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MANUAL PART
Accuraspray–G3C

EDITION
Edition 3, October 2012

The material contained in this document is provided “as is” and is subject to change without notice in future editions.

OVERVIEW
Orientation:
- Table of contents at the front of the manual

This manual contains the following sections:
- “Safety”
- “Product description”
- “Installation and commissioning”
- “Maintenance”
- “Operation”
- “APPENDIX”
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1 SAFETY SUMMARY

The following safety precautions should be observed during all phases of operation of the Accuraspray–G3C.

Tecnar Automation Ltd. assumes no liability for user’s failure to comply with these precautions or with specific warnings elsewhere in this manual.

1.1 GENERAL PRECAUTIONS

- Make sure to use an unloaded, properly grounded power line.
- Supply cooling/cleaning air at 1.7–2.7 bar (25–40psi) to sensor head.
- Use only original spare parts.

1.2 AUTHORIZED USE

Accuraspray–G3C is intended solely for thermal spray process monitoring and control use. Any other use is considered as unauthorized.

This manual should be read before the use of the system is authorized and a copy of it should be kept near the equipment.

Accuraspray–G3C has been designed and manufactured according to state of the art technology and world standard safety regulations. However, unauthorized use can result in danger to the operator or third parties’ body or even life and/or in damage to the product itself or other machinery.

1.3 SAFETY SIGNS

Signs such as the ones shown in the two examples below indicate particular hazards or risks to consider when operating the Accuraspray–G3C:

The warning sign denotes a hazard. It warns about dangers which could result in either serious damages to the system or in serious personal injury or even death.

The caution sign denotes a hazard. It warns about dangers which could result in minor personal injury or equipment damage.
2 PRODUCT DESCRIPTION

Accuraspray–G3C was designed to continuously record, display, and compare the following eight spray plume parameters against adjustable acceptance parameter ranges:

- Average particle temperature
- Average particle velocity
- Position of the spray plume
- Width of the spray plume
- Maximum luminosity of the spray plume
- Overall intensity of the spray plume
- Sensor head temperature
- Substrate temperature (optional)

Note that Accuraspray–G3C features a built-in TCP/IP protocol (refer to page 42) that allows for complete remote control operation of the equipment as well as direct linkage to computer-based spray controllers.
2.1 ACCURASPRAY-G3C PRODUCT STRUCTURE

2.1.1 MAIN COMPONENTS

Note
Controller’s power configuration is automatic.
Auto-switch feature allows it to support 100–120 or 200–230 VAC 50–60 Hz.

Note
Sensor heads are available for both low temperature processes (low brightness) such as:
- High velocity oxygen fuel spraying
- See Accuraspray-G3C parts list in APPENDIX

And high temperature processes (high brightness) such as:
- Plasma
- Flame wire/powder
- Electric arc
- Spraying of materials containing titanium oxide
- See Accuraspray-G3C parts list in APPENDIX
2.1.2 **ACCESSORIES**

**Software**
Windows 7 operating system with license.

**Spare parts (attenuator, spare windows, fuses)**
Fuses as substitute.

**Power cable**
Power supply mains to controller.
(Appropriate type for local electrical net conditions)

**Sensor head cable**
Sensor head to controller connection.

**Air hose with valve**
Cooling device for sensor head.

**Carrying case**
Carrying device for Accuraspray–G3C.

**Alarm box**
(Optional)
Light and sound alarm device.

**Substrate temperature sensor(s) with cable**
(Optional)
Device for substrate temperature measuring.
2.2 **CONTROLLER CONNECTIONS**

**Figure 2**

1. Power on LED indicator
2. Power switch
3. Power supply connector
4. Multiple outputs
5. Head sensor power supply
6. Substrate pyrometer
7. Alarm box output
8. Ethernet port for computer
9. Ethernet port for controller board
10. Ethernet port for camera
2.3 SENSOR HEAD CONNECTIONS

1. Air purge connector
2. Camera Ethernet port
3. Control board Ethernet port
4. Power supply connector

2.4 SENSOR HEAD WINDOW

1. Two-color pyrometer viewport
2. Wide-angle camera viewport

2.5 CONTROLLER FUNCTION
The controller digitizes the video and detector signals respectively provided by the camera and the temperature sensor. It performs the required calculations and returns the results through the user interface (refer to page 20) on the computer screen. The graphical user interface displays all data relevant to the measured process.

Note
The male/female arrangement prevents mix-ups between cables.
2.6 SENSOR HEAD FUNCTION

2.6.1 PARTICLE VELOCITY MEASUREMENT

Accuraspray–G3C’s dual fibre optic device (1) “sees” the particles flow at two different measuring points (A, B) along the spray stream. Two brightness signals detected by a sensor (3) a few millimetres apart allow for the calculation of a very precise time delay value through cross-correlation analysis. The velocity can then be calculated from this time delay since the gap between the two measuring points is precisely known and constant.
2.6.2 **PARTICLE TEMPERATURE MEASUREMENT**

The detected signals are filtered at two different wavelengths which allows for the use of the twin wavelength pyrometry principle in order to measure the mean particle temperature. It is assumed that the particles emissivity is equal for the two wavelengths.

