

Chapter 3:

Commands and Programming

This chapter describes how to set up the data analyzer and control it using commands sent from a connected CFX-9850G or CFX-9800G graphic scientific calculator.

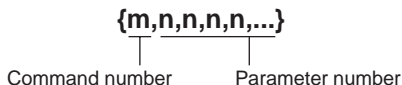
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Command Conventions and Formats

Commands sent from a connected CFX-9850G or CFX-9800G graphic scientific calculator can be used to make various settings and control operations of the data analyzer.

Commands

Commands can be written as CFX-9850G list data or CFX-9800G matrix data in the format shown below.



There are a total of 10 commands numbered from 0 through 9. The following describes the function of each command.



- Note that execution of the commands marked with asterisks (0, 1, 3) causes all data sampled up to that point to be deleted.

Number	Description
0*	All Clear This command initializes all channels.
1*	CHANNEL SETUP This command sets up a channel for data sampling.
2	DATA TYPE AND DISPLAY SETUP This command specifies the data type when transferring data from a connected calculator.
3*	SAMPLE AND TRIGGER SETUP This command controls data sampling timing and sets up trigger parameters.
4	CONVERSION EQUATION SETUP This command sets up parameters for converting measured data to another unit.
5	DATA RANGE SETUP This command specifies the data type (raw sample data, first derivative, second derivative) when transferring data to a connected calculator. It also specifies the start point and end point of the data being recalled.

Number	Description
6	MULTIMETER MODE SETUP This command sets the Multimeter Mode unit of measurement for a particular channel.
7	REQUEST STATUS This command creates a data list concerning the data analyzer's current status (error status, probe connection data, etc.) being requested by the connected calculator.
8	SAMPLING START This command causes the data analyzer to start sampling immediately.
9	PROBE CALIBRATE This command calibrates probe sampling values and is used to calibrate sampling levels when multiple probes are being used.

Initial Settings

The standard syntax for a command is {1,n,n,n,n,...}, where "n" indicates a parameter. Command parameters are automatically set to their initial defaults whenever any of the following occurs.

- When a parameter is not specified inside a command.
- Whenever an Auto-ID operation is performed.
- Whenever the data analyzer is put into the READY state by operation of the [RESTART] key.
- Whenever you exit the Setup Mode after changing settings, and the data analyzer enters the READY state.

You can find information about the initial defaults for each command in the Command Reference.



Programming

Programs can be input on the CFX-9850G graphic scientific calculator and then sent to the data analyzer to make it perform a series of tasks.



- Note that data analyzer control programs can be input on the CFX-9850G graphic scientific calculator only. The CFX-9800G can be used to send commands one-by-one.

Tasks Normally Controlled by Programs

The following outline describes the normal sequence of a data analyzer system control program.

1. Command 0 (ALL CLEAR) or Command 1 (CHANNEL SETUP, setting the channel parameter to 0)

Either of these commands is used to reset all channels and clear any sampled data currently in data analyzer memory.

2. Command 1 (CHANNEL SETUP)

This command is used to perform channel setup and specify the type of data to be sampled.

3. Command 2 (DATA TYPE/DISPLAY SETUP)

This command is used when necessary to specify special data type.

4. Command 4 (CONVERSION EQUATION SETUP)

This command is used when necessary to specify a conversion equation.

5. Command 9 (PROBE CALIBRATE)

This command is used when necessary to calibrate the probe.

6. Command 3 (SAMPLE AND TRIGGER SETUP)

This command specifies such sampling parameters as sampling duration, number of samples, time recording, etc. The data analyzer interprets receipt of Command 3 as being the end of the setup routine, and expects sampling to begin next.

Whenever using Command 3, be sure to also include a display halt command (▲). This causes the calculator to wait until the data analyzer finishes its sampling operation before continuing with program execution.

————— Sampling operation with data analyzer

7. Command 5 (DATA RANGE SETUP)

This command is used when necessary to specify the range of data to be transferred from the data analyzer to the CFX-9850G.

8. Data transfer from the data analyzer to the CFX-9850G

Though the actual tasks included in a program will differ according to the type of sampling being performed, tasks 1, 2, 6, and 8 in the above outline should be included in all programs.

Example Program

The following is an example program written for the CFX-9850G.

Cls ↵	CFX-9850G graph clear operation
{1,0} → List 6 ↵ Send(List 6) ↵	Clears all channel settings and data.
{1,1,1} → List 6 ↵ Send(List 6) ↵	Specifies sampling with Auto-ID probe connected to CH1.
{3,0.5,100,1} → List 6 ↵ Send(List 6) ▲	Specifies sample time of 0.5 seconds, 100 samples, and absolute time recording on. Note the use of the display halt command (▲), which causes the calculator to wait until the data analyzer finishes its sampling operation before continuing with program execution. Always use the display halt command (▲) with Command 3.
Receive(List 1) ↵	Transfers time data to List 1.
Receive(List 2) ↵	Transfers CH1 data to List 2.
S-Gph1 DrawOn,Scatter, List1,List2,1,Dot, Blue ↵	Sets up CFX-9850G statistical graph.
S-Gph2 DrawOff ↵ S-Gph3 DrawOff ↵	Turns off statistical graphs that are not being used.
DrawStat	Draws statistical graph on CFX-9850G.

Sending Commands from a Calculator to the Data Analyzer

This section explains how to send individual command from a graphic scientific calculator to the data analyzer. Note that the procedure you should use depends on whether you are using a CFX-9850G or a CFX-9800G calculator.

Sending List Data with the CFX-9850G “Send(” Command

Use the CFX-9850G calculator’s Send(List) command to send list data to the data analyzer, which executes commands in accordance with the contents of

the list. When using the Send(List) command, you should specify the list that contains the commands by replacing "List" with a CFX-9850G List variable (List 1 through List 6).



- Sending a new setup command (Command 1 or Command 3) clears all previously sampled data from data analyzer memory.

To input the "Send(" command on the CFX-9850G

1. In the CFX-9850G PRGM EDIT Mode, press [SHIFT] [PRGM] [F6] (>) [F4] (I/O) [F3] (Send) to input the Send(command at the current cursor position.
2. Press [OPTN] [F1] (LIST) [F1] (List) [1] to input List 1. You can input any value from 1 through 6 in place of [1] to specify List 1 through 6.

Send(List) Examples

The following shows two samples using the Send(List) command.

{1,2,2,1} → List 2
Send(List 2)

{3,0.2,100} → List 3
Send(List 3)



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For full details about using commands to control the data analyzer, see "Command Reference".

Sending Matrix Data with the CFX-9800G LINK Mode

Use the CFX-9800G calculator's LINK Mode to send matrix data to the data analyzer. Note that the matrix you use for this purpose must have only one column.



- Sending a new setup command (Command 1 or Command 3) clears all previously sampled data from data analyzer memory.



