP before landing.

1.0 Product Description

1.1 Introduction

The Back-Scatter Cloud Probe (BCP) measures cloud droplet size distributions from 5µm to 75µm, which are then used to derive the total number concentrations, liquid water content (LWC), median volume diameter (MVD), and effective diameter (ED). The BCP's non-intrusive optical housing allows use in a range of ground-based or airborne applications with no contamination from ice crystal shattering and no airflow distortion.

Droplet Measurement Technologies (DMT) has implemented state-of-the-art electronics and optics, which offer flexibility to the BCP user in a variety of applications. The non-intrusive optical housing allows use in a range of ground-based or airborne applications. This housing contains the laser module, back-scatter optical components, optical heating circuit, photodetector, and analog signal-conditioning circuit. The analog signal is transmitted to the BCP Electronics Processing Module, where it is received, digitized and processed. Once digitized, particle pulse height is categorized into a 10-bin histogram. Analog "housekeeping" parameters are combined with the size information and sent in a serial data stream (RS-422 or RS-232) to the data system.

Figure 1: Back-Scatter Cloud Probe

1.2 BCP Specifications

Size Range:	5µm to 75 µm
Number Concentration Range:	0 - 1,000 cm^{-3}
Air Speed Range:	10 - 250 ms^{-1}
Number of Size Bins:	10
Sampling Frequency:	Selectable, 0.04 sec to 20 sec
Light Collection Angles:	Center-line: 156°, +/- 13°
Laser Wavelength:	658 nm
Laser Power:	50mW or less
Data System Interface:	RS-232 or RS-422 serial interface
Additional components:	Electronics box, 1 m connecting cable
Calibration:	Glass beads
Routine Maintenance:	Optics cleaning before every field campaign
Recommended Service:	Annual cleaning and calibration at DMT service facility
Software:	Optional Particle Analysis and Display System (PADS) software
Temp:	-40 to +40 °C. Note: the laser will automatically shut down above +45 °C, preserving laser life-time.
Altitude:	0 - 50,000 feet
Humidity:	0 - 100%
Weight:	1.5kg

1.3 Physical Specifications

Weight:	1.5 kg
Probe Dimensions:	11.7 cm x 10.7 cm x 4.5 cm, with 5.9 cm diameter mounting flange
Electronics Box Dimensions:	21.6 cm x 12 cm x 5.7 cm

1.4 Electrical Specifications

Power Requirements:	28 VDC, 5 A for system and heaters

CAUTION: The requirement for the BCP to be non-intrusive to aircraft operations (i.e., no external components) dictates that there be no laser beam-stop mechanism. The laser beam will project unimpeded from the optical window. The laser is not eye-safe, so precautions must be enforced for operation on the bench or ground.

1.5 Summary of BCP Electronic and Software Features

- Classification of particle size in histogram form.
- Size distributions accumulated in the probe, with serial transmission to any standard computer communications port (RS-232 or RS-422).
- Monitoring of multiple variables, e.g. total particles, average transit time, over-range particles, and various probe health indicators. See section 8.3.4.2 for conversion equations for analog-to-digital channels.
- User-programmable sample rates and bin thresholds.
- Zero dead-time losses.
- Dynamic threshold feature (see section 3.0)

2.0 Theory of Operation

Particles passing through the laser beam scatter light in all directions, but only those photons that transmit within a cone subtending angles between 143° and 169° are collected and directed onto a photodetector (see Figure 2). The photodetector converts the photon pulses into electrical pulses that are transmitted to a signal processor that amplifies and digitizes them. The peak amplitude of the scattering signal is related to the cloud particle size by Mie theory. A size distribution that relates number concentration to each particle's optical diameter is accumulated at programmable time intervals and stored along with information that monitors the data quality and health of the system.

