User's Manual

Datataker Manual

A Concise Reference

for Datataker Models
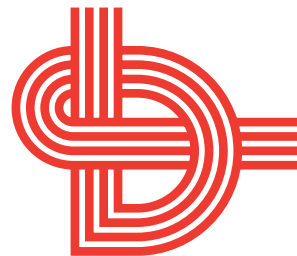DT50
DT500, DT600
DT505, DT605
DT515, DT615
and the
Channel Expansion Module

Series 2

Data Electronics

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Data Electronics warrants the instruments it manufactures against defects in either the materials or the workmanship for a period of 3 years from the date of delivery to the original customer. This warranty is limited to the replacement or repair of such defects, without charge, when the instrument is returned to Data Electronics or to one of its authorized dealers.

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Firmware (ROM) Versions

This manual is applicable to the Series 2 Datataker data loggers fitted with firmware version 5.xx.

The version number is returned in the first line of the TEST command — see "More Commands".

See "Firmware Change History" for compatibility with the earlier firmware versions.

Related Documents:
Getting Started with Datataker
Reference Manual
Advanced Communications Manual

Related Products:
DeTerminal for DOS
DeTerminal for Windows
DeLogger
DeLogger Pro
DeCopy / DeImage
DeLink DDE Server
Panel Mount Display
Sensor Simulation Panel
Memory Cards
Memory Card Interface

Contents

Getting Started ... also see the *Getting Started with Datataker* User's Guide

The Datataker ....

The Datataker data logger is a tool to measure and record a wide variety of parameters in the real world.

With the Datataker simple tasks are easy. For example entering in the command line:

RA5S 1..5TJ LOGON [return]

declares a reporting schedule (**RA**5S) which is to report every five seconds (RA**5S**) the temperatures on five Type J thermocouples (**1..5TJ**), and to log or store the results in memory (**LOGON**). Programs are executed only after the receipt of a (carriage) return character.

Recovering the logged data is even simpler:

U [return]

returns the data in the default format:

```
1TJ   384.7 Deg C
2TJ   335.2 Deg C
3TJ   367.1 Deg C
      etc.
```

If you want to do more complex tasks, you'll need to learn about the Datataker commands. You can be sure that the Datataker has the flexibility to handle very complex situations, once you become familiar with the full command set. The more familiar you are with the Datataker's features, the better you'll be able to use it. Explore in detail the features that are of most interest.

First Time

The *Getting Started with Datataker* User's Guide included with your logger is recommended reading for first-time users. The manual will quickly teach you how to program the Datataker. Alternatively you may read on!

The first task in preparing the Datataker is to establish a communications link with your computer. Connect the communications cable supplied between the Datataker and to any IBM or compatible computer. Load and run either DeTerminal for DOS or DeTerminal for Windows, which will configure your computer's RS232 port (COM1 by default) to match the Datataker's communications parameters. These programs also provide a terminal type interface for programming the Datataker and for receiving data.

If you are using a different computer type, construct or purchase a communications cable – see "COMS Port" on page 13 for wiring details. Load and run a terminal emulation or communications program, and ensure that the computer's communications parameters are set to the Datataker's default settings:

Baud rate	4800
Data bits	8
Stop bits	1
Parity	none
Protocol	XON - XOFF

The second task is to connect power. Connect the output from the power adaptor (240 or 110 Vac to 12Vdc) to the two screw terminals marked "~ ~" or "AC/DC" depending on the Datataker model. Polarity is not important.

A word of caution – do not connect external power to the terminals labelled "Bat". These are reserved for an external battery, and have a limit of 9 volts DC. See "Power and Battery Connection" on page 15 for information on power connection and power consumption.

When power is switched on, the red Convert Lamp flashes for about half a second. The following message appears on the computer display:

Datataker 0 Version 5.xx
Initializing ... Done

If a charged internal or external battery is already connected to the logger, then this will not occur as the unit is already powered and does not perform another "cold start".

If communications are OK, then typing an upper case **T** followed by the Enter key (or **Alt L** in DeTerminal) returns the current time (this may be different to your local time):

Time 09:10:55

The Datataker only responds to upper case characters, except for the Switch command (see Switches on page 11).

Use lower case characters to document and add clarity to commands. For example **Time** is the same as **T** and **Report_schedule_A_every_15_Minutes** is the same as **RA15M**, (using the underscore character to improve the readability as a "space" character is a command separator).

If communication is not successful, check the COMS cable and COMS port parameters. Change the Datataker's DIP switches (see the Appendix for your Datataker) or the computer's parameters so that both are the same.

Successful Data Logging

Data logging is an orderly process and should be undertaken in a systematic way. Clearly define the purpose for data logging so that the data you collect maximises the knowledge gained. Consider the following:

- identify the parameters to be measured
- select sensors and number of channels
- determine sensor output scaling
- determine how data is to be processed and reported
- decide on sample frequency - minimise redundancy
- calculate volume of data to be collected
- decide method of data recovery and archiving
- consider power consumption

When you have defined the task, you can connect sensors and program the Datataker.

Sensor Connection ... pages 4, 19, 20

You must know the output signal for each sensor. Make sure that the input to the Datataker does not exceed ratings. As a general rule, the voltage on any analog input terminal should be within –3.5 to +3.5 volts relative to Datataker ground. Datataker models with a relay multiplexer and attenuator can accept higher input levels.

Select the most appropriate channel type for each sensor from the table on page 4. The second last column shows appropriate wiring configurations from pages 19 and 20. Connect the sensors accordingly.

Use channel options to modify channel function. In a channel definition these are listed in brackets immediately after the channel type. The table on page 5 describes the channel options.

Test each sensor by declaring a simple schedule. For example
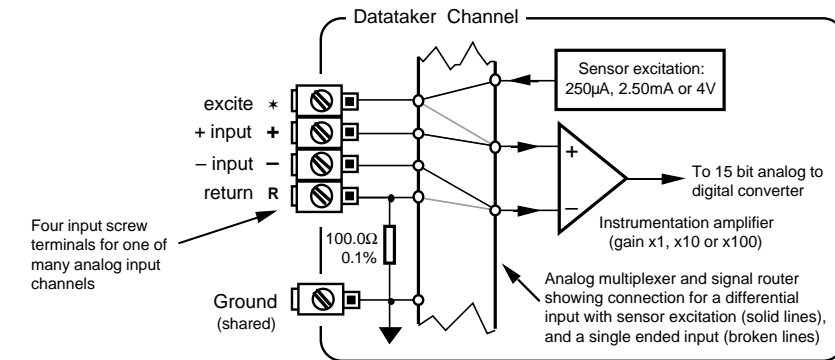
RA1S 2PT385(4W)

will return every **1** second (**RA1S** – see page 3) the temperature of a platinum resistance temperature sensor (**PT385** – see page 4) connected as a four wire resistance (**4W** channel option – see page 5) on channel **2**.

Analog Input Channels

An analog input channel on a Datataker is a four wire connection that allows voltage, current, resistance and frequency to be measured. These are the fundamental signals output by most sensors. It is not necessary to use all four connections - two are often adequate.

As can be seen in the simplified drawing of a Datataker channel below, there is a multiplexer and a programmable instrumentation amplifier between the screw terminals and the analog to digital converter.

The multiplexer is essentially a patch board that directs signals from the channel screw terminals to the amplifier inputs. Many different connections are possible.

A Standard Datataker Analog Input Channel

Differential Input

A differential input is one in which the signal is the voltage between two wires, and neither wire is necessarily at ground potential. On the Datataker the + and – terminals provide for differential input. The multiplexer patches the channel's + terminal to the amplifier's + input and the – terminal to the amplifier's – input. This patching is achieved by defining the channel number and type (see page 4). For example a differential voltage on channel one is patched by the channel definition **1V**.

Single Ended Input

A single ended input also provides a signal voltage between two wires, except that one of the wires must be at ground potential. On the Datataker this "grounded" wire is connected to the channel's R terminal (R for return). The other signal wire is connected to any one of the other three terminals.

To patch a single ended channel the channel number is given a suffix indicating the terminal to which the second wire is connected. For example a single ended voltage input applied to channel one between the R and + terminals would be patched by the channel definition **1+V**.

You can apply three single ended inputs to each Datataker channel. These use the suffix's **+**, **–** and **∗** (asterisk). Thus the three single ended voltage inputs on channel one would be **1+V**, **1–V** and **1∗V**. Note that the ∗ single ended input in not supported on the DT50.

Channel Type .. see page 4

The input channels are very versatile, however the Datataker is not smart enough to know what type of sensor is connected. It must be told. A channel is defined by a channel type that determines how the multiplexer is patched and how the readings are to be processed. There are more than thirty different channel types.

The same channel may be read using different channel types. For example a thermocouple may be read as a thermocouple or as a voltage. The command

1TK 1V

will return both a temperature and a voltage based on two readings of the same sensor.

Sensor Excitation

Many sensors require power (or excitation) to enable them to output a signal. For example to read the temperature of a thermistor (a temperature dependent resistor), excitation current is passed through the thermistor to generate a voltage drop that can be measured.

The Datataker has three different excitation sources – 250µA, 2.50mA and 4V. These are output on the excite (∗) terminal of each channel, when the channel is read. This action is automatic for most sensor types, but may also be evoked as a channels option.

Analog to Digital Conversion

The Datataker converts its input signals to a frequency, and then measures the frequency over one line cycle period (20.00mS or 16.67mS). This method provides high noise rejection and good signal averaging over the sample period.

Many sampling parameters can be adjusted by means of channel options (page 5), switches and parameters (page 11). These include calibration, settling time, sampling time and extended or multiple sampling. The default values of these parameters are suited to the majority of sensors. See "ADC Details" page on 18.

For the Technically Minded

To gain an understanding of how your Datataker works, study the "Simplified Circuit" on page 22. This will help you to exploit many of Datataker's features.

More Getting Started ... more compulsory reading !

Schedules .. page 3

A schedule is a list of channels preceded by a scan trigger specification. As a general rule don't read channels more frequently than is really necessary (for example, temperatures generally change slowly, so rapid reading does not provide extra information).

You can declare up to four different schedules, each with a different scan trigger based on a time interval or a digital input event. The schedule's trigger can be changed at any time. This allows the trigger to be modified under program control (see "Alarm - Action Text" on page 9).

A list of channels without a trigger specification may be entered at any time. These are scanned immediately, without affecting other schedules which may be operating.

A schedule's channel list cannot be altered without re-entering all schedules. In fact all schedules must be entered at the same time, either all on one line or between **BEGIN** and **END** keywords (see "Schedules" on page 3).

Scaling and Calculations ... page 7

The Datataker can scale the channel input data to engineering units by applying polynomials, spans or intrinsic functions. Arithmetic expressions provide cross channel and other calculations. Various statistical functions including averaging and histograms can be applied.

Data Reduction ... pages 3, 6, 9

In many instances you can reduce the volume of the data recorded by taking averages, maximums, minimums, standard deviations, histograms or integrals. Use conditional statements to determine when data is logged (see "Trigger While" on page 3 and "Alarms" on page 9).

Alarms ... page 9

The Alarm facility of the Datataker is flexible and powerful. Alarms are used to warn of error conditions and to control the Datataker's operation. The key words **ALARM** and **IF** have identical meaning. Alarms allow:

- logical comparisons with set points
- control of digital output on the alarm condition
- issuing of messages to the host computer and Display
- execution of Datataker commands

Executing Datataker commands from an alarm can be particularly useful in modifying the Datataker's program in response to changes in input(s).

Programming .. see Sample Program opposite

You program the Datataker by entering schedules and other commands. Entered commands are not processed until a carriage return is received. The input buffer is 254 characters, so command lines must not exceed this length. Each command must be separated by one or more spaces, tabs or carriage returns. All schedules must be entered on one line or placed between the **BEGIN** and **END** keywords.

The **BEGIN END** construct is also very useful for enhancing program clarity. When the **BEGIN** keyword is encountered the Datataker is halted and prepared to receive a new program. As each line of the program is entered it is compiled into a new task. The **END** keyword indicates that all schedules have been entered.

While the **BEGIN** – **END** construct is necessary only for the entry of multi-line schedules, it can contain any other commands. Placing switches, parameter definitions, and alarms in the construct gives a program a more structured and easy to read appearance, especially if indenting is used.

Managing Power ... page 15

In applications where power consumption is critical, the Datataker has a sleep mode which reduces battery current draw from 120 – 400mA to less than 0.4mA.

The Datataker will automatically wake from sleep mode when input channels are to be scanned. Plan your program to ensure that the Datataker does not wake more often than is necessary. This particularly applies to the Statistical Sub-schedules (see page 3) and Alarms (see page 9).

Data Logging ... page 8

The Datataker stores data internally (13,650 readings) and in a Memory Card (up to 340,000 readings). The internal memory acts as a buffer for the Memory Card, so that data is not lost during card changes.

By default the Datataker stops logging when both memories are full. An overwrite mode allows continued logging, with the oldest data being overwritten by new readings. See "Data Logging and Retrieval" on page 8 and "Switches - **/O**" on page 11.

You can selectively log channels (see "Channel Options - Output format" on page 5). Logging begins only after you issue the **LOGON** command. Time and date stamping is automatic.

The Datataker does everything possible to avoid data loss caused by careless use. However it does respond to the **RESET**, **CLEAR**, **CLAST**, **CTEST** and **CDATA** commands, which will erase data from memory, without question. Be very careful.

Data Retrieval ... page 8

Data stored in the internal memory or in a Memory Card is retrieved via the COMS or Network ports. You can retrieve data for an individual schedule or for all schedules merged.

The Operating Environment

The Datataker is an electronic instrument. Electronics and water do not mix! Condensation can be a serious problem in the tropics and in cooler areas where wide temperature variations are possible. Use a sealed case, and include sachets of silica jell, to avoid problems.

If your Datataker becomes wet, immediately disconnect the power and batteries, and dry the logger in a warm place. If the Datataker has come into contact with salt water, rinse thoroughly in fresh water, then distilled water, then dry. Salt must not be allowed to remain on the circuit boards.

The Datataker will operate over a wide temperature range, however the accuracy can be reduced. While the electrical zero is stable with temperature, the scale factor can drift slightly. Endeavour to minimise the Datataker's exposure to temperature extremes.

Operating Scenarios ...

You can deploy the Datataker in many ways depending on factors such as location, data volume, power availability:
- on-line to a host computer with Datataker as a front end
- periodic down loading to an on-line host
- periodic down loading to a portable computer
- periodic down loading via modem to a host, initiated either by the host computer or by the Datataker
- data recovery (and programming) using the removable memory cards

The method of deployment influences the fine tuning of the Datataker's program. As a general rule it is better to recover data as often as reasonably possible. In this way sensor failures, program faults, etc. will be detected earlier.

Channel Setup - first check the sensors

2TT	a channel (in this case channel 2 as a thermocouple) can be read once, or read multiple times as in the next example:	`2TT 449.3 DegC`

RA1S 2..4TT	returns data in the default format (in this case every one second (**RA1S**) for three thermocouple type T channels).	`2TT 451.5 Deg C`
		`3TT 563.2 Deg C`
		`4TT 487.8 Deg C`
		`2TT 451.9 Deg C`
		`...`

	Channels (page 4). Sensors can be wired to channels, calibrated and tested prior to full program entry.	
/n/u P22=44	changes the output format (in this case channel number and units are disabled, and data separator is ASCII 44 – the comma)	`452.0,565.4,451.0` `452.3,566.2,450.5`

Sample Program

```
' Boiler monitoring program for the Datataker 600
' Author:  Henry Higgins  23/4/95

CSCANS CALARMS CLEAR CDATA

/n/u/S/e

P22=44

Y10=4.5,0.213"KPa"
S1=0,50,0,100"L/m"

ALARM1(1V>2.25)3DSO
ALARM2(4TT>110.0)3DSO,1DSO"Over temp. ?[RB5S]"
ALARM3(4TT<100.0)" [RB1M]"

BEGIN

   RB1M    2..4TT ("Temp")
   RC15M   1V(AV,Y10)  6L(AV,S1)

END

LOGON
G
```

Comments can follow the apostrophe character, up to a carriage return.

Commands. Only upper case characters are accepted. Commands must be separated by one or more spaces or carriage returns, and are not processed until a carriage return is received.

Switches (page 11) determine system function (upper case is ON and lower case is OFF).

Parameters (page 11) are internal system settings which determine system function. Most can be set and all can be read.

Scaling (page 7). Various methods can be used to scale output data to engineering units. These are the Channel Factors, Functions, Spans, Polynomials and Calculations.

Alarms (page 9) detect out of range conditions. Can also be used to change logger function, schedule timing, control outputs and event annunciation.

BEGIN & **END** see Schedules on page 3

Schedules (page 3). Four general purpose schedules (**RA**, **RB**, **RC** and **RD**), each a list of channels to be scanned at programmable time intervals or on events. A special schedule (**RX**) allows polling from a host computer.

Channels (page 4). A wide range of channel types provide sensor support. Options allow custom configuration. Channel lists entered without a schedule ID return data immediately and cannot be logged to memory.

Logging (page 8) Global data logging is activated by the **LOGON** command. Disable logging of particular channels by the **NL** channel option.

Scan control commands – see page 3

Data Retrieval

|	
/n/u P22=32	Disables channel identification and units, and sets the output format to ASCII 32 (i.e. space) delimited data.
U	Begins to unload stored data, oldest data first (if a memory card is fitted, card data is unloaded first).
Q	Terminates unload.
CLEAR	Clears data from the Datataker's internal memory and disables logging.
CDATA	Clears data from the memory card (if fitted). Logging is *not* disabled. Data from the logger's internal memory is copied to the card.

Schedules ... what to do, when to do it

Introduction

Schedules have three parts: a schedule identification, a scan trigger, and a list of channels to scan.

RA2M:1W 1V 2R 3..5TT

Schedule ID   Trigger   Channel List
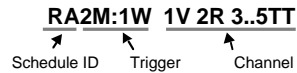
Schedule ID

Datataker provides four distinct types of schedules which are identified by their schedule ID:

RA, **RB**, **RC**, **RD**   triggered schedules
RX   polled schedule. (**X** from host)
RS   statistical sub-schedule
RZ   alarm schedule - see page 9

The schedule identifier (except for the **RX** schedule) is followed by a trigger – a **Time Interval** or an **Event**, and optionally a **While** condition. If there is no schedule ID or trigger, then the channel list (up to the next carriage return) is scanned once immediately. If the trigger is omitted, then the channel list is scanned as rapidly as possible until halted.

Trigger by Time Interval

An integer number of seconds, minutes, hours or days defines a schedule scan interval:

n**S**	seconds	n**D**	days
n**M**	minutes	n**H**	hours
none	as rapidly as possible		

where n is in the range 1 to 65535. For example **RA5S** will scan every 5 seconds. The first scan occurs on the next multiple of the interval since last midnight (see "Synchronise to Midnight" below).

OR

Trigger on Events

Digital inputs n**DS** (excluding CEM), low speed counters n**C** and high speed counters n**HCS** can also trigger scans:

n**E**	trigger on + and – transitions of a digital input
n**+E**	trigger on + transition of a digital input
n**–E**	trigger on – transition of a digital input
n**C**(c)	trigger after c counts on a low speed counter
n**HCS**	trigger after ANY counts on a high speed counter

where n is a digital channel number (can also be a channel sequence $n..m$). For example **RA1+E** will scan every 0 to 1 transition of digital input 1, and **RA2..3-E** will scan every 1 to 0 transition of digital input channels two OR three. These transitions could be generated by an **ALARM** (see "Action Commands" on page 9).
Note: If a counter input is preset outside of the trigger range (eg. **2C(10)=15**), then a trigger will not occur.

AND OPTIONALLY

Trigger While (condition is true)

A schedule's trigger can be enabled or disabled by the state of one or more digital input channels (n**DS**), by appending a While to either a **Time Interval** or an **Event**.
  :n**W**   enable while digital input n is high.
  :$n..m$**W**   enable if ANY digital input n to m is high.
Note that the colon is required. An example of a conditional event triggered schedule is **RA1E:2W** which will scan on every transition of digital input one (**1DS**) while digital input two (**2DS**) is high.

NOTE: Digital inputs are not read while the logger is asleep, and so n**E**, n**C** and **:**n**W** triggers will not be detected. High speed counter triggers (n**HCS**) will be detected on next wake.

Schedule A

RA10M 1..5V

Schedule B

RB1H:2W 1..4DS 6..9PT385(AV)(MX) 2C(R)
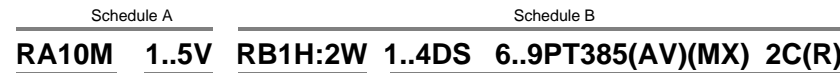
Channel Lists

Any set of channels (see page 4) separated by at least one space character is a Channel List. For example:

1..5V 6TK("Boiler Temp") 1DSO=1

where **1..5V** is a voltage channel sequence 1 through 5 inclusive, **6TK** is a type K thermocouple channel named "Boiler Temp" and **1DSO=1** sets digital output channel 1 ON. Channels are processed left to right.

Triggered Schedules

Triggered schedules begin with the schedule identifiers **RA**, **RB**, **RC** or **RD**. They scan their channel lists at intervals and times determined by the trigger (see left).

Polled Schedule

Channels entered in the **RX** schedule are scanned and reported only when the host computer or an **ALARM** (see "Action Commands" on page 9) issues the "**X**" command. The **RX** schedule will not accept a trigger.

Entering Schedules ... BEGIN & END

The reporting schedules (**RA**, **RB**, **RC**, **RD** and **RX**) must be entered as a group. If extending over more than one line, they must be between the keywords **BEGIN** and **END**, as in:

```
    BEGIN
       RA10S  4TT("Oven Temp")
              5TK("Flue Temp")
       RB1S   1C("Gas Flow")
              2C("Water Flow")
    END
```

Each line can be up to 254 characters long. Channels on lines without a schedule header are included in the previous schedule. A carriage return must terminate each line, and separate last channel definition and next schedule header.

When the **BEGIN** keyword is received then all schedules (including alarms) are **H**alted, and previous **RA**, **RB**, **RC**, **RD** and **RX** schedules are deleted unless data logging is enabled (see "**Data Logging**" on page 8), the scan schedules are locked (see "**/F**" on page 11), or the memory contains data. The **BEGIN** - **END** construct may contain blank lines, and any other of the Datataker commands (these are executed on entry). When the **END** is received, the original **H**alt - **G**o state is restored. You cannot append additional channels to a schedule once it has been entered. Instead you must re-enter the full set of schedules, including the additional channels.

Immediate Scans

A channel list with no schedule ID or trigger is scanned once immediately. The channel list can be scanned again by the ∗ (asterisk) command. Immediate scans are not logged.
Note: An immediate scan should be given time to execute before a **BEGIN** command is issued. If this is not done the immediate scan's data may not be returned.

If requests for immediate scans are too rapid, then the channels may be appended as if they were part of a single channel list. Setting **P22=13** can overcome this by ensuring a return character is placed after each reading.

Statistical Sub-schedule

Channels can be read frequently to produce a statistical data summary at longer intervals. This summary is returned, logged and displayed at intervals determined by **RA**, **RB**, **RC**, **RD** or **RX** schedules.

The statistical scan is a sub-schedule. Channels that require statistical scanning must include a channel option to indicate the statistical information required (see "Channel Options" on page 5, and "Statistical Channels" on page 6). If more than one statistical channel is required for a channel, then each statistical option must be placed in a separate option list (see Multiple Reports on page 4):

1TT(AV)(SD)(MX)

The trigger for the statistical sub-schedule is defined in the same way as for the main scan schedule (see Triggers ... beside), using the **RS** identification. If you do not specify the **RS** schedule's trigger, the sample rate will be as fast as possible. You may change the **RS** schedule at any time:

RS10S	sample every 10 seconds
RS30M	sample every 30 minutes
RS1-E	sample on each 1 to 0 transition of digital input 1
RS	sample as rapidly as possible

If the statistical sub-schedule is halted by a **HS** command, then statistical sampling of channels is stopped and the reported statistical summaries do not include data from this halt period. This is most significant for the integral summary.

If statistical channels have not been scanned before they are reported, then these channels report error E53 (see page 21) and data is set to 99999.9. This condition can occur when the **RS** trigger is an event, the statistical sub-schedule has been halted, or a statistical scan interval is longer than the reporting time interval.

An example of a schedule including statistical sampling is:

RA1H RS10S 1TT 2TT(AV)(MX)

which returns three temperature readings – a spot reading each hour of channel 1, and the average and maximum over the hour from 10 second samplings of channel 2.

Synchronize to Midnight - /S

By default all scan timing is synchronized to the previous midnight. Schedules with a time trigger will scan on every multiple of the time interval since last midnight. For example the schedule **RA10H** will scan at 10:00:00, 20:00:00, 10:00:00 (on the next day), and so on.

If synchronization is disabled by **/s** switch (see page 11), scanning is then relative to the time that the schedules are entered. **RA10H** entered at 09:30:00 will scan at 19:30:00 on the first day, at 05:30:00 and 15:30:00 on the next day, at 01:30:00 and 11:30:00 on the following day, and so on.