The correlation value is normalized between 0 and 1. A correlation threshold typically set at 0.6 ensures that both measuring points (A, B) correspond to the same population of particles, and therefore that the twin wavelength pyrometry is working properly.

2.6.3 **SPRAY PLUME GEOMETRY AND INTENSITY MEASUREMENT**

The following spray plume properties are measured from the digitized video feed provided by the CCD camera (2) which records a live plume image.

- Plume WIDTH (at 70% of maximum)
- Plume POSITION (deviation from the reference point)
- Plume maximum luminosity (HEIGHT)
- Plume INTENSITY

The spray plume optical intensity is measured at each point along the “sampling line” at a given stand-off providing an intensity profile with a maximum value (HEIGHT) close to the plume center.

Integrating the total area under that curve results in a value, called INTENSITY, that is proportional to the total optical energy radiated by the spray plume at that particular stand-off.

Units are normalized intensity values, i.e. 100% corresponds to a light intensity very close to the CCD camera saturation intensity threshold when it is set to its minimum sensitivity (shutter speed of 1/10,000 s). This ensures that every CCD camera calibrated in such a way provides the same intensity value when aimed at the exact same light source.
2.7 SUBSTRATE TEMPERATURE SENSOR FUNCTION
For detailed description of the sensor operation, refer to manufacturer’s OS100 Mini Infrared Transmitter product manual.


2.7.1 SUBSTRATE TEMPERATURE MEASUREMENT
The substrate temperature sensor offered as an option with the Accuraspray-G3C is a single-color pyrometer based on infrared light. When aimed at the work piece, it will provide its temperature in the range of -18 to 535 Celsius.

A three minutes warm up period after power up is required before the temperature measurement can be made.

The work piece must be larger than the measuring field. The following graph defines the relationship between the measuring filed and the distance to the work piece.
2.8 DATA FLOW WITHIN CONTROL ARCHITECTURE

Figure 7

1. Controller board
2. Hub
3. CCD camera
4. Microcontroller
5. Computer CPU
6. Computer GUI
7. Twin sensor channels
8. Ethernet link (9, 10, 11, 12)
2.8.1 ADDITIONAL EXPLANATIONS

The microcontroller (4) acquires analog sensor signals (7) and temperature sensor signals. It controls the signal gain. Note that it contains all the required calibration information and additional information like the product serial number.

The controller board (1) controls the outputs and the alarms. It also performs the reading of the external substrate temperature pyrometer.

The computer CPU (5) controls all the equipment parameters (camera, sensor signals, temperature signals etc.). Adjustable parameters are determined through the graphical user interface (6). Measure readings are provided through the graphical user interface. Data communication to and from the computer CPU is supported by Ethernet links (8, 9, 10, 11, 12).
## 2.9 Technical Data

### Standalone system including
- Sensor head
- Controller
- Computer
- Small parts
- Tripod

### Sensor head

**Dimensions**

- Width 105 mm (a)
- Height 65 mm (b)
- Length 185 mm (c)

**Carrying case dimensions and weight**

- To follow

**Figure 8**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>1.6 kg</td>
</tr>
<tr>
<td>Working distance from spray gun axis</td>
<td>200 mm</td>
</tr>
<tr>
<td>Particle temperature measurement range</td>
<td>900°C and higher</td>
</tr>
<tr>
<td>Particle velocity measurement range</td>
<td>5–1200 m/s at 0.5% precision</td>
</tr>
<tr>
<td>Plume relative intensity measurement</td>
<td>0.5% precision</td>
</tr>
<tr>
<td>Plume geometry measurement</td>
<td>0.1 mm precision</td>
</tr>
<tr>
<td>Camera field of view</td>
<td>380 mm</td>
</tr>
<tr>
<td>Camera measurement volume</td>
<td>3.2 mm DIA x 25 mm DOF=200 mm³</td>
</tr>
</tbody>
</table>

### Controller

**Dimensions**

- Width 260 mm (a)
- Height 60 mm (b)
- Length 390 mm (c)

**Figure 9**

<table>
<thead>
<tr>
<th>Specification</th>
<th>4.4 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td></td>
</tr>
<tr>
<td>Power requirements</td>
<td>100–120 or 200–230 VAC, 50–60 Hz</td>
</tr>
<tr>
<td>Auto-switch</td>
<td></td>
</tr>
</tbody>
</table>

### Computer

**Minimum screen resolution**

- 1024 x 768

**Power requirements**

- 100–120 or 200–230 VAC, 50–60 Hz
3 INSTALLATION AND COMMISSIONING

**Step 1**
Mount sensor head (1) on tripod or other customer specific support device. The sensor head can be set on either side of the spray plume between the spray gun (2) and the work piece (3).