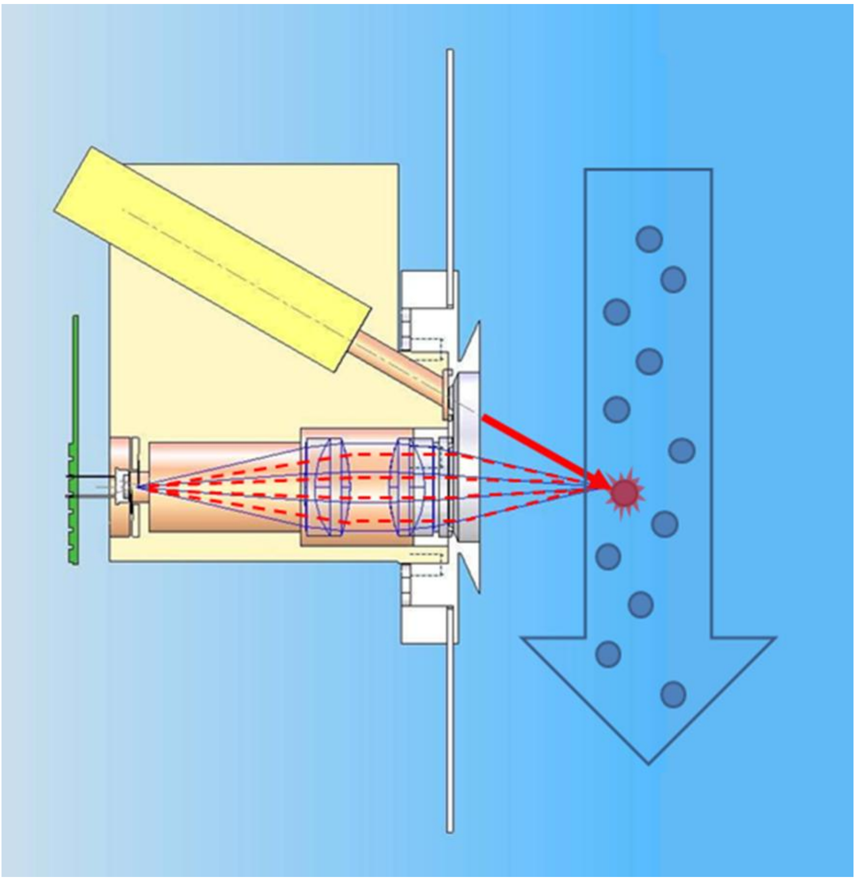

Figure 2: Back-Scatter Cloud Probe Optical Path

2.1 Accounting for Location of Particles in the Beam

The location of the particle in the beam is a critical piece of information needed to interpret the measurement. Because the laser intensity is Gaussian, particles passing through the center of the beam, where there is greater power density, will scatter more light than those passing through the edge. However, this location cannot be exactly known with the BCP. To account for spreading of the size distribution caused by non-uniform intensity, an “inversion routine” is used to derive the ambient size distribution.

3.0 Dynamic Threshold Feature

The dynamic threshold feature automatically adjusts the BCP’s sizer baseline to account for drifts due to temperature changes.

The dynamic threshold feature works as follows. The instrument’s sizer signal voltage is digitized with a 12-bit ADC, which yields a 0 to 4095 count. A histogram is created of all counts between 0 and 512. (Signals above 512 are assumed to be responses to particles, and thus not relevant to establishing the baseline.) The system then identifies the narrowest band that contains at least 75% of counts in the histogram. This band, referred to as the “noise band,” is the system’s attempt to identify a range for baseline noise when no particles are present.

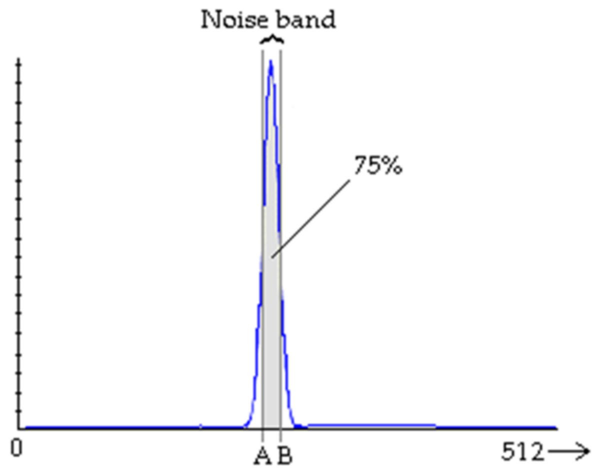

Figure 3: Identifying a Noise Band

If the noise band exceeds 20 counts (i.e., the width is too wide), or if no noise band was identified, the previous noise band is used. These qualifications are imposed in order to distinguish the noise from actual particle events. The instrument then uses the noise band to adjust the sizer baseline and identify particles. The noise band updates at a rate of 10 Hz.

BCPs with the dynamic threshold feature have two new channels included in their serial data output. **DT Bandwidth** is the width of the noise band—that is, [B – A] in Figure 4. **Dynamic Threshold** is the upper boundary of the noise band, i.e. B in Figure 4. Both of these channels are given in digital counts.