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To send matrix data from the CFX-9800G

1. Check to make sure that the data analyzer and the CFX-9800G are connected properly.
 2. Turn on the data analyzer.
 3. On the CFX-9800G, press [B] (LINK) to enter the Data Communication Mode.
 4. Press [F1] (TRN) [▼] [▼] [▼] [▼] [EXE] [F2] (ONE) to display all of the matrix data currently stored in memory.
 5. Use [▲] and [▼] to scroll through the data and select the matrix that contains the command you want to send.
 6. Press [EXE] to send the data.
- The data analyzer receives the matrix data and executes setup commands accordingly.

- Repeat steps 5 and 6 as many times as necessary to send any other matrix data that you want.

Matrix Data Example

The following describes a typical example procedure for sending commands that set up the data analyzer for sampling of distance data with a distance sensor.

- Input the following matrix data on the CFX-9800G.

$\begin{bmatrix} 1 \\ 0 \end{bmatrix}$	Channel clear
--	---------------

$\begin{bmatrix} 1 \\ 4 \\ 2 \end{bmatrix}$	Command 1 Channel: SONIC Unit: meters
---	---

$\begin{bmatrix} 3 \\ 0.5 \\ 20 \\ 1 \end{bmatrix}$	Command 3 Sampling duration: 0.5 second Number of samples: 20 Absolute time recording: On
---	--

- Now perform the steps under "To send matrix data from the CFX-9800G" above to send the matrix to the data analyzer. Note that the final matrix data sent to the data analyzer before the start of sampling must be Command 3 (SAMPLE AND TRIGGER SETUP).
- Press the data analyzer's [TRIGGER] key to start data sampling.
- The DONE indicator appears on the display when data sampling is complete. See "Transferring Data to the CFX-9800G" for details on transferring sampled data from the data analyzer to the CFX-9800G.

Transferring Sampled Data to a Calculator

This section explains how to send sampled data between the data analyzer and a connected CFX-9850G or CFX-9800G graphic scientific calculator for graphing and analysis.

Transferring Data to the CFX-9850G

The following explanations all apply to transferring data from the data analyzer to the CFX-9850G only.

To use the “Receive(” command to fetch data

1. Connect the data analyzer to the CFX-9850G.
 2. On the CFX-9850G, perform the following key sequence to execute the Receive(command: [SHIFT] [PRGM] [F6] (▷) [F4] (I/O) [F4] (Recv).
- Execution of the Receive(command on the calculator starts transfer of data from the data analyzer.
 - The sampled data is stored in calculator memory in accordance with the parameter you specify (variable, list or matrix) with the Receive(command.
 - Further data transfer stops if CFX-9850G memory becomes full during execution of the Receive(command. See the documentation that comes with the CFX-9850G for details on what to do when memory becomes full.



Each execution of a Receive(List) command recalls one data group only. CH1 original sampled data, CH1 d/dt , and CH1 d^2/dt^2 are each one data group.

Post-processing Off

Only the raw sample data is transferred by the Receive(command when post-processing is turned off with CHANNEL SETUP (Command 1). Data items are recalled in the following sequence.

RecTIME→CH1→CH2→CH3→SONIC→DIG IN→RecTIME→....

Post-processing On

When post-processing is turned on with CHANNEL SETUP (Command 1), the data produced by the post-processing is sent following the raw sample data. Data items are recalled in the following sequence (when a: raw sample data, b: d/dt , c: d^2/dt^2).

RecTIME→CH1 a→CH1 b→CH1 c→CH2 a→CH2 b→CH2 c→CH3 a→CH3 b→CH3 c→SONIC a→SONIC b→SONIC c→DIG IN→RecTIME→....



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- Note that the data transferred by a Receive(List) command execution is somewhat different when statistical post-processed data is involved. See “Using Receive(List) to Fetch Statistical Post-Processed Data”.

The following are detailed explanations of how the Receive(command works with each type of parameter that can be specified with it.

Receive(Variable)

This format assigns received data to a variable. Variable names A through Z, r, and θ can be used for storage of data. When more than one sample data item is involved, each execution of Receive(returns the last data item sampled (or calculated) from the active channel. This format is normally used for data obtained by real-time sampling.



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Receive(List n)

This format can be used to specify one of six lists (List 1 through List 6) for storage of up to 255 data points.



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Receive(Mat n)

This format specifies a matrix (Mat A through Mat Z) for storage of up to 14 rows of data samples.



- Data can be transferred from the data analyzer as many times as you like, until it is deleted by Command 0, Command 1 or Command 3.

Sample Program Using Receive(Variable)

The following program fetches up to 30 sample data items and assigns them to CFX-9850G variables.

{3,1,-1} → List 6

Send(List 6)

Specifies sample time of one second for real-time sampling.

For 1 → I To 30

Sets up a loop that repeats 30 times by sequentially assigning values from 1 to 30 to variable I.

Receive(A)

PlotOn I,A

Next

Sequentially recalls sample data and displays it in a graph.

Text 2,10,"TEMP."

Text 55,100,"TIME" ▲

{0} → List 6

Send(List 6)

Sends the CLEAR command (Command 0) and exits real-time sampling.

Sample Operation Using Receive(List)

The following program fetches sampled data items and assigns them to CFX-9850G list variables.

Receive(List 1) Fetches up to 255 data items from the lowest numbered channel*, and stores them in List 1.

Receive(List 2) Fetches up to 255 data items starting from the next active channel, and stores them in List 2.

* The lowest numbered channel available in the following sequence:
RecTIME→CH1→CH2→CH3→SONIC→DIG IN

Fetching Data Using Receive(Matrix)

Transferring data to a matrix is a bit different from other data transfer operations. The Receive(Mat n) command causes up to 255 sample data items for all active channels (or RecTIME) to be returned to the matrix specified by the command. The number of data items transferred to the calculator depends on the amount of memory available on the calculator. The number of rows in the matrix matches the number of active channels (RecTIME is counted as one channel when it is selected) where the data (including post-processed data) is stored.

Sample Operation Using Receive(Matrix)

The following program fetches CH1 and CH2 sampled data and assigns them to a CFX-9850G matrix.

Receive(Mat A) Fetches up to 255 data items from each active channel (CH1 and CH2 in this example), and stores them in matrix Mat A, whose dimensions are 2×255 . CH1 data is stored in Row 1, while CH2 data is stored in Row 2.

Using Receive(List) to Fetch Sampled Data and Post-Processing Data

This example provided in this section performs the following calculations.

- First derivative of data sampled by CH1
- Second derivative of data sampled by SONIC channel

The following data is transferred to the CFX-9850G.

- All CH1 data (raw sample data and first derivative)
- Post-processed SONIC channel data (second derivative only)

In this example, a total of 300 samples are taken with CH1 and the SONIC channel, and all other channels are inactive. Post-processing is turned on,



with the first derivative calculated for CH1 sample data, and the second derivative calculated for the SONIC channel.