*Cooling air must always be fed into air purge connector at 1.7-2.7 bar (25-40 PSI)*

**Step 2**
Position sensor head 200 mm (8) from the plume axis (4).

**Step 3**
Position sensor head in such a way that it never aims directly into the plasma flame itself (5), otherwise the measurements will reflect the plasma temperature instead of the particles temperature.

It is not necessary to take the reference measurements at the exact same stand-off you use for coating, as long as you keep the reference distance (6) constant over time.
Step 4
If monitoring is required while spraying, set measuring point within measuring area (7), away from the substrate because of flow perturbation phenomena as the spray hits the substrate.

Step 5
Connect all cables and cooling hose (refer to page 9).

Step 6
Switch on controller main switch.

Step 7
Acknowledge Windows user password window by pressing the [ENTER] key. Windows boots and the desktop will be displayed.

Enter password if required.

Step 8
Start Accuraspray–G3C software by double-clicking the corresponding icon on the desktop. After system communication check out is completed, the graphical user interface (refer to page 20) will be displayed. If check out fails, an error message window with information concerning the problem appears.

Step 9
Acknowledge error message. The software is running down after acknowledgement.

Step 10
Check system cable connections and reboot software.
Step 11
Place sensor head vertically so that the particle sensor aims at the center of the plume. Use the live video image (refer to page 21) of the main screen.
4 MAINTENANCE

4.1 REPLACEMENT OF SENSOR HEAD WINDOW

Step 1
Loosen the six locking screws on the sensor head front panel and remove the window assembly (see spare parts list in APPENDIX)

Do not open sensor head.

Step 2
Using gloves in order not to put grease or dirt on the glass, install a new window on the sensor head front panel and gently tighten the six locking screws.
5 OPERATION

Controller must be switched ON at least thirty (30) minutes prior to taking any measurement.

5.1 MAIN SCREEN

The main screen is divided into the following areas:

(1) Video frame
(2) Plume profile chart
(3) Strip chart

Figure 13
5.1.1 Video frame

This screen (1) displays the live image of the plume captured by the CCD camera. It shows the following elements:

(A) Spray gun

(B) Bulls eye circle
This circle indicates the area where the particle velocity and temperature are measured.

(C) Profile sampling line
This line indicates the exact path along which the intensity profile is measured.

(D) Stand-off and plume width lines
The stand-off line is stationary as it points to the center of the sampling line.

The plume width lines point to where the computer finds the upper and lower half maximum intensity points and therefore dynamically moves with the varying plume shape.

(E) Plume INTENSITY gauge (arbitrary units)

(F) Particle VELOCITY gauge (m/s)

(G) Particle TEMPERATURE gauge (°C)

(H) SUBSTRATE TEMPERATURE gauge (°C)
(Optional)

The gauges’ orange color delimit the acceptable range for the corresponding parameter. When the value exceeds the acceptable range, the needle changes color to orange and an alarm condition may be triggered according to the alarm protocol setup. The gauges are also equipped with two blue and yellow cursors showing the maximum and minimum excursions of the needle since the last reset.

(I) Light-emitting diode
The LED is used to adjust sensor head and spray gun during installation (refer to page 16).

Clicking this button switches the alignment light-emitting diode on or off (toggle button).

Note
In this section, the term button refers to on-screen buttons represented by icons.
(J) Alarm
This button enables or disables the alarm protocol.

(K) Play/pause
This button sets gauges, plume profile and plume video image to play (active) or pause (freeze). Data acquisition is not interrupted.

(L) Stop
This button is present only during an experiment file (*.ex) is being played. Pressing this button stops the reading.

(M) File and settings menu icons (refer to page 27)
This screen (2) displays the live intensity across the plume (A). Note that the plume intensity (orange plot) is overlaid on a reference profile (yellow plot). The x axis represents a vertical cross section of the plume.

Based on the profile shape, the following parameters are displayed:

- Position of the maximum in mm (Plume POSITION)
- Value of the maximum in arbitrary units compensated for the CCD camera shutter speed (Plume HEIGHT)
- Plume Width in mm, at 70% of the maximum (Plume WIDTH)

Note
Buttons (B) change camera shutter speed. The “plus” icon increases the exposure time whereas the “minus” icon reduces it.
The acceptable range for each of those three parameters is delimited by blue strips. The corresponding strip turns orange and an alarm is triggered when a parameter falls outside its acceptable range. The area under the complete profile curve is also calculated and displayed as “INTENSITY” by the corresponding gauge located at the bottom left side of the video window.
5.1.3 **Strip Chart**

This section of the screen (3) displays strip charts (I, J) showing the evolution over time of any of the nine measured parameters displayed in this area (in the present case, the second parameter, i.e. the plume temperature value, is displayed). An additional ninth value, the correlation, is also calculated and recorded. Only one strip chart at a time can be viewed. The buttons (K) allow the user to scroll in between each of the nine parameters.