4.0 Bench-top Testing

4.1 Bench-top test and Calibration Confirmation

CAUTION: The BCP can be safely operated on the bench if certain precautions are followed. The requirement for the BCP to be non-intrusive to aircraft operations (i.e., no external components) dictates that there not be a laser beam-stop mechanism. The laser beam will project unimpeded from the optical window. The laser is not eye-safe, so precautions must be enforced for operation on the bench or ground. The optical block should be secured on the technician's bench and a beam-stop must be secured in such a position that the direct beam or reflections cannot be seen by the operator or others in the room. Operators should wear protective optical glasses, preventing the 658 nm wavelength from passing.

Operation can be verified by using a can of "Freeze Mist," commonly available at electronic supply stores. Direct the mist through the laser beam at a point directly above the collection optics, about 4-5 cm from the sapphire window. Calibration with precision glass beads is performed at DMT's facility, as the company maintains a bead-dispenser fixture to ensure correct placement of particles in the beam. Correct particle sizing is determined in post-processing, once the inversion routine is applied.

Standard BCP serial communication is configured for RS-232, and the supplied cable can be used with any computer that supports RS-232.

The BCP will communicate with the PADS software package supplied with the BCP. Review the PADS manual for details.

The BCP heater circuits are temperature controlled and can be activated on the ground. The optics block heater and the electronic heaters are set for 20ºC.

5.0 Aircraft Operation

For operation on an aircraft, it is the responsibility of the system operator or power distribution system to apply 28 VDC power to the BCP only after airborne. The laser beam diverges quickly, and does become eye-safe after just several meters, so the instrument can safely be operated while airborne. It is also the operator's or power distribution system's responsibility to deactivate the BCP before landing. DMT is not liable for misuse of the BCP.

The Optics Cap (MP-2322), seen below on the left, is mounted to the inside of the aircraft skin. The BCP Optics Block is then attached to the Optics Cap and secured via 4 post and nylon lock-nuts. The posts are 8-32 screws. If the aircraft needs to be flown while the BCP Optics Block is away for maintenance, the Blanking Cap (MP-2363A), seen below on the right, can be installed allowing the aircraft to remain pressure tight.

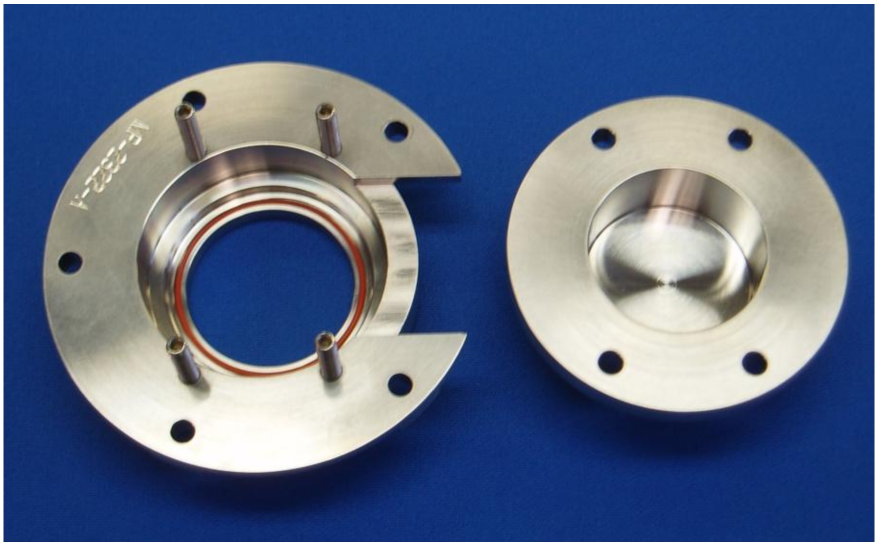

Figure 4: BCP Optics Cap (left) and Blanking Cap (right)

6.0 Particle Analysis and Display System (PADS)

DMT's Particle Analysis and Display Software (PADS, shown in Figure 5) can be purchased with the BCP, allowing any computer with an available serial port to act as the data logger. The PADS program needs Windows 2000, Windows 7 or Windows XP for successful operation (see the PADS manual for operating instructions). *The BCP does not work with DMT's older PACS software.*

PADS allows the user to do the following tasks, among others:

- Start data recording and sampling
- View a size histogram of particles measured by the BCP
- View particle volume and number concentrations, as well as Liquid Water Content (LWC), Median Volume Diameter (MVD) and Effective Diameter (ED)
- Monitor instrument operational parameters like optic block temperature, electronic box temperature, and the baseline monitor voltage