Returning Entered Schedules

The **STATUS2** command returns the currently entered scan schedules and channel lists up to a maximum of 512 characters. See "Other Commands" on page 10.

This Example has two schedules:
- Schedule A which scans every 10 minutes (**RA10M**), reporting channels 1 through 5 as voltage data.
- Schedule B which scans every hour (**RB1H**) while digital input 2 is true (**:2W**), reporting the state of digital inputs 1 through 4 (**1..4DS**), the average and maximum temperatures from RTDs connected to channels 6 through 9 (**6..9PT385(AV)(MX)**), and the interval count on the resetting counter channel 2 (**2C(R)**). The statistical sampling is as fast as possible.

Scan and Sample Order

When different schedules are due to scan at the same time, the schedules are scanned in the order of **RA**, **RB**, **RC**, **RD** and **RZ**. When there are statistical channels in a schedule, and the statistical sub-schedule is due at the same time as the reporting schedule, the channels are scanned statistically prior to reporting. You cannot change this order. Channels within schedules are sampled in the order of entry.

The **RX** polled schedule is scanned after the receipt of each **X** command.

Changing a Schedule Trigger

You can change a schedule's trigger at any time simply by entering a new schedule ID and trigger without a channel list as follows:

RC10M:2W

If you include a channel list, then a new schedule is created which replaces all previous schedules unless these previous schedules have logged data into memory, or logging is enabled by the **LOGON** command (see page 8), or the schedules are locked by the **/F** switch (see "Switches" on page 11).

Halting & Resuming Schedules

Schedules can be halted individually or as a group:

H	Halt all schedules including alarms
HA, HB, HC, HD	Halt **RA**, **RB**, **RC** or **RD** schedule
HS	Halt the statistical sub-schedule
HZ	Halt the alarm schedule

The polled schedule **RX** cannot be halted. **HX** will generate an error message.

Corresponding commands for resuming (or **G**oing) the schedules are **G**, **GA**, **GB**, **GC**, **GD**, **GS** and **GZ**.

Locking Schedules

Schedules can be locked by the **/F** switch command, to prevent them from being accidentally changed or deleted. The schedules can be unlocked by the **/f** switch command.

Clearing Schedules

The command:

CSCANS

erases all schedules. However if any schedule(s) has stored data into memory, or data logging is enabled by **LOGON**, or schedules are locked by **/F**, then the Datataker will issue the error message E4 or E48 (see page 21). You cannot erase individual schedules.

Channel Types ... how to specify channels

Introduction

All analog and digital channels on the Datataker are multipurpose. The channel specification determines internal signal and excitation routing, sampling method and data processing. A channel is defined by its channel number, channel type, and possibly one or more channel options.

Channel Number

Each input and output channel has a channel number. Each single ended analog input has a suffix label corresponding to a screw terminal:

- ∗ Excite output or positive single ended input terminal
- + Positive differential or positive single ended input terminal
- – Negative differential or positive single ended input terminal
- # Return common or single ended current input terminal

Thus **5V** defines a differential input between the + and – terminals, while **5∗V**, **5+V** and **5–V** defines single ended inputs between the ∗, + or – terminals respectively and the **R** terminal. Similarly **5#I** defines a single ended current input between the **R** terminal and a **GND** (ground) terminal. The DT50 does not support the excite terminal as a single ended input.

Two channel numbers separated by two or more points (ie. "..") defines a continuous sequence of channels. If the first label indicates a single ended channel, then the channels included depends on the first single ended channel label as follows:

1..5	is equivalent to	1 2 3 4 5
1+..3–	≻	1+ 1– 2+ 2– 3+ 3–
1–..4+	≻	1– 2+ 2– 3+ 3– 4+
1∗..2+	≻	1∗ 1+ 1– 2∗ 2+
1#..4#	≻	1# 2# 3# 4#

The DT50 does not support the excite terminal as a single ended input.

Channel Expansion Module Address

The Channel Expansion Module (CEM) channels are addressed by prefixing the module number and colon to the channel number.
eg. **2:5V** indicates channel 5 on the second CEM.

5+TJ(AV,NL)(MX,NL)

- Channel Number
- Channel Type Label
- Channel Options (see page 5) and default options column

This Example declares a thermocouple type J, connected to channel 5 as a single ended input. The channel option **NL** indicates that the channel is not to be logged. The logger returns two values: the average reading (**AV**) at report time and the maximum (**MX**) since the previous report time.

Multiple Reports

are possible from each channel by adding additional sets of channel options. The Datataker samples the channel (eg. **5+TJ**) only once every scan, however the second and subsequent sets of (channel options) generate additional reports. This is particularly useful for statistical reports (see "Schedules" on page 3) and display formatting (see "Channel Options" on page 5).

The first channel option set determines how the channel is sampled, and must include all sampling options required for the channel. These channel options are listed above the "Config Line" in the Channel Options table on page 5. If statistical options are included, then each option list in the multiple report MUST hold a statistical option.

Signal Category	Signal or Sensor Details	DT5xx.6xx (Channels Diff/SE)	DT50 (Channels Diff/SE)	CEM (Channels Diff/SE)	Single Ended Channel Label	Channel Type Label	Examples	Default Channel Options	Channel Factor (Channel option for scaling, etc)	Resolution	Output Units	Wiring Configuration (See pages 19, 20)	Comments
Voltage	Voltage ±25mV, ±250mV and ±2.5V ranges	10 / 30	5 / 10	10 / 30	∗, +, –	V	1V 1+V	(1.0, T∗)	attenuation factor	1µV	mV	1, 2, 3, 4, 5, 6	Common mode range ±3.5V.
	High voltage ±7V, ±70V and ±100V ranges ∗	10 / 30	5 / 10	10 / 30	∗, +, –	HV ∗	2HV	(1.0, A)	attenuation factor	250µV	V	1, 2, 3, 4, 5, 6	Common mode range ±100V (DT505, 515, 605, 615 only).
Current	Current, internal 100Ω shunt or external shunt.	10 / 40	5 / 15	10 / 40	∗, +, –, #	I	3#I	(100.0, T∗)	current shunt Ω	10nA	mA	7, 8, 8a	The internal 100.0Ω shunts are between Return (**#**) and Ground Terminals. eg. **3#I**, **5#L(S2).**
	4-20mA current loop.	10 / 40	5 / 15	10 / 40	∗, +, –, #	L	1#..5#L	(100.0, T∗or A)	current shunt Ω	0.01%	Percent	7, 8, 8a	
Resistance	Resistance by 2, 3 or 4 wire methods, 7KΩ max.	10 / 20	5 / 10	10 / 20	+,–	R	4R(II)	(I)	–	1mΩ	Ohms	9, 10, 11, 12	Four wire configuration requires (**4W**) option.
Bridge	3 & 4 wire, 1/4, 1/2 & full bridge, current excitation.	10 / 30	5 / 10	10 / 30	∗, +, –	BGI	1BGI(60)	(350.0, II)	arm resistance Ω	1ppm	ppm	13,14, 15	Four wire full bridge use (**4W**) option (see Bridges page 17)
	Ratiometric, 4 & 6 wire bridges, voltage excitation.	10 / 30	5 / 10	10 / 30	∗, +, –	BGV	1BGV	(0.0, V, 4W)	offset in ppm	0.1ppm	ppm	16, 17	External completion required for 1/2 & 1/4 bridges.
Frequency	Frequency (analog channels, 0.102Hz to 20KHz).	10 / 30	5 / 10	10 / 30	∗, +, –	F	2F(F2)	(30.0, T∗)	longest period mS	1mHz	Hz	1, 2, 3, 4, 5, 6	0.102Hz to 20kHz, use (**2V**) option for 0 – 5 volt single
	Period (analog channels, 50µS to 9.8S).	10 / 30	5 / 10	10 / 30	∗, +, –	P	2–P(X)	(30.0, T∗)	longest period mS	1µS	uS	1, 2, 3, 4, 5, 6	ended inputs, but for low level (100mV) input to 300kHz.
	Vibrating wire sensor - frequency ∗∗	10 / 30	-	10 / 30	∗, +, –	FW ∗∗	3+FW	(ES9, 200.0)	delay in mS	0.01Hz	Hz	2	Geologger DT515 and DT615 models only.
Time	Time of day.	1	1	–	none	T	T	( )	–	1S	Time	–	See "Time" and "Date" sections on page 6.
	Day or date.	1	1	–	none	D	D	( )	–	1D	Day	–	
	System timers (for program control etc).	4	4	–	none	ST	1ST	(60),(60),(24),(7)	range	1	Counts	internal	Increment every sec (**1ST**), min (**2ST**), hr (**3ST**), day (**4ST**)
Temperature	Thermocouples B, C, D, E, G, J, K, N, R, S and T.	10 / 30	5 / 10	10 / 30	∗, +, –	TB, TC .. TT	3TJ	(1.0, T∗)	attenuation factor	0.1℃	DegC∗∗∗	1, 2, 3, 4, 5	See "Thermocouples" on page 16.
	Platinum RTD's (α = 0.00385, 0.00392).	10 / 20	5 / 10	10 / 20	+,–	PT385, PT392	5PT392	(100.0, II)	0℃ resistance Ω	0.1℃	DegC∗∗∗	9, 10, 11,12	Three wire is the default connection (see "RTDs"
	Nickel RTD's (α = 0.005001).	10 / 20	5 / 10	10 / 20	+,–	NI	1NI(50)	(1000.0, I)	0℃ resistance Ω	0.1℃	DegC∗∗∗	9, 10, 11,12	on page 16), however a 4 wire connection (**4W**)
	Copper RTD (α = 0.0039)	10 / 20	5 / 10	10 / 20	+,–	CU	CU(135)	(100, II)	0℃ resistance Ω	0.1℃	DegC∗∗∗	9, 10, 11,12	can be used for greater measurement accuracy.
	Thermistors (Yellow Springs 400XX series).	10 / 20	5 / 10	10 / 20	+,–	YS01..07,16,17	2YS04	(1e10, I)	parallel resistor Ω	0.1℃	DegC∗∗∗	9, 10, 11,12	See "Thermistors" on page 16.
	AD590 & AD592 (Analog Devices).	10 / 40	5 / 15	10 / 40	∗, +, –, #	AD590	4AD590	(100.0, V)	shunt resistor Ω	0.1℃	DegC∗∗∗	18, 7, 8	Calibrate by variation of shunt value channel factor.
	LM335 (National Semiconductor Corp.).	10 / 30	5 / 10	10 / 30	∗, +, –	LM335	3LM335	(2.0, V)	attenuation factor	0.1℃	DegC∗∗∗	18, 4, 5	Slope correction via attenuation factor relative to 0℃K.
	LM34 & LM35 (National Semiconductor Corp.).	10 / 30	5 / 10	10 / 30	∗, +, –	LM34, LM35	5LM35	(1.0, V)	calibration factor	0.1℃	DegC∗∗∗	20, 21, 1, 2, 3	Calibration slope correction relative to 0℃ or 0℉.
Digital	State input on a digital channel.	4	5	20	none	DS	4DS	( )	–	1	State	22	If averaging, increase precision with FF *n* option.
	Byte input on a group of digital channels.	1 (4 bit)	1 (5 bit)	2 (8 bit)	none	DB	1DB(7)	(255)	bit mask (decimal)	1	Byte	22	Result is 0 to 15 (or 32). Channel No. = LSB of byte.
	Digital state input on an analog channel.	10 / 30	5 / 10	10 / 30	∗, +, –	AS	5–AS	(2500, T∗)	threshold (mV)	1	State	1, 2, 3, 4, 25	If averaging, increase precision with the FF *n* option.
	Output on a single digital channel. "1" = ON & low	4	5	10	none	DSO	3DSO=1	(0)	delay or width (mS)	–	–	23,24	Delay < 65,535mS, nDSO(delay,R) will generate pulses.
	Byte output on a group of digital channels.	1 (4 bit)	1 (5 bit)	1 (8 bit)	none	DBO	1DBO=0	(255)	bit mask (decimal)	–	–	23,24	0's in mask not modified. Channel No. = LSB of byte
	Display (if present) backlight, LED's and beeper.	6	6	–	none	WARN	3WARN=1	(0)	delay or width (mS)	–	–	internal	Display panel, 1-3=LED, 4=beep, 5-6=backlight (page 12)
Counts	Up counter (10Hz maximum).	4	5	–	none	C	1..4C	(65536)	range	1	Counts	22	Count range is 0-65535. eg. 1C(3) counts 0,1,2,0,1 etc.
	Phase encoder up-down counter (connect 3D,4D).	1	1	–	none	PE	1PE	(65536)	range	1	Counts	22	Presetting a counter outside of the maximum count
	High speed counter (1KHz maximum).	3	3	–	none	HSC	3HSC	(65536)	range	1	Counts	22	range (eg. 1C(5)=8) will cause an error (99999.9).
	High speed counter prescaler output.	1	1	–	none	HSCO	1HSCO(0)	(2)	prescaler mode	1	none	CMOS level	Set high speed counter **1HSC** output mode (see page 18).
System Data	System variable.	14	14	–	none	SV	3..5SV	( )	–	1	none	–	See "System Variables" on page 6.
Variables	General purpose variables for calculations etc.	100	100	–	none	CV	5CV	( )	–	6 digits	none	–	Assigned via Channel Options, return as for a channel.
Text	General purpose text for heading etc	1	1	–	none	$	$	( )	–	–	none	–	Assigned by **$="text"** maximum 80 characters, see page 6.

∗ Relay multiplexer models only
∗∗ Geologger models only   Indicates the capacity for each model ◄   The ∗ terminal not available for input on DT50 ► See Channel Options

∗differential only   ∗∗∗also ℉, ℉K, ℉R - see P36 on page 11

Channel Options
... in brackets, separated by commas, no spaces

Introduction

Channel Options allow the tailoring of channels for input configuration, sensor excitation, statistical reporting, variable assignment, and output format. Enclose options in brackets after the channel type label. Options are comma separated (no spaces allowed) and in any order. When the same channel is listed more than once, each listing is treated as a separate entity, with options applying only to the listing in which they are placed.

Channel Number   Channel Type

5PT385(4W,200.0,"Steam Temp",FF0)

Channel Options

This example configures the logger for 4 wire (**4W**) resistance measurement of an RTD temperature sensor. The sensor is a platinum temperature sensor (**PT385**) which has a 200Ω resistance at 0℃. The channel is labelled **"Steam Temp"** for output, and **FF0** sets the output resolution to 1℃. The data is returned as:

```
Steam Temp 266 DegC
```

instead of the default:

```
5PT385 265.7 DegC
```

Category	Option	and mutual exclusions	Function	Range of Option (n)	Order of Application	Comments
Input termination	T		Terminates +, – inputs with 1MΩ to ground		1	Provides input bias current path. Defaults ON for most differential inputs and off for single-ended types.
	U		Un-terminates +, – inputs		1	Input impedance >100MΩ. Signal source must provide input bias current path (approx. 5nA).
Resistance	4W		Configures input for a 4 wire measurement		1	Default resistance & constant current bridge (BGI) measurement method is by a three wire method. Four wire method is usually more accurate.
Single ended input	X		Use SE Ref terminal as common		1	Input applied between + or – or ✳ and SE Ref. (Single Ended Reference) terminals.
	2V		Use internal 2.500 Vref as common		1	Input applied between + or – or ✳ and GND or R. The Datataker applies a 2.500V offset to GND. Ground currents can cause small errors.
Gain	GL*n*		Gain Lock	1,10,100	1	Inhibits auto-ranging and presets amplifier gain to 1, 10 or 100 respectively.
	A, NA		Attenuation, No Attenuation		1	Controls attenuator on DT5x5/6x5 models – **A** switches attenuator in and **NA** switches attenuator out. See Appendices re DT505/605 and DT515/615.
Excite terminal (output current or voltage)	G		Guard signal		1	Provides a voltage equal to the input common mode voltage via approx. 3KΩ. For high impedance signal sources where cable leakage is a problem.
	V		Voltage source approx. 4.5V via 1KΩ		1	Useful for powering some sensors, however it is not regulated and is likely to drift with temperature.
	I		Current source 250.0µA		1	Default current source for Resistance measurement. Very stable over environmental temperature range.
	II		Current source 2.500mA		1	Default source for RTD and bridge measurement. Very stable over environmental temperature range.
	N		Open circuit excite terminal (no excitation)		1	Excite terminal may be used as a single ended input channel. (Not available on DT50).
Special	M*x:y* all above		Special input signal routing	0 to 255	1	e.g. **0%V(M18:156, 101.0)** returns battery voltage and **0%I(M17:188, –0.22)** returns battery current (positive indicates charging, negative discharging).
	ES*n*		Extra samples	0 to 15	1	Allows addition sequential samples to be taken at scan time and averages the results. Results in reduced noise and increased resolution.
Resetting (to zero)	R		Reset counter, timer, variable after reading		2	Valid only for counters, system timers, variables e.g. *n***CV(R)** and for pulsing digital outputs (e.g. **1DSO(1000,R)=1** pulses output on for 1000mS).
Scaling	*f.f*		Channel factor	±1e18	2	Generally a scale factor specific to channel type (see "Channel Factor" column on page 4).
	Y*n*		Polynomial	1 to 20	3	Applies a previously defined polynomial of form **Y*n*=a,b,c,d,f,g"***text***"** (see "Polynomials" on page 7).
	S*n*		Span	1 to 20	3	Applies a previously defined span of form S*n*=*physical low, physical upper, signal lower, signal upper*"*text*" (see "Spans" on page 7).
	F*n*		Intrinsic functions	1 to 7	3	1 = 1/x, 2 = √x, 3 = Ln(x), 4 = Log(x), 5 = Absolute(x), 6 = x**2, 7 = Grey code to binary conversion (8 bit).
Data manipulation (cannot be used in Alarms)	DF		Difference Δx = (current - previous reading)		4	Returns the difference between latest reading and the previous reading.
	RC		Rate of change (per second) Δx/Δt		4	Rate of change based on latest and previous readings and their respective times.
	RS		Reading / time difference in seconds x/Δt		4	Useful when the sensor reading is already a difference (e.g. resetting counters).
	IB		"Integrate" (x_units.seconds) (x - Δx/2)*Δt		4	"Integration" with respect to time between two readings - the latest and previous.
Reference channel (not logged or displayed)	TR		Thermocouple reference temperature		5	Any non-thermocouple temperature sensor measuring isothermal block temperature. If already compensated use **11SV(TR)** as reference channel.
	TZ		Thermocouple reference zero channel		5	An electrical zero as measured at isothermal block (see "Thermocouples" on page 16)
	BR		Bridge excitation voltage channel		5	Used to nominate a voltage channel as reference for ratiometric bridge measurements (see "Bridges" on page 17)
Statistical (cannot be used in Alarms)	AV		Average of channel readings		6	Average
	SD		Standard deviation of channel readings		6	Standard deviation
	MX		Maximum channel reading		6	Maximum
	MN		Minimum channel reading		6	Minimum
	TMX		Time of maximum channel reading		6	Time of maximum
	TMN		Time of minimum channel reading		6	Time of minimum
	DMX		Date of maximum channel reading		6	Date of maximum
	DMN		Date of minimum channel reading		6	Date of minimum
	INT		Integral for channel		6	Integral
	H*x:y:n.m*CV		Histogram *x* = lower limit, *y* = upper limit	x,y ±1e18	6	Report time sampling, the results are place in variables *n*..(*m*-3)CV classes, (*m*-2)CV under range, (*m*-1)CV overange, *m*CV total counts (see page 6)
Variables	=*n*CV		Assign channel reading to variable	1 to 100	7	Assign
	+=*n*CV		Add channel reading to variable	1 to 100	7	Add
	–=*n*CV		Subtract channel reading from variable	1 to 100	7	Subtract
	*=*n*CV		Multiply variable by channel reading	1 to 100	7	Multiply
	/=*n*CV		Divide variable by channel reading	1 to 100	7	Divide
Output format	FF*n*		Fixed point *n* = decimal places	0 to 6	8	e.g. **FF2** returns 71.46 mV
	FE*n*		Exponential, *n* = significant digits	0 to 6	8	e.g. **FE2** returns 7.14e1 mV
	FM*n*		Mixed FF and FE, *n* = decimal places	0 to 6	8	Uses exponential format if exponent is less than – 4 or greater than *n*
	"*text*"		User defined channel name text	ascii text	8	Replaces the channel type text returned to host (when enabled by /**C**, /**U**, /**N**), and on the top line of the display (if present).
	NR		No return		8	Channels tagged with **NR** are not returned to the host computer. Useful for display channels (e.g. Bar Graphs) that need special formatting.
	NL		No log (cannot be used in Alarms)		8	Channels tagged with **NL** are not logged, but they are returned to the host computer.
	ND		No display		8	Channels tagged with **ND** cannot be displayed on the LCD screen (if present) in either normal or display list modes.
	W		Working or intermediate channel		8	Channels declared as intermediate working channels are not reported or displayed unless the working switch is on (/**W**). They are not logged.
	BG*x:y*		Bar graph	±1e18	8	Plots a bar graph on display. *x* = lower limit and *y* = upper limit. (see "Bar Graph" on page 12).

These conditions are established 10mS before the channel is sampled. This settling time can be changed by **7SV** and **P10** - see pages 6 and 11.

These options cannot be used directly in alarms. The channel must be included in a scan schedule where the channel value is assigned to a variable which can then be tested in alarm statements. e.g. **RA2S 1V(RC,=1CV) RZ2S ALARM1(1CV>0.45)1DSO**

Config Line – see "Multiple Reports" on page 4

These channel options link the channel to the statistical sub-schedule **RS**. The channel will be sampled at times determined by the **RS** trigger (which defaults to continuous rapid scanning). At the report time as determined by the **RA**, **RB**, **RC**, **RD** or **RX** schedules, the statistical summary will be reported. If no sample has been taken before the reporting time, then an error (9999.9) is reported. NOTE: Statistical options are not valid in alarms. If you want to alarm on a statistical value then use a channel variable (i.e. *n***CV**) to pass the statistical value to the alarm.

The time integral's time base is seconds. For other time bases apply a Span or Polynomial e.g. **Y1=0,2.778e-4"AHrs"** for hours.

The variables are like memory registers in a calculator. You can assign them directly (e.g. **1CV =2.5**) or assign a channel reading to the variable at scan time (e.g. **1V(=7CV)**). You can read the contents of a variable, modify it and then replace it with the modified value. For example **1V(/=7CV)** means the value of **7CV** is divided by the reading on channel 1 and the result is returned to **7CV**. NOTE: These actions occur only at report times and not during statistical sampling.

Options grouped by a bar are mutually exclusive. If more than one of a mutual exclusion group is placed in a channel list, then only the last is applied.

* Poly & Span index shared, a total of 20 allowed

Order of Application - this column indicates the order in which the options are applied. This order is independent of the order you list the options. For example the table shows that the logger evaluates a polynomial (**Y*n***) before a difference (**DF**).

Time and Other Channels ... channels on the inside

Time

The Datataker hardware clock has a resolution of one second, based on a 24 hour clock. The Time is read in the same way as any channel, but without a channel number:

T   returns   **Time 11:45:10**

Time can be in several formats, selected by **P39** as follows:

P39=	Format	Example
0 (default)	hours:minute:seconds	**11:45:10**
1	seconds since midnight	**42310**
2	decimal hours	**11.7528**

System Variable **12SV** returns Day.Time as decimal days.

P40 defines the separator in the hh:mm:ss format, which defaults to ASCII 58 (colon). When setting the clock you must use the Time format defined by **P39** and **P40**. For example if **P39=2** (in this case **P40** does not matter), then the clock Time must be set as a decimal value:

T=11.7528

Time is maintained during a **RESET** or power down. Time and Date stamp can be added to real time data and to logged data (see "Switches /T and /D" on page 11). Time and Date are automatically logged whenever data is stored.

Date

The clock also maintains the Date which is read in the same way as a channel, but without a channel number:

D   returns   **Date 25/12/1991**

Date can be in several formats, selected by **P31** as follows:

P31=	Format		Example
0	Day number	ddddd	**724**
1	European	dd/mm/yyyy	**25/12/1991**
2	N America	mm/dd/yyyy	**12/25/1991**

System Variable **12SV** returns Day.Time as decimal days. System Variable **15SV** returns the day of the current year.

The default Date format depends on the Country DIP switch (see the Appendices for your model). Set the Date format by **P31**, for example **P31=0** sets day number format. The clock Date must be set in the current Date format, for example if **P31=1** (European format) then Date is set by:

D=25/12/1995   or   **D=25/12/95**

In the day number format **P31=0** day number 0 is 1/1/1989. The Date is maintained during a **RESET** or power down. Time and Date stamp can be added to real time data and to logged data (see "Switches /T and /D" on page 11). Time and Date are automatically logged whenever data is stored.