The numerical value of the trace at the point where it intersects with the vertical center (H) line is displayed. The values of the maximum and minimum excursions since the last reset are also indicated. When data acquisition is active, the center line (H) corresponds to the current time. When stopped, the trace can be panned with a simple click and horizontal drag of the mouse to any moment in the file.
The two dotted orange lines (G) delimit the acceptable range. When the trace crosses outside these lines, the exceeding portion is displayed in orange (I) instead of the regular blue when it is within the acceptable range (J), which perfectly reflects the orange & light blue on the gauges.

The following icons control the data acquisition and display:

(A) Data eraser
This button erases all currently displayed data. Saved data are not affected.

(B) Back
This button brings back the display to the beginning of the file. It works only if the data acquisition is stopped.

(C) Stop
This button stops the file recording.

(D) Recording indicator
This icon blinks (red) when a file is recorded (for example, following a "save strip chart file" instruction).

(E) Forward
This button brings back the display to the end of the file again. It works only if the data acquisition is stopped.

(F) Control icons
These buttons control vertical and horizontal scaling of the display. The center buttons bring back default values.
5.2 MENUS

5.2.1 FILE MENUS
The following file types can be loaded/retrieved through the “Load File Menu” (A) and saved through the “Save File Menu” (B):

**Spray instruction files (*.ig)**
These files contain general instructions for thermal spray process control. That is to say all the settings required (application settings, minimum and maximum acceptance range settings, and alarm settings) are saved in this type of file.

After a load, the software performs the analysis based on the settings saved in the file.

Note that these files include no measured values except for the reference profile.

**Production files (*.prd)**
These files contain all the current measured values and settings at the time the “Save Production File” option was selected.

**Strip chart files (*.str)**
Strip chart files contain the data required to plot all nine parameters charts (including correlation values). These charts can also be saved in comma-separated value (*.csv) files (from “Application Settings” panel described in page 34) for easier import in spreadsheet software for further processing or analysis.

Note that when user loads a strip chart file, a popup is displayed to provide a saving option regarding the current strip chart.

**Experiment files (*.ex)**
The experiment files are a complete recording of a live experiment, including the video images captured by the CCD camera. Beware that such experiment files can become huge rapidly!!!
5.2.2 PADLOCK

In order to get access to the settings menus, the user must first click on the padlock (C) (which is locked by default) and then type in the password.

The default password is: TECNAR (CAPS insensitive)

The password can be changed by the user.

5.2.3 SETTINGS MENU

The settings menu is used to navigate through the user adjustable settings windows. These settings windows are described in further details in section 5.3 (refer to page 29).

The following keyboard shortcuts are available to select settings menu items:

(F5) “Min-Max Settings”
This shortcut displays the minimum and maximum adjustment panel on screen 1.

(F6) “Alarm Settings”
This shortcut displays the alarms settings panel on screen 1.

(F7) “Application Settings”
This shortcut displays the analysis parameters adjustment panel on screen 2.

(F8) “Reaction Time Setting”
This shortcut displays a popup on the right side of the main screen allowing for the reaction time setting by means of a single cursor.

(F9) “Scope Signal Settings”
This shortcut displays the scope signals settings window on both screen 1 and screen 2.
5.3 Settings

5.3.1 Minimum and Maximum Adjustment Panel

(A) Minimum and maximum acceptable limits
These values can be edited for each parameter by clicking in the corresponding numerical field.

(B) Current
This field is for display purposes, it is non-editable.

(C) Reference
This field is for display purposes only, it is non-editable.

Reference values are a snapshot of eight parameters captured at the moment a new reference profile was acquired.
(D) New reference
Clicking on this button triggers the acquisition of a new reference profile and changes the reference values accordingly. Simultaneously, the plume profile changes color to yellow.

(E) Apply and close
This button is used to apply a new reference profile and close the panel.

Note that if settings are not valid for proper operation, a warning popup (refer to appendix for main popup windows explanation) is displayed and the parameters causing problem are highlighted in red.

(F) Cancel and left arrow
These buttons return to normal display.
5.3.2 **ALARM SETTINGS PANEL**

When any parameter falls outside tolerances, an alarm condition can be triggered. The alarm can make a popup window appear indicating the source of the alarm and also open or close a user-defined, contact closure type, digital I/O port.