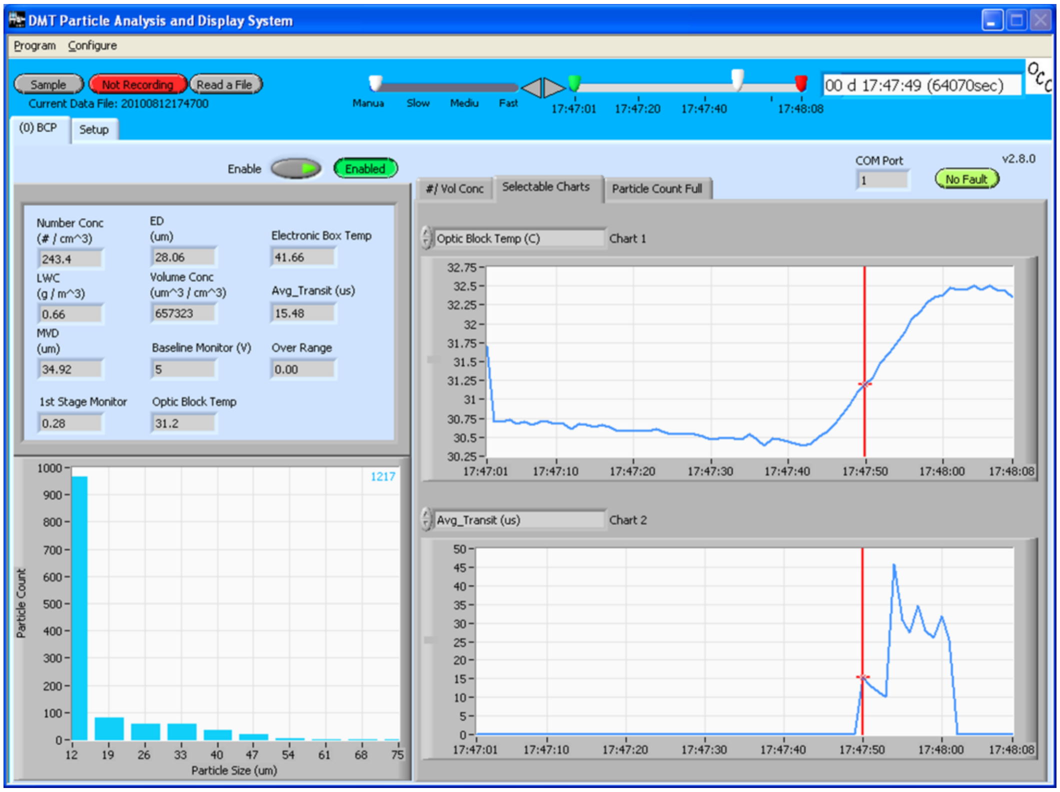

Figure 5: The PADS BCP Module

7.0 Routine Maintenance

The Back-Scatter Cloud Probe is environmentally sealed and is water resistant, ***but not waterproof***.

The optical path is protected with a sapphire window. It can be seen through the water trough port. Water residue can cause contamination on the windows and this contamination will distort or attenuate the amount of scattered light collected from a particular particle.

To clean the sapphire window, follow accepted optical cleaning techniques:

- Use white vinegar on a Q-tip to remove water spots on the exposed sapphire window, then use alcohol or acetone for final cleaning procedures. Use the Q-tip for only one swipe of the window. Do not clean with a continued circular motion as that may cause scratches on the window.
- If the aircraft is “de-iced” before takeoff, the chemical residue may end up on the sapphire window and prevent correct operation during

the flight. The window will need to be protected or cleaned before operation will be restored.

8.0 Communications between the PC and BCP Electronics

8.1 Communications Parameters

The Particle Analysis and Display Software (PADS) will communicate with a BCP. Any computer capable of communications over an RS-232 or RS-422 port should also be capable of communicating with the BCP Electronic Processing Module. The port parameters for communications should be set to 38400 baud, 8 data bits, one stop bit with no parity checking.

Since binary data are sent across the interface it is possible that some systems will react to the non-ASCII characters that are sent as control characters. It is recommended that all communications with the BCP Electronics be programmed at a low level to avoid this problem.

After completing a data request, the BCP Electronics clears all of its summation registers and starts taking a new set of data. The communications between the host computer and BCP Electronics occurs through predefined structures. More information about these structures appears below.