Internal Channels

There are several internal channels which are read in the same way as normal channels:

Internal Channel	Command
Logger temperature	**1%LM35**
Expander Module (*n*) temperature	*n*:**1%LM35**
Electrical zero at multiplexer	**2%V**
Precision 100.0Ω ±0.1%	**2%R**
Precision 4700Ω ±0.1%	**3%R** (DTxx5 models)
Battery voltage	**0%V(M17:156,101)**
Battery current	**0%I(M17:188,-0.22)**

Text String

A Text channel of 80 characters is available for labelling, data headings, site identification, logger identification, etc. The string is defined by **$="***my text string***"**, and the current string is returned (or **U**nloaded) whenever **$** is included in a channel list. Control characters are entered as for example **^M** for carriage return, **^J** for line feed (see list on page 23).

System Variables - *n*SV

System Variables provide various system values. These are used in the same way as channels (See page 5).

1SV   Data points free in internal memory
2SV   Data points stored in internal memory
3SV   Data points free in card memory
4SV   Data points stored in card memory
5SV   Number of statistical scans in last schedule
6SV   Number of remote network errors (also **P9**)
7SV   ADC settling time in mS (**P10**), defaults to 10mS
8SV   Mains frequency in Hz (**P11**), defaults to 50/60Hz
9SV   =1 if memory card inserted, =0 if card not inserted
10SV Returns the schedule ID from which it is returned

   0 for **RX** (poll by host)   4 for **RD** schedule
   1 for **RA** schedule   5 for Immediate scan
   2 for **RB** schedule   6 for **RZ** (alarm schedule)
   3 for **RC** schedule

11SV Returns 0.0 (useful as a reference channel)
12SV Decimal day.time e.g. 56.5 is midday of day 56.
   Use formatting for more precision e.g. **12SV(FF4)**
13SV Returns the logger's address
14SV System attenuation factor (default = 214.61)
15SV Returns date as day number of the current year

Note: System Variables normally have no decimal places. Use the **FF***n* option to increase the resolution.

Values or expressions can be assigned to the System Variables **7SV** and **8SV**. For example

7SV=15

which sets the ADC settling time to 15mS (see "ADC Details" on page 18 for more information). Assignments to **7SV** and **8SV** can be within a schedule and the assignment is executed each time the schedule scans. Assignments outside of a schedule are executed immediately.

System Timers - *n*ST

There are four internal reloading System Timers, which are read in the same way as channels. The four Timers increment at different rates as follows, and reset to zero when their range (maximum value) is reached.

Timer	Rate	Default Range
1ST	1 second	60 (1 minute)
2ST	1 minute	60 (1 hour)
3ST	1 hour	24 (1 day)
4ST	1 day	7 (1 week)

The System Timers are synchronised to previous midnight or Sunday, and increment at the beginning of each second, minute, hour or day. The Timers are initialised to new values corresponding to the new time and date if the Datataker clock time or date is changed. For example if the time and date are set to 13:45:53 and 25/12/92, the Timers are set to **1ST=53**, **2ST=45**, **3ST=13** and **4ST=5** (Friday).

System Timers have channel options (see page 4):

*n***ST(** *range*, **R)=***initial*

The channel factor *range* is set between 1 - 65535, and if the **R** option is included then the Timer resets to zero after it is scanned (read) in a schedule. If a *range* other than the default is specified, then the timer is initialised to a value calculated from the previous midnight or Sunday.

Timers can be assigned an *initial* value or expression e.g. **2ST=3**. If the *initial* value is greater than the *range*, then the timer is set to zero when the next increment is due.

Statistical Operations ... great for reducing data

Introduction

Channels can be sampled frequently and a statistical summary returned at longer intervals (see "Statistical Sub-schedule" on page 3). Statistical channels are sampled for the period between report times, and the statistical summary is generated and returned at report time.

Channels that require statistical sampling must include a channel option to indicate the statistical information to generate. These options are:

Option	Description	Appended to Units
AV	average	**(Ave)**
SD	standard deviation	**(SD)**
MX	maximum	**(Max)**
MN	minimum	**(Min)**
TMX	time of maximum	**(Tmx)**
TMN	time of minimum	**(Tmn)**
DMX	date of maximum	**(Dmx)**
DMN	date of minimum	**(Dmn)**
INT	integral	**(Int)**
(**H***x:y:n..m***CV**	histogram	none)

The statistical option is defined by including it as a channel option in parentheses after the channel type. For example:

RA1M 3TT(AV)

will return

3TT 103.7 Deg C (Ave)

which is the average (**AV**) temperature returned every one minute (**RA1M**) for the type T thermocouple (**3TT**) which is connected to channel 3. The text "**(Ave)**" is appended to the units to indicate that the data is an average.

If statistical channels have not been sampled before they are reported, then these channels report error E53 (see page 20) and data returned as 99999.9. This condition is likely to occur when the **RS** trigger is an event, the statistical sub-schedule has been halted or a statistical scan interval (**RS**) is longer than the reporting time interval.

If statistical options are part of a Multiple Report channel (see page 4), then each option list must contain a statistical option. For example:

4PT385(I,500,AV)(MX)(TMX)(MN)(TMN)

Note the first option list (**I,500,AV**) must include all of the options required for managing and sampling the channel. This rule applies to any options above the "Config Line" in the "Channel Options" table (page 5), because the channel is sampled and scaled according to the first option list.

Statistical results are tested in alarms by first assigning them to Channel Variables (see page 7).

Average (AV)

The average or mean is the sum of all the channel readings divided by the number of readings. It is very useful in reducing sensor noise.

Standard Deviation (SD)

The standard deviation is a measure of the variability of the data about the average or mean. The variation may be due to electrical noise or process changes. The units of standard deviation are the same as the channel reading.

Maximum and Minimum

Maximum and minimum of a set of channel readings can be reported with the **MX** and **MN** options. Similarly the time and date of these can be reported with the **TMX**, **TMN**, **DMX** and **DMN** options. (Also see **/X** switch on page 11).

Integration (INT)

The integration option returns the integral (or "area under the curve") with respect to time in seconds using a trapezoidal approximation. The units of an integration are those of the original reading multiplied by seconds. When applied to a flow rate sensor:

S5=0,0.1,0,1000"litres"
3F("Fuel Consumption",S5,INT)

integration returns the volume of the flow:

Fuel Consumption 34.54 litres (Int)

The flow rate sensor with a frequency output (**3F**) is scaled by a span (**S5** - see "Spans" on page 7) and then integrated. Note that the span units have been declared as litres, which is the result after integration, although the span calibration is actually to litres per second.

Histogram (H*x:y:n..m*CV)

You can use the Datataker to generate a histogram (frequency distribution) of channel samples. When you attach the histogram option to a channel, the channel value is returned at report time and the respective channel variables are incremented. Then you use another schedule to read, log and clear the channel variables.
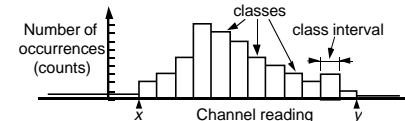
A histogram is specified as a channel option with the following format:

H*x:y:n..m***CV**

where
x is the lowest channel reading of interest
y is the highest channel reading of interest ($y > x$)
n is the first Channel Variable (*n***CV**) to store counts
m is the last Channel Variable (*m***CV**) to store counts

Three other counts are also stored as follows:

$(m-2)$**CV** = number of readings under range (<x)
$(m-1)$**CV** = number of readings over range (>y)
m**CV** = total number of readings including those out of range

For example, to histogram a temperature channel over 5 classes requires 8 Channel Variables as follows:

RA1S 1TT(H25.0:35.0:1..8CV)

This generates a histogram with 5 temperature classes with intervals of 2℃ as follows:

1CV   first class (25 to 27℃ interval) counts
2CV   second class (27 to 29℃ interval) counts
3CV   third class (29 to 31℃ interval) counts
4CV   fourth class (31 to 33℃ interval) counts
5CV   fifth class (33 to 35℃ interval) counts
6CV   number of samples under range (< 25℃)
7CV   number of samples over range (>35℃)
8CV   total counts or sum of 1..7CV

Then, for example, you can log the channel variables using another schedule:

RB1H 1..13CV(R)

The histogram channel option does not affect the usual reporting or logging of the channel's readings.

Note: There are only 100 Channel Variables, so the number of channels that can be histogrammed is limited.

Scaling Data and Calculations ... getting sophisticated !

Introduction

The Datataker provides many different methods for scaling and manipulating channel readings. Often a combination of methods is the most effective:

Automatic Scaling

All channel types return data in engineering units: volts, amps, ohms, hertz and °C (see "Channel Types" on page 4). Most sensors output one of these basic signals.

Channel Factor .. a floating point number

Many input channel types include a channel factor as an option. This usually provides a linear scaling. For example in

1V 1V(101.0)

the first item **1V** returns true millivolts, and second item **1V(101.0)** returns the Datataker reading multiplied by 101.0 in units of millivolts as follows

```
1V 2.543 mV
1V 256.84 mV
```

In this example the channel factor could for example be the attenuation of an input voltage attenuator network.

Intrinsic Functions - F*n*

The Datataker has seven inbuilt and mutually exclusive intrinsic functions. An Intrinsic Function is applied as a channel option. The Intrinsic Functions available are:

| Function	Description	Text Modifier
F1	1/x inverse	**(Inv)**
F2	√x square root	**(Sqrt)**
F3	Ln(x) natural logarithm	**(Ln)**
F4	Log(x) logarithm base ten	**(Log)**
F5	Absolute(x) absolute value	**(Abs)**
F6	x*x square	**(Squ)**
F7	Grey code conversion (8 bit)	**(Gc)**

Channels with an Intrinsic Function applied will return data appended with the text in the right-hand column of the table. For example **1V(F2)** will return the square root of the reading:

```
1V 455.6 mV (Sqrt)
```

If you place more than one Intrinsic Function in a channel's option list, only the last will be applied.

Spans - S*n*

Spans are used to define calibrations for linear sensors. Spans are particularly suited to 4–20mA loop inputs.
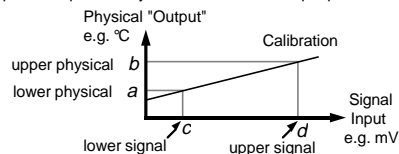
A total of 20 Spans and Polynomials can be defined. A span is defined with the following syntax:

S*n*=a,b,c,d " text "

where *n* = 1 to 20, the *text* replaces the channel units text. The physical (*a, b*) and signal (*c, d*) limits define any two points on the calibration line, not necessarily the end points. Note: *c* and *d* default to 0 and 100 if not specified, which is useful for 4-20mA current loop channels.

A single Span definition may be applied to any number of channels in any schedules or alarms.

The defined span is applied to a channel as a channel option. For example

**S17= 0,300,100,1000"KPa"
1V(S17,"Boiler pressure")**

returns

```
Boiler pressure 239.12 KPa
```

As a rule it is best to define Spans (and Polynomials) in a program before the schedules and alarms are entered.

Polynomials - Y*n*

Polynomials are used to define calibrations for non-linear sensors using the formula:

$$y = \sum_{n=5}^{0} k_n x^n = k_0 + k_1 x + k_2 x^2 + k_3 x^3 + k_4 x^4 + k_5 x^5$$

where *x* is the channel reading, and the k's are coefficient terms. The polynomial is defined by the coefficient terms:

Y*n* = $k_0, k_1, k_2, k_3, k_4, k_5$ " text "

where *n* is the polynomial number between 1 and 20. A total of 20 Spans and Polynomials can be defined.

Only the coefficient terms up to the required order need to be entered. Simple scale and offset corrections are also possible (internally the Datataker treats Spans as a first order polynomial). The *text* replaces the channels default units text. Polynomials are applied to channels as a channel option:

**Y18= 25.5,0.345,0.0452"Deg C"
1V(Y18)**

will return

```
1V 44.35 Deg C
```

The coefficient terms of a polynomial are evaluated by a least square regression. Various statistical programs are available for this purpose. Some nonlinear sensors are supplied with their calibration polynomial.

A single Polynomial definition may be applied to any number of channels in any schedules or alarms.

Channel Variables - *n*CV

Channel Variables are floating point data registers. The Datataker has 100 Channel Variables, identified as **1CV** to **100CV**, which can store channel readings and the result of expressions. Channel Variables can be used within expressions (see "Calculations" below), and can be included in schedules to return, store and display their current values.

Channel Variables are assigned the current value of any input channel by including the Channel Variable in a channel option list. For example

1V(=2CV)

returns the voltage for channel 1 AND stores (overwrites) the value into the channel variable **2CV**.

You can also use one of four basic arithmetic operations (**+=, −=, ∗=** and **/=**) when storing input channel data into channel variables. For example:

5V(+=1CV) - scans channel **5V**
  - sets **1CV=1CV+5V**
  - reports the value of **5V**
5V(S1, /=1CV) - scans channel 5V
  - applies span 1 (S1)
  - sets **1CV=1CV/5V(S1)**
  - reports the value of **5V(S1)**

The assignments are made at the report time of the embracing **RA**, **RB**, **RC**, **RD**, **RX** schedule. Channel Variable assignments are not made at the Statistical Sub-schedule scan time.

When a Channel Variable is included as a channel option for a statistically scanned channel, the statistical **result** is stored in the Channel Variable and not the individual readings. For example the program

RS5S RA10M 3V(AV,=1CV)(MX,=2CV)(MN,=3CV)

will store the 10 minute average, maximum and minimum into Channel Variables **1CV**, **2CV** and **3CV** respectively.

Channel variables can also be assigned the results of expressions (see "Calculations" below). For example

3CV=(1+COS(2CV))∗1.141

evaluates the expression and assigns the result to **3CV**.

Using Channel Variables

Channel Variables are used in the same way as input channels within schedules and alarms. Channel options can be used to modify the function and data format of Channel Variables. For example

5CV(BG-5.0:5.0,NL,NR)=6CV+7CV

assigns to **5CV** the sum of **6CV + 7CV**, and displays the result as a bar graph (**BG**). Data is not logged or returned.

Channel Variables are not normally returned with units text, however you can define units using polynomials:

**Y20=0,1.0"KPa"
11CV(Y20)=SQRT(4CV/6CV)**

Channel Variables can be used in alarms both as the test value and as the setpoint(s). For example

ALARM1(4CV< >2CV,3CV)"[5CV=20]"

Channel Variables are useful when comparing an input channel against several thresholds. For example

**IF1(1V(=1CV)>0.5)"Over 0.5 Volts"
IF2(1CV>0.6)"Over 0.6 Volts"
IF3(1CV>0.7)"Over 0.7 Volts"**

where channel **1V** is sampled once (rather than risking different values) and tested against a number of setpoints.

Where statistical results are to be tested, then Channel Variables provide the only means of using statistical results in alarms. For example the program

**RZ1M RS1S RA1M 3TT(SD,=1CV,W)
ALARM1(1CV>0.1)"Excessive variability"**

tests the standard deviation of the temperatures read over each minute.

When input channels or Channel Variables are used in intermediate steps of a program, then the **W** channel option can declare these as working channels and prevent data being returned, logged or displayed. During program debugging the **W** option can be over-ridden by the **/W** switch (see page 11) to return and display intermediate data.

Calculations .. only at report time

The Datataker has a powerful expression evaluation capability. Results can be assigned to Channel Variables, output channels, System Timers and System Variables.

Expressions can ONLY contain Channel Variables and constants. Data from input channels must first be assigned to Channel Variables to be used in expressions.

Expressions can contain the following operators

Arithmetic	**+, −, ∗, /, %** (modulus) and **^** (exponent)
Relational	**<, <=, =, >=, >** (result 1 is true, 0 is false)
Logical	**AND, OR, XOR, NOT** (>0 is true, result 0 or 1)
Functions	**ABS(), LOG(), LN(), SIN(), COS(), TAN(), ASIN(), ACOS(), ATAN(), SQRT(),** Y*n*(), S*n*()
Other	Parentheses **()**

Note: The trigonometric functions require arguments in radians, where 1 radian = 57.296 degrees.

The operator precedence is **(), ^, ∗, /, %, +, −, <, <=, =, >=, >, AND, OR, XOR** and **NOT**. The underlined operators have equal precedence. Expressions evaluate left to right, however parentheses can be used to define a particular order of evaluation. Parentheses can be nested.

The total number of expressions in a program is limited to 100, and collectively are limited to 3848 characters.

Expressions are evaluated at the report time of the embracing schedule, and in the order in which they occur within the schedule.

Conditional Calculations

Boolean logic within expressions can be used to return a result which is dependent on a condition being true or false as follows:

2CV=(1CV∗2∗(1CV<1000))+(1CV∗4∗(1CV>=1000))

which returns a value of 2∗**1CV** if **1CV** is less than 1000, or a value of 4∗**1CV** if **1CV** is greater than or equal to 1000.

Combining Methods

The different scaling and calculation methods can be used together. Comprehensive examples are the best way to demonstrate. In the following program, a vector average is calculated. The inputs are wind speed and direction.

```
'Wind speed calibration   0 – 50 m/s = 0 –1000mV
S1 = 0,50,0,1000"m/s"

'Wind direction  0 – 2π radians (0 – 360 deg) = 0 –1000mV
S2 = 0,6.2832,0,1000"radians"

Y3 = 0, 1"m/s"     ' Units text for wind speed report
Y4 = 0, 1"Deg"     ' Units text for wind direction report
BEGIN
  RA5S   ' Schedule to scan every 5 seconds
    1V( S1, = 1CV, W)  ' Sample wind speed
    2V( S2, = 2CV,W)   ' Sample wind direction
    3CV( W ) = 3CV + 1CV ∗ COS( 2CV )  ' Sum x comp's
    4CV( W ) = 4CV + 1CV ∗ SIN( 2CV )  ' Sum y comp's
    5CV( W ) = 5CV+1.0   ' Number of scans

  RB1M   'Calculate, report and log every minute
    'calculate mean magnitude
    6CV(W) = SQRT(( 3CV ∗ 3CV ) + ( 4CV ∗ 4CV )) / 5CV
    6CV("Mean Wind Mag.",Y3,FF1)

    'calculate direction
    7CV(W) = ATAN ( 4CV / 3CV ) ∗ 57.29

    'determine direction quadrant
    7CV(W) = 7CV + (( 3CV > 0 ) AND (4CV < 0 )) ∗ 360
    7CV(W) = 7CV + (( 3CV < 0 ) AND (4CV < 0 )) ∗ 180
    7CV(W) = 7CV + (( 3CV < 0 ) AND ( 4CV > 0 )) ∗ 180

    'if wind speed is zero, return -1.0
    7CV(W) = 7CV − ( 6CV < = 0 ) ∗ ( 7CV + 1 )
    7CV("Mean Wind Dir.",Y4,FF0)

    1..5CV(W) = 0
END
LOGON  G
```

The following program scans ten channels and calculates a cross channel average:

```
BEGIN
  RA10S
    1CV(W) = 0          ' clear 1CV
    1..10V(+ = 1CV, W)  ' sum 10 voltages into 1CV
    1CV = 1CV / 10      ' divide by 10 for average
END
```

Data Logging and Retrieval ... go for quality not quantity

Introduction

The Datataker has two locations in which to store data:
- the internal memory, which stores 13,650 data points
- PC Card (PCMCIA) memory cards, which store up to 343,980 data points in a 1Mbyte memory card

The management for the internal memory and memory card varies according to the state of an inserted card as follows:

• If an empty memory card is inserted, the Datataker will transfer any data in the internal memory to the memory card, and then will continue logging to the card.

• If a memory card containing data from the same program is inserted, the Datataker will append any data in the internal memory to the memory card, and then continue logging to the card.

• If a memory card containing the data from a different program is inserted, the Datataker will not transfer data from internal memory to the card, but will continue logging to the internal memory. If you issue a **CDATA** command to clear the memory card, then data will be transfered after clearing.

Data Logging Commands

Data logging is globally enabled by **LOGON** and is disabled by **LOGOFF**. By default data logging is disabled.

How Data is Stored

All data is logged as 24 bit (16 bit mantissa) floating point numbers. Internal calculations are 32 bit floating point.

Each schedule stores a three byte header per scan for identification, scan time and scan date. When logged data is unloaded this header and the original schedule are used to interpret the data. Schedules cannot be replaced when data has been logged, until data is cleared by **CLEAR** & **CDATA**.

Stop When Full Mode - /o

By default, data logging stops when the memory is full – the earliest data is retained and the most recent discarded. If a memory card is used, the internal memory is used only after the memory card is full.

Overwrite Mode - /O

Alternatively the oldest data may be overwritten when the memory is full. This is invoked by the **/O** switch. The internal memory is not used in overwrite mode when a memory card is used. You can change the **/O** mode switch at any time, however the internal memory does not become available if a memory card is in use.

Storage Capacity

Data storage capacity is difficult to calculate because of the three byte header per schedule per scan. If the three byte header is considered as a channel, then the following figures are reasonably accurate:

Memory	Capacity (readings)	Total (card+internal)
Internal	13,650	13,650
512K PC Card	169,260	182,910
1M PC Card	343,980	357,630

Time and date in a channel list are handled as any other channels, i.e. three bytes each. It is more efficient to use the **/T** and **/D** switch commands - see pages 6 and 11.

Not Logging Channels

All input channels in **RA**, **RB**, **RC**, **RD** and **RX** schedules are logged after the **LOGON** command is issued. The **NL** (No Log) channel option prevents logging of individual channels. The **W** (Work) channel option prevents logging, return and display of the channel data.

Unloading Data

Logged data is unloaded from internal or card memory by:

U *source schedule* **(***start point***)(***end point***)**

source	**I** - from internal memory
	M - from memory card
	none - unload from the memory card then if same data set, internal memory
schedule	**A**, **B**, **C**, **D**, or **X** - schedule
	none - unloads all schedules logged
(*start point***)**	(time,date) or (time)
	BEGIN - from beginning of stored data
	LAST - from end of last unload
	none - from beginning of stored data
(*end point***)**	(time,date) or (time)
	END - to end of stored data
	LAST - to end of last unload
	none - to end of stored data

All are optional, however an **(***end point***)** can only be included if a **(***start point***)** is included. Some examples are:

U	unload all data, oldest first
U(LAST)	unload most recent unloaded data
UA(BEGIN)(LAST)	unload schedule **A** from beginning to the same point as previous unload
UMB(12:00,19/1/91)(12:00,20/1/91)	unload **B** schedule data from memory card between the two times

The oldest data is returned first and the schedules are merged chronologically in **X**, **A**, **B**, **C**, then **D** order. The format of unloaded data is the same as for real-time data (see page 5). During an Unload the **/r** (return), **/e** (echo) and **/m** (error messages) switches are disabled. These are returned to their previous state on completion of unload.

Data is not cleared from memory by Unload operations.

Quitting an Unload

An Unload operation is aborted by the **Q** quit command.

Time and Date Stamping

The scan Time and Date can be prefixed to the data unloaded from each schedule by enabling the **/T** and **/D** switches. This can be done even after the data is logged.

Time and Date prefixing defaults to OFF (**/t /d**).

Logging Status

You can check the number of data points stored and the free space with commands and system variables:

STATUS	lines 5, 6 and 7 (or **STATUS5 STATUS6** etc.)
1SV	Internal data points free
2SV	Internal data points stored
3SV	Memory Card data points free
4SV	Memory Card data points stored

Clearing Stored Data

You can clear logged data anytime with the commands:

CLEAR	clears all data logged in the internal memory and disables logging (**LOGOFF**)
CLAST	clears data in internal memory or memory card card that has been unloaded by **U** command i.e. only if all schedules were unloaded.
CDATA	clears all data logged in memory card
RESET	clears internal memory (and program) but not memory card data (or program)

The **CLEAR** command may appear to fail if logging is enabled, because new data is logged soon after the clear. The solution is to first stop the logging with **LOGOFF** or **H**.

Memory Cards and Programs ...added convenience

Introduction

The Datatakers support PC Card memory cards which conform to the PCMCIA Type II standard. PC Card memory cards of up to 1Mbyte in capacity can be used.

The memory cards increase the storage capacity of the Datataker, and because the cards are removable they are also a reliable media for transporting data and programs.

For maximum reliability, do not expose the memory card to temperatures over 45°C for extended periods, to ionising radiation or to static electricity discharge.

Replace the lithium battery annually, using the same cell or another cell recommended by the card manufacturer.

Card Specific Commands

There are seven commands specifically for managing memory card operation:

CDATA	clears card data
CPROG	clears program space on a card
COPY	transfer internal data to the card
NOCOPY	disables transfer of data to the card
CARDID="*text***"**	assigns a card ID
CARDID	returns the card ID
RUNPROG	forces running of card program
CTEST	clears data and program, and tests the entire card

Card Identification

You can name a memory card with the command:

CARDID="*label text***"**

The *label text* can be up to 40 characters, of which the first 16 are displayed. This text is shown on the lower line of the display when you insert the memory card. It is also returned in response to the command **CARDID**.

Card Formatting

New Cards are automatically formatted when inserted into the logger, and are given the default CARDID="*xxx*KB" where *xxx* is the size of the memory card.

Card Processing Flow Chart

When a memory card is inserted into the Datataker, the subsequent processing and actions depends on the status of the memory card and the status of the logger.

The tests performed on the memory card by the logger, and the actions taken as a result the tests, is detailed in Appendix - "Memory Card Processing Flow Chart".