*Maximum load 3 W/ 24 V*

*Figure 18*

<table>
<thead>
<tr>
<th>Direct connection load</th>
<th>Indirect connection load</th>
</tr>
</thead>
<tbody>
<tr>
<td>P &lt; 3 W / U &lt; 24 V</td>
<td>P &gt; 3 W / U &gt; 24 V</td>
</tr>
</tbody>
</table>

- **Lamp**
  - 24 V
  - I max = 250 mA
  - P > 3 W

- **Relay**
  - 24 V
  - I max = 250 mA

- **Horn**
  - U > 24 V
  - P > 3 W

The popup function is particularly important when operating in twin mode because they appear even if the display is not set to the station where the alarm condition is triggered.
Except for "No data", which is a binary condition, all parameters have the following settings:

(A) Low error
If it is selected, an alarm will be triggered when the parameter falls below its lower acceptance threshold.

(B) High error
If it is selected, an alarm will be triggered when the parameter rises above its upper acceptance threshold.

(C) Popup warning
Checking this box enables that function for the associated parameter.
(D) **Network warning**
If it is selected, and if a connection is present on the TCP/IP command port, an alarm will be sent through the network.

(E) **Electronic warning**
If it is selected, activation of a digital output is enabled.

(F) **Alarm #**
Pull-down menu through which one of the three possible alarm outputs is selected and set to an active state.

(G) **Output #**
Pull-down menu through which one of the three possible outputs is selected and set to an active state.

(H) **Left arrow**
This button returns to normal display.
5.3.3 **APPLICATION SETTINGS PANEL**

This panel is divided into the three following sections:

- **Plume settings**
- **Camera settings**
- **General settings**

The following parameters can be edited from this panel:

**(A) Spray direction**

On mouse click, the image is switched horizontally. The image in this area must reflect the sensor head/gun arrangement in order to ensure proper operation of the equipment. As a matter of fact, the camera can be mounted either on the left or on the right of the spray plume.
(B) **Stand-off distance**
The stand-off distance is the distance between nozzle exit and the center of the sampling line. Thus this field's value determines where to capture the plume profile.

(C) **Sampling offset**
This field can be used to modify the profile sampling line position displayed on the video frame screen.

(D) **Plume angle (depends on various conditions)**
This value tilts the sampling line so that it lays perpendicular to the general direction of the particle flow (typically -5° for top injected plasma spraying and 0° for HVOF spraying).

(E) **Sampling line length**
This value determines the length, in the plane of the plume, of the path along which the intensity profile is measured. It is normally set to about four times the regular plume width.

(F) **Shutter speed**
This pull-down menu sets the CCD camera's shutter speed (so sensitivity) to one of eight values between 1/60 s and 1/10,000 s.

(G) **Measuring units**
This pull-down menu allows switching from the metric system to the imperial system.

(H) **Save strip chart in *.cvs**
This pull-down menu provides the option to save the strip charts in *.cvs file format.

(I) **Signal amplification**
This pull-down menu sets the amplification factor to one of eight values between 1 and 256.

(J) **OK and left arrow**
These buttons return to normal display.
5.3.4 REACTION TIME SETTING

This sliding cursor determines the mean calculation time interval in seconds.

The Accuraspray OS performs a rolling average over REACTION TIME seconds. Practically, this means that if for instance you set REACTION TIME to 5s, it will take at least 5 seconds before the effect of a change in the input knobs is completely reflected into the results.

Buffer size ranges from 0 to 60 seconds.

Based on many years of field experience, a REACTION TIME on the order of 5 to 7 seconds is recommended.
5.3.5 Scope signals panel

The main function of this panel is to display the two amplified brightness signals acquired by the photodetectors.

(A) Play/pause
This button activates (play) or deactivates (pause) digital scopes. Data acquisition is not interrupted.

(B) Load file
This button can be used to load previously saved raw data scope signals.

(C) Save file
This button can be used to save raw data scope signals.
(D) **Weak signal**
This field is for display purposes, it is non-editable. It indicates the “weakness percentage” as a function of a predetermined threshold (set in Accuraspray–G3C configuration file).

(E) **Saturation**
This field is for display purposes, it is non-editable. It indicates the “saturation percentage” at the analog to digital converters of the sensor head’s microcontroller.

To prevent saturation, reduce amplifier gain (K).

(F) **Data**
This field is for display purposes, it is non-editable. It indicates the percentage of acquired data below saturation (i.e. with 30% saturation, the data percentage should be 70%).

(G) **Correlation**
This field is for display purposes, it is non-editable. It indicates the cross-correlation value.

(H) **Speed**
This field is for display purposes, it is non-editable. It indicates the current particles speed.

(I) **Temperature**
This field is for display purposes, it is non-editable. It indicates the current temperature of the process.

(J) **Left arrow**
This button returns to normal display.

(K) **Gain**
This pull-down menu sets the amplification factor to one of eight values between 1 and 256.
APPENDIX

MAIN POPUP WINDOWS

ERROR MESSAGES
If the following error messages appear, the operator should check if all the required cables are properly connected.

It might be necessary to restart the controller if popup appears for the second time.
**WARNING MESSAGES**

If this message appears after setting minimum and maximum parameters' values, it means that one parameter or more are not set properly. The operator should check the settings.