DATA RANGE SETUP parameters (Command 5) can be used to specify the data groups and data range to be transferred to the CFX-9850G. This command comes in handy when you want to fetch only specific data items, or when there are more than 255 data items in data analyzer memory. Note that executing the Receive(List n) command without using Command 5 to specify a data range when there are more than 255 data items causes an error on the calculator because the number of data items that can be assigned to a list is limited to 255.



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- Whenever you are fetching post-processed data, you must use CHANNEL SETUP (Command 1) to set the post-processed sample parameter to 1 (d/dt), 2 (d/dt or d^2/dt^2) or 3 (STAT). Note also that the DATA RANGE SETUP (Command 5) Data Select parameter must match the specification you make here.

Sample Operation Using Receive(List) to Fetch Sampled Data and Post-Processed Data

The following program fetches sampled data and post-processed data to a CFX-9850G list.

{5,1,0,1,255}→List 6 Send(List 6) Receive(List 1)	Fetches CH1 data samples (1 to 255).
Receive(List 2)	Fetches d/dt for CH1 (1 to 255).
{5,4,2,1,255}→List 3 Send(List 3)	Sends DATA RANGE SETUP Command (Command 5) to specify SONIC and second derivative data to data analyzer.
Receive(List 3)	Fetches SONIC d^2/dt^2 (1 to 255).
{5,1,0,256,300}→ List 4 Send(List 4)	Sends DATA RANGE SETUP command to data analyzer: CH1 (256 to 300).
Receive(List 4)	Fetches CH1 data samples (256 to 300).
Receive(List 5)	Fetches d/dt for CH1 (256 to 300).
{5,4,2,256,300}→ List 6 Send(List 6)	Sends DATA RANGE SETUP command to data analyzer: SONIC d^2/dt^2 (256 to 300).
Receive(List 6)	Fetches SONIC d^2/dt^2 (256 to 300).

Two Receive(List) cycles are required in this example because there are more than 255 samples. Following the first two Receive(List) commands, a single Send(List) is necessary to verify the data fetches from the SONIC channel. The next Send(List) command specifies the data range of Receive(List4) and Receive(List5). The following shows how data is stored in the different lists after execution of this program is complete.

List 1 CH1 data samples (1 to 255)

List 4 CH1 data samples (256 to 300)

List 2 CH1 sample post-processing data d/dt (1 to 255)

List 5 CH1 sample post-processing data d/dt (256 to 300)

List 3 SONIC channel sample post-processing data d^2/dt^2
(1 to 255)

List 6 SONIC channel sample post-processing data d^2/dt^2
(256 to 300)

Using Receive(List) to Fetch Statistical Post-Processed Data

When statistical post-processing is specified as the post-processing type, only one channel can be active for output of statistic post-processed data only from the data analyzer (raw sample data is deleted).

Four executions of the Receive(List) command are required to fetch statistical data, one each for the mean, standard deviation, minimum value, and maximum value, all of which are produced based on the raw sample data.

If CH1 is reserved for statistical data, for example, the following commands would be required to fetch statistical data and store it in a CFX-9850G list.

Receive (List 1)	CH1 mean data
Receive (List 2)	CH1 standard deviation data
Receive (List 3)	CH1 minimum value data
Receive (List 4)	CH1 maximum value data



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Using Receive(to Fetch Time Data

Either relative or absolute time data recording can be specified with the time recording parameter of the SAMPLE AND TRIGGER SETUP (Command 3). Specifying 1 (absolute time on) or 2 (relative time on) records time data in seconds whenever data is being sampled.

Let's say, for example that we want to sample temperature data with only CH1 is active, and the time recording parameter set to 1 (absolute time on). The following command fetches the sampled data and the recorded time data and stores them into a CFX-9850G matrix.

Receive (Mat A) Fetches up to 255 items consisting of time data and CH1 data and stores them in matrix MatA, which measures 2×255 .

Matrix Mat A data includes recorded time data in row 1 and the sampled data in row 2.



- If you save the above data to another type of variable besides a matrix, you will have to execute two Receive(commands: one for the time data and one for the sample data.

Transferring Data to the CFX-9800G

You can transfer data from the data analyzer to a connected CFX-9800G using the LINK Mode of both units. Data is sent to the CFX-9800G in REG format.

To transfer data to the CFX-9800G

1. Sample data using the data analyzer.
2. On the CFX-9800G, press [B] to enter the Data Communications Mode.
3. Use the following key operation to enter receive standby: [F2] (RCV) [▼] [▼] [▼] [▼] [EXE] [F2] (REG).
4. On the data analyzer, press [SHIFT] [XMIT-9800] to start sending data to the CFX-9800G.
 - Sampled data is sent to the CFX-9800G as REG data, and stored as REG X/Y data. Even when there are more than two channels with sample data, Command 2 sends only the data for the two specified channels.
 - The message "COMMUNICATION COMPLETE" appears on the screen of the CFX-9800G after data transfer is complete.

Example CFX-9800G Operation Following Data Transfer

1. Enter the REG Mode.
2. Press [SHIFT] [SETUP] to enter the Setup Mode, and then set the following parameters.

S-data: STO

S-graph: DRAW

3. Use [Range] to specify the graph screen range (window) in accordance with the sampled data.
 4. Use the following key sequence to clear any existing statistical data: [SHIFT] [CLR] [F2] (Sci) [EXE].
 5. Press [F6] (CAL) to recalculate the statistical data and plot the data.
 6. Perform the following key operation to draw a regression graph: [Graph] [SHIFT] [F4] (LIN) [1] [EXE].
- Try repeating the above procedure with different REG settings in the Setup Mode until you find the setup that produces the type of regression graph you want.

Command Reference

This section provides full details on the syntax and all of the parameters of each of the 10 available commands.

Command 0 - All Clear

Command 0 clears all previously stored data and returns all channels to their initial defaults.

Syntax

{0}

Description

Command 0 sends the following instructions to the data analyzer.

- Turn off all channel indicators.
- Clear all data.
- Clear all conversion equations and turn off the EQ indicator.



- If an Auto-ID probe is connected to the data analyzer, the data analyzer also initializes the connected probe when Command 0 is received.

Command 1 - CHANNEL SETUP

Command 1 specifies various parameters for a channel where a probe is connected. Executing Command 1 clears all sampled data currently stored in data analyzer memory. Clears all previously stored data and returns all channels to their initial defaults.

Syntax

{1, Channel, Operation, Post-processing, Stat Samples, Trigger Threshold, Trigger Edge}

The following syntax is used for DIG OUT:

{1, 6, Number of Data Elements, Data Elements}



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A number of examples using the Command 1 can be found under "Channel Setting Example".

Channel Parameter

This parameter specifies the channel to be used for data sampling. The initial default for this parameter is 1.



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- | | |
|---|--|
| 0 | Clears all channels.
See "Channel Clear" for details. |
| 1 | Channel 1 (CH1 - analog channel) |
| 2 | Channel 2 (CH2 - analog channel) |
| 3 | Channel 3 (CH3 - analog channel) |
| 4 | Channel 4 (SONIC channel) |
| 5 | Channel 5 (digital input channel) |
| 6 | Channel 6 (digital output channel) |



- The meanings and settings of other parameters depend on the type of channel specified by the channel parameter. The following sections describe the parameter settings for each channel type.