Programming from Cards

A memory card can hold a Datataker program of up to 4090 characters. Commands are entered into the Datataker in the normal way, except that each line must begin with a semi-colon. The logger copies lines prefixed by a colon into the program area of an inserted memory card. For example:

```
;CSCANS CALARMS
;/m /n /u P22=44 P24=13
;ALARM1(1V>55.0)4DSO
;ALARM2(5TJ>107.0)"Temp. Alarm"
;RA5M 1V 5TJ 2HSC
;LOGON
```

Note: If a program in a write protected PC Card memory card includes a **RESET** command, then the Datataker will suspend operation until the card is removed, or the write protect switch is moved to the disabled position.

When the commands are copied into the program area of the memory card, these are appended to the current contents of the program area. If there was a previously stored program on the memory card, then the new program is appended to the old program. The old program must first be cleared by a **CPROG** command if not required.

The **STATUS** command returns the used and available space in the program area of the memory card, and **STATUS8** also shows the full program listing.

NOTE: The syntax of the card program is not checked until the program is actually run. Check the program by executing the **RUNPROG** command while the card is inserted, or by removing and re-inserting the card. Inserting a card causes immediate program execution (if **/Q** is set to the default in the Datataker – see below).

When is a Card Program Run ?

When you insert a memory card into the Datataker, any program on the card is normally loaded into the logger, compiled and run immediately. Datatakers with a display will show the message **Prog**. You can stop automatic loading of card programs by setting the **/Q** switch to **/q**.

The program on an inserted memory card can be loaded and run by the **RUNPROG** command. This executes a card program immediately, irrespective of the setting of the **/Q** switch. Only the **/F** switch will prevent the execution of the **RUNPROG** command (see "Switches" on page 11).

Transferring Data to the Card

Normally data in the internal memory is transferred to the memory card after any card program is executed. The transfer can take up to 100mS.

Datatakers with a display module will show the message **Append**, depending on whether the data is appended to existing compatible data, and shows the message **Xfer** when the transfer occurs.

If the card already holds data from a different program, then no transfer occurs and Datatakers with a display will show the message **Can't Copy Data**.

When a single memory card is to be used to recover data, and to reprogram the logger, you must transfer the logged data before reprogramming. This is done by using the **COPY** command in the program to force data transfer before the logger is reprogrammed:

```
;COPY
;LOGOFF CLEAR CSCANS
;RA10M 1..5V LOGON
```

Automatic data transfer from the internal memory to card can be prevented by placing a **;NOCOPY** command on the first line of the card program. The **NOCOPY** action is automatically cleared when the card is removed.

Clearing the Memory Card

The data storage and program areas on a memory card can be separately erased as follows:

CDATA	clears all data
CPROG	clears the card program
CTEST	clears data and program, and tests the entire card

CDATA and **CPROG** commands can be executed from a card program. However **CPROG** must be the last command in the card program, since any commands after it will be cleared from the card before execution.

Removing the memory card's battery for more than two minutes also clears the card.

Alarms ... limits and tests

Introduction

The Datataker Alarm allows you to make decisions about input channels, timers, the clock, variables, etc. If an Alarm condition is true you can set digital outputs, issue messages or execute commands to change Datataker function. There are two basic types of Alarm:
- **ALARM** or **IF** command which acts once on the transition from false to true.
- **ALARMR** and **IFR** command which acts repeatedly while the alarms tests true.

The Number of Alarms

Alarms share an internal scan table of up to 110 entries with the data acquisition schedules. The scan table must be partitioned before any schedules or alarms are defined, with the **P30** command. For example **P30=40** will allow the entry of 40 alarms, and 110 – 40 = 70 data acquisition channels. **P30** defaults to 20 alarms.

The Scanning of Alarms

By default the Datataker scans alarms as fast as possible. The actual rate depends on the number of Alarms and data channels defined. As a rule, allow 40mS for each analog input and 10mS for each Channel Variable, time and digital input.

The Alarms schedule is triggered in the same way as schedules for data acquisition (see"Schedules" on page 3):

RZ	rapidly as possible (default)
RZ*n* **S**	seconds
RZ*n* **M**	minutes
RZ*n* **H**	hours
RZ*n* **D**	days

where *n* is an integer in range 1 to 65535

RZ*n* **E**	event on either transition	
RZ*n*+**E**	event on positive transition	where *n* is
RZ*n*-**E**	event on negative transition	a digital
RZ*n***C(***count***)**	counter event after *count*	channel
RZ*n***HSC**	event on *any* HSC counts	number

HZ, GZ	**H**alt and **G**o for all Alarm scanning
HZ*n*, **GZ***n*	Disable and enable Alarm number *n*

Note: an Alarm disabled by an **HZ***n* command will not be enabled by the global **GZ** command. Only the **GZ***n* command will re-enable individually disabled alarms, and then only if alarm scanning is enabled (**GZ**).

The Listing of Alarms

The **STATUS3** command (see page 10) returns a list of all defined alarms. The keyword "ALARM" is in upper case for enabled alarms and in lower case for disabled alarms. Channels in the alarm list do not show their channel options.

Erasing Alarms

Erase all defined Alarms with the **CALARMS** command, and erase individual alarms with the **CALARM***n* command, where *n* is the Alarm number.

Polling Alarm Data

Return the most recent data from the Alarm input channel to the host by using the Alarm query command:

?*n*	returns Alarm number *n* data
?ALL	returns data for all defined Alarms

The data format is the same as for channel data, except that the channel number is replaced by the Alarm Number. For example **?5** will return:

```
A5 123.4 Deg C.
```

ALARM5(4#L(S3)<>110.0,150.0/10S)1DSO,4DSO"Boiler Temp ?[RA2S]"

Alarm Number

The Alarm Number identifies the alarm. If you enter two alarms with the same number the second overwrites the first.

The Alarm Number must not be greater than the **P30** value (see Number of Alarms). The Alarm Number is also used to poll for current alarm data values with the **?***n* command (see Polling Alarm Data), and in the **HZ***n*, **GZ***n* and **CALARM***n* commands.

Channel Definition

Any input channel type with options (see "Channel Types" on page 4), or Channel Variable, or System Timer, System Variable, etc. can be the input to Alarm commands.

Conditional Test

The input channel or Channel Variable is compared with one or two (comma separated) set points. The set points can be a floating point constant or a Channel Variable. The number of set points depends on the logical operator:

Operator	Set Points	Operation
<	1	less than set-point
>	1	greater than or equal to set-point
< >	2	less than first set-point, OR greater than or equal to second set-point
> <	2	greater than or equal to first set-point AND less than second set-point

The following example shows use of a conditional test:

ALARM3(2V>660.0)4DSO

When the voltage on channel 2 equals or exceeds 660.0mV, the digital output channel 4 is turned ON. When the voltage drops below 660.0mV the output is turned OFF.

Output Channels (optional)

One or two (comma separated) output channels (see "Channel Types" on page 4) can be declared for each Alarm to reflect the alarm condition. These outputs are set on transitions of the Alarm condition and after all Alarms have been scanned. Only two output channel types are permitted:

*n***DSO**	General purpose digital output
*n***WARN**	LEDs (1..3), Beeper (4) etc. (see page 12)

If multiple alarms use the same output channel, then the effects are OR'ed. Any active alarm will set the output to ON, but all alarms must be false to reset the shared output OFF. The output channel can be cleared at any time by digital assignment (e.g. **1DSO=0**). Unlike Action Commands (see right), the Output Channels are set or cleared on both the positive and negative transitions of the Alarm condition.
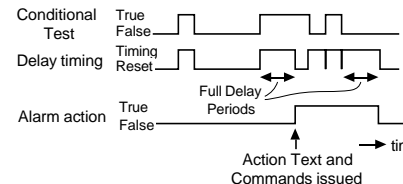
Delay Period (optional)

When the Alarm's conditional test changes state (i.e. false to true or true to false) no action is taken until the delay period has expired AND the state has not changed during this period. The format is:

/*n***S**	Seconds
/*n***M**	Minutes
/*n***H**	Hours
/*n***D**	Days

where *n* is an integer in the range 1 to 255

When the state changes during the delay period the delay counter is reset and will not count again until the next state change. The result is a filtering action that ensures that input noise will not cause unwanted or rapid output actions.

Note that the output channels (if any) reflect the state of the Alarm Action line in the above diagram. This line changes state only after the full delay period has expired.

Action Text (optional)

Text placed in quotes is sent to the host computer and display whenever an **ALARM***n* or an **IF***n* alarm transits from false to true, or repeatedly at the **RZ** rate while an **ALARMR** or **IFR** alarm remains true, and any delay period has expired. The action text may be up to 200 characters, however the total text space reserved for all Alarms is 4000 characters.

Note: There is no garbage collection in this text space. Each new action text is appended to the list, and superseded text is only removed by a **RESET** or **CALARMS** command.

Control characters can be embedded in the Action Text such as **^G** (bell), **^M** (CR), **^L** (LF), **^b** (quotes), etc.

Various data can be placed into the Action Text by including special substitution characters:

!	insert Datataker address and alarm number (*a*:*n*)
?	insert current data value
#	insert day or date (in **P31** format)
@	insert time (in **P39** and **P40** format)

e.g. the Action Text **"Boiler Pressure = ? MPa"** will return:

```
Boiler Pressure = 1.563 MPa
```

on each false to true transition of the Alarm. No Action Text is issued on the true to false transition.

Setting the **/Z** switch to **/z** will stop the return of the Action Text to the host (see "Switches" on page 11). This is useful when the Action Text is only required for the display.

This Example: Alarm number 5 is defined (or replaces any previous definition). A current loop on single ended channel 4 (**4#L**) scaled by a span (**S3**) is monitoring a boiler temperature. If the temperature drops below 110.0 or rises to or above 150.0, for more than 10 seconds (**/10S**), digital outputs 1 and 4 (**1DSO**, **4DSO**) are set ON, the message **"Boiler Temp 152.0"** is sent to the host and to the display (if present), and schedule "**RA**" is re-programmed to scan at two second intervals (**[RA2S]**).

Action Commands (optional)

The Action Text can include a group of one or more Datataker commands enclosed by square brackets. These are Action Commands, and are executed once when an **ALARM** or **IF** alarm transits from false to true, or repeatedly at the **RZ** rate while an **ALARMR** or **IFR** alarm remains true.

Action commands are a very powerful programming facility for the Datataker. You can use any Datataker command in this context, so many things become possible:

- re-programming on events
- adaptive schedules
- programmed calibration cycles
- control of digital outputs

Adaptive scheduling is a common use for managing the Datataker from the Alarm command. In the example:

```
RA15M 1V(AV,"Wind speed",S1,=1CV)
IF1(1CV>5.0)"[RA2M]"
IF2(1CV<4.5)"[RA15M]"
```

the average wind speed is recorded every 15 minutes and assigned to a variable (**1CV**). If the average exceeds 5.0 m/s, the schedule's report interval is reduced to 2 minutes by the first alarm (**IF1**) command. When the 2 minute average drops below 4.5m/s the report interval is returned to 15 minutes by the second alarm command (**IF2**). Note the deliberate 0.5 hysteresis to prevent an "oscillation" around the switch over point. Adaptive scheduling can reduce total data volume while giving greater time resolution when required.

Instead of changing the report interval as in the above example, data logging could have been enabled or other schedules modified. The possibilities are endless!

Combining Alarms

Alarms can be logically combined to yield a single result by replacing the action text / action commands of all except the last Alarm in the group with a logical operator for example

```
IF1(3TK>100)OR
IF2(2TK>100)OR
IF3(5TK>100)AND
ALARM4(1DS>0/10S)"Temp. Error [RA5S]"
```

where the message is output 10 seconds after digital input 1 is high and any one of the three temperatures exceeds and stays above 100 degrees. Note the substitution of the keyword **IF** to improve readability of the program. Only the delay period, output channels and action text of the last Alarm are performed.

Available logical operators are **AND**, **OR** and **XOR**. You must order the Alarm numbers from low to high, as evaluation is sequentially from low to high. Missing Alarm numbers are allowed provided you do not define them elsewhere.

Output Format

Introduction

The Datataker has many ways to format data returned to the host computer and display. Data format is controlled globally by the following Parameters and Switches (see also page 11):

- **/H** fixed format mode - defaults off (see Advanced Coms. Manual).
- **/U** include units text appended to the data - defaults on
- **/N** include channel number and type (ID) before data - defaults on
- **/L** include logger number before scan data - defaults off
- **/C** include channel type (**/C**) or number only (**/c**) - defaults on
- **/D** include scan date at beginning of returned data - defaults off
- **/T** include scan time at beginning of returned data - defaults off
- **P22** data delimiter in **/u** mode (default 32, a Space)
- **P24** scan delimiter in **/u** mode (default 13, a Carriage Return)
  - Note: A Line Feed character (ASCII 10) is always added to a Carriage Return (ASCII 13)
- **P31** date format - see "Date" on page 6
- **P32** maximum number of significant digits - 0 to 9, default is 5
- **P33** defines a fixed field width for output data - default 0, variable
- **P38** decimal point locator character for floating point numbers - default is ASCII 46, a period "**.**"
- **P39** time format - see "Time" on page 6
- **P40** time separator character - default is 58, a colon " **:** ")

The default data format is verbose and descriptive, for example:

```
    RA5S 1V 3PT385 1C("Widgets") /T /D
```

returns

```
    Date 25/12/92
    Time 12:45:00
    1V 2.490 Volts
    3PT385  395.0 Deg C
    Widgets 3498 Counts
```

where the Switches default to **/U/N/C**. Parameters **P22** and **P24** are not used as delimiters while units text is enabled (**/U**). However the data format can be condensed the to a form more useful for computers

```
    1453, 12.7500, 2.490, 395.0, 3498
```

where the Switches are set to **/u/n** and the Parameters are set to **P22=44** (a comma), **P24=13** (a return), **P31=0** (day number) and **P39=2** (decimal hours).

Data format control is global and is applied to real-time data, unloaded data and the data returned by the **TEST** and **STATUS** commands. Note: All data is kept internally as 3 byte data, and is formatted when returned. Data format can be changed between successive memory Unloads.

Data Numeric Format

The numeric format of data is set for channels by channel options:

- **FF**n Fixed point, n = number of decimal places (n = 0 - 7)
- **FE**n Exponential, n = number of significant digits (n = 0 - 7)
- **FM**n Mixed **FF** or **FE** formats. Uses **FE** format if exponent is less than −4 or greater than n. (n = 0 - 7)

Examples of the numeric format channel options for returned data:

Default	FF1	FE3	FM1	FM2
23.456	23.5	2.346e1	23.5	23.46
−0.025	−0.0	-2.542e−2	−0.0	−0.03
1034.6	1034.6	1.035e3	1e3	1034.64

Note that the default format depends on the channel type returning the data. See the "Channel Types" table on page 4, especially the resolution column. Formatting options are not applied to the 99999.9 error data code (see "Errors" on page 20).

Parameter **P33** allows returned data to be in fixed fields. All data is placed into fields of the same width defined by **P33**, by space padding to the left. If the field width is not sufficient, least significant characters are truncated from the right. Fixed fields are useful when returned data is to be tabulated, or forwarded to software with a simple string parser.

More Commands

TEST

The **TEST** command forces a calibration, and checks the functionality of the hardware. The **TESTR** command will force continuous calibrations. The information returned to the host computer is:

Returned Data	n	Description	Valid Range
`Datataker 52 Ver 5.xx`	0	configuration & ROM version	–
`Vos (mV) 0.009`	1	input offset voltage	±1 mV
`Vfo  (V) 7.308`	2	input voltage for VCO = 0Hz	6.0 to 8.50V
`Fc (kHz) 18.200`	3	VCO centre frequency	11.46 to 23.87kHz
`CMRR(db) 99.6`	4	common mode rejection ratio	>90db
`Vos3(mV) 0.238`	5	three wire input offset voltage	-1.9 to 3.1mV
`Tos   1.0023`	6	terminator attenuation	0.99 to 1.01
`Ios (nA) -3`	7	input bias current offset	±30nA
`Ibia(nA) 15`	8	input bias current	±90nA
`Ibat(mA) 0.5`	9	battery current (– for discharge)	-500 to +600mA
`Vbat (V) 6.6`	10	battery voltage	5.4 to 13.0V
`Vos*(uV) -95`	11	✳ single ended offset voltage	−600 to +110µV
`Vos+(uV) 33`	12	+ single ended offset voltage	±180µV
`Vos-(uV) 10`	13	− single ended offset voltage	±180µV
`Vos#(uV) 66`	14	# single ended offset voltage	−110µV to 600µV
`Vosd(uV) 5`	15	differential offset voltage	±180µV
`Ics1(mA) 2.4994`	16	current source 1 current	0.5mA to 10mA
`Ics2(uA) 250.31`	17	current source 2 current	1µA to 500µA
`PASS`		test pass or fail	–

Test data that is out of range is flagged with a "fail" message. Use the **/u** switch to make test results less verbose.

TESTn returns line n of the test results and **TEST**n**R** produces continuous test cycles of line n. Continuous reporting is stopped by the next carriage return.

RESET

The **RESET** command clears the Datataker of all data and programs. Use it carefully, or risk losing valuable data. The **RESET** command also initiates a calibration, and a sign-on message is returned to the host computer:

```
        Datataker 0 Version 5.xx
        Initializing ... Done
```

The **RESET** command does not clear the Datataker clock, or clear data or program from a memory card.

Do not send any other commands to the Datataker for five seconds after you have entered the **RESET** command. Use **\Wn** in DeTerminal to force a pause after **RESET** in a command file, for example:

```
RESET
\W5
CDATA
```

STATUS

The **STATUS** command returns the status of the Datataker's schedules, channels, alarms, memory and logging to the host computer. Typical returned information:

	n
`Datataker 0 Version 5.xx`	1
`A,none Scan Schedules Active,Halted`	2
`0,0 Alarms Active,Halted`	3
`0 Polynomials/Spans Defined`	4
`Logging is OFF`	5
`13650,0 Internal Data Points Free,Stored`	6
`169260,0 Card Data Points Free,Stored`	7
`4090,0 Program Characters Free,Stored`	8
`/A/C/d/E/f/h/J/K/l/M/N/o/Q/r/S/t/U/v/w/x/y/Z`	9

The first line shows the Datataker's address (see "Networking" on page 14) and ROM version. The line of switches indicates the current switch settings (see "Switches" on page 11). Use the **/u** switch to make **STATUS** results less verbose.

The remaining lines are described below. Each **STATUS** line can be returned individually:

```
                    STATUSn
```

where n is the line number. **STATUS2**, **3**, **4** and **8** return extra information. There are also other status levels that are not returned by the general **STATUS** command.

STATUS2 returns the scan schedules:

```
    A, none Scan Schedules Active,Halted
    RA15M 1TT("Room Temp")
```

If a memory card containing data is present, then the schedules returned are appropriate to the card's data. The **X** schedule is not given an active or halted state. Note: For this status report the schedules are simply stored as text in a buffer of 512 bytes. If your program exceeds 512 characters, the remaining program text is not returned and is replaced by three periods ("...").

STATUS3 returns alarms (without channel options). The keyword "alarm" is in lower case if the alarm is halted (by the **HZ**n command - see page 9):

```
    2,1 Alarms Active,Halted
    RZ5S
    ALARM1(3V>105)1DS0
    ALARMR2(4V<75)2DSO"[1DS0=0]"
    alarmr3(5TT<72.0)3DS
```

STATUS4 returns defined polynomials and spans:

```
    2 Polynomials/Spans Defined
    Y1=3.54,1.009"Deg C"
    S7=0.0,100,0.0,1.0"KPa"
```

STATUS5 STATUS6 STATUS7 returns the data logging status, and the data stored and free in the internal memory and card memory respectively.

STATUS8 returns the memory card program:

```
    4015,75 Program Characters Free/Stored
    ;Y1=0.0382,14.4"kPa"
    ;RA15S T 1V(Y1,=1CV)
    ;ALARM1(1CV>150)2DSO"Boiler"
```

STATUS9 returns the Datataker's current switch settings

```
 /a/C/d/E/f/h/J/K/l/M/N/o/Q/R/S/t/U/v/w/x/y/Z
```

STATUS10 returns further information about the current program in the logger.

```
27113,1989,1,0,"",<A,"2S",H,<"Dry bulb","",0,0,5,4,3>,
<"Wet bulb","",0,0,5,4,3>,<"Humidity","%RH",0,0,5,4,
3>>,<B>,<C>,<D>,<X>
```

This report is a list of comma separated items providing details about the Datatakers program. In order, they are Program ID, Base year, Time resolution, Card status, Current $ string, followed by Schedule fields that identify individual channels, their format and their units. If there is no program the following is returned:

```
            0,0,0,0,"",<A>,<B>,<C>,<D>,<X>
```

Refer to the "Datataker Advanced Communications Manual" for detailed description.

STATUS11 returns information about the program on an inserted memory card. The format is the same as for **STATUS10**. Refer to the "Datataker Advanced Communications Manual" for a detailed description.

STATUS12 returns the time and date of the first and last data points stored in the Datataker's internal memory:

```
00:11:33 on 05/11/1992,00:13:00 on 19/01/1993 Internal
data Start,End times
```

STATUS13 returns the time and date of the first and last data points stored in an inserted memory card:

```
00:11:33 on 05/11/1992,00:13:00 on 19/01/1993 External
data Start,End times
```

These and other **STATUS**n commands are described fully in the "Datataker Advanced Communications Manual".

Parameters ... internal settings

Introduction

Parameters are internal system settings. They are global in their effect, and let you set a variety of options. As a general rule, set the parameters that require changing before you program schedules and alarms.

Setting Parameters

Parameters can be set at any time, and new settings generally take effect immediately. For example

P22=44 set Parameter 22 to 44

Note that in fixed format mode (see below) three parameters are forced: **P22=44**, **P24=13** and **P38=46**. The original values for these are restored on leaving the fixed format mode.

Reading Parameters

Entering the command:

P22

will return the setting of parameter **22**.

Parameters are not the same as channels or variables. If you include a parameter in a schedule, it does not become part of the schedule. Instead it is processed immediately.

You can set or read parameters from the host computer, from a memory card program or from Alarm Actions.

Param. Number	Function	Units	Default Value	Range of Values	Comment
P0	Calibration interval	µV	4µV	0 to 10,000	Input zero drift allowed before re-calibration (see "Accuracy" on page 17).
P1	2.500 volt reference trim	10µV	0µV	-30,000 to 30,000	Software trim of 2.5000 volt reference for calibration (see "Accuracy" on page 17).
P2	Temperature trim	0.001°C	0°C	-30,000 to 30,000	Trims internal LM35 temperature sensor. For thermocouple reference junction temperature calibration (see page 16).
P3	Reference resistor trim	mΩ	0mΩ	-30,000 to 30,000	Trims the internal 100.0Ω±0.1% reference resistor (see "Accuracy" on page 17).
P4	Lost count flag	count	0	read only	If this is greater than zero, then counts may have been missed by the low speed counters.
P7	Network turnaround time	# 14mS	1	1 to 30,000	Set as number of 14mS intervals. Useful for use with radio modem network. Typically would set **P7=22** corresponding to 300mS
P9	Remote network error	# errors	0	0 to 30,000	Network errors have occurred if **P9**>0.
P10	ADC settling period	mS	10mS	0 to 30,000	Time between channel selection and beginning of ADC (see also "**7SV**" on page 6 and "ADC Details" on page 18).
P11	Mains frequency	Hz	50/60Hz	48 to 1000	Sets ADC sample duration to 1/Hz seconds. Default value read from the country DIP switch (see "**8SV**" on page 6).
P12	Transmit errors	# errors	0	0 to 30,000	Transmission errors in protocol mode (see the "Datataker Advanced Communications Manual").
P13	Digital input sample period	mS	50mS	0, 10 to 100	Sample interval on digital inputs (and keys on display), determines minimum detectable pulse width. **P13=0** disables digital input.
P14	Password timeout	seconds	300S	1 to 30,000	When a password is defined the Datataker will automatically **SIGNOFF** after this period of inactivity (see "COMS Port", page 13).
P15	Low power operation	mode	0	0 to 2	0 = auto, 1 = force low power, 2 = force normal power mode (see"Setting the Power Mode" page 15).
P16	ADC warm up time	100mS	1 (100mS)	1 to 255	Minimum time from wake-up to first ADC in 100's of milliseconds, useful for sensors with a long power-up settling time.
P17	Delay to low power mode	seconds	30S	1 to 255	Delay to low power mode from last communications, external wake, or keypad input (see "Setting Power Modes" page 15).
P18	Auto scroll time	seconds	2S	1 to 255	Time in seconds to display each screen when Display is in scroll mode (see "Scroll Keys" on page 12).
P19	Status screens to display	bit map	255	0 to 255	Bit map of status screens to display on Display (see "Status Screens" on page 12).
P20	Wake schedules	bit map	0	0 to 255	Bit mask of schedules that are not to wake the logger – D C B A S X Z (see "Low Power Operation" on page 15).
P21	Return data to address	address	128	0 to 128	Logger address to which returned data is to be sent. **P21=**address. **P21** defaults to 128 which means normal addressing.
P22	Data delimiter character	ASCII	32 (space)	1 to 127	ASCII character (as decimal number) between data points in **/u** mode (see "Output Format" on page 10). Forced to 44 by **/H**.
P23	Calibration samples	count	3	1 to 10	Determines calibration "noise", a compromise between calibration speed & accuracy.
P24	Scan delimiter	ASCII	13 (CR,LF)	1 to 127	ASCII character (as decimal number) between groups of data points in a scan in **/u** mode (see "Output Format" on page 10).
P25	Unload completed character	ASCII	0 (none)	0 to 127	ASCII character (as decimal number) that is placed at the end of an **U**nload dump in **/u** mode (see "Output Format" on page 10).
P26	XOFF timeout before XON	seconds	30	1 to 254	Timeout before XOFF is automatically switched to XON. **P26**=0 disables timeout, and **P26**=255 ignores received XOFFs.
P30	Number of alarms permitted	count	20	0 to 110	Number of alarms that can be entered. Must be set before any schedules or alarms are entered (see "Introduction" on page 9).
P31	Date format	mode	1 or 2	0 to 2	0 = day number, 1 = dd/mm/yy (European), 2 = mm/dd/yy (N American) (see "Date" on page 6 for default value).
P32	Number of significant digits	# digits	5	1 to 9	Sets significant digits of output data. Note: logged data is always stored to 5 digits, so **P32**>5 is only useful for realtime data.
P33	Field width	# characters	0 (variable)	0 to 200	If P33>0 this defines fixed field width for all output data (right justified, space padded or least significant digits truncated).
P36	Temperature units	mode	0 (°C)	0 to 3	0 = °C, 1 = °F, 2 = °K, 3 = °R. Data is converted before being placed into store and cannot be converted at **U**nload time.
P38	Decimal point character	ASCII	46 (.)	0 to 127	The character used as a decimal point in floating point numbers (see "Output Format" on page 10).
P39	Time format	mode	0 (hh:mm:ss)	0 to 2	0 = hh:mm:ss, 1 = seconds, 2 = decimal hours (hh.hhhh) (see "Time" on page 6).
P40	Time separator	ASCII	58 (:)	1 to 127	ASCII character (as decimal number) separator character for hh:mm:ss time format (see "Time" on page 6).