This message appears when an attempt is made to save a production file while not in live mode. For example, it is not possible to save a production file after loading an experiment file.

**QUESTION PROMPT**

This message appears when saving or loading a strip chart file.
This screenshot illustrates the folder organization of Accuraspray–G3C main folder.

**ErrorLog**
This folder contains error logs as HTML files describing the technical environment at the time a bug occurred.

**Experiments**
This folder contains experiment files (*.ex) and is linked to associated save and load instructions.

**ProductionReports**
This folder contains production files (*.prd) and is linked to associated save and load instructions.

**RawDataScopeSignals**
This folder contains raw data scope files (*.raw) and is linked to associated save instruction.

**SprayInstructions**
This folder contains spray instruction files (*.ig) and is linked to associated save and load instructions.

**StripCharts**
This folder contains strip chart files (*.str) and is linked to associated save and load instructions. It also contains the comma separated value files (*.csv).

**Files**
- AccuraPlume.exe: Accuraspray–G3C software executable file
- AccuraPlume.ini: Accuraspray–G3C software configuration file
- AccuraPlume.bak: Accuraspray–G3C software backup for configuration file
TCP/IP PROTOCOL DETAIL

COMMAND MODE
PC IP
Default Port : Station A: Port 1557 / Station B : Port 1558

Notes:

- All commands are case insensitive.
- All file extensions are optional. If no file extension is given, default file extension is used.
- If a file name if given without path, default directory is used.
- "Start production" command file's name is optional. If no file name is given, default file name is used.
- Version format: x.x.x
- All command answer are preceded by 3 numbers and a space. Those numbers represent the standard TCP/IP status code of the command (more information about this can be found at http://www.w3.org/Protocols/HTTP/1.0/spec.html). The application will precede the answer with 200 for a good command, and it will use 400 for a bad request.