<table>
<tr><th>Structure</th><th>Bits</th><th>Order of Bytes</th></tr>
<tr><td>Unsigned Character</td><td>8</td><td>N/A (only one byte)</td></tr>
<tr><td>Unsigned Integer</td><td>16</td><td><table><tr><td>Byte 0</td><td>Byte 1</td></tr><tr><td>Bits 7:0</td><td>Bits 15:8</td></tr></table></td></tr>
<tr><td>Unsigned Long</td><td>32</td><td><table><tr><td>Byte 2</td><td>Byte 3</td><td>Byte 0</td><td>Byte 1</td></tr><tr><td>Bits 23:16</td><td>Bits 31:24</td><td>Bits 7:0</td><td>Bits 15:8</td></tr></table></td></tr>
</table>

Table 1: Data Structures Used in BCP-Host Computer Communications

8.2 Initiating Communications

The host computer initiates all communications with the BCP. Since the BCP only responds with data after it has received a request for data, all of the timing for data acquisition needs to be performed in the host processor. To increase the rate data are relayed from the BCP, the host only needs to increase the rate at which it makes requests for data. After completing a data request, the BCP clears all of its summation registers and starts taking a new set of data.

Note that the first data packet of particle information the BCP sends is relatively meaningless. This is because the time interval between instrument start-up and the first data packet being sent likely differs from the standard sampling interval.

8.3 Communications Commands

There are two commands that the BCP Electronics responds to: the ***Setup*** data acquisition parameters command (command = 1) and the ***Send Data*** command (command = 2). These commands and the BCP's responses are discussed in detail in the following sections.

8.3.1 SETUP DATA ACQUISITION PARAMETERS Command

This command allows the host computer to transmit data acquisition parameters to the BCP. The BCP automatically comes up with default parameters at power up, but to ensure these are correct, the data system should set up the parameters each time the instrument is used. These parameters will remain in effect until power is cycled or a new Setup command is sent.

The data packet the host computer sends the BCP is outlined below. Section 8.3.2 provides definitions of these parameters.

<table>
<tr><th>Byte</th><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>1B</td><td>Start Byte: Esc Character</td></tr>
<tr><td>1</td><td>01</td><td>Command Number: Setup Command</td></tr>
<tr><td>2</td><td>00</td><td rowspan="2">ADC_Threshold = 0x0400h = 1024d</td></tr>
<tr><td>3</td><td>04</td></tr>
<tr><td>4</td><td>00</td><td rowspan="2">TransRej = Off</td></tr>
<tr><td>5</td><td>00</td></tr>
<tr><td>6</td><td>14</td><td rowspan="2">Bin Count = 0x0014h = 20 Bins</td></tr>
<tr><td>7</td><td>00</td></tr>
</table>

<table>
<tr><th>Byte</th><th>Value</th><th>Description</th></tr>
<tr><td>51</td><td>06</td><td>Bin 16</td></tr>
<tr><td>52</td><td>A4</td><td rowspan="2">Bin 17</td></tr>
<tr><td>53</td><td>06</td></tr>
<tr><td>54</td><td>08</td><td rowspan="2">Bin 18</td></tr>
<tr><td>55</td><td>07</td></tr>
<tr><td>56</td><td>6C</td><td rowspan="2">Bin 19</td></tr>
<tr><td>57</td><td>0B</td></tr>
<tr><td>58</td><td>D0</td><td>Bin 20</td></tr>
</table>

8	00	DOF Reject? = Off
9	00	
10	00	Range
11	00	
12	40	Avg. Trans. Weight = 0x0040 = 64 Clk Cycles
13	00	
14	00	ATT_Accept = OFF
15	00	
16	00	Divisor Flag = 20MHz
17	00	
18	00	Count method
19	00	
20	64	Bin 1 Upper Threshold = 0x0064h = 100d
21	00	
22	C8	Bin 2 Upper Threshold = 0x00C8h = 200d
23	00	
24	2C	Bin 3 Upper Threshold
25	01	
26	90	Bin 4 Upper Threshold
27	01	
28	F4	Bin 5
29	01	
30	58	Bin 6
31	02	
32	BC	Bin 7
33	02	
34	20	Bin 8
35	03	
36	84	Bin 9
37	03	
38	E8	Bin 10
39	03	
40	4C	Bin 11
41	04	
42	B0	Bin 12
43	04	
44	14	Bin 13
45	05	
46	78	Bin 14
47	05	
48	DC	Bin 15
49	05	
50	40	Bin16