Switches .... UPPER CASE "**ON**", lower case "**off**"

Introduction

Switches are analogous to electrical switches, and are turned on by upper case and off by lower case. Switches are internal system settings, and generally global in effect. Switch commands can be issued at any time, and most take effect immediately. Delay in effect may occur if data is buffered in the Datataker or in the host computer.

Viewing Switch Settings

The **STATUS9** command returns the current switch settings to the host e.g.

        /a/C/d/E/f/h/J/K/l/M/N
        /o/Q/r/S/t/U/v/w/x/y/Z

Fixed Format Mode /H

The fixed format mode is recommended for those writing drivers to interface host software with the Datataker. In this mode the **/u/n/e/r** switches are forced to ensure a fixed format. These switches are restored to their original values when the Datataker receives **/h**. (See the "Datataker Advanced Communications Manual" for a complete description. For advanced users only).

| Switch Enabled	Switch Disabled	Function	Default	Comment
/A	/a	Display alarms	/a	Enable the display of displayable alarms (see "Displaying Alarms" on page 12)
/C	/c	Channel identification	/C	Channel type is included with channel number with returned data e.g. "**5PT392**" instead of "**5**" (see "Output Formats" on page 10).
/D	/d	Prefix date to data	/d	Prefix date to logged data – equivalent to a **D** at beginning of a schedules channel list.
/E	/e	Echo	/E	Enables echo of commands to host. Useful in terminal mode communications with the Datataker.
/F	/f	Fix schedules	/f	Prevents a logger's scan schedules (trigger or channel list) being modified (see "Schedules" on page 3). A **RESET** will still erase schedules.
/H	/h	Formatted mode	/h	Fixed format mode of data output. Switches and Parameters are saved by **/H** and restored by **/h**. See the "Datataker Communications Manual".
/J	/j	Over range error carry	/J	Errors are carried through expressions so that expression will return 99999.9. If disabled, 99999.9 is substituted for reading in the expression.
/K	/k	Calibration	/K	Enables auto-calibration. Issuing a **/K** forces an immediate calibration. Datataker always calibrates during a **RESET**.
/L	/l	Logger number prefix	/l	Prefixes the logger number to a schedule's returned data e.g. **Datataker 19 5PT385 232.5** indicating the data is from logger 19.
/M	/m	Messages	/M	Enables error and warning messages to be returned to host (see "Errors" page 21).
/N	/n	Channel numbers	/N	Includes channel number (and type if **/C** switch is on) with returned data (see "Output Formats" on page 10).
/O	/o	Overwrite memory	/o	Oldest data is over-written (**/O**), otherwise logging stops when memory is full (see "Logging and Data Retrieval" on page 8).
/Q	/q	Program from card	/Q	Allows the logger to be programmed using a memory card (see "Memory Card" on page 8). **/q** will prevent a logger executing a card program.
/R	/r	Return data	/R	Allows real-time data to be returned to the host via the COMS port. Switching returns off (**/r**) can reduce power consumption.
/S	/s	Synchronise	/S	Synchronises all schedules' time intervals to midnight (e.g. **RA1M** will scan on the minute), otherwise schedules run from entry time (see page 3).
/T	/t	Prefix data with time	/t	Prefix time to logged data – equivalent to a **T** at beginning of a schedules channel list.
/U	/u	Units text	/U	Measurement units are appended to returned data (see "Output Formats" on page 10), and error messages are verbose (see "Errors" on page 21).
/V	/v	Speaker enable	/V	Enable speaker and headphone output by Geologger.
/W	/w	Intermediate channels	/w	Allows working channels (see channel option "**W**" on page 5) to be reported and displayed but not logged (see also "Calculations" on page 7).
/X	/x	Progressive max, min	/x	Allows the display of progressive maximum and minimum values for statistical channels on a Datataker display.
/Y	/y	Priority to return data	/y	If real-time data has not been returned before next scan becomes due, the returning of data is given priority and the scan may be omitted.
/Z	/z	Stops alarm messages	/Z	Enables alarms to issue action text to host computer or printer. See "Action Text" on page 9.
//	–	Default switches	–	Sets all switches to default state.

Display Panel Operation ...

Introduction

The Datataker display panel has a 2 line by 16 character back-lit liquid crystal display, 5 keys, 3 warning LEDs and a buzzer. The display provides information about Datataker status, channel data, alarms and memory card operation.

You cannot program the Datataker from the display panel, however you can issue pre-defined commands by pressing a panel key combination (function key).

List Key:

While the key is held down the display is in list edit mode. In this mode you can access all displayable items using the Scroll keys. Items that are not normally displayed will become visible, and will be seen to be flashing on and off. Pressing the Light key while the List key is held down toggles the display / non-display (flashing) state of the selected item.

Function Shift Key:

Pressing this key in conjunction with one of the other keys (F1 to F4) executes a user defined command sequence. When pressed, the display shows the four function key labels:

```
┌─────────────────────┐
│ ←       LED On    → │
│           LEDOff    │
└─────────────────────┘
```
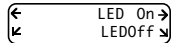
These are the default assignments. When a function key is pressed, the display identifies the key and its label:

```
┌─────────────────────┐
│      Function 2     │
│    --> LEDOff <--   │
└─────────────────────┘
```
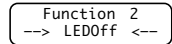
Pressing List and Function Shift keys together will reinitialize the display controller if affected by noise or otherwise corrupted. Setting **6WARN** to any value has the same effect.

Function Keys

Assign function keys by the command:

K*n***="***label***","[***command sequence***]**

where *n* is the function key number, *label* is the text (up to six characters) that appears on the display and *command sequence* is any set of space separated commands. For example:

K2="Scan 1",[/r/s RA10S 1..5TT]

places the **/r/s RA10S 1..5TT** program on function key F2. Each command sequence may be up to 255 characters, and must be entered in a single line.

The default function key assignments are:

K1="LED On", [1..3WARN=1]
K2="LEDOff", [1..3WARN=0]
K3="", [ ]
K4="", [ ]

The function keys can be very useful. For example, they can be used to completely reprogram the Datataker. A different program could be assigned to each key. They can be assigned by **ALARMS**. Remember however that stored data must be cleared before a new program can be loaded.

Light Key:

Toggles the back-light on and off. Setting **6WARN=1** turns the back-light on and **5WARN=1** flashes it. When the Datataker sleeps the back-light is switched off.

In conjunction with List key, the Light key enables or disables items for display. Disabled screens are flashed while the List key is pressed, but are not visible when the key is released.
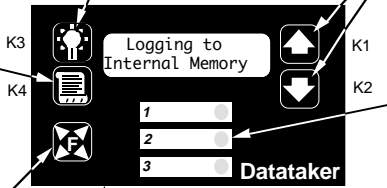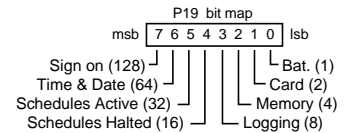

Label Area:

You can label the warning LEDs with a felt tipped pen.

Status Screens

There are 8 status screens (see Scrolling through the Status Screens) which display system information. By default all screens are available for display and enabled. They can be disabled using the List and Light keys.

Status screens can be made unavailable for display by **P19**. Each bit in this parameter value represents a status screen. A "1" enables and "0" disables. The bit mapping is:

```
              P19 bit map
      msb  7 6 5 4 3 2 1 0  lsb
```

Sign on (128) ┐   ┌ Bat. (1)
Time & Date (64) ┤   ├ Card (2)
Schedules Active (32) ┤   ├ Memory (4)
Schedules Halted (16) ┘   └ Logging (8)

To make screens available set **P19** to the sum of the numbers following the required screens, e.g. for Battery Condition and Logging Status screens only set **P19=9** (i.e. 1 + 8). By default **P19=255** and all screens are available. If **P19=0** and there are no channels or alarms to display then the Sign On Screen is displayed.

Any status screens disabled by this method are not available for display by the List key.

Power Consumption

The Datataker Display Panel draws less than 3mA while the back-light is off. However with the back-light switched on the current draw increases to approximately 80mA. This is very significant and represents a 70% increase in the logger's normal power consumption. The result can be that battery life is reduced when the back-light is left on.

However if the power mode is left at the default (see "Setting the Power Mode" on page 15) the display power consumption should not be an issue.

Scroll Keys:

Allow scrolling through the displayable screens. Holding a scroll key down for more than three seconds starts auto-scrolling in that direction. The scroll speed is set by **P18** in seconds. By default **P18=2** seconds. Pressing either scroll key stops the auto-scroll.

Warning LEDs & Buzzer:

Three LEDs may be illuminated under program control, for example:

1..2WARN=1 3WARN=0

switches LEDs 1 and 2 ON and LED 3 OFF. The buzzer is controlled by **4WARN** and the display back-light by **5WARN**. These both pulse about twice per second when ON. **6WARN** controls the display back-light but without flashing.

Displaying Channels

When you display channel data, the top line of the display shows the channel identification. The default is the channel number and type. If a channel identification text has been entered as a channel option, then the first 16 characters of that text is displayed.

The bottom line on the display shows the most recent reading as a numeric value or bar graph. See examples to the right.

If the channel has not been sampled, the display shows " – – – ". Normally displayed channels are only up-dated at report time. The **/X** switch allows the progressive display of statistical channels at the statistical scan time.

By default all scheduled channels are available for display and are displayed. To stop display of a channel, include the **ND** option in the channel's option list. For example:

1V(ND)

won't display data in normal or list edit modes.

You can declare channels as intermediate working channels with the **W** option. This makes those channels unavailable for display, logging or returning to the host computer while the **/W/w** switch is set to the default **/w**. Setting the switch to **/W** allows normal display and returning to host, but not logging.

Displaying Alarms

When you display alarms, the top line of the display identifies the alarm and the state of the alarm – ON or OFF. If the alarm channel definition includes identification text, then this is displayed when the alarm is not true. If the alarm contains action text, this is displayed when the alarm is true.

The bottom line of the display shows the most recent reading as a numeric value or bar graph. See the examples to the right.

Alarms are available for display by default, but are not automatically displayed. They can be enabled for display using the List and Light keys. The **/A** switch forces display of alarms if entered before the alarm commands. The **ND** channel option can be used to make alarm channels unavailable for display.

Controlling The Screens

On first power-up or after a **RESET**, the display shows the Sign On Screen. There are two levels of display control:

First level – the programmer uses:
    W (intermediate working channel) option
    P19 (status screen enable)
   **ND** (no display) channel option.

These controls determine if a channel is available for display. By default data channels and alarms are available. The screen is then displayed only if enabled at the second level.

Second level – the operator using the keys:
    List (hold down for edit list mode)
    Scroll (select screen)
    Light (enable – disable display item)

This process enables or disables available screens for display. By default, status and channel data screens are displayed. Alarm screens must be manually enabled for display, or by setting **/A**.
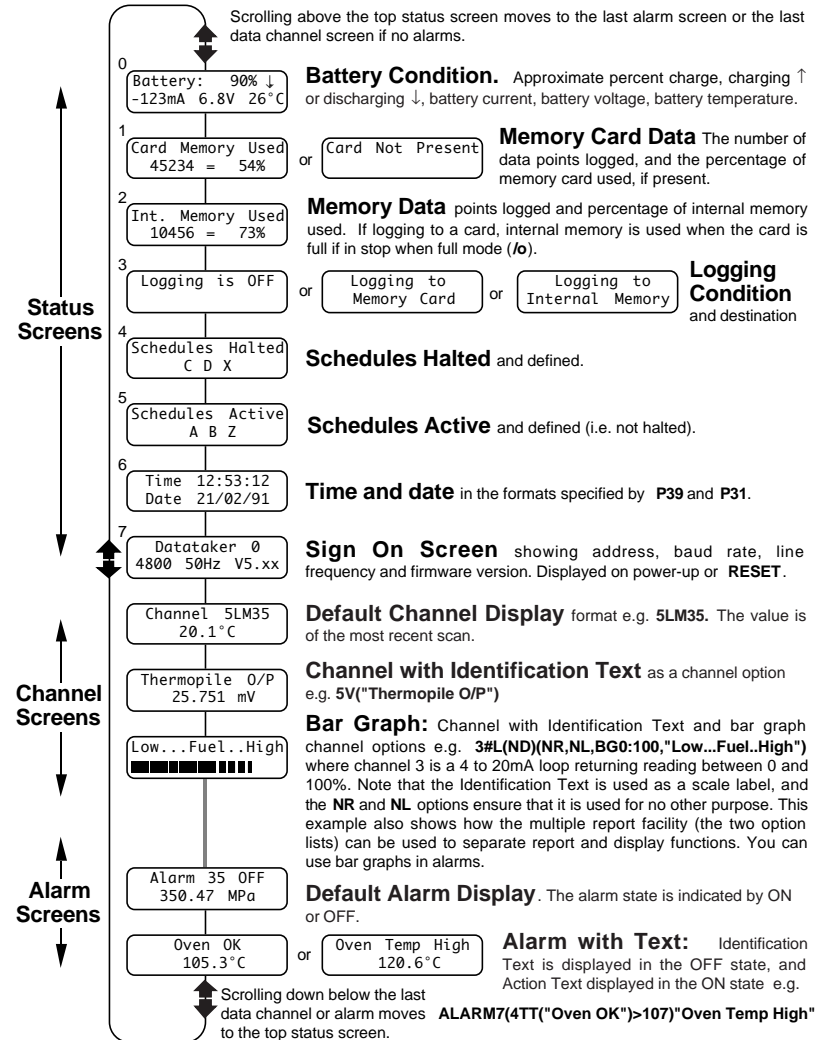
Scrolling above the top status screen moves to the last alarm screen or the last data channel screen if no alarms.

Status Screens

```
0 ┌────────────────────┐
  │ Battery:   90% ↓   │
  │ -123mA 6.8V 26°C   │
  └────────────────────┘
```
Battery Condition. Approximate percent charge, charging ↑ or discharging ↓, battery current, battery voltage, battery temperature.

```
1 ┌────────────────────┐        ┌────────────────────┐
  │ Card Memory Used   │   or   │ Card Not Present   │
  │   45234 = 54%      │        │                    │
  └────────────────────┘        └────────────────────┘
```
Memory Card Data The number of data points logged, and the percentage of memory card used, if present.

```
2 ┌────────────────────┐
  │ Int. Memory Used   │
  │   10456 = 73%      │
  └────────────────────┘
```
Memory Data points logged and percentage of internal memory used. If logging to a card, internal memory is used when the card is full if in stop when full mode (**/o**).

```
3 ┌────────────────────┐   ┌────────────────────┐   ┌────────────────────┐
  │ Logging is OFF     │ or│ Logging to         │ or│ Logging to         │
  │                    │   │ Memory Card        │   │ Internal Memory    │
  └────────────────────┘   └────────────────────┘   └────────────────────┘
```
Logging Condition and destination

```
4 ┌────────────────────┐
  │ Schedules  Halted  │
  │      C D X         │
  └────────────────────┘
```
Schedules Halted and defined.

```
5 ┌────────────────────┐
  │ Schedules  Active  │
  │      A B Z         │
  └────────────────────┘
```
Schedules Active and defined (i.e. not halted).

```
6 ┌────────────────────┐
  │ Time 12:53:12      │
  │ Date 21/02/91      │
  └────────────────────┘
```
Time and date in the formats specified by **P39** and **P31**.

```
7 ┌────────────────────┐
  │ Datataker 0        │
  │ 4800 50Hz V5.xx    │
  └────────────────────┘
```
Sign On Screen showing address, baud rate, line frequency and firmware version. Displayed on power-up or **RESET**.

Channel Screens

```
  ┌────────────────────┐
  │ Channel 5LM35      │
  │    20.1°C          │
  └────────────────────┘
```
Default Channel Display format e.g. **5LM35.** The value is of the most recent scan.

```
  ┌────────────────────┐
  │ Thermopile O/P     │
  │   25.751 mV        │
  └────────────────────┘
```
Channel with Identification Text as a channel option e.g. **5V("Thermopile O/P")**

```
  ┌────────────────────┐
  │ Low...Fuel..High   │
  │ ▮▮▮▮▮▮▮▮▮▮▯▯▯▯▯▯   │
  └────────────────────┘
```
Bar Graph: Channel with Identification Text and bar graph channel options e.g. **3#L(ND)(NR,NL,BG0:100,"Low...Fuel..High")** where channel 3 is a 4 to 20mA loop returning reading between 0 and 100%. Note that the Identification Text is used as a scale label, and the **NR** and **NL** options ensure that it is used for no other purpose. This example also shows how the multiple report facility (the two option lists) can be used to separate report and display functions. You can use bar graphs in alarms.

Alarm Screens

```
  ┌────────────────────┐
  │ Alarm 35 OFF       │
  │   350.47 MPa       │
  └────────────────────┘
```
Default Alarm Display. The alarm state is indicated by ON or OFF.

```
  ┌────────────────────┐   ┌────────────────────┐
  │ Oven OK            │ or│ Oven Temp High     │
  │   105.3°C          │   │   120.6°C          │
  └────────────────────┘   └────────────────────┘
```
Alarm with Text: Identification Text is displayed in the OFF state, and Action Text displayed in the ON state e.g.

ALARM7(4TT("Oven OK")>107)"Oven Temp High"

Scrolling down below the last data channel or alarm moves to the top status screen.

Introduction

All Datataker models have a 9 pin female (DE9) connector for RS232 or RS423 communications to a computer. This interface, referred to as the COMMS port, is the means by which you program the Datataker (or a network of Datatakers) from a host computer.

The COMMS port of all models of the Datataker is electrically isolated. Refer to the Appendix for details of the COMMS port of your Datataker .

COMMS Port Parameters

The COMMS port parameters are fixed except for the baud rate as follows

Baud rate	300, 1200, 2400, **4800** or 9600
Data bits	8
Parity	none } fixed
Stop bits	1

The baud rate is set by a DIP switch which is accessed by removing the Datataker top cover. Refer to the Appendix for your Datataker for details of the location of the switch, and the settings. **The Datatakers are shipped with the baud rate set to 4800 baud.**

Operation

All communications with the Datataker are with the ASCII character set. The eighth bit is normally a "0", however an extension to the character set (for the text strings and for special display characters) is possible if this bit is set to a "1". For all commands other than switches and text strings, the Datataker ignores lower case characters.

By default most characters that are received by the Datataker are echoed (transmitted back to the host). This action is disabled by the echo switch **/e**.

Special Characters

XOFF	stops Datataker transmitting
XON	allows Datataker to transmit
BS (backspace)	deletes previous character
	(echoes BS space BS)
DEL (delete, Alt 127)	clears command input buffer
	(echoes < < CR LF)
CR (return)	terminates a command line
	(echoed as CR LF)
LF (line feed)	ignored
Space and tab	command separator
# (hatch)	network address identifier
; (semicolon)	directs command to memory card
' (single quote)	comment character (up to a CR)
@	message to remote COMS port
	in a network

XOFF – XON

If the Datataker returns data faster than the host is able to receive, then the host can transmit an XOFF character. Within two character periods the Datataker will stop data transmission, giving the host time to process its buffered data. When the host is again ready to receive data, it should transmit the XON character allowing the Datataker to resume transmission. A logger in XOFF mode can also auto-XON (see P26 on page 11).

The Datataker also issues an XOFF when its input buffer is 50%, 75% and 90% full and an XON when the input buffer is empty.

Special Commands

The Datataker has three serial interface commands to assist in managing communications.

^ZCMSRST will clear the input and output buffers, and set XON.
^ZSXOFF will XOFF the Datataker
^ZQXON will XON the Datataker

The last two commands allow remote loggers to be XOFF'ed and XON'ed without modems in the link "consuming" the commands.

Loading a Program

The Datataker's input buffer is 250 characters long, and a burst of 250 characters without a pause between characters is possible. A single command line must be less than 250 characters. The Datataker begins to process the input buffer when the first carriage return is received. A full 250 characters of program takes up to 500mS to compile if the Datataker is not scanning, and up to 5 seconds if it is running long schedules and many alarms. Any digital assignment delay periods such as **1DSO(1000)=0** add to this time.

The host must ensure that the Datataker has sufficient time to process a down-loaded program. This can be achieved by using the XOFF – XON protocol, or by time delays between transmissions.

Waking From Sleep Mode

If characters are received while the Datataker is in Sleep Mode, the Datataker wakes. Characters received in the first 75mS are lost. Characters received between 25 and 75mS after the first character may generate communications errors and should be avoided.

To reliably wake and communicate with a Datataker that may be in sleep mode, send a carriage return or line feed and wait 300mS before sending commands.

Password Protection

The Datataker has a password protection scheme on the COMS port. When enabled, communications through the COMS port is only possible after the user defined password is entered. Password protection is particularly useful when the Datataker is connected to a modem. This eliminates the situation where line noise may be interpreted as commands during call establishment. Unauthorised access also becomes more difficult. The password is set by assignment:

PASSWORD="*password text***"**

where the *password text* may be any string (except for command keywords) up to 10 case sensitive characters. Assigning a null string (i.e. **PASSWORD=""**) removes a password.

To establish communications, enter the password followed by a carriage return at any time. This signs the user on. The COMS port stays open until the **SIGNOFF** command is issued, or while there is communications activity. If there is no communications for a period of time defined by **P14** (in seconds), the COMS port will timeout and is closed. The default timeout period is 300 seconds (5 minutes).

The Datataker will respond to the DEL character with **<<** CR LF regardless of the password state. This can be used to identify a Datataker.
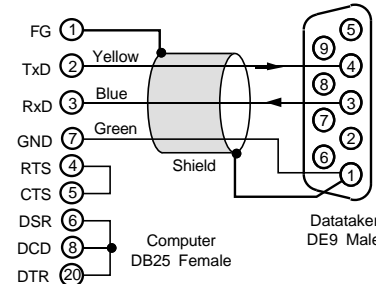
The COMMS Port

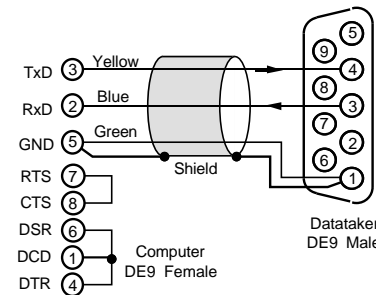The Datataker COMMS port connector is detailed below
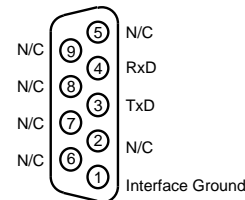
The configuration of communications cables for connecting the Datatakers to various computers and modems are detailed below.
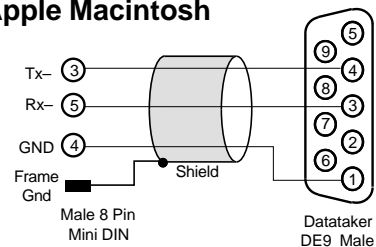
IBM and Compatibles - 25 pin

IBM and Compatibles - 9 pin

Apple Macintosh

COMMS Port Isolation

The COMMS port of all models of the Datataker Series 2 data loggers are electrically isolated to 500V.