Channel 1, 2, 3 (Analog)

The following parameter settings apply only when Channel 1 (CH1), Channel 2 (CH2), or Channel 3 (CH3) is specified by the Command 1 channel parameter.

Operation Parameter

This parameter specifies the type of data to be sampled by the selected channel. The initial default for this parameter is 1.



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- | | |
|---|--|
| 0 | Clears the selected channel.
See "Channel Clear" for details. |
|---|--|



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- 1 Auto-ID
If Auto-ID is not activated, voltage in the range 0 to 5V is used.
- 2 Voltage ($\pm 10V$)
- 3 Current ($\pm 10A$)
Based on V_{in} input, $1V = 1A$.
- 4 Resistance (1k Ω to 100k Ω)
- 5 Period (0.000004 to 50 seconds)
See "Period and Frequency Measurement" in Appendix A.
- 6 Frequency (0.02Hz to 250kHz)
See "Period and Frequency Measurement" in Appendix A.
- 7 Temperature ($-20^{\circ}C$ to $130^{\circ}C$)
- 8 Temperature ($-4^{\circ}F$ to $266^{\circ}F$)
- 9 Light (100 to 999)
- 10 Voltage (0 to 5V)

Post-Processing Parameter

This parameter specifies the type of post-processing to be applied to sampled data. The initial default for this parameter is 0.

- 0 None (no processing)
- 1 d/dt (first derivative)
Only the d/dt indicator is on the display when this type of post-processing is selected.
- 2 d/dt and d^2/dt^2 (first derivative and second derivative)
The d/dt and d^2/dt^2 indicators are on the display when this type of post-processing is selected.
- 3 Statistics (mean, standard deviation, minimum, maximum)

Derivative and statistical post-processing are performed using values produced by conversion equations.



- Post-processing is disabled whenever the number of samples parameter of Command 3 (SAMPLING/TRIGGER SETUP) is -1 , which specifies real-time display of sampled data.

Stat Samples Parameter

This parameter is used during statistical post-processing to specify how many samples should be used for post-processing. This parameter is valid only when 3 (statistics) is specified for the post-processing parameter. A value from 2 to 512 can be specified for this parameter, and The initial default for this parameter is 10.

Trigger Threshold Parameter

This parameter is used when period (5) or frequency (6) is specified as the operation parameter to set the level at which measurement starts. The initial default for this parameter is 1. A value in the range of -10 to $+10$ can be specified for this parameter to set in input voltage threshold value of $-10V$ to $+10V$.



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- See “Period and Frequency Measurement” in Appendix A.

Trigger Edge Parameter

This parameter is used when period (5) or frequency (6) is specified as the operation parameter to select the edges for measurement. The initial default for this parameter is 0.

- | | |
|---|------------------------------|
| 0 | Rising edge to rising edge |
| 1 | Falling edge to falling edge |
| 2 | Rising edge to falling edge |
| 3 | Falling edge to rising edge |



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- See “Period and Frequency Measurement” in Appendix A.

Channel 4 (SONIC)

The following parameter settings apply only when Channel 4 (SONIC) is specified by the Command 1 channel parameter.

Operation Parameter

This parameter specifies the type of data to be sampled by the SONIC channel. The initial default for this parameter is 1.

- | | |
|---|--|
| 0 | Clears the selected channel.
See “Channel Clear” for details. |
| 1 | Auto-ID
If Auto-ID is not activated, meters is used. |
| 2 | Meters |
| 3 | Feet |



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- Distance is measured based on 343 meters per second for the speed of sound.



Post-Processing Parameter

This parameter specifies the type of post-processing to be applied to sampled data. The initial default for this parameter is 0.

- | | |
|---|---------------------------|
| 0 | None (no processing) |
| 1 | d/dt (first derivative) |

Only the d/dt indicator is on the display when this type of post-processing is selected.

- 2 d/dt and d^2/dt^2 (first derivative and second derivative)

The d/dt and d^2/dt^2 indicators are on the display when this type of post-processing is selected.

- 3 Statistics (mean, standard deviation, minimum, maximum)

Derivative and statistical post-processing are performed using values produced by conversion equations.



- Post-processing is disabled whenever the number of samples parameter of Command 3 (SAMPLING/TRIGGER SETUP) is -1, which specifies real-time display of sampled data.

Stat Samples Parameter

This parameter is used during statistical post-processing to specify how many samples should be used for post-processing. This parameter is valid only when 3 (statistics) is specified for the post-processing parameter. A value from 2 to 512 can be specified for this parameter, and the initial default for this parameter is 10.

Channel 5 (DIG IN)

The following parameter setting applies only when Channel 5 (DIG IN) is specified by the Command 1 channel parameter.

Operation Parameter

This parameter applies to digital input only. When 1 (active) is specified for this parameter, data sampling can be performed from the digital logic circuit. The initial default for this parameter is 1.



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- 0 Clears the digital input channel.

See "Channel Clear" for details.

- 1 Active



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- See "Clock-In Line Operation" for further technical information about this parameter.

Channel 6 (DIG OUT)

The following parameter settings apply only when Channel 6 (DIG OUT) is specified by the Command 1 channel parameter.

Number of Data Elements Parameter

This parameter applies to digital output only. It specifies the number of data elements included in a list. The initial default for this parameter is 1.

- 0 Clears the digital output channel.
See "Channel Clear" for details.
- 1 to 22 Number of output data elements

Data Elements Parameter

This parameter applies to digital output only. It specifies the actual data elements to be output from DIG OUT whenever the trigger conditions defined by Command 3 are satisfied. Output consists of binary numbers that are 4-bit (TTL 0-5 V) representations of each element (i.e. 0 = 0000, 1 = 0001, 2 = 0010, 10 = 1010, 15 = 1111). The initial default for this parameter is 0.

0 to 15 Output data element value

- See "Clock-In Line Operation" and "Digital Output Buffer" for further technical information about this parameter.

Channel Clear

Following are the tasks performed when channel clear is specified for the operation parameter.

- Turns off applicable channel's indicator.
- Turns off applicable channel's conversion equation and turns off its EQ indicator.
- Clears all data items saved on all channels.

Statistical Post-Processing Example

This example assumes that Stats post-processing is selected and that four data samples are collected for each computed Stat point. Command 1 (CHANNEL SETUP) defines four samples per Stat point, while Command 3 (SAMPLE AND TRIGGER SETUP) defines the five Stat points for collection.

The data analyzer collects 20 samples (5 points \times 4 samples), and the data returned to the data analyzer is made up of four lists (mean, standard deviation, minimum, maximum), each of which consists of five elements.

The original raw data is deleted and the calculated statistical data can be retrieved by a calculator.