59	0F	
60	01	Bin 21
61	02	
62	03	Bin 22
63	04	
64	05	Bin 23
65	06	
66	07	Bin 24
67	08	
68	09	Bin 25
69	0A	
70	0B	Bin 26
71	0C	
72	0D	Bin 27
73	0E	
74	0F	Bin 28
75	10	
76	11	Bin 29
77	12	
78	13	Bin 30
79	14	
80	15	Bin 31
81	16	
82	17	Bin 32
83	18	
84	19	Bin 33
85	1A	
86	1B	Bin 34
87	1C	
88	1D	Bin 35
89	1E	
90	1F	Bin 36
91	20	
92	21	Bin 37
93	22	
94	23	Bin 38
95	24	
96	25	Bin 39
97	26	
98	27	Bin 40
99	28	
100	05	Checksum
101	0E	

Table 2: Data Packet Host Computer Sends BCP during Setup Data Command

8.3.2 Definition of the Declared Parameters

The possible values for the parameters the host computer sends to the BCP are explained below.

- Start Byte — ASCII 27, HEX = 1B, the escape character.
- Command Number — The command number: 01h = setup data; 02h = send data.
- ADC Threshold — The minimum ADC trigger level, which can be any hex number between 0001h and FFF0 hex. This parameter sets a digital amplitude or pulse-height threshold, and it can be used to raise the bottom end of bin #1 to reduce noise. In the SPP-100, this is a sample clock-count threshold. In the BCP, this sets a digital amplitude, or minimum pulse-height threshold.
- TransRej — Enables Average Transit Time Rejection: 0000h = off, 0001h = on. Average Transit Reject feature is active in SPP-100 electronics only. The BCP should always have transit reject turned off.
- Bin Count — Indicates the number of bins or channels of the histogram. Can either be 10 (0Ah), 20 (14h), 30 (1Eh) or 40 (28h). BCP only uses 10-bin histograms.
- DOF Reject? — An instruction to the BCP to either reject or include particles for statistical processing based on the depth of field signal. 0000h = includes particles outside the DOF, 0001h = rejects them. The BCP should always have DOF rejection turned off.
- Range — Sets the probe range. Valid from: 0000h → 0003h. Range is not used in BCP and is an SPP-100 feature only.
- AvgTransWeight — Weights the average transit rejection algorithm. For example, if this value is 64 (decimal), then the previous 64 transit times will be used to calculate the current average transit time. NOTE: in BCP, this value is unused, BCP is fixed at 64.
- AttAccept — Sets the percent of average transit time for acceptance. NOTE: in BCP, this value is not used.
- Divisor Flag — Selects the PHA divisor of basic clock speed to determine sampling speed. NOTE: in BCP, this value is not used. For SPP-100: 0000h = 20MHz Sample Rate, 0001h = 10MHz Sample Rate.
- Count method — Determines how particles are counted. Derived 'Average Transit Count' uses particle width if 0000h, or particle area divided by particle peak if 0001h. NOTE: in BCP, the average transit time is derived from sample clock cycles. Sample rate is 40MHz, or 25nS per clock cycle.
- Upper Bin Boundaries — Sets the peak count thresholds for the bins/channels. These values set the UPPER threshold of each size bin. The first value here will be the upper threshold of Bin Number 1. Thus, every ADC value read in below this value and above the ADC Threshold value will fall into Bin 1. *Note*: The last bin, Bin 10 in this case, must be FFFF hex. The SPP-100 uses a 12-bit ADC (4096), while the BCP has a 14-bit ADC, but only uses 12 bits. *Note*: No matter how many bins are selected,

40 bin thresholds must be sent out. Again in this example, if the Bin Count is 10, 10 valid thresholds are sent out, and the remaining 30 bins should be 0000 hex or FFFF hex, but can really be any hex number.

- Checksum — The 16-bit sum of all the 8-bit characters in the packet.

8.3.2.1 Response to Setup Data Command

For command number 1 (setup data acquisition parameters), the probe responds with four bytes of information.

The first two bytes indicate whether the received and calculated checksums match. If they do, the BCP/SPP-100 probe responds with two ACK characters (ASCII character 6, HEX = 06). If the received checksum differs from the calculated one, the probe responds with two NAK characters (HEX = 15). (Note: the BCP, not SPP-100, generates this response.)

The second two bytes indicate the revision number of the BCP's code. This information allows for easy determination of which version of code is being used in a particular instrument.

The response does not include the ESC char to begin the data packet nor does it have a CKSUM at the end of the packet. It is just the four bytes described above.

8.3.3 SEND DATA Command

Table 3 shows the packet that is sent to the BCP/SPP-100 probe to request a data packet.

Byte	***Value***	***Description***
0	1B	Start Byte: Esc Character
1	02	Command Number: Send Data Command
2	1D	Checksum
3	00	

Table 3: Data Packet Host Computer Sends BCP during Send Data Command

Start Byte, Command Number and Checksum are the same as described in section 8.3.2.