Using Modems with Datataker

The following comments relate to the Remote Modem (at the Datataker end). Settings for the Local Modem (at the computer end) are not critical, and the manufacturers defaults can be used.

Enter the following commands into the Datataker using a computer running DeTerminal or other communications program, before connecting the Remote Modem

/e	'Datataker echoes OFF
/m	'Datataker messages OFF
/r	'Datataker returns OFF

It is suggested that a PASSWORD (see opposite) be used for link security, and to protect the logger from "garbage" characters created when the link between the modems is disconnected.

The DTR input to the Remote Modem must be asserted. This is done in the cabling by tying DTR high, by a DIP switch setting on some modems, or by using the AT&D0 command.

Enter the following commands into the Remote Modem with a computer running DeTerminal or other communications program. These commands are typical, however some modems may need different commands for some of these settings. (The text in the brackets are comments, and should not be entered).

AT&F	(Set factory defaults)
AT&D0	(Ignore the DTR signal)
AT$F0	(Xon/Xoff flow control - CTS/RTS cannot be used)
ATS0=2	(Auto Answer after two rings - other values are OK)
ATQ1	(Disable response codes - CONNECT , OK etc.)
ATE0	(Disable echo)
ATY1	(Enable Break disconnect)
AT&W0	(Save settings in User Profile 0 - sometimes AT&W)

It is important that the RS232 port of the Remote Modem is locked to a baud rate. 4800 baud is recommended. Two command possibilities are shown below. Please consult your modem manual for the exact commands

| AT&L7 | (Sets modem to the Datataker default of 4800 baud) |

or

| ATN0 | (Set baud rate to that nominated by S37) |
| ATS37=8 | (S37 defines 4800 baud) |

For a more comprehensive discussion about use of modems, refer to the "Datataker Advanced Communications Manual".

If the Remote Modem has a "dumb" mode, use it! This mode is manufacturer specific, and usually means that the modem is preconfigured to a known state, and will not respond to commands. Consult the modem's manual for details.

Modem (DCE) Cable
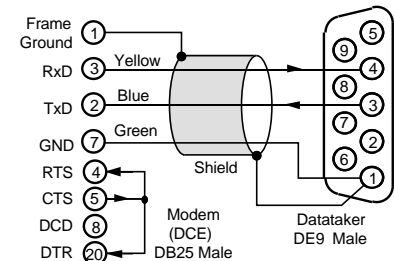
Networking ... distributed processing

Introduction

Datataker models with an RS485 network port can be connected in a local area network (LAN) with up to to 32 Datatakers. A total of 1000 meters of cable is allowed in the network.

The proprietary network protocol has error detection and correction, and operates at 1200 baud over a single twisted pair of polarised wires. Datatakers are wired in parallel so that all "NET+" screw terminals are connected to one wire and all "NET−" screw terminals are connected to the second wire. Ideally, the network cable should have a shield that is grounded at a single point.

Network - a Twisted Pair of Wires (note polarity)

"Local Logger"

RS232 or RS423 interface
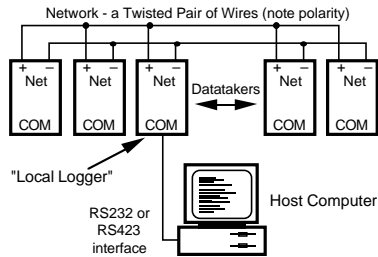
Host Computer

The host computer may be connected to any of the Datatakers (referred to as the local logger) in the network through its COMS port. Data is returned to the COMS port of the local logger. **P21** will allow this return address to be over ridden - see "Parameters" on page 11.

You can connect host computers to different Datatakers in a network. If each host is simply polling for data with immediate schedules (see page 3), operation is predictable. If you enter repeating schedule types (**RA**, **RB**, **RC** or **RD**), then the data generated by these schedules will only be available to the host that issued them.

Addressing Datatakers

The host may issue commands to any Datataker by placing an address prefix at the beginning of a command line:

#n *commands*   send *commands* to logger *n*
*commands* send *commands* to all loggers

e.g.

#5 RA1M 3V

will command logger 5 to return to the host the voltage on channel 3 every minute.

Take care in using the global address **##** when the command returns data, as the data from the loggers may be mixed and not easily separated. The global address is particularly useful for setting the time, switches and parameters on all loggers:

T=11:23:30
/N/c/u/L P22=44

The address is optional for commands to the local logger. Remote loggers must be addressed.

Identifying the Data Source /L

Data returns by to the COMS port that made the request, unless changed by **P21**. To identify the data source, it is recommended that all loggers in the network be issued with the **/L** switch so that all Datataker responses have the logger address at the beginning of each schedule's returned data.

For example, for channels **1..3TT** with switches set to **/n/c/u/L** and **P22=32** (i.e. "space" - the default), the returned data will have the following format:

19 25.6 45.8 32.7

If the **/N** switch is enabled (default), then the word "Datataker" is added to the logger address and the channels are identified:

Datataker 19 1TT 25.6 2TT 45.8 3TT 32.7

If the units text switch is also on **/U** then the returned data will look like the following:

Datataker 19
1TT 25.6 Deg C
2TT 45.8 Deg C
3TT 32.7 Deg C

Note that the logger address is placed at the beginning of each schedule's scan report. Data unloaded from the data memory is treated identically.

An alternative method to identify the Datataker from which the data is being sent is to load the Datataker with an identifying string (e.g. **$="Logger 19"**), which is then included in a schedule. For example the program:

#19 $="Logger 19"
#19 $ 1..3TT P22=44 /n/u

will return data to the host:

Logger 19,25.6,45.8,32.7

This method allows any string of up to 80 characters to be used as the logger identification. Special control characters may be included to assist in identification. See "Text String" on page 6 and "ASCII-Decimal Equivalents" on page 23.

Setting the Address

The Datataker address is set by a DIP switch in a binary code. The DIP switch is accessed by removing the Datataker top cover. Refer to the Appendix for your model Datataker for location and setting details. Datatakers are shipped with the address set to 0.

If you give two loggers the same address, then network errors will occur when commands are directed to them.

The Datataker models without network support also have an address, however it only serves for Datataker identification.

Network and Modems

The network can be extended by modems or radio modems that can operate at 1200 baud and can automatically "turn-around" (change direction of data transfer). This is an important issue with radio modems, where changing from transmit mode to receive mode can take as long as 500mS.

The network turn-around time can be adjusted by parameter **P7** in increments of 14mS. For example setting **P7=22** would set the turn-around time to 300mS.

There is no electrical signal to indicate turn-around. The modem must detect when the Datataker is sending network data and rapidly switch to transmit mode. The Datataker does not issue any message preamble. See the "Datataker Advanced Communications Manual" for details.

Network modems must be "dumb". As the Datataker already provides an error correcting protocol, the modem must not overlay an additional protocol layer. This applies particularly to radio modems where it is common to find error correction built-in.

Messages to COMS Ports

You can connect other devices to the remaining Datataker COMS ports. These may be a printer, a terminal or another computer.

Network - a Twisted Pair of Wires (note polarity)

Datatakers

Host Computer   Printer   Second Host
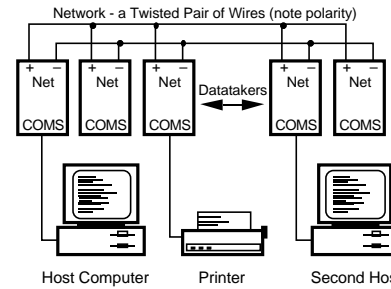
The following commands allow text to be sent to these ports from the network host:

@n *text*   sends *text* to COMS port of logger *n*
@@ *text*   sends *text* to all COMS ports

e.g.

@27 Hello there^M^J

will direct the message to the COMS port of logger 27. The text string may be up to 250 characters long, and can include control characters in the text as illustrated above (e.g. see also "ASCII Characters" on page 23).

Networking and Power Down

Normally when a logger is asleep, it will not wake when network activity begins. To ensure proper operation the loggers must be kept awake by setting **P15=2**. Alternatively loggers can be programmed to be awake (by **ALARM**s) when network communications are expected.

Programming a Network

The main difference between operating a single logger and a network of loggers is that the task of managing the returned data and alarms becomes more complex. The best method for managing the network will depend on the goals:

- data logging
- monitoring for alarm conditions
- rapid real-time response
- simplicity of programming
- telemetry or modem connection

Don't underestimate the complexity of managing a large volume of data. Unloading a Datataker with a large memory card over a network link can take over an hour.

There are two distinct class of networks: part-time and real-time networks.

Part-Time Network

If the main task is data logging, then communications between the network and the host computer can be infrequent (hours, days or weeks) and so you can program and unload each logger in the network individually. This is the same as using a single logger, except that you must address each logger.

Real-Time Network

Where the emphasis is on rapid response or tracking conditions, network speed becomes vital. There are many ways the network can be managed, however as a general rule more speed leads to more complexity in host software.

1. Poll channels one at a time. This method is simple but slow. Any polling over a network can take up to two seconds before a reply is received. As only one operation is undertaken at a time, there can be no confusion about the source of the data. For example:

poll (assume **/n/u**)	**#21 2V**
receive	156.54
poll	**#29 5TT**
receive	105.1

The polling speed can be as low as one channel every two seconds.

2. Poll by alarms one at a time using the **?n** command (see "Polling Alarm Data" on page 9). This is similar to method 1, but is slightly faster as it returns the last reading of the alarm channel rather than initiating a new scan.

3. Poll channel groups using the **RX** schedule (see "Polled Schedule" on page 3). For example:

program logger 21	**#21 RX 2V 3..4TT(FF1) /u/n**
logger 29	**#29 RX 1..4DS /u/n**
poll logger 21	**#21 X**
receive	156.54 23.5 28.9
poll logger 29	**#29 X**
receive	0 1 1 0

This method retains most of the simplicity of method 1, but is faster - up to 20 channels every two seconds.

4. Poll all alarms on a logger by the **?ALL** command (see "Polling Alarm Data" on page 9). This is similar to the previous method but is faster at 30 channels every two seconds.

5. By frequent **U**nloads (see "Data Logging and Retrieval" on page 8). This method uses the Datataker's store as an expanded output buffer, that is cleared after each unload by the **CLAST** command. For example

program all loggers	**## /u/n P25=36**
program logger 21	**#21 RA10S 2V 3..4TT LOGON**
logger 29	**#29 RA10S 3TT 1..4DS LOGON**
unload logger 21	**#21 U**
receive	156.54 23.5 28.9
receive	157.33 23.3 29.7
	$
clear data	**#21 CLAST**
unload logger 29	**#29 U**
receive	105.6 0 1 1 0
receive	104.4 0 0 1 0
	$
clear data	**#29 CLAST**

The unload steps are repeated for the duration of the monitoring task. This method ensures regular sampling by normal schedules.

6. By synchronous returns from all loggers that have been programmed by standard schedules (**RA**, **RB**, **RC** and **RD** - see page 3). This is the most flexible method, as it allows each logger full control of the schedule scanning. However in order to work, it requires that the host software use more complicated data routing and time stamping techniques.

7. The use of the fixed format mode /H is recommended for real-time networks. (See "Fixed Format Mode" and the "Datataker Advanced Communications Manual").
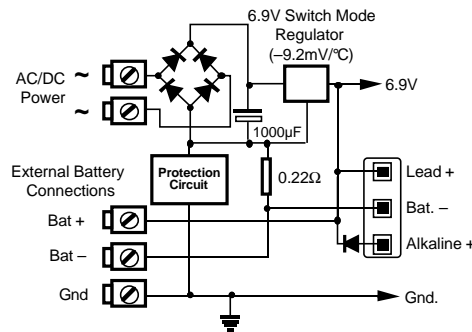
Power and Battery Connection ... take care

Powering the Datataker

The Datataker data loggers can be powered from:

Source	Typical Range	Connection Terminals
AC	9 – 18Vac	~AC/DC and ~AC/DC
DC	11 – 28Vdc	~AC/DC and GND
Battery	6 – 9 Vdc	+ Bat and –Bat

Refer to the Appendix for details of your Datataker. The following diagram shows a simplified power circuit:

Caution: If a DC supply is grounded, it MUST be a negative ground. An AC supply MUST NOT be grounded.

If an external battery is connected to a Datataker 500, 600, 505, 605, 515 or 615 data logger which has an internal 6V gel cell battery, then the external battery must also be a 6V gel cell battery, and MUST be connected with the correct polarity, or damage WILL occur.

Low Power Operation

The Datataker uses little power, and a set of six alkaline D cells can power the logger for over one year. However precautions must be taken to avoid excessive current draw.

The Datataker has two states - wake and sleep. While in the wake state the logger is fully active and draws up to 500mA, but typically 120mA. In the sleep state only the counters (nHSC), clock and the wake circuit remain active, and current draw is reduced to less than 0.4mA.

The Datataker will wake when:
- any scheduled scan becomes due
- a memory card is inserted
- characters are received at the COMMS port
- the wake terminal is grounded
- a key is pressed on display versions

The Datataker will sleep unless the program inhibits sleeping by setting **P15=2**, or by rapid scanning. Make sure that input channels (for alarms or data logging) are not being sampled more frequently than is necessary.
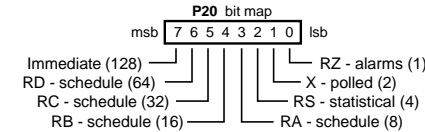
Setting the Power Mode

P15 is used to set the power mode, as follows:

P15	Sleep entry condition
0	Sleep only if battery powered (default)
1	Sleep if not busy
2	Disable Sleep mode

When logger is awake, and **P15=0**, the battery current is measured every second. If less than 20mA is drawn from the battery (because the battery is being charged from an external supply), then sleep mode is not entered. **P15=1** allows sleep mode without testing battery current.

P17 sets the delay period in seconds that the Datataker remains awake after a COMS, network, keypad or wake terminal activity ceases. The default is 30 seconds.

P20 prevents nominated schedules from waking a sleeping logger. This is done using a disabling bit mask:

P20 bit map

| msb | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | lsb |

Immediate (128)
RD - schedule (64)
RC - schedule (32)
RB - schedule (16)
RZ - alarms (1)
X - polled (2)
RS - statistical (4)
RA - schedule (8)

The default is **P20=0**, which means that all schedules can wake the logger when they become due. If for example, **P20=65** (i.e. 64 + 1), then the main **RD** and alarm **RZ** schedules will not wake the Datataker. **P20** does not disable schedules if the Datataker is already awake.

Powering the Multiplexer

Power consumption can be minimised by powering down the input multiplexers of some models of Datataker while the logger is in the sleep state. The factory preset for these models is to power down the multiplexers in the sleep state. The current saving is approximately 150µA. Refer to the Appendix for your Datataker for precise details.

The disadvantage of powering down the multiplexer is that it may cause problems with some sensors. For inputs over about 0.5 volts, the input impedance drops from tens of megohms to hundreds of ohms. This may cause draw of current from sensors, and possibly inject some of this current into other sensors.

Datatakers with relay multiplexers do not require these considerations, since the relays are open circuit when off.

The Wake Terminal

A low state (less than 0.7 volts) on the Wake Terminal will wake the logger within 300mS. The signal can be generated by a relay closure, or an open collector NPN transistor to ground. The Wake signal line has an internal 1800Ω pull-up resistor to +5 Volts and requires a signal level of less than 0.7 Volts.

A permanent low state on the wake terminal will not prevent short periods (~100mS) of sleep if there is no scheduled activity! Only **P15=2** keeps the Datataker permanently awake.

A Low Power Program!

You may find this framework useful when designing low power programs. After **RESET**ing the Datataker, enter the following program:

```
P15=1                      'sleep if not busy
P17=5                      'go to sleep quickly
/u/n                       'disable channel ID and units
S1=0,100,0,1"%RH"          'define spans, etc. here
BEGIN
  RS15M                    'scan as infrequently as possible,
  RA1H                     'especially for statistical schedules
    1V("Humidity",S1,AV)       'define channels
    2PT385("Air temp.",4W,AV,=1CV)
  RZ1H                     'set alarm rate if using alarms
    IF(1CV>25)"[LOGON]"
    IF(1CV<20)"[LOGOFF]"
END
```

The COMS port activity could be reduced to save power by setting the **/r** switch, but this can cause confusion!

Battery Life

The battery life that can be achieved by the Datataker depends on:
- scan interval (including alarm and statistical scans)
- number of analog channels
- number of digital channels
- number of alarms
- sensor excitation power draw
- complexity of any calculations
- baud rate

A precise calculation is very involved, but the chart below gives a conservative estimation of battery life for different operational conditions.

The chart makes certain assumptions:
- all channels are scanned at the same rate
- alarms are scanned at same rate as channels
- default switch and parameter settings
- sensor current draw is less than 5mA and is switched
- 80% of battery energy is available
- battery shelf life is long
- baud rate is 1200

If your operation arrangements vary greatly from these assumptions, then refer to "Some Details" (below) to calculate average current draw and battery life.

Battery Life for DT50 and DT500/600 models by Number of Channels Scanned at Regular Intervals
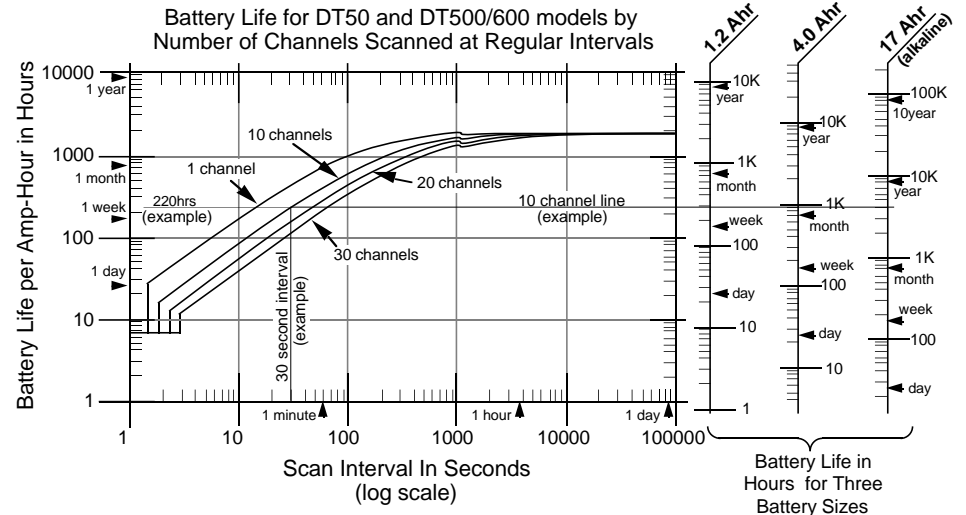
Using the Battery Life Chart

Establish the scan interval and locate it on the Scan Interval axis. The chart shows an example of 30 seconds.

Project a vertical line to the curves. The curves correspond to different numbers of channels. Interpolate if necessary. The channels are assumed to be analog. For this estimation a digital channel is equivalent to one quarter of an analog channel.

Project a horizontal line from the curve intersect to the right, across the three scales that correspond to standard Datataker battery sizes. From the appropriate scale read the battery life. For the example on the chart, the battery lives are 300, 800 and 4000 hours for 1.2, 4 and 17 Ah batteries.

If you use a non-standard battery, then look at the chart axis on the left. The battery life is equal to the scale value (220 hrs. for the example) multiplied by the battery's amp-hour rating.

Some Details

The Datataker takes approximately 300mS to wake up, 40mS for each analog channel, 10mS for each digital channel, and 10 to 50mS for each calculation. Also the Datataker must wake at least once every 18 minutes for time keeping, and will not sleep unless it can sleep for at least one full second. Current draw is 120mA while awake and 0.4mA while asleep.

Solar Charging

Sealed gel cell batteries may be charged via a 12V solar panel. The Datataker provides current and voltage limiting to protect both the panel and battery, provided that the panel is connected to the AC/DC Power input. Do not attempt to charge alkaline battery packs.

The size of the solar panel required depends on the hours of full sunlight that can be expected. As a general rule only one day in seven should be regarded as a "charge day", and the charge must be able to fully replenish the batteries on that day. The solar panel rating is calculated as follows:

$$\text{Panel Rating} = \frac{Iw}{Tw \times \eta} \text{ Amps (in full sunlight)}$$

where
Iw is the amp-hours per week consumed by the logger
Tw is the hours per week of full sunlight
η is the efficiency - a combination of battery charge absorption and the cosine effect. Typical 0.65.

Setting **P15=1** ensures that the Datataker sleeps whenever possible to conserve power.

Sensors 1 ... understanding helps

Thermocouples

Introduction

A thermocouple is two wires of dissimilar metals that are electrically connected at one end (the measurement junction) and thermally connected at the other end (the reference junction).
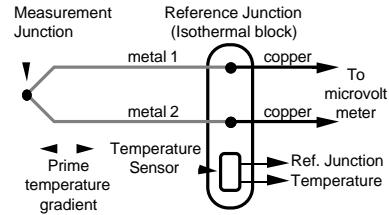
A small voltage is produced when the two junctions are at different temperatures. This voltage is produced by the temperature gradient along the wires and not by the junctions.

It is important that the purity of the thermocouple wire be maintained where significant temperature gradients occur. Because high purity wire can be expensive it is common practice to use thermocouple extension wire to cover long distances where temperatures are within the normal environmental range. Such wire can be used for measurement junctions, but only over a restricted temperature range of typically -20℃ to 120℃.

Making the Measurement Junction

The measurement junction can be made by welding, brazing, soldering or crimping the two wires together. Take care to ensure that the wire material is not contaminated where the temperature gradient is to occur.

The junction can be insulated or left bare for a more rapid response. If left bare, ensure that the junction does not make intermittent contact with metal objects. This can introduce electrical noise (see "Grounded Thermocouples" below).

Reference Junction Compensation

Conventionally the reference junction is held at 0℃, and thermocouple responses are determined with a 0℃ reference. This is inconvenient in most situations, and so in practice the reference junction is allowed to follow to ambient temperature. However this non-zero reference junction temperature must be compensated for by measuring the reference temperature with a different type of temperature sensor.

This correction can be made in hardware or, as with the Datataker, in software. The software approach allows support for any thermocouple type without hardware dependence.

Isothermal Block

Generally the reference junctions are held at the same temperature by a physical arrangement that ensures good thermal conductivity between the junctions. This structure is called an "isothermal block". It is advisable to insulate the isothermal block from rapid ambient temperature changes.

Thermocouple Types

The Datataker supports all of the commonly recognised thermocouple types:

Type	Positive	Negative	Range ℃
B	Pt, 30%Rh	Pt, 6%Rh	+300 to 1700
C	W, 5%Re	W, 26%Re	0 to 2320
D	W, 3%Re	W, 25%Re	0 to 2320
E	Ni, 10%Cr	Cu, 45%Ni	-200 to 900
G	W	W, 26%Re	0 to 2320
J	Fe	Cu, 45%Ni	-200 to 750
K	Ni, 10%Cr	Ni, 2%Mn, 2%Al	-200 to 1250
N	Ni,14%Cr,1%Si	Ni,4%Si,0.1%Mg	-200 to 1350
R	Pt, 13%Rh	Pt	0 to 1450
S	Pt, 10%Rh	Pt	0 to 1450
T	Cu	Cu, 45%Ni	-200 to 350

Each type has characteristics (sensitivity, stability, temperature range, robustness and cost) that make it appropriate for particular applications.

Thermocouples on the Datataker

Thermocouples are wired to the Datataker as for any voltage signal. The channel type is a **T***t* where *t* is the thermocouple type (**TB**,**TC**...**TT**).

Using the thermocouple channel type reads the channel as a voltage and automatically applies cold junction compensation and linearisation.

Reference Junction Support

The Datataker by default uses the internal temperature sensor (channel **1%LM35** on the Datataker and *n***%LM35** on Expansion Modules) as the reference junction sensor. The internal sensor has an accuracy of ±0.5℃, and may be trimmed by **P2** (in units of 0.001℃).

However you can also use any channel as the reference junction temperature sensor channel. This is done by including the **TR** option in the channel's option list. The channel must return its value in the current temperature units. The following are valid:

4LM35(TR)	an external LM35 as a reference
3V(Y1,TR)	polynomial Y1 would convert to temp.
11SV(TR)	use when thermocouple is externally compensated (Note 11SV=0.00).

A second compensation facility lets you correct for voltage offset errors that may occur on all channels of an external isothermal block. This is the **TZ** channel option. The channel must return its value in the units of mV. e.g. **1V(TZ)**.

This arrangement of reference channels provides the flexibility to use multiple external isothermal blocks. Each isothermal block can have its own set of reference channels.

The reference temperature and reference zero channel readings remain current until the reference channels are scanned again. They should be placed in the same schedule before the thermocouple channels to which they apply, as in the following example:

RB15M 1PT395(TR) 2V(TZ) 3..5TT

which assumes an external isothermal block with its temperature measured on channel 1, and electrical zero on channel 2.