Stat Point	Raw Data	Post-processing Result			
		\bar{x}	$x\sigma_n$	minX	maxX
1	1.0, 1.2, 1.1, 1.3	1.15	0.11	1.0	1.3
2	2.3, 4.0, 2.6, 3.2	3.03	0.65	2.3	4.0
3	3.5, 2.6, 3.7, 4.8	3.65	0.78	2.6	4.8
4	3.7, 4.2, 4.5, 5.2	4.4	0.54	3.7	5.2
5	4.8, 5.6, 4.3, 5.4	5.03	0.51	4.3	5.6
	↓ Cleared	↓ List1	↓ List2	↓ List3	↓ List4

↓
To CFX-9850G

Channel Setting Example

The following two examples are for analog channels.

{1,4,2} 1 = CHANNEL SETUP
 4 = SONIC
 2 = Meters

{1,1,3,1} 1 = CHANNEL SETUP
 1 = CH1
 3 = Current
 1 = Post-processing (first derivative)

The following two examples are for the digital output channel.

{1,6,1,10} 1 = CHANNEL SETUP
 6 = DIG OUT
 1 = One output data element
 10 = Digital pattern of 1010 for output element

{1,6,5,2,4,6,8,10} 1 = CHANNEL SETUP
 6 = DIG OUT
 5 = Five output data elements
 2,4,6,8,10 = Digital pattern of 0010, 0100, 0110,
 1000, 1010 for output element

Command 2 - DATA TYPE AND DISPLAY SETUP

Command 2 specifies the data type for data sent to a connected graphic scientific calculator. It is also used to specify whether or not channel data should be displayed during sampling.

Syntax

{2, Data Display CH, Data Type, REG X Data, REG Y Data, X-Data Post-Processing, Y-Data Post-Processing}

Data Display CH Parameter

This parameter specifies the channel whose data should be displayed on the data analyzer in the READY state or while sampling is in progress. The data display frequency during sampling is in accordance with the sampling time specified using Command 3. For details, see "Sample Time Parameter".

The initial default for this parameter is 0.

- This function is valid for sample times of 0.2 second or greater.

- | | |
|---|--|
| 0 | Data display for lowest numbered channel |
| 1 | Channel 1 (CH1) data |
| 2 | Channel 2 (CH2) data |
| 3 | Channel 3 (CH3) data |
| 4 | SONIC Channel data |
| 5 | DIG IN Channel data |

Data Type Parameter

This parameter specifies REG data format for the type of data being transferred to a connected graphic scientific calculator.

- | | | |
|---|------------------------|--|
| 0 | No data type specified | This setting is used when transferring data to a calculator list or matrix. |
| 1 | REG data | This specification is used when transferring sampled data to the calculator as REG data. This setting is for CFX-9800G only. |

- 1 can be specified for the data type parameter only when using the [XMIT-9800] key ([SHIFT] [INTERNAL]) to transfer data to a CFX-9800G.



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Data Type 1 (REG)

The following are the parameter settings when the data type parameter setting is 1: REG X data, REG Y data, X-data post-processing, Y-data post-processing.

REG X Data Parameter

This parameter specifies which channel should be assigned as REG X data. The initial default for this parameter is 0.

- 0 Highest channel of data send order
- 1 Channel 1 (CH1) data
- 2 Channel 2 (CH2) data
- 3 Channel 3 (CH3) data
- 4 SONIC channel data
- 5 Recorded time data



- Whenever REG X data is 5, you also have to use Command 3 to turn on time data recording.

REG Y Data Parameter

This parameter specifies which channel should be assigned as REG Y data. The initial default for this parameter is 0.

- 0 Second channel of data send order
- 1 Channel 1 (CH1) data
- 2 Channel 2 (CH2) data
- 3 Channel 3 (CH3) data
- 4 SONIC channel data
- 5 DIG IN channel data

X-Data Post-Processing Parameter

This parameter specifies the type of post-processing to be applied to data output as REG X data. The initial default for this parameter is 0.

- 0 None (raw data)
- 1 d/dt (first derivative)
- 2 d^2/dt^2 (second derivative)

Y-Data Post-Processing Parameter

This parameter specifies the type of post-processing to be applied to data output as REG Y data. The initial default for this parameter is 0.

- 0 None (raw data)

- 1 d/dt (first derivative)
- 2 d^2/dt^2 (second derivative)



- Whenever 1 (first derivative) or 2 (second derivative) is specified for this parameter, you must also use Command 1 to specify the same setting for post-processing.

DATA TYPE AND DISPLAY SETUP Example

{2,1}	2 = DATA TYPE AND DISPLAY SETUP 1 = CH1 data display
{2,0,1,5,1}	2 = DATA TYPE AND DISPLAY SETUP 0 = Lowest numbered active channel data 1 = REG data 5 = Set time data as REG X data 1 = Set CH1 data as REG Y data

Command 3 - SAMPLE AND TRIGGER SETUP

Command 3 specifies sampling duration, when to start sampling (trigger), and whether or not to record time data. Executing Command 3 clears any data currently in data analyzer memory, and puts the data analyzer into the READY state.

Syntax

{3, Sample Time, Number of Samples, Record Time, Trigger Source, Trigger Threshold, Trigger Edge, Clock Source, Clock Threshold, Clock Edge, Prestore Data%, Filter}



- Make sure that Command 3 always is the last command sent to the data analyzer before sampling starts.



- When controlling the data analyzer with a CFX-9850G, be sure to always insert a display halt command (▲) following the Send(command. This tells the CFX-9850G to pause until sampling by the data analyzer is finished, and ensures smooth data communications. Once sampling is finished, pressing [EXE] on the data analyzer restarts the program. If the CFX-9850G is left for more than 60 minutes without performing any key operation, its Auto Power Off function will activate, turning off CFX-9850G power.

Sample Time Parameter

This parameter specifies how long sampling should be performed in seconds. Setting 0.001 for this parameter specifies that sampling should be performed for 1 millisecond. The initial default for this parameter is 0.5.

0.001 to
16000 Number of seconds



- Set the sample time to 0.5 whenever an external clock is specified as the clock source.
- Actual sampling time resolution is as shown below, which means that it does not necessarily match the setting value exactly.

Sampling Time \leq 2 seconds : 3.2 μ s

Sampling Time > 2 seconds : 3.2768ms

Also note that sampling over multiple channels, recording of time data, and other settings also may make it impossible for the data analyzer to perform sampling according to the sampling time setting.

Number of Samples Parameter

This parameter specifies the number of samples. The initial default for this parameter is 20.

1 to 512 Number of samples

-1 Continuous data sampling using CFX-9850G Receive(command

This value is necessary for real-time data sampling.

Once real-time sampling is started, it can be interrupted by sending a clear command from the calculator or by pressing the data analyzer's [HALT] key.



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The following points apply whenever -1 is specified for the number of samples parameter for continuous data sampling.

- Only one channel can be active.
- Post-processing cannot be performed.
- Time data recording cannot be performed.
- Data filtering cannot be performed.
- The clock source parameter can only be set to 0 (TIMER) or 1 ([TRIGGER] key).