8.3.4 Send Data Response

After the BCP/SPP100 receives a Send Data request, it responds with the data packet below. The total length of this packet is 76 bytes.

<table>
<tr><th>Byte</th><th>Description</th><th>Notes</th></tr>
<tr><td>0</td><td rowspan="2">1st Stage Monitor / Housekeeping 1</td><td rowspan="16">The first 8 channels in the data packet are analog-to-digital signals that must be converted by the data system (e.g., PADS) into meaningful numbers. The data arrive in hex format. PADS or another data system must then use a scaling algorithm specified within the program to yield valid results.</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td><td rowspan="2">Baseline Monitor / Housekeeping 2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">Housekeeping 3</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td rowspan="2">Optic Block Temp / Housekeeping 4</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="2">Electronics Temp / Housekeeping 5</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td><td rowspan="2">Housekeeping 6</td></tr>
<tr><td>11</td></tr>
<tr><td>12</td><td rowspan="2">Housekeeping 7</td></tr>
<tr><td>13</td></tr>
<tr><td>14</td><td rowspan="2">Housekeeping 8</td></tr>
<tr><td>15</td></tr>
<tr><td>16</td><td colspan="2" rowspan="4">Unused</td></tr>
<tr><td>17</td></tr>
<tr><td>18</td></tr>
<tr><td>19</td></tr>
<tr><td>20</td><td colspan="2" rowspan="4">Unused</td></tr>
<tr><td>21</td></tr>
<tr><td>22</td></tr>
<tr><td>23</td></tr>
<tr><td>24</td><td colspan="2" rowspan="2">Average Transit</td></tr>
<tr><td>25</td></tr>
<tr><td>26</td><td colspan="2" rowspan="2">DT Bandwidth</td></tr>
<tr><td>27</td></tr>
<tr><td>28</td><td colspan="2" rowspan="2">Dynamic Threshold</td></tr>
<tr><td>29</td></tr>
</table>

Byte	Description	Notes
30	ADC Overflow	
31		
32		
33		
34	Bin 1 Counts	
35		
36		
37		
38	Bin 2 Counts	
39		
40		
41		
…Bins 3 – 9 …		
70	Bin 10 Counts	
71		
72		
73		
74	Checksum	
75		

Table 4: Data Packet BCP sends to Host Computer in Response to Send Data Command

8.3.4.1 Definitions of the Send Data *Response Parameters*

- Housekeeping [1-8] — An array which holds the most recent Analog-to-Digital conversion values for the eight analog house-keeping channels.
- AvgTransit — The average of the raw counts of the particle widths in the current sample period. BCP only gives the average of the raw count.
- DT Bandwidth — The width of the noise band in digital counts. See section 3.0 for more information.
- Dynamic Threshold — The upper boundary of the noise band in digital counts. See section 3.0 for more information.
- ADCoverflow — A counter for how many times that the Analog to Digital Converter was at its maximum digitized count (4096). These particles are not processed into the calculated parameters and only reported as "over-

range particles”.

- Bin Counts — An array which holds the digital thresholds for the different peak size channels which are defined in the Setup command.
- Checksum — The 16-bit sum of the characters in the packet.

8.3.4.2 Conversion Equations for Analog-to-Digital Housekeeping Channels

Channel	Name	Offset	Scale
1	1st Stage Monitor	0	0.001221 V/ADC count
2	Baseline Monitor	0	0.001221 V/ADC count
3	n/c		
4	Optic Block Temperature	T(degC) = (1 / ((1 / 3900) * ln((4096 / adc count – 1) + (1 / 298))) – 273	
5	Electronics Temperature	819 ADC counts	0.06104 degreeC/count
6	n/c		
7	n/c		
8	n/c		

Table 5: Conversion Equation for Analog-to-Digital Channels

8.3.5 Setting the Serial Packet Protocol

The BCP Electronics box contains the power supply module, and underneath is the FPGA module. On the FPGA module, there are 5 jumpers used to select either RS-232 or RS-422. Review the BCP Electronic schematic section, see page 9 of 10: J901 through J905 are used to select the expected protocol. In the 5 sets of 3-pin jumpers, connect pins 1+2 for RS-422, and pins 2+3 for RS-232. Remember that RS-232 is a 3-wire serial protocol with a range of only 20 meters. RS-422 is a 4-wire differential protocol and rated for up to 350 meter transmissions. The computer serial port must be of the same protocol as the instrument. Built-in serial ports are typically RS-232 (see schematics for the power connections and signal connections).