Grounded Thermocouples

Frequently, thermocouple measurement junctions are electrically connected (by welding, brazing, soldering or by contact) to the object being measured. This is only possible if the object is grounded to the Datataker's ground, however this may introduce a troublesome ground loop that can allow significant series mode noise to affect readings.

This effect can be minimised by using differential connection (eg. **1TK**) or single ended connection with the S.E.Ref. terminal connected to the grounded object (eg. **1TK(X)**).

A ground loop via the COMS port and host computer is the most common cause. This can be prevented by isolating the interface (see "COMS Port" on page 13). Ideally all grounds should be connected to a single common point.

Accuracy

The accuracy of temperature measurement with thermocouples is dependent on the:
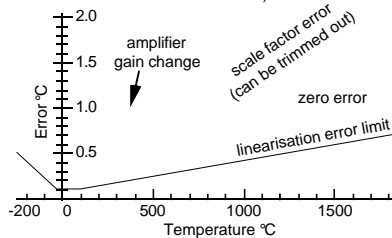
- reference junction isothermal characteristics
- reference temperature sensor accuracy
- induced electrical noise
- quality of the thermocouple wire
- drift in the wire, especially at high temperatures.
- basic measurement accuracy of the Datataker
- linearisation accuracy of the Datataker

The most significant source of error is the reference junction. The Datataker must not be exposed to differential heating as a single reference temperature sensor is used to measure the temperature of the screw terminals of all channels. Should a temperature gradient occur along the terminal strip, then errors of the magnitude of the temperature difference will occur.

The Datataker's basic measurement accuracy can be a source of error. The zero error is ±4μV for inputs up to 30mV (±40μV for inputs up to 300mV), while the scale factor error is ±0.1%. For a T type thermocouple at 100℃ this can result in an error of ±0.2℃, climbing to ±0.5℃ at 400℃. Note also that the error is dependent on thermocouple sensitivity. For example the K type thermocouple at 1200℃ the error can be as high as 2.1℃.

The Datataker's linearisation errors are much lower than other error sources.

These errors are additive and are generally contained within the error bounds as shown in the following diagram (the reference junction error is assumed to have been trimmed out):

Thermistors

| Channel Type	RΩ at 25℃	YSI Sensor	Max. Temp ℃	Min. Temp ℃ (without Rp)
YS01	100	44001A, 44101A	100	-65
YS02	300	44002A, 44102A	100	-45
YS03	1000	44003A, 44101A	100	-20
		44035	100	-20
YS04	2252	44004, 44104	150	1
		44033	75	1
		45004, 46004	200	1
		46033, 46043	200	1
		44901	90	1
		44902	70	1
YS05	3000	44005, 44105	150	7
		44030	75	7
		45005, 46005	200	7
		46030, 46040	200	7
		44903	90	7
		44904	70	7
YS07	5000	44007, 44107	150	18
		44034	75	18
		45007, 46007	250	18
		46034, 46044	250	18
		44905	90	18
		44906	70	18
YS17	6000	44017	150	22
		45017	250	22
		46017	200	22
		46037, 46047	200	22
YS16	10K	44016	150	34
		44036	75	34
		46036	200	34
YS06	10K	44006, 44106	150	35
		44031	75	35
		45006	250	35
		46006	200	35
		46031, 46041	200	35
		44907	90	35
		44908	70	35

Introduction

Thermistors are semiconductor devices that change their electrical resistance with temperature. Thermistors measure temperatures from –80℃ up to 250℃. They are sensitive but highly nonlinear. Datatakers support all two wire YSI* thermistors. The response is:

$$T = \frac{1}{a + b.\text{Ln}(R) + c.\text{Ln}(R)^3}$$

The constant terms are those recommended by YSI*.

As the Datataker is unable to measure resistances over about 7KΩ, a resistor should be connected in parallel when a thermistor is expected to exceed 7KΩ:
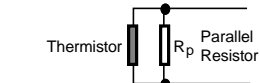
and

$$R_p = \frac{7000 \times R_{max}}{R_{max} - 7000} \text{ Ohms}$$

where Rmax is the maximum value of the thermistor's resistance at the lowest expected temperature. The value of Rp is placed in the channel option list e.g.

5YS07(10000)

The resistor quality should be 1% and 50 ppm/℃ or better.

* YSI Incorporated
Yellow Springs, Ohio 45387 USA
Fax 513 767-9353

RTDs

Introduction

Resistance Temperature Detectors or RTDs are sensors generally made from a pure (or lightly doped) metal whose electrical resistance increases with temperature. Provided that the element is not mechanically stressed, and is not contaminated by impurities, the devices are stable, reliable and accurate.

Datatakers support four RTD types **PT385**, **PT392**, **NI** and **CU**:

Metal	Alpha	Standard
Platinum	α = 0.003850	(DIN43760)
Platinum	α = 0.003916	(JIS C1604)
Nickel	α = 0.005001	
Copper	α = 0.00390	

The Alpha is defined by:

$$\alpha = \frac{R_{100} - R_0}{100 \times R_0} \, \Omega/\Omega/℃$$

where R0 and R100 are the resistances at 0° and 100℃.

The three RTD channel types are connected as for a resistance. The 0℃ resistance is assumed to be 100Ω for platinum, and 1000Ω for nickel types. Other values can be specified as a channel option. The default connection is for a 3 wire measurement, but 4 wire can be specified as a channel option for greater accuracy. For example:

PT385(4W,50.0)

will read a 4 wire 50Ω (at 0℃) device.

Sensors 2 ... understanding helps

Hints for Successful Measurement

Ground Loops

Ground loops are a common cause of many measurement problems, including noise, offsets and erratic behaviour. Ground loops occur when a circular conduction path is established between grounds in a system. The use of differential inputs instead of single ended inputs overcomes most ground loop problems.

Fundamental to the condition is the incorrect assumption that there is a single ground potential in a measurement system. In practice, two grounds in a system are rarely at the same potential. The result is that ground currents are very common, and if allowed to flow through the sensor wiring then measurement errors are inevitable.

The communications cable often creates a ground loop. If disconnecting the COMS cable has an effect on logged data, this suggests a poor wiring arrangement. Isolating the COMS port normally solves the problem (see "COMS Port Isolation" on page 13).

Noise Pick-up

There are two main ways in which noise can be introduced into signal wiring: by capacitive coupling and by magnetic induction. There are different counter measures for each.

Shielding signal wiring will minimise capacitive noise pick-up. Signal wiring that is close to line voltage cable should always be shielded (see "Config 1" on page 19).

Magnetic induction of noise from current carrying cables or from electrical machines (especially motors and transformers) is a greater problem. Shielded cable is not an effective counter-measure. The only practical measures are to avoid magnetic fields, and to use close twisted conductors for the signal wiring. Shielding in steel pipe can be effective, but is generally not economic or convenient.

The influence of noise can be minimised using the **ES**n channel option (see "Extra Samples" on page 5) and averaging (see "Statistical Channels" on page 6).

Self Heating of Sensors

Sensors that need excitation power to be read are heated by power dissipation. This can be particularly acute with temperature sensors and some sensitive bridges. Minimise error by minimising the excitation power, exciting only when needed (by using the excite terminal), or by calibrating out steady state errors.

Accuracy

The basic accuracy of the Datataker is 0.1% of reading (not full scale) plus a small offset error (4μV, 40μV and 400μV) for each voltage measurement range at 25°C. The temperature coefficient for the scale factor is 20ppm/°C max. Any one of the three basic ranges may be trimmed to 0.003% by trim-pot or **P1**. The Datataker self calibrates its measurement circuits whenever its input voltage offset drifts by more than a value set by **P0** in microvolts (defaults to 4μV).

The calibration procedure employs two standards - a 2.500V (20ppm/°C) voltage reference and a 100.0Ω (10ppm/°C) reference resistor. You can trim these with **P1** and **P3** (see "Parameters" on page 11).

IC Temperature Sensors ... wiring configs. 18, 19, 20, 21

Introduction

Integrated Circuit (IC) temperature sensors are devices that are constructed on small silicon chips. These are linear, sensitive and available in both voltage and current output configurations. They share the thermistor's disadvantage of limited temperature range (generally –40°C to +150°C) and self-heating from power dissipation caused by the excitation current needed to read the sensor.

Datataker supports the four most commonly available IC sensor types:

Sensor	Output	Channel Type	Wiring Config.
AD590* & AD592*	1μA/°K	n**AD590**	18, (7, 8)
LM34**	10mV/°F	n**LM34**	20, 21, (1, 2, 3)
LM35**	10mV/°C	n**LM35**	20, 21, (1, 2, 3)
LM335**	10mV/°K	n**LM335**	19, (4, 5, 6)

Calibration

IC temperature sensors have different calibration grades. The lowest grades typically have an error of up to ±2°C at 25°C. More expensive sensors have an error of ±0.25°C. This error is a combination of an offset (or zero) error and a slope error.

The Datataker provides a slope (or scale) correction capability on a per sensor basis using the channel factor. See "Channel Types" on page 4 and "Channel Options" on page 5. Frequently, a slope correction based on a single point calibration point is enough for reasonable accuracy. The pivot point for the slope correction is dependent on the sensor type.

Sensor	Slope Pivot Tp	Channel Factor	Formula
AD590	0°K (-273.15°C)	Series resistor R (Ω)	= R x C
LM335	0°K (-273.15°C)	Attenuation factor A	= A x C
LM34	0°F (-17.78°C)	Calibration factor	= C
LM35	0°C	Calibration factor	= C

The calibration factor is calculated from the pivot temperature T_p, the temperature error ΔT and the temperature T of the calibration.

$$C = 1 - \frac{\Delta T}{T - T_p}$$

All temperatures must be of the same units.

Example

For the AD590 sensor, the channel factor represents the value of the series resistor used to measure the output current (the default value is 100.0Ω). Without changing the actual resistor, this channel factor is adjusted. If the temperature error is determined to be 1.7°C higher than actual at 100°C, the channel factor correction is:

$$\text{Channel factor} = R \times \left(1 - \frac{\Delta T}{T - T_p}\right)$$

$$= 100 \times \left(1 - \frac{1.7}{100 - (-273.15)}\right)$$

$$= 99.544$$

The correction can be applied e.g. **5AD590(99.544)**.

* Analog Devices   ** National Semiconductor Corp.

Bridges ... wiring configs 13, 14, 15, 16, 17

Introduction

Because of its sensitivity, the Wheatstone bridge circuit is a commonly used circuit for the measurement of small changes in electrical resistance. Applications include load cells, pressure sensors and strain gauges.
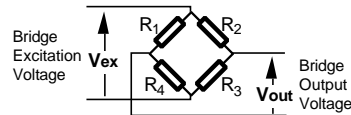
When one of the four resistors in a bridge is active (sensitive to the parameter being measured) the circuit is called a quarter bridge, and the remaining three resistors are called bridge completion resistors. Similarly, half and full bridges imply two and four active gauges.

The bridge is a ratiometric circuit where the output sensitivity is proportional to the excitation voltage. Unfortunately the excitation voltage is reduced by resistive cable and connector voltage drops. There are two ways the Datataker can resolve this problem.

Voltage Excitation

The Datataker can measure the excitation voltage at the bridge and compensate numerically for the voltage loss. This requires a six wire connection (see wiring configs. 16 and 17 on page 20) with the **BGV** channel type. This is termed "voltage excitation". **BGV** channels expect the bridge excitation voltage **V**ex to have been previously sampled in the same schedule by a voltage channel with a **BR** (bridge reference) channel option e.g. n**V(BR)**. If this is not done, the excitation voltage is assumed to be 5.0 volts.

The **BGV** channel type lets you declare an offset for each channel, e.g. n**BGV(–325)** which will subtract 325 ppm from the reading. This is useful for zeroing out initial offsets.

Constant Current Excitation

The alternative lead compensation method is to apply a constant current (defaults to 2.50mA) to the bridge, assuming the bridge resistance is known and constant, and then calculate the excitation voltage **V**ex.

For full and half bridge constant current excitation use the n**BGI**(Ra) channel type where Ra is the bridge arm resistance in ohms. If the arm resistances are not equal then a correction must be applied.

For the full bridge, all four resistors are external to the Datataker (see wiring config. 15 on page 19). One or more of these resistors may be active, and the remainder are completion resistors. Four connection wires are required so that the **4W** channel option is required. For example n**BGI(4W,120)** defines a four wire constant current bridge with an arm resistance of 120 ohms.

For the half bridge, two resistors are external and the bridge completion is internal to the Datataker. The connection is by three wires as seen in wiring configs. 13 and 14 on page 19. One or both of the external resistors can be active with full lead resistance compensation.

Scaling

The Datataker scales all bridge channel types to a ratiometric form with units of parts per million:

$$\text{Reading (B}_{out}) = \frac{V_{out} \cdot 10^6}{V_{ex}} \text{ ppm}$$

where the **V**out term is measured as a voltage while the **V**ex term is measured by a reference channel for voltage excitation but is calculated for constant current excitation.

To convert to other engineering units apply a Polynomial, Span or use calculations (see page 7).

Strain Gauges

Strain gauges change resistance when stretched or compressed, and are commonly wired in a bridge. The strain to resistance relationship is:

$$\text{strain} = \frac{\Delta L}{L} = \frac{1}{G} \cdot \frac{\Delta R}{R}$$

where ΔL and L are the length change and initial length, and ΔR and R are the gauge resistance change and initial resistance. G is the Gauge Factor, a measure of the sensitivity of the gauge. Typical foil gauges have a Gauge Factor of 2.0 which means that if they are stretched by 1% their resistance will change by 2%.

To convert the Datataker's ppm bridge readings to strain use the following formula:

$$\mu S = k \cdot B_{out} \quad \text{where} \quad k = \frac{2}{G \cdot N}$$

and μS is micro-strain, Bout is the Datataker's bridge channel (**BGV** or **BGI**) result, G is the Gauge Factor and N is the number of active gauges in the bridge.

The conversion can be done in the Datataker by applying a polynomial (see page 7) as a channel option:

Y1=0,k**"uStrain"**	'Polynomial definition
2V(BR)	'Reference **V**ex channel
3BGV(Y1)	'Bridge channel

where k is defined above.

The following table indicates the Datataker performance for different bridge inputs:

Arrangement	Excitation	Gauge ohms	Resolution μS	Range* μS
BGV full bridge	5V	120	0.07	±1,500
quarter bridge	5V	120	0.26	±6,000
BGI full Bridge	2.5mA	120	0.6	±12,500
quarter bridge	2.5mA	120	2.2	±50,000
BGI full Bridge	2.5mA	350	0.2	±4,300
quarter bridge	2.5mA	350	0.7	±17,000

*Note: Exceeding the Range causes a gain change and resolution to be reduced by factor of ten.

Sensors 3, Other Subjects

Humidity Measurement

Relative humidity is commonly measured by wet bulb depression. Two temperature sensors are required, one to measure air temperature and the other the cooling effect of a wetted surface. Usually a temperature sensor is encased in a wick extending into a reservoir of distilled water. The temperature difference between the two sensors is the "wet bulb depression".

The following program will read two RTD's and compute the relative humidity with an accuracy of a few percent for temperature above 5°C and over most of the relative humidity range. The algorithm assumes that the sensors are ventilated but not aspirated.

```
Y1=6.1,0.44,0.014,2.71E-4,2.73E-6,2.75E-8    'SVP poly
Y2=0,100"%RH"
BEGIN
 RA5S
  1PT385("Dry bulb",4W,=1CV)
  2PT385("Wet bulb",4W,=2CV)
  3CV(Y1,W)=1CV
  4CV(Y1,W)=2CV
  5CV("Humidity",Y2,FF1)=(4CV-0.8*(1CV-2CV))/3CV
END
```

The choice of temperature sensors is critical if reasonable accuracy is required at high relative humidity where the wet bulb depression is small. If platinum RTD's are used as in the above example, then they should have good accuracy or matching (0.2°C).

Good accuracy can also be achieved by use of a temperature difference sensor such as a thermocouple or thermopile. Measure the dry bulb with a standard grade temperature sensor and subtract the difference sensor reading to obtain the wet bulb temperature.

The sensors are normally placed within a radiation screen to prevent radiant heat affecting the readings. This is particularly important for out door applications.

ADC Details

The Datataker uses a precision voltage controlled oscillator as an analog to digital converter (ADC). An input voltage is converted to a frequency and the resulting frequency is measured digitally. This method of conversion provides high linearity, true signal integration and excellent 50/60 Hz noise rejection.

There are three programmable parameters of the ADC: settling period, conversion time and number of samples per reading.

Settling Period

The settling period (the time allowed for the input signal to stabilise before it is measured) is set by **7SV** or **P10** in units of milliseconds. This defaults to 10 milliseconds, but can range from 0 to 30,000mS.

There are two main reasons for adjusting the settling period. One is to speed up scanning by reducing the settling period. The other is to allow additional time for sensor signals to stabilise. Some sensors require this time because of thermal or electrical effects after excitation. It is best to change the settling period only for the sensors that need it by framing the channels in **7SV** assignments:

```
RA10M  1V  7SV=5000  2V 3V  7SV=10  4V
```

where channels **1V** and **4V** are sampled with the default 10mS settling period, while channels **2V** and **3V** with a settling period of 5000mS or 5 seconds.

Note that during the settling period no other Datataker activity can take place other than some communications. Even new commands will not be processed until the settling period and the scan are complete. For long settling periods this can create the disturbing impression of a "hung" Datataker.

Conversion Time

The conversion time (the time during which the Datataker measures the input signal) can be set by **8SV** or **P11** in terms of a frequency. The conversion time is one full cycle of this frequency i.e. the conversion time = 1000/**P11** milliseconds.

For maximum line hum rejection the conversion time defaults to one line period, i.e. 16.67 or 20.0mS depending on the DIP switch country setting (see the Appendix).

Reducing the value of **7SV** and **8SV** forces the Datataker to sample channels more rapidly. **8SV** can be any value between 48 and 1000 hertz. The penalty for increasing the line frequency setting is that it reduces input resolution proportionally.

Extra Samples

The number of samples per reading is controlled by the **ES**n channel option, where n (0 to 15) indicates the number of Extra Samples required. For most channels types n defaults to 0 indicating no extra samples. The vibrating wire channel type defaults to 9, indicating a reading of 10 samples (1 plus 9 extra samples).

The extra samples are averaged to calculate the reading. This process is different to the statistical averaging function in that the additional samples are taken immediately, before moving on to the next channel. Both averaging methods can yield similar results - significant improvement in resolution and noise performance.

How Fast?

The net sampling speed of the Datataker is dependent on the parameters discussed above, and a number of other factors over which control is limited:

Delay	Cause	To remove
40mS	overhead per scan	fixed
5mS	overhead in channel selection	fixed
~2mS	data return to host (per chn.)	**/r**
35mS	checking input offset voltage	**/k**
1000mS	auto-calibration	**/k** or **P0=1000**
15mS	checking battery current	**P15=1** or **2**

For the fastest possible scanning, it is best to create a schedule in which the channels are repeated, for example:

```
RA 1V 1V 1V 1V 1V 1V 1V 1V 1V 1V 1V 1V 1V 1V
```

combined with above methods will allow up to 75Hz rates.

Program "Branching"

The Datataker has no formal branching or alternative processing commands to control program flow. However some flow control is possible using Boolean logic and/or alarms.

Boolean expressions can be used to return a result which is dependent on a condition being true or false as follows:

2CV=(1CV∗2∗(1CV<1000))+(1CV∗4∗(1CV>=1000))

which returns a value of **2∗1CV** if **1CV** is less than **1000**, or a value of **4∗1CV** if **1CV** is greater than or equal to **1000**. The Boolean expressions **(1CV<1000)** and **(1CV>=1000)** will result in 1.0 if true or 0.0 if false. The BASIC language equivalent of this expression is

IF 1CV<1000 THEN 2CV=1CV∗2 ELSE 2CV=1CV∗4

The same branch can also be effected by a pair of alarms as follows:

IF1(1CV<1000)"[2CV=1CV∗2]"
IF2(1CV>1000)"[2CV=1CV∗4]"

However alarms must be used with care when controlling branching or alternative processing:

• two alarms are required.
• the alarm schedule scan rate must be the same as any other schedules which use the result.
• the alarms are executed after other schedules, and so the result will not be available until the next scan of the other schedules.
• the standard alarms (e.g. **ALARM2** or **IF2**) execute the action commands each time that the alarm becomes true, and not while the alarm remains true.
• the repeat alarm (e.g. **ALARMR2** or **IFR2**) continues to execute the action commands while the alarm is true.

Alarms can also be used to activate scan schedules if test conditions are true. For example the **RX** schedule can be activated to log data if one of the temperatures exceeds a threshold as follows

```
        RX 1..2TK
        RZ1M
          IFR1(1TK>100.0)OR
          IFR2(2TK>100.0)"[X]"
          LOGON
```

The out of range temperatures will be logged at the alarm scan rate (**RZ1M**) whenever either temperature exceeds 100 Deg.

Placing Program in EPROM

A Datataker program can be permanently loaded into the internal EPROM. The logger will execute the program whenever it is powered up or **RESET**, behaving as a dedicated instrument.

This is a process best undertaken by a technician with the equipment and experience in burning EPROM's. An application note is available.

Counters 0 to 65535 and back

The Datataker has two types of 16 bit counters: low speed (**n C** channel type) and high speed (**nHSC** channel type). Both counter types behave in a similar way.

The counters have a settable range count after which they reset to zero. The range is set as a channel option and has a maximum value of 65,535. For example **1C(3)** sets the range of low speed counter one to 3. On the third input pulse the counter will be reset to zero:

Input pulse no.	0 1 2 3 4 5 6 7 8 9 10 11
Counter reading	0 1 2 0 1 2 0 1 2 0 1 2

The resetting channel option **R** may be used with counters. This will cause the counter to be reset to zero after it is read in a schedule. For example **3HSC(R)** will cause high speed counter three to be set to zero after being read.

Counters may be assigned a value or the result of an expression:

```
        1C=15
        2HSC(10)=1CV/100*SIN(2CV/3CV)
```

Such assignment (as with all assignments) may be included in a schedule to be executed on each scan.

Low Speed Counters   *n* C

The low speed counters are software counters that share input terminals with the digital inputs (labelled D1, D2, D3, etc). They increment on negative going transitions. The digital inputs are sampled (to detect transitions) at a rate determined by **P13**. The default is once every 50mS, but the allowable range is 10mS to 100mS. If the value of **P13** is set towards the lower end of the range, the Datataker can become slow in executing other tasks.

The shortest pulse that can be counted reliably is equal to the **P13** value in milliseconds. Shorter pulses are not counted reliably. Being software counters, low speed counters only operate while the Datataker is awake.

High Speed Counters   *n* HSC

The high speed counters are implemented in hardware and will continue to function when the Datataker sleeps. The high speed counters have dedicated input terminals (labelled C1, C2 and C3) and increment on a positive going transition. They can count at rates of up to about 500Hz. The maximum count speed is limited by the 1mS debounce circuit. The high speed counter inputs have a 100KΩ pull up resistor to 5 volts.

High Speed Counter Output   **1HSCO(** *mode* **)**

High speed counter one has an output terminal that allows the counter to be used as a programmable prescaler or frequency divider (mode 3), pulse generator (mode 0), or even a crude analog output (mode 2 with low pass filter). Note: using high speed counter output interferes with the operation of the counter as a counter.

The high speed counter output is set up by:

1HSCO(*mode* **)=N**

where *mode* is the counter mode and *N* is the counter range (a constant or expression). The following timing diagram shows how the output is dependent on the *mode* :
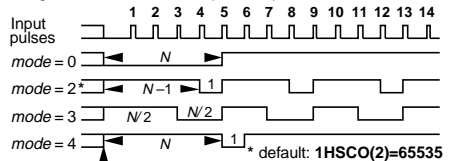
command issued here   e.g. **1HSC0(** *mode* **)= N** where *N* =4

* default: **1HSCO(2)=65535**

Analog Input Configurations 1

Config 1

Shield

Examples
1V
5F
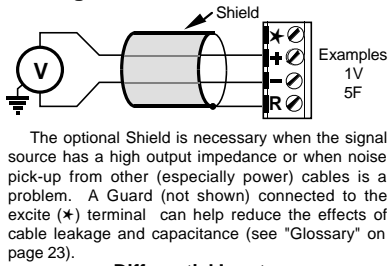
The optional Shield is necessary when the signal source has a high output impedance or when noise pick-up from other (especially power) cables is a problem. A Guard (not shown) connected to the excite (∗) terminal can help reduce the effects of cable leakage and capacitance (see "Glossary" on page 23).

Differential Input

Config 2

Examples
1+V
3∗AS
1-..3+TK

The excite terminal (∗)cannot be used as a single ended input on the DT50.