Time Recording Parameter

This parameter specifies whether time recording during sampling should be performed using absolute time or relative time. The initial default for this parameter is 0.

- | | | |
|---|-------------------------|--|
| 0 | Off | Time recording is not performed. |
| 1 | Absolute time recording | Actual time is recorded in seconds when sampling starts. |
| 2 | Relative time recording | The time between samples is recorded. |



- The time recording parameter is disabled whenever -1 (real-time display of sample data) is specified for the number of samples parameter of Command 3.

Trigger Source Parameter

This parameter specifies the source of the trigger that starts sampling. You can trigger sampling to start at a specific point on the actual data or an external clock. The initial default for this parameter is 1.

- | | | |
|---|------------------------|---|
| 0 | Off | Sampling starts immediately after receipt of Command 3. |
| 1 | Manual ([TRIGGER] key) | |
| 2 | CH1 ($\pm 10V$) | |
| 3 | CH2 ($\pm 10V$) | |
| 4 | CH3 ($\pm 10V$) | |
| 5 | CH1 (0 to 5V) | |
| 6 | CH2 (0 to 5V) | |
| 7 | CH3 (0 to 5V) | |
| 8 | DIG IN clock | |
| 9 | DIG IN 4-bit data | |



- Whenever 5 (period) or 6 (frequency) is specified for the operation parameter of Command 1 and 2 (CH1), 3 (CH2), or 4 (CH3) is specified for the trigger source parameter of Command 3, the setting for the trigger source parameter channel specified in by Command 3 must match the channel parameter of Command 1. In this case, trigger level and trigger edge parameter settings made with Command 1 take priority over trigger level and trigger edge settings made with Command 3.

Trigger Threshold Parameter

This parameter specifies the trigger level when any external trigger (any trigger other than manual triggering with the [TRIGGER] key) is specified for the trigger source parameter. The initial default for this parameter is 1.

The trigger threshold setting range depends on the source specified by the trigger source parameter, as shown below.

Trigger Level	Trigger Source
-10 ~ 10 (A, V)*	2, 3, 4
1 ~ 100 (k Ω)*	5, 6, 7
0 ~ 5 (V)*	5, 6, 7
0000 ~ 9999 **	9

* Measurement is automatically determined in accordance with Command 1 operation parameter setting.

** The trigger level when the trigger source parameter is 9 (DIG IN 4-bit data) is specified as a four-digit value in the range of 0000 to 9999, which corresponds to 4-bit data input from the DIG IN channel. Each digit is read as LOW for 0 and HIGH for 1, with values in the range of 2 through 9 being ignored.

Trigger Edge Parameter

This parameter specifies the measurement edge orientation. It is used when any setting from 2 through 7 is specified for the trigger source. The initial default for this parameter is 1.

0	Falling edge
1	Rising edge

Clock Source

This parameter specifies sampling timing. It can be used to synchronize sampling with an external clock. The initial default for this parameter is 0.

0	Timer (sampling time)
1	[TRIGGER] key
2	CH1 ($\pm 10V$)
3	CH2 ($\pm 10V$)
4	CH3 ($\pm 10V$)
5	DIG IN clock



- Whenever 5 (period) or 6 (frequency) is specified for the operation parameter of Command 1 and 2 (CH1), 3 (CH2), or 4 (CH3) is specified for the clock source parameter of Command 3, the setting for the clock source parameter channel specified in by Command 3 must match the channel parameter of Command 1. In this case, clock level and clock edge parameter settings made with Command 1 take priority over clock level and clock edge settings made with Command 3. The DIG IN clock cannot be used for period and frequency sampling.

Clock Threshold Parameter

This parameter specifies the clock threshold level when a clock source (2, 3, or 4) is specified for an analog channel. The initial default for this parameter is 1.

Clock level: -10 to 10 (A, V)



- When the same channel is specified for both the trigger source and clock source, the trigger lever specification is used as a clock level, which in effect means that the clock level specification is ignored.

Clock Edge Parameter

This parameter is used when a clock source is specified for an analog channel (clock source parameter: 2, 3 or 4) to define the measurement edge orientation. The initial default for this parameter is 1.

0	Falling edge
1	Rising edge

Prestore Data % Parameter

This parameter specifies the percentage of the number of samples that should be collected before the trigger condition is satisfied. The initial default for this parameter is 0.

0 to 100 Percentage of number of samples

Specifying 10 for this parameter for example causes 10% of the data to be collected before triggering and 90% to be collected after triggering.



- Depending upon the amount of time from the point that the data analyzer received Command 3 up to the point when trigger conditions are satisfied, the number of samples prior to triggering may be less than the number of samples specified by Command 3.

Filter Parameter

This parameter specifies one of six filter algorithms for removing noise from sampled data and post-processed data. A value from 1 to 4 specifies one of Savitzky-Golay (S-G) second-order and third-order filters with varying numbers of points. 5 and 6 select median filters for removal of outline values.

- | | |
|---|--------------------------|
| 0 | No filtering |
| 1 | 5-point S-G smoothing |
| 2 | 9-point S-G smoothing |
| 3 | 17-point S-G smoothing |
| 4 | 25-point S-G smoothing |
| 5 | 3-point median filtering |
| 6 | 5-point median filtering |



- No filtering is performed when the number of samples parameter of Command 3 is -1 (real-time sampling).

SAMPLING/TRIGGER SETUP Example

{3,0.2,50}

3 = SAMPLING/TRIGGER SETUP

0.2 = Sampling every 0.2 second

50 = 50 samples

Initial defaults are used for triggering and other parameters.

{3, 0.001, 255, 1, 2, 2}

3 = SAMPLING/TRIGGER SETUP

0.001 = Sampling every 1 millisecond

255 = 255 samples

1 = Absolute time recording

2 = External trigger (CH1)

2 = Trigger on voltage greater than 2V

Command 4 - CONVERSION EQUATION SETUP

Command 4 specifies conversion type, order, and constants for conversion to special units (like Newtons or degrees Celsius).

Syntax

{4, Equation Number, Equation Type, Units Display, Constants}

Equation Number Parameter

This parameter specifies a equation number for loading of conversion equations. Equations have a fixed relationship with channels, so that Equation 1 corresponds to Channel 1, Equation 2 corresponds to Channel 2, and so on. The initial default for this parameter is 0.

- | | |
|---|----------------------------|
| 0 | Clears all equations.* |
| 1 | Equation 1 (Channel 1) |
| 2 | Equation 2 (Channel 2) |
| 3 | Equation 3 (Channel 3) |
| 4 | Equation 4 (SONIC channel) |

- * Even if 0 is specified for this parameter, the conversion equation function remains enabled if the EQ indicator is on the display.

Equation Type Parameter

This parameter specifies the type of equation to be used for conversion. The initial default for this parameter is 1.