<table>
<thead>
<tr>
<th>Command</th>
<th>Return Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>version</td>
<td>200 version[version::ok::ApplicationName]</td>
</tr>
<tr>
<td>Returns the application name.</td>
<td></td>
</tr>
<tr>
<td>live off</td>
<td>200 live off[version::ok]</td>
</tr>
<tr>
<td>Sets Live mode off.</td>
<td></td>
</tr>
<tr>
<td>live on</td>
<td>200 live on[version::ok]</td>
</tr>
<tr>
<td>Sets Live mode on.</td>
<td></td>
</tr>
<tr>
<td>live</td>
<td>200 live[version::ok::state]</td>
</tr>
<tr>
<td>Returns the state of live mode. on or off.</td>
<td></td>
</tr>
<tr>
<td>enable alarms</td>
<td>200 enable alarms[version::ok]</td>
</tr>
<tr>
<td>Command</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Enable all alarms.</td>
<td></td>
</tr>
<tr>
<td>disable alarms</td>
<td>200 disable alarms[version::ok]</td>
</tr>
<tr>
<td>Disable all alarms.</td>
<td></td>
</tr>
<tr>
<td>load setup [setup_name.ig]</td>
<td>200 load setup[version::ok]</td>
</tr>
<tr>
<td>Load the setup file (.ig) specified as parameter.</td>
<td></td>
</tr>
<tr>
<td>reset</td>
<td>200 reset[version::ok]</td>
</tr>
<tr>
<td>Resets all measures taken by the machine so far.</td>
<td></td>
</tr>
<tr>
<td>start production [operator::production notes::optional_file_name.prd]</td>
<td>200 start production[version::ok]</td>
</tr>
<tr>
<td>Saves a production file. If no file name is given, a default file name will be used.</td>
<td></td>
</tr>
<tr>
<td>head temperature</td>
<td>200 head temperature[version::ok::value]</td>
</tr>
<tr>
<td>Returns the current head temperature.</td>
<td></td>
</tr>
<tr>
<td>historical low head temperature</td>
<td>200 historical low head temperature[version::ok::value]</td>
</tr>
<tr>
<td>Returns the lowest head temperature measured since the last Reset.</td>
<td></td>
</tr>
<tr>
<td>historical high head temperature</td>
<td>200 historical high head temperature[version::ok::value]</td>
</tr>
<tr>
<td>Returns the highest head temperature measured since the last Reset.</td>
<td></td>
</tr>
<tr>
<td>velocity</td>
<td>200 velocity[version::ok::value]</td>
</tr>
<tr>
<td>Returns the current velocity.</td>
<td></td>
</tr>
<tr>
<td>historical low velocity</td>
<td>200 historical low velocity[version::ok::value]</td>
</tr>
<tr>
<td>Returns the lowest velocity measured since the last Reset.</td>
<td></td>
</tr>
<tr>
<td>historical high velocity</td>
<td>200 historical high velocity[version::ok::value]</td>
</tr>
<tr>
<td>Returns the highest velocity measured since the last Reset.</td>
<td></td>
</tr>
<tr>
<td>correlation</td>
<td>200 correlation[version::ok::value]</td>
</tr>
<tr>
<td>Returns the current correlation.</td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>historical low correlation</td>
<td>Returns the lowest correlation measured since the last Reset.</td>
</tr>
<tr>
<td>historical high correlation</td>
<td>Returns the highest correlation measured since the last Reset.</td>
</tr>
<tr>
<td>clear stripcharts</td>
<td>Clears the stripcharts</td>
</tr>
<tr>
<td>start stripcharts recording [filename.str]</td>
<td>Start recording stripchart data to the a the specified file.</td>
</tr>
<tr>
<td>stop stripcharts recording</td>
<td>Stops the recording of stripcharts.</td>
</tr>
<tr>
<td>clear output N</td>
<td></td>
</tr>
<tr>
<td>read inputs</td>
<td></td>
</tr>
<tr>
<td>set output N</td>
<td></td>
</tr>
<tr>
<td>saturation</td>
<td>Returns the current signal saturation level.</td>
</tr>
<tr>
<td>weak signal</td>
<td>Returns the current signal weakness.</td>
</tr>
<tr>
<td>get station active</td>
<td>Returns Yes if the station currently connected to is active, otherwise returns No.</td>
</tr>
<tr>
<td>set station active</td>
<td>Sets the currently connected station as active.</td>
</tr>
<tr>
<td>plume position</td>
<td>Returns the current plume position.</td>
</tr>
<tr>
<td>historical low plume position</td>
<td>Returns the lowest plume position recorded since</td>
</tr>
</tbody>
</table>

```plaintext
200 historical low correlation[version::ok::value]
200 historical high correlation[version::ok::value]
200 clear stripcharts[version::ok]
200 start stripcharts recording[version::ok]
200 stop stripcharts recording[version::ok]
200 clear output N[version::ok]
200 read inputs[version::ok::value]
200 set output n[version::ok]
200 saturation[version::ok::value]
200 weak signal[version::ok::value]
200 get station active[version::ok::value]
200 set station active[version::ok]
200 plume intensity[version::ok::value]
200 historical low plume position[version::ok::value]
```
<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>historical high plume position</td>
<td>Returns the highest plume position recorded since the last Reset.</td>
</tr>
<tr>
<td>plume width</td>
<td>Returns the current plume width.</td>
</tr>
<tr>
<td>historical low plume width</td>
<td>Returns the lowest plume width recorded since the last Reset.</td>
</tr>
<tr>
<td>historical high plume width</td>
<td>Returns the highest plume width recorded since the last Reset.</td>
</tr>
<tr>
<td>plume height</td>
<td>Returns the current plume height.</td>
</tr>
<tr>
<td>historical low plume height</td>
<td>Returns the lowest plume height recorded since the last Reset.</td>
</tr>
<tr>
<td>historical high plume height</td>
<td>Returns the highest plume height recorded since the last Reset.</td>
</tr>
<tr>
<td>plume intensity</td>
<td>Returns the current plume intensity.</td>
</tr>
<tr>
<td>historical low plume intensity</td>
<td>Returns the lowest plume intensity measured since the last Reset.</td>
</tr>
<tr>
<td>historical high plume intensity</td>
<td>Returns the highest plume intensity measured since the last Reset.</td>
</tr>
<tr>
<td>substrate temperature</td>
<td>Returns the current substrate temperature.</td>
</tr>
<tr>
<td><strong>historical low substrate temperature</strong></td>
<td>200 historical low substrate temperature[version::ok::value]</td>
</tr>
<tr>
<td><strong>historical high substrate temperature</strong></td>
<td>200 historical high substrate temperature[version::ok::value]</td>
</tr>
<tr>
<td><strong>temperature</strong></td>
<td>200 temperature[version::ok::value]</td>
</tr>
<tr>
<td><strong>historical low temperature</strong></td>
<td>200 historical low temperature[version::ok::value]</td>
</tr>
<tr>
<td><strong>historical high temperature</strong></td>
<td>200 historical high temperature[version::ok::value]</td>
</tr>
</tbody>
</table>

--- On Error ---
command[version::Error::error number::error description]

--- On Alarm ---
alarm[version::ok::alarms number list(comma separated)::alarms description list(comma separated)]

--- On invalid command ---
Unknown command
STREAMING MODE

PC IP
Default Port: Station A: Port 555 / Station B: Port 556

Setup Requirements
The subnet mask of the Ethernet connection used for the streaming mode should be 255.255.255.0 in order to avoid the collisions with the IP addresses used within the G3C system.