9.0 BCP Part Numbers

- The BCP optics block, electronics module, interconnecting cable and power-in/signal-out cable have been assigned an assembly P/N 000214D010000-01.
- The Optics Cap is P/N MP-2322-A.

- The Blank Cap is P/N MP-2363-A.
- The Optics Cap and Blank Cap, with associated screws, have a DMT assembly number ASSY-0151.

Appendix A: Revisions to Manual

Rev. Date	Rev No.	Summary	Section
9-29-09	B-2	Reformatted Communications Section	6.0
		Corrected passage that erroneously stated the length of the Send Data Response data packet is variable	6.3.4
12-18-09	C	Added Schematics	Appendix B
10-18-10	D	Updated specifications and theory of operation, added PADS section	Throughout
1-12-12	E	Removed mention of insulators in ASSY-0151	8.0
		Removed obsolete packing list	Appendix B
		Inserted information about dynamic threshold	3.0
2-6-12	E-1	Inserted new digital board schematic, ABD-0234, which replaces ABD-0072. BCPs up to serial number 11 (i.e., those manufactured before the end of January 2012) have the ABD-0072 board. Subsequent BCPs have the ABD-0234 board.	Appendix B
4-18-12	E-2	Removed schematics	Appendix B
		Inserted information on DMT Instrument Locator	Appendix B

Appendix B: DMT Instrument Locator—Operator Guide

Purpose

The Droplet Measurement Technologies (DMT) Instrument Locator tests whether a DMT instrument is responsive to an initialization command. This can be useful in determining if an instrument is powered on and has functional communications lines, or in verifying the serial port number that each instrument is connected to. Beyond this, the software does not ensure that the instrument is functioning properly.

This document describes version 1.0.1 of the Instrument Locator. This version of the program supports the following DMT instruments:

- APSD
- BCP
- CAS and CAS-DPOL
- CDP and CDP-PBP
- CIP and CIP-GS
- CPSD
- FM-100
- FSSP
- MPS
- PCASP-100X
- PCASP-X2
- PIP

Installation

The DMT Instrument Locator is on a USB stick included in a sealed plastic bag. To install the software, follow the instructions on the small card also included in the bag.

Operation

1. To open the Instrument Locator, navigate to `C:\Program Files\PADS 3` and double-click on `DMT Instrument Locator.exe`. You will see the window in Figure 1.

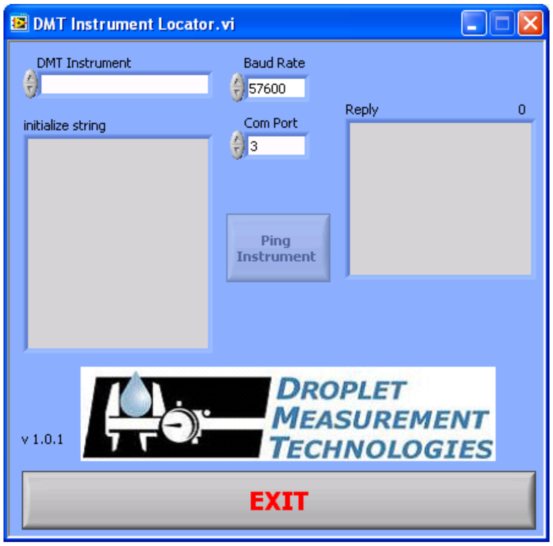

Figure 6: Instrument Locator

2. Click on the **DMT Instrument** field to bring up a list of available instruments. (Grayed-out instruments have not yet been tested with the Instrument Locator.) Select your instrument from the list. The **Baud Rate** will auto-populate, though in some special cases you may need to adjust the baud rate for your specific instrument.

3. Select the COM port for the instrument you want to test.

4. Click on **Ping Instrument.**

5. The Instrument Locator will display the initialization string sent to the instrument and the instrument's reply. All instruments reply with "0606" when sent a valid initialization command. If there is no reply, the Instrument Locator will indicate this with a **No Reply** indicator. The Instrument Locator also displays a possible reason for the communication failure in the **Reply** box.

6. To quit the Instrument Locator, click on **Exit.**

Note: Several DMT instruments—the CDP, CDP-PbP, BCP, FSSP, and FM-100—all respond to the same initialization string. The instrument locator simply sends this string to the instrument. The program has no way of knowing if the instrument connected to the COM port is actually of the correct type. Thus, if you have multiple instruments in your system, it is important to specify the correct COM port for the instrument you wish to test.