- | | |
|----|--|
| 0 | Clears equation selected by the equation number parameter. |
| 1 | Polynomial |
| 2 | Mixed polynomial |
| 3 | Power |
| 4 | Modified power |
| 5 | Logarithmic |
| 6 | Modified logarithmic |
| 7 | Exponential |
| 8 | Modified exponential |
| 9 | Geometric |
| 10 | Modified geometric |
| 11 | Reciprocal logarithmic |
| 12 | Steinhart-Hart |

- See “Conversion Equations” in Appendix A for details on equation types, forms, and restrictions.

Units Display Parameter

This parameter specifies the unit to use for display of post-processed values. The initial default for this parameter is 0.

- | | |
|---|-----------------|
| 0 | None |
| 1 | °F (Fahrenheit) |
| 2 | °C (Celsius) |
| 3 | K (Kelvin) |

Constants Parameter

This parameter specifies the constants used by the conversion equation. The number of constants differs according to the conversion type parameter specification. You should always input zero as the parameter value for any constant that is not being used.



CONVERSION EQUATION SETUP Examples

{4,1,1,0,0,12,34} 4 = CONVERSION EQUATION SETUP
 1 = Conversion equation 1
 1 = Polynomial
 0 = No display of units
 0 = Constant K_0
 12 = Constant K_1
 34 = Constant K_2

{4,2,3,2,2,5} 4 = CONVERSION EQUATION SETUP
 2 = Conversion equation 2
 3 = Power
 2 = Units display ($^{\circ}\text{C}$)
 2 = Constant K_0
 5 = Constant K_1

Command 5 - DATA RANGE SETUP

Command 5 specifies the channel number and whether sampled data or post-processed data should be transferred to a connected CFX-9850G. It also specifies the range of sample data to be transferred to a calculator list or matrix.

Syntax

{5, Channel Select, Data Select, Data Begin, Data End}

Channel Select Parameter

This parameter specifies the channel from which data should be transferred to the calculator. The initial default for this parameter is 0.

- 0 Current send channel
- 1 Channel 1 (CH1 - analog channel)
- 2 Channel 2 (CH2 - analog channel)
- 3 Channel 3 (CH3 - analog channel)
- 4 Channel 4 (SONIC channel)
- 5 Channel 5 (DIG IN channel)
- 6 Recorded time data



- Command 3 must also be used to select absolute or relative time data whenever 6 (recorded time data) is specified for this parameter.

Data Select Parameter

This parameter specifies which data should be returned to the calculator. The initial default for this parameter is 0.

- | | |
|---|--|
| 0 | Raw data
Filtered data is returned when data filtering is turned on with the filter parameter of Command 3. |
| 1 | d/dt
Filtered data when data filtering is on. |
| 2 | d^2/dt^2
Filtered data when data filtering is on. |
| 3 | Raw data
Filter setting is ignored. |
| 4 | d/dt
Filter setting is ignored. |
| 5 | d^2/dt^2
Filter setting is ignored. |

Specifying 3, 4, or 5 for this parameter makes it possible to transfer unfiltered data even when filtering is specified by the filter parameter of Command 3. All subsequent Receive(commands transfer unfiltered data until this data select parameter is change to 0, 1, or 2.

In the same way, specifying 0, 1, or 2 for this parameter causes subsequent Receive(commands to transfer filtered data to the calculator.



- To transfer d/dt , d^2/dt^2 , or statistical data, you must use the post-processing parameter of Command 1 to specify the type of post-processing to be performed.

Data Begin Parameter

This parameter specifies the starting sample number for data being sent to a CFX-9850G list or matrix. The initial default for this parameter is 1.

1 to 512 Starting sample number

Data End Parameter

This parameter specifies the ending sample number for data being sent to a CFX-9850G list or matrix. The initial default for this parameter is 0.

The value specified for this parameter must be greater than or equal to the specification made for the data start parameter. Specifying a value of 0 here causes the data end parameter to be ignored, transferring all data up to the final sample.

0 to 512 Ending sample number



- When transferring data to the CFX-9850G, the data range must be set so the total number of data items is 255 or less.

DATA RANGE SETUP Examples

{5,1,2}	5 = DATA RANGE SETUP 1 = Transfer data from CH1 2 = Filtered d^2/dt^2 data (when filtering is turned on with Command 1)
{5,2,0,256,300}	5 = DATA RANGE SETUP 2 = Transfer data from CH2 0 = Filtered raw data (when filtering is turned on with Command 1) 256 = Starting sample number 300 = Ending sample number

Command 6 - MULTIMETER MODE SETUP

Command 6 specifies a channel for multimetering. Only one channel (the one you specify) is enabled in the Multimeter Mode at a time.

Syntax

{6, Set/Reset, Channel Select, Operation}



- Pressing the [MODE] key and entering the Multimeter Mode makes it possible to use the data analyzer as a stand-alone measuring instrument without commands from a graphic scientific calculator.

Set/Reset Parameter

This parameter executes a Multimeter Mode set or reset operation. The initial default for this parameter is 1.

- | | |
|---|------------------------------------|
| 0 | Returns to the Communications Mode |
| 1 | Enters the Multimeter Mode |

The following points apply whenever the data analyzer is in the Multimeter Mode.

- Command 6 with a set/reset parameter of 0 is the only valid command accepted by the data analyzer.
- The default sample time is approximately 1 second.
- Sampling results appear on the display, but are not sent to a connected calculator.

Channel Select Parameter

This parameter selects a channel for measurement.

- | | |
|---|-----------------|
| 1 | Channel 1 (CH1) |
| 2 | Channel 2 (CH2) |
| 3 | Channel 3 (CH3) |

- 4 Channel 4 (SONIC)
- 5 DIG IN channel

Operation Parameter

This parameter specifies the sampling unit for the Multimeter Mode.

The following are the available operation parameter settings whenever Channel 1 (CH1), Channel 2 (CH2), or Channel 3 (CH3) is specified by the channel select parameter.

- 1 Auto-ID
If Auto-ID is not activated, voltage in the range 0 to 5V is used.
- 2 Voltage ($\pm 10V$)
- 3 Current ($\pm 10A$)
- 4 Resistance value (1k Ω to 100k Ω)
- 5 Period (0.000004 to 50 seconds)
- 6 Frequency (0.02Hz to 250kHz)

The following are the available operation parameter settings whenever SONIC is specified by the channel select parameter.

- 1 Auto-ID
- 2 Meters
- 3 Feet

MULTIMETER MODE SETUP Example

The following example takes a single data sample on Channel 1.

{6,1,1,3} 6 = MULTIMETER MODE SETUP
 1 = Enters Multimeter Mode
 1 = Channel 1
 3 = Current measurement

Command 7 - REQUEST STATUS

Command 7 creates data analyzer status data, which can be sent to a connected CFX-9850G.

Syntax

{7}

Request Status

This command creates a list that shows the system status and settings of the data analyzer. The following items are included within the list.