Commands
SPRAYON = Start streaming
SPRAYOFF = Stop streaming

Result example:

11:04:09;658.58;366.54;1944.24;190.52;0.29;0.00;0.24;0.17;16
53.0;0.20

Hour; Velocity; STD Velocity; Temperature; STD Temperature; Intensity; STD Intensity; Peak Position; STD Peak Position; Substrate Temp; STD Substrate Temp
<table>
<thead>
<tr>
<th><strong>Glossary / Acronyms</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CCD camera</strong></td>
<td>Semi-conductor camera comprising a barrier diode matrix that accumulates an amount of electrons proportional to the amount of received photons. The built image is then shifted one line at a time to an output register and an amplifier.</td>
</tr>
<tr>
<td><strong>Correlation value</strong></td>
<td>Indicative of the degree of similarity between 2 signals</td>
</tr>
<tr>
<td><strong>CPU</strong></td>
<td>Central processing unit</td>
</tr>
<tr>
<td><strong>Cross-correlation</strong></td>
<td>Method used to determine precisely the average time shift between 2 signals</td>
</tr>
<tr>
<td><strong>Ethernet (protocol)</strong></td>
<td>A family of frame-based computer networking technologies for local area networks</td>
</tr>
<tr>
<td><strong>Giga Ethernet (protocol)</strong></td>
<td>New version of the Ethernet protocol with a rate up to 1Gbits/s within a local area network</td>
</tr>
<tr>
<td><strong>GUI</strong></td>
<td>Graphical user interface</td>
</tr>
<tr>
<td><strong>Popup window</strong></td>
<td>Window appearing inside another one without user intervention, in order to question or notify the user regarding the current situation</td>
</tr>
<tr>
<td><strong>Pyrometer</strong></td>
<td>Contactless temperature measuring device</td>
</tr>
<tr>
<td><strong>RMS value</strong></td>
<td>That is to say, the square root of the mean of the squares of the time equidistant instantaneous values during one complete period</td>
</tr>
<tr>
<td><strong>TCP/IP</strong></td>
<td>Delivery (TCP) and transport (IP) of data packages</td>
</tr>
<tr>
<td><strong>Root-mean-square value</strong></td>
<td></td>
</tr>
</tbody>
</table>
DESCRIPTION OF FIGURES

- Figure 1 is a drawing showing the main product components
- Figure 2 is a drawing showing a front and a rear view of the controller
- Figure 3 is a drawing illustrating the sensor head connections
- Figure 4 is a drawing illustrating the sensor head window
- Figure 5 is a drawing illustrating the sensor head function
- Figure 6 is a chart illustrating the substrate temperature sensor behaviour
- Figure 7 is a block diagram illustrating the data flow within the product's architecture
- Figure 8 is a drawing illustrating the sensor head dimensions
- Figure 9 is a drawing illustrating the controller dimensions
- Figure 10 is a drawing illustrating the product's installation process
- Figure 11 is a drawing illustrating the product's installation process
- Figure 12 is a drawing illustrating the sensor head's window removal for maintenance
- Figure 13 is a view of the main screen during normal operation (video frame)
- Figure 14 is a view of the main screen during normal operation (plume profile graph)
- Figure 15 is a view of the main screen during normal operation (strip chart)
- Figure 16 is a view of the graphical interface's menus
- Figure 17 is a view showing the minimum and maximum adjustment panel
Figure 18 is a schematic illustrating the alarm output’s loads

Figure 19 is a view illustrating the alarm settings panel

Figure 20 is a view illustrating the application settings panel

Figure 21 is a view illustrating the reaction time setting sliding cursor

Figure 22 is a view illustrating the scope signals panel
### QUICK TROUBLE-SHOOTING

<table>
<thead>
<tr>
<th>Problem</th>
<th>Potential cause</th>
<th>Remedy</th>
</tr>
</thead>
</table>
| Temperature or INTENSITY suddenly seem significantly different than the typical results for a given process | • Process really changed  
• Disposable protective windows are dirty or frosty | • Your responsibility!  
• Clean or replace the windows assembly with clean air and iso-propanol |
| Only temperature seems significantly different than usual | • Head is due for recalibration | • Contact TECNAR or your local Sulzer Metco representative |

*Accuraspray-G3C is a new product, therefore the trouble-shooting section will evolve over time.*
SERVICE & SUPPORT
Below are the points of contact for questions and/or service-support on Accuraspray/PlumeSpector-g3 & G3C systems.

TECNAR Automation Ltd (The original manufacturer)
1321, Hocquart Street,
St-Bruno, Qc, Canada, J3V 6B5
Phone: 450-461-1221
Fax: 450-461-0808

Contact names (please contact in the following order):
Mr. Bruno Paradis, Thermal Spray Service technician (phone ext 251, bparadis@tecnar.com)
Mr. Dominic Larrivee, Thermal spray production floor supervisor (phone ext 240, dlarrivee@tecnar.com)
Mr. Olivier Jolicoeur, Director of LUT & Thermal Spray operations (phone ext 236, ojolicoeur@tecnar.com)
Mr. Luc Pouliot, Vice-President Operations (phone ext 235, lpouliot@tecnar.com)