- Device code: 1 (device code identifier)
- Last error code: 0 = no errors
An error causes a 3-digit error code to appear on the display. The first digit indicates the command number, while the remaining two digits indicate the parameter where the error occurred (i.e. first parameter is indicated by 01, second indicator by 02, and so on).
- Auto-ID resistance value (Ω) for CH1, CH2, CH3, and SONIC
A reading in the vicinity of 999k Ω indicates that the applicable channel is open.
- List of all active channels

To create a list of the data analyzer system status, send Command 7 from the connected calculator and then fetch the list.



- The data analyzer does not respond to calculator commands while an error condition exists. Error messages can be cleared after pressing the data analyzer's [HALT] key to recover from the error condition.

REQUEST STATUS Example

{7} → List 1

Send(List 1)

Sends Command 7 to the data analyzer telling it to create a system status list.

Receive(List 1)

Fetches the list created by Command 7 to List 1 of the calculator.

Command 8 - SAMPLING START

Command 8 tells the data analyzer to start sampling immediately. This command can be used to immediately restart sampling when data that is transferred to a calculator and graphed reveals a problem with the sampled data.

Syntax

{8}

Command 9 - PROBE CALIBRATE

Command 9 tells calibrates probe sampling values and is used to calibrate sampling levels when a high level of accuracy is required or when multiple probes are being used.

Calibration is approximated using a linear equation and quadratic equation, with coefficients specified using this command's coefficient parameter.

When performing calibration to improve accuracy, it is necessary to use a separate reference measuring instrument of the level of accuracy desired to sample a number of points under actual sampling conditions. At least two points are required for the linear equation, while a minimum of three points are required for the quadratic equation. The more points provide a greater improvement in accuracy.

Selection of the linear equation or quadratic equation depends on sampling conditions. The linear equation is normally used when calibrating for measurement using multiple probes.



- The calibration performed by this command is approximate calibration, and should not be relied upon when high accuracy is required. When the sampling levels of two probes are calibrated with each other, values produced by sampling with the two probes under identical conditions will not necessarily produce identical values.

Syntax

{9, Channel, Equation Type, Coefficient}

Channel Parameter

This parameter specifies channels for calibration. The initial default for this parameter is 0.

0	Clears all calibration channels.
1	Channel 1 (CH1)
2	Channel 2 (CH2)
3	Channel 3 (CH3)
4	SONIC channel

Equation Type Parameter

This parameter specifies whether a linear equation or quadratic equation should be used for calibration. The initial default for this parameter is 0.

0	Clears channel calibration equation for channel specified by the channel parameter.
1	Linear equation
2	Quadratic equation

Coefficient Parameter

This parameter specifies the coefficients of the calibration equation being used. Two coefficients (a , b) are specified for the linear equation ($ax + b$), while three coefficients (a , b , c) are specified for a quadratic equation ($ax^2 + bx + c$).

CALIBRATE PROBE Examples

Example 1: Calibrating the light probe to a reference value

The light probe can perform sampling at a distance of one to four meters from a light source. The following example uses a light source with a brightness of 800 at one meter and 200 at four meters, to produce calibration values based on changes in brightness between those two points.

{1,0}→List 6↓

Send(List 6)↓

{1,1,1}→List 6↓

Send(List 6)↓

Specifies light probe connected to Channel 1 (CH1).

ClrText↓

"HOW MANY POINTS"?→N↓

Seq(0,X,1,N,1)→List 2↓

Seq(0,X,1,N,1)→List 3↓

For 1→I To N Step 1↓

Calibration of probe for two-point data for this example.

ClrText↓

"ENTER BASE VALUE"?→B↓

B→List 2[I]↓

{3,0.01,5,0,0}→List 6↓

Send(List 6)▲

Input of reference value. At this time, light probe should be in state that will be experienced during sampling.
(display halt)

Receive(List 4)↓

(Sum List 4-Min(List 4)-Max(List 4))/3→List 3[I]↓

Next↓

LinearReg List3,List2↓

"FINISHED"↓

"A=":a▲

"B=":b↓

(display halt)

Values a and b obtained by this program can be set using Command 9 before performing actual sampling.

{9,Channel,1,a,b}→List 6

Send(List 6)

("Channel" is the specification of the channel to be used for sampling.)

Example 2: Calibrating multiple probe levels

The following example produces calibration values for use with temperature probes connected to two different data analyzers. Three calibration points are used.

{1,0}→List 6↵

Send(List 6)↵

{1,1,1}→List 6↵

Send(List 6)↵

Specifies that the reference temperature probe is connected to CH1.

{1,2,1}→List 6↵

Send(List 6)↵

Specifies that the temperature probe being calibrated to the reference probe is connected to CH2.

ClrText↵

"HOW MANY POINTS"?→N↵

Specify three points (approximate maximum, minimum, and midpoint of sampling range) for this example.

Seq(0,X,1,N,1)→List 2↵

Seq(0,X,1,N,1)→List 3↵

For 1→I To N Step 1↵

ClrText↵

"READY?" ▲

Inserting a display halt command (▲) causes execution to stop when setup is complete. Press [EXE] to continue.

{3,0.01,5,0,0}→List 6↵

Send(List 6) ▲

(display halt)

Receive(List 4)↵

Receive(List 5)↵

(Sum List 4-Min(List 4)-Max(List 4))÷3→List 2[I]↵

(Sum List 5-Min(List 5)-Max(List 5))÷3→List 3[I]↵

Next↵

LinearReg List3, List2↵

"FINISHED"↵

"A=":a ▲

"B=":b↵

Values a and b obtained by this program are specified with Command 9 on the data analyzer whose probe is being calibrated to the reference probe (the CH2 probe in this example) before performing actual sampling.

{9,Channel,1,a,b}→

List 6

Send(List 6)

("Channel" is the specification of the channel to be used for sampling.)

Example 3: Improving probe accuracy

The following example produces calibration values for improving the accuracy of sampling using a light probe.



- When performing calibration to improve accuracy, it is necessary to first produce reference values using a high-accuracy measuring instrument.

{1,0}→List 6.↓

Send(List 6).↓

{1,1,1}→List 6.↓

Send(List 6).↓

ClrText.↓

"HOW MANY POINTS"?→N.↓ Specify five points (approximate maximum, minimum of sampling range and additional 3 points) for this example.

Seq(0,X,1,N,1)→List 2.↓

Seq(0,X,1,N,1)→List 3.↓

For 1→I To N Step 1.↓

ClrText.↓

"ENTER BASE VALUE"?→B.↓ Input of reference value. At this time, light probe should be in state that will be experienced during sampling.

B→List 2[I].↓

{3,0.01,5,0,0}→List 6.↓

Send(List 6)▲

Receive(List 4).↓

(Sum List 4-Min(List 4)-Max(List 4))÷3→List 3[I].↓

Next.↓

QuadReg List3, List2.↓

"FINISHED".↓

"A=":a▲

"B=":b▲

"C=":c

Values a, b, and c obtained by this program are specified using Command 9 before performing actual sampling.

{9,Channel,2,a,b,c}→

List 6

Send(List 6)

("Channel" is the specification of the channel to be used for sampling.)