Single Ended Inputs

Config 3

Examples
1-V(X)
2+..5-F(X)
5+LM35(X)

SE Ref

The excite terminal (∗) cannot be used as a single ended input on the DT50.
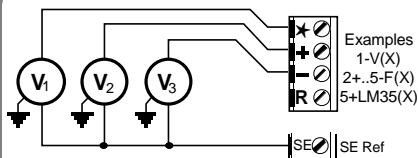
Single Ended Inputs with External Reference

Config 4

R1
R1
R2   R2

Examples
1V(10)
3TJ(2)
5+V(100)

attenuation = (R1+R2)/R2
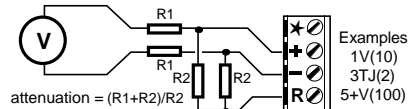
Attenuated voltage inputs let you measure large voltages, extend the common mode range and provides greater input protection. Differential or single ended measurement is possible.

For sensors with built-in amplification the attenuation factor can be less than unity, or negative for a sign reversal.

Attenuated Input

Config 5

R1
R2
R1
R2

Examples
1+V(11,X)
3+TJ(X,2)
5-V(X,100)

SE   SE Ref
G   Ground

this line common to other channels
attenuation = (R1+R2)/R2

This configuration is useful for high voltage differential input and situations where high accidental voltages are likely. For maximum common mode rejection match the attenuator pads.

Attenuated Input with External Reference

Config 6

R1
R2

Examples
1V(10)
5V(100)

close to GND

atten. = (R1+R2)/R2

Attenuated voltage inputs for situations where one signal line is always close to ground potential.
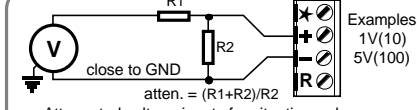
Half Attenuated Differential Input

Config 7

Power Supply

I

Examples
1#I
1#..10#I
5#L

G   Ground

You can combine this arrangement with the External Shunts arrangement to give four single ended current channels for each full differential channel
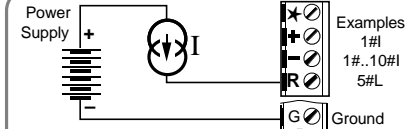
Single Ended Current Input with Internal Shunt

Config 8

I_1 I_2 I_3

Power Supply

Shunt Shunt Shunt

Examples
1∗..1-I(X)
5+L(X)
6-AD590(X)

G   Ground
SE   SE Ref

"bus bar"

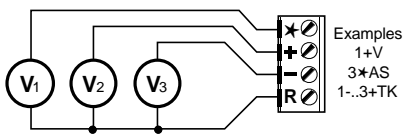To avoid cross channel coupling, connect the bottom of the shunts with the minimum of shared resistance to the SE ref. take-off point.

The excite terminal (∗) cannot be used as a single ended input on the DT50.
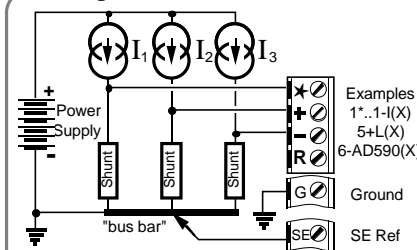
Single Ended Current with External Shunt
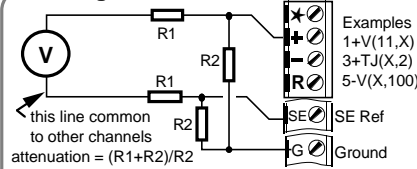
Config 8a

Power Supply

I

shunt
(10 to 100Ω)

Examples
2I
1..10I
5L(10)
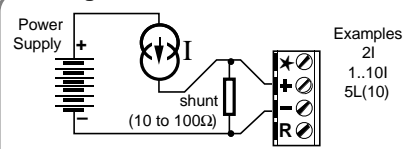
Note: Common mode voltage limits must be adhered to for correct operation. For models with CMOS multiplexers this is ±4 volts relative to the Datataker's ground.

Differential Current Input with External Shunt

Config 9

R

Examples
2R(4W)
3R(4W,I)
5PT392(4W)

Four Wire Resistance Input

Config 10

R   link

Examples
1R
2R(I)
3PT385
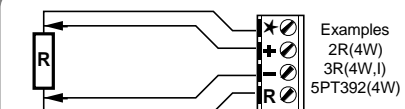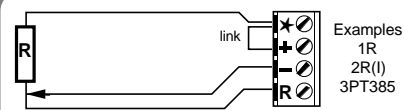
Three Wire Resistance Input

Config 11

R   link
link *

Examples
3R
1..5R
4PT385
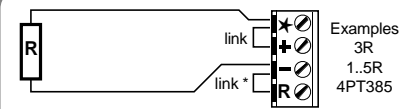
* You can get lead compensation by replacing the lower link with a resistor of value equal to the total lead resistance. This configuration is recommended only for resistances > 500Ω

Two Wire Resistance Input

Config 12

R1 nR(4W)
R2 n-R

Examples
5R(4W)
5-R(II)
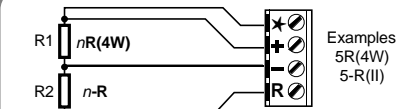
The measurement current passes through both resistors. By definition n**R(4W)** and n-**R** will measure R1 and R2 respectively. This configuration does not provide lead compensation for R2.

Mixed Resistance Input

Config 13

active arm   2.500mA
Rc

Examples
1BGI(120.0)
3BGI(I,350)
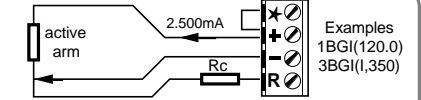
Rc can be a bridge completion resistor (for the same value as the active arm) located near the logger, or preferably an active arm of the bridge. This configuration compensates for lead resistance, and in the case of a half bridge, temperature compensation. For quarter bridge 120Ω foil strain gauge the resolution is 2µStrain. The configuration is also useful to read the position of the wiper of a potentiometer. The channel factor is set to the potentiometer's resistance (≤ 5KΩ) eg 2BGI(I,2000).

Three Wire, Half and Quarter Bridge Input

Config 14

link

Examples
1..5BGI(350)
4BGI
2BGI(Y1)

Rc

To other bridges   To other channel R terminals
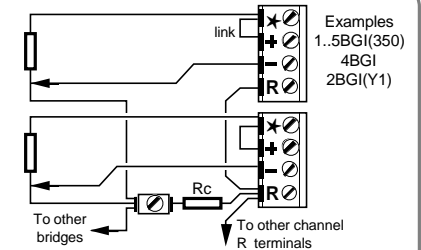
The bridge completion resistor is shared between channels. Its value is equal to the nominal value of the "unknown" resistor. The configuration is similar to Config 11 - no reference channel is needed.

Multiple Three Wire, Quarter Bridge Inputs

Config 15

2.500mA

Bridge

Examples
3BGI(4W)
4BGI(120,4W)
5V(II,Y3)
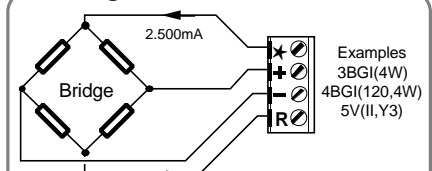
The bridge is powered by the 2.500mA constant current source, resulting in readings independent of lead length (resistance). This arrangement has a sensitivity of approximately 1 ppm per active arm.

Full Bridge, Constant Current Excitation

Analog Input Configurations 2

Config 16

Bridge Supply

Bridge

★ + − R Reference channel e.g. 3V(BR,N)

★ + − R Measurement channel e.g. 5BGV(N) 2BGV(108)

G Ground

The (external) bridge supply should not exceed 2.5V unless the reference channel input is attenuated.

The difference between six and four wire connection is the location of the reference channel measurement point - at the bridge or at the logger.

Six (& Four) Wire, Ratiometric Bridge Input

Config 17

5V 5V switched

SE SE Ref

Rc Rc

Bridges

★ + − R Reference channel e.g. 1V(BR,2)

G Ground

★ + − R Measurement channels e.g. 2*BGV(N,X,23) 3+BGV(N,X)

This is a combination of Config 1 for the reference channel and Config 3 for measurement channels.

The half bridge completion resistors Rc are best located near the active bridge arms, however they can be located at the logger

Half and Quarter Bridge, Ratiometric Input with Shared Half Bridge Completion

Config 18

AD590 AD592

Bottom view of metal can version

1µA/°K

★ + − R Examples 2#AD590 2#I(V)

Note: Sensor power can be any 4 to 12 volt source. The above arrangement is equivalent to Config 7. Differential and single ended wiring (Config's 1 & 2) with external shunts may be used.

AD590 Temperature Input

Config 19

LM335 adj

Bottom view

50K Cal.

10K

10K

link

★ + − R Examples 2LM335 2+LM335 2V(2,V)

optional potentiometer

With internal sensor power as illustrated, the upper response is limited to approx. 70℃. External power should be current limited.

Be aware of self heating effects - a 500µA sensor current can cause 1.5℃ error. A fourth wire to the sensor's negative pin in place of the link will improve accuracy. Single ended input as in Config's 2 & 3.

LM335 Temperature Input

Config 20

LM34 LM35 out

Bottom view of TO92 case

10mV/°F or 10mV/°C

link

★ + − R Examples 5LM35 5+LM35

This configuration limits the sensor's lower range to approx. 10°F and 10℃ for the LM34 and LM35 respectively due to the lack of a pull-down capacity.

Accuracy is improved if the link is replaced by a fourth wire to the sensor's negative pin. Without the link the sensor is read as a single ended input as in Config's 2 & 3. Sensor power may be externally derived (eg 5V) to free the Excite terminal.

LM34 & LM35 Temperature Input

Config 21

LM34 LM35 out

Bottom view

2K2*

10K

1N914's

★ + − R Examples 2LM35 5V(V)

This arrangement allows full range measurement. Multiple single ended sensor connection (Config 3) is possible by connecting the LM35 negative pins to SE ref. The diodes can be shared. Sensor power can also be derived from external sources.

* This resistor may be needed to prevent sensor oscillation with long leads. See manufacturer's data (National Semiconductor Corp.) for more details.

LM34 & LM35 Temperature Input

Digital Configurations

Config 22

3D 4D G Digital inputs Ground

Examples 1..4DS 3C(R) 1PE

The digital and counter inputs both employ 10KΩ pull-up resistors to 5 volts, allowing the use of voltage free contacts. The thresholds are <1.5V for a "0" and >3.5V for a "1". During sleep mode the digital inputs are inoperative, however the high speed counters remain active.

Example above also shows wiring for the one phase encoder up-down counter.

Digital and Counter Input

Config 23

Power Supply

1 2 3 4 Digital Output / Input

G Ground

The bidirectional digital channels can sink 200mA from up to a 30 volt supply. The solid state switch is not protected against sustained over currents.

For inductive loads parallel reverse diodes are recommended although not essential as the Datataker has internal transient protection.

Relay Connection - Externally Powered

Config 24

5V 5V switched

330Ω

LED

1 2 3 4 Digital I/O

Example 3DSO=1

The internal 5V switched (off in sleep mode) supply is limited to approximately 100mA. The saturation ON voltage drop of the switches is 1 volt so the relays must be able to activate at 4 volts over the expected temperature range.

Relay and LED Connection Internally Powered

Config 25

1KΩ

Externally powered Internally powered

★ + − R Examples 5+AS(II) 5−AS 3AS(1500)

The power source must be able to provide sufficient voltage to exceed the Analog States's threshold which defaults to 2500mV. Ensure input voltages do not exceed Datataker's common mode range.

Digital Input via Analog Inputs

Wiring Index

Error Messages ... help!

Introduction

The Datataker returns a message when it detects an error in a command, an error in an input channel, or an operational difficulty. The form of the error report is controlled by the **/U** switch. The default is the verbose form shown in the table below. If the switch is set to **/u** the error message is reduced to an error number (e.g. **E3**). (Note this Switch also reduces the verbosity of other returned data).

Error messages can be switched off by the **/m** switch. The default is for errors to be reported (**/M**). During an **U**nload operation (see "Data Logging and Retrieval" page 8), error reporting is disabled until the **U**nload is complete. In a Network, errors in remote Datatakers are reported back to the host computer.

Errors that are a result of reading a channel will cause a value of 99999.9 to be returned or logged as the reading. This value is not modifiable by format channel options. Channel errors are normally carried through calculations and statistical evaluations so that they also return 99999.9. The carry through can be disabled by the **/ j** switch (see "Switches" on page 11).

Errors that occur as a result of reading an alarm channel are reported in the same way as data channels, and the alarm condition automatically becomes true.

The table below lists all of the Datataker errors, and an explanation of their likely cause and correction.

Error Category

Error No. and Cause	Syntax	Operation	Memory	Reading	Hardware
E1-time set error • must be in format defined by **P39** and **P40** • illegal separator or non-digits entered	*				
E2-input buffer full • command too long (maximum 250 characters) • successive commands input too quickly	*	*	*		
E3-channel option error • illegal channel option used − see page 5 • mutually exclusive options used	*				
E4-clear data memory • attempt to enter new Schedule while the store contains data, or **LOGON** is enabled		*	*		
E5-data memory full • internal data storage memory is full • overwrite switch not enabled (**/O**)		*	*		
E6-data memory empty • no data in internal or card memory		*			
E7-day set error • illegal day number entered	*				
E8-Parameter read/set error • parameter index out of range • parameter value out of range	*				
E9-Switch error • missing switch command character • illegal switch command character	*				
E10-command error • **CARDID**, **CLEAR**, **CLAST**, **CDATA**, **CSCANS**, **CALARMS**, **CPROG**, **LOGOFF**, **LOGON** or **RESET** incorrectly entered	*				
E11-input(s) out of range • one or more analog inputs is over range • check common mode voltage				*	*
E12-channel list error • channel number outside the legal range • diff. and SE channels mixed in sequence • options invalid for channel type • incomplete channel sequence • invalid channel type • single ended channels illegally specified • polynomials or spans specified for day or time • polynomials or spans index out of range	*				
E13-digital failure • digital input − output circuit has failed • return logger for service				*	*
E14-communications error • baud rate, parity or stop bit errors • framing errors due to noise on COMS port		*			
E15-assignment error • channel number too large • output channel or system variable out of range • counter preset to value greater than maximum count i.e. 1C(25)=30	*				
E16-linearization error • thermocouple outside range • RTD or thermistor outside linearization range				*	*

Error No. and Cause	Syntax	Operation	Memory	Reading	Hardware
E17-clear card data • inserted card has data in data area	*	*			
E18-STATUS command error • **STATUS** incorrectly entered • **STATUS** *n* outside the range 1 to 9	*				
E19-Card Write Protected • Move card write protect switch to unprotected	*	*			
E20-illegal character(s) • invalid characters in the command	*				
E21-illegal separator(s) • commands not separated by spaces or return	*				
E22-statistical option error • statistical option not in each multiple report	*				
E23-scan schedule error • Schedule ID not **A**, **B**, **C**, **D**, **S** , **X** or **Z** • scan time interval too large (i.e. >65535) • scan interval type invalid (i.e. **S**, **M**, **H**, **D**) • event or counter channels invalid	*				
E24-Unload command error • Schedule ID is not one of **A**, **B**, **C**, **D** or **X**	*				
E25-channel table full • internal acquisition and alarm table filled • additional channels cannot be declared	*	*			
E26-Halt command error • Schedule ID not **A**, **B**, **C**, **D** or **Z**	*				
E27-TEST command error • **TEST** incorrectly entered • **TEST** *n* where *n* is outside the range 1 to 2	*				
E28-Go command error • Schedule ID not **A**, **B**, **C**, **D** or **Z**	*				
E29-poly/span declaration error • polynomial or span index out of range (1 to 20) • individual terms not separated by a comma • range of terms outside 1.0e–18 to 1.0e18	*				
E30-calibration failure *nn* • internal error during self calibration • *nn* identifies the cause of the failure	*				*
E31-test channel failure *nn* • return logger for service					*
E32-battery sample failure • return logger for service					*
E33-CSIO bus failure • CEM or Display cable too long • return logger for service					*
E34-function key command error • bad declaration of function key	*				
E35-Card Faulty • card may have an electrical fault					*
E36-CLAST not valid • due to use of schedule UNLOAD	*	*			
E38-address error • Network address out of range (0 to 31)	*				
E40-no data found • No logged data to unload in specified time interval	*				

Error No. and Cause	Syntax	Operation	Memory	Reading	Hardware
E41-program area full • attempt to store >4090 program char's in card		*	*		
E42-no card inserted • no memory card inserted into card socket • memory card not fully inserted • memory card battery discharged • memory card failure		*	*		*
E43-RS485 chip failure • RS485 Network interface hardware has failed • return logger for service					*
E44-network transmission error • network integrity is failing • a logger on the network has failed • network traffic heavy		*			*
E45-remote logger not found or network failure • there is no logger with address specified • logger at address specified has failed • local logger not connected to the network • network cable is broken or wiring error		*			*
E46-ROM checksum error • ROM has failed checksum test • Datataker may behave strangely • return logger for service				*	*
E47-user string error • incorrect declaration **$=**"*text*"					
E48-channel list fixed • channel list has been secured (fixed) by **/F** • enter **/f** to enable changes	*	*			
E51-ALARM command error • alarm number out of range defined by **P30** • setpoint character **<**, **>**, **<>** or **><** missing • **AND**, **OR**, **XOR** incorrectly entered • setpoint not specified or too large • delay incorrectly specified	*				
E52-alarm text memory full • memory for storage of alarms text is filled • cannot specify additional alarm strings				*	*
E53-no statistical samples • no statistical sample taken so cannot calculate statistical function	*			*	
E54-expression error • syntax error • expression too complex	*				
E55-expression memory full • total expression(s) text > 3847 characters • reduce number of expressions			*	*	
E60-RAM *n* **failure** • RAM number *n* has failed self test • may cause strange behaviour and data loss • return logger for service				*	*
E61-memory card failure • replace battery • replace card (memory card is not serviceable)				*	*

Simplified Circuit ... the guts of the Datataker

Sensor Excitation Selector. Selection is generally automatic but can be forced by the **I**, **II**, **V** or **G** channel options (see page 5)

3 volts

Two precision current sources are available for resistance and bridge measurements as well as for powering sensors

Internal battery on some models

6.9V Regulator with temperature compensation to match the charging requirements of 6V lead-acid gel cells.

Input multiplexer

5 volts

Power Supply

Input channels are a four wire connection with five switched lines. Each channel can be split into 2 to 4 single ended channels. The maximum voltage allowed on any terminal is ±3.5 volts relative to ground. Exceeding these limits is likely to cause measurement errors.

Selector

2.5mA (**II**)

250µA (**I**)

5V (**V**) or custom

guard (**G**)

1kΩ

excite *

+ input **+**

− input **−**

return **R**

+5V

+5V

6.9V

+5V

AC/DC

Guard signal combat the effects of cable capacitance and leakage on high impedance signal sources

1mF

100.0Ω
0.1%

1M

1M

Input termination resistors can be switched in by the **T** channel option or out by the **U** option

0.22Ω

Com. ▽

Gnd. ▼

Protection Circuit

External Battery

Lead

Alkaline

excite *

+ input **+**

− input **−**

return **R**

−5V

−5V

Switched 6.9 volt line (off in sleep mode)

Special signal conditioning connector (for Vibrating Wire support etc)

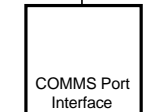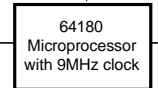Ground is locally sampled

100.0Ω
0.1%

+5V

5Vsw

5V switched for sensor power

Caution - To avoid damage use 6 Volt lead acid battery only, ensure correct polarity before connecting the battery

The SE Ref. terminal can be internally routed to the negative input of the instrumentation amplifier by using the **X** channel option for single ended inputs. This can provide many of the benefits of differential input for single ended input.

SE ref.

Precision Voltage to Frequency Converter

Programmable Time-base & Frequency Counters

The VFC frequency is measured over one line period (16.67 or 20mS) to maximise "hum" and noise rejection (see "**8SV**" etc. on page 6)
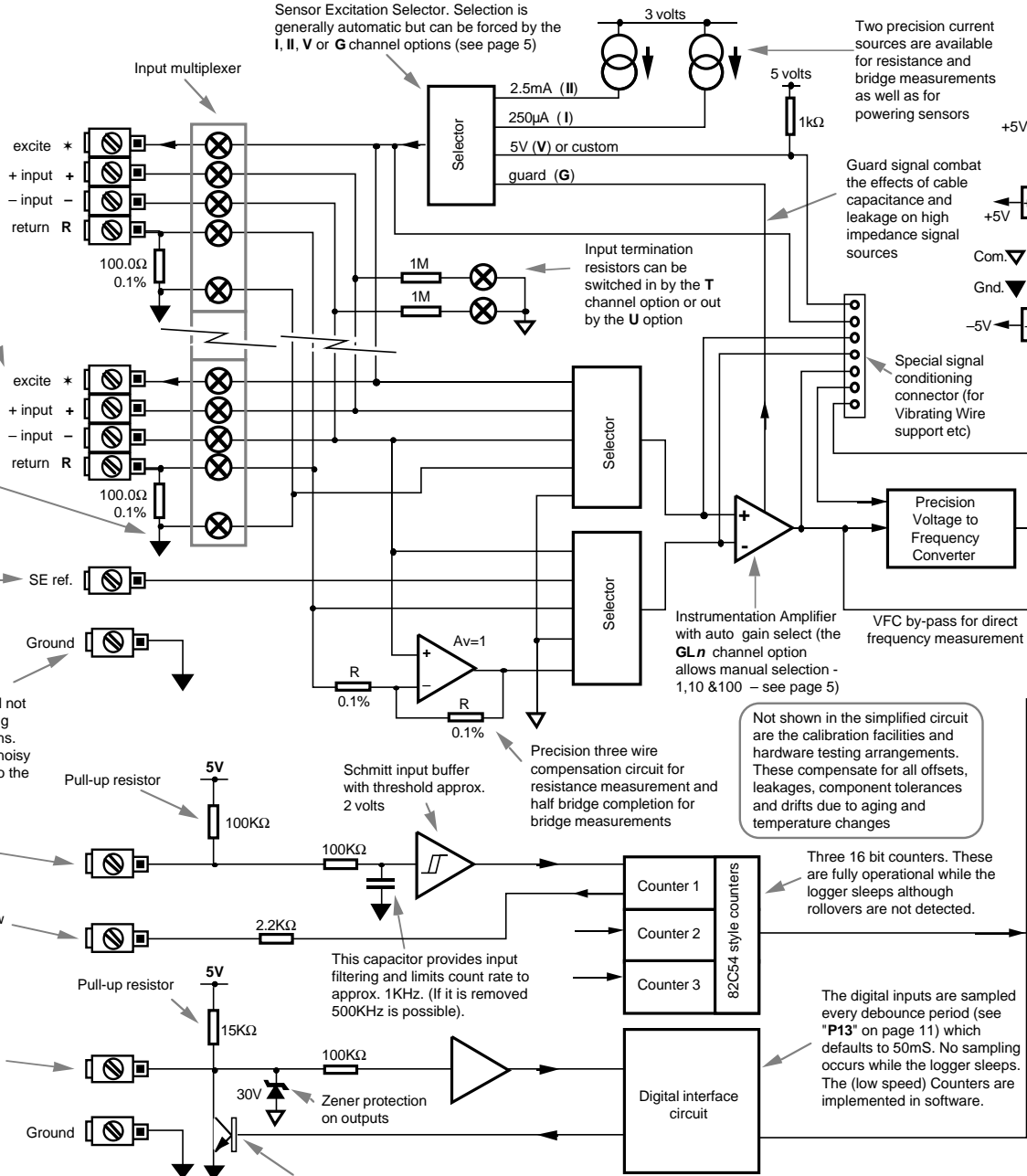
Selector

+

-

Ground

Instrumentation Amplifier with auto gain select (the **GL**n channel option allows manual selection - 1,10 &100 − see page 5)

VFC by-pass for direct frequency measurement

Network is not on all models

Network RS485 interface

Network

+

−

The ground terminals should not be used for signal referencing except for current return paths. Grounds can be electrically noisy and have an offset relative to the Return terminals.

Av=1

+

−

R
0.1%

R
0.1%

Precision three wire compensation circuit for resistance measurement and half bridge completion for bridge measurements

Not shown in the simplified circuit are the calibration facilities and hardware testing arrangements. These compensate for all offsets, leakages, component tolerances and drifts due to aging and temperature changes

64180 Microprocessor with 9MHz clock

Pull-up resistor

5V

100KΩ

Schmitt input buffer with threshold approx. 2 volts

COMMS Port Interface

7

8

9

High Speed Counter Channels ~ 2V threshold (see **HSC** on page 4)

100KΩ

Three 16 bit counters. These are fully operational while the logger sleeps although rollovers are not detected.

Counter 1

6

5

1HSC has a square wave overflow output that can be applied to the input of another counter. The 1**HSCO**=n output channel assignment sets the counter's divisor to n (with n = 1 to 65,535).

2.2KΩ

Counter 2

Counter 3

82C54 style counters

COMS Port RS232 Interface

Common

4 Rx

3 Tx

1 Interface ground

Pull-up resistor

5V

This capacitor provides input filtering and limits count rate to approx. 1KHz. (If it is removed 500KHz is possible).

15KΩ

Digital Input (**DS** and **DB**) - Output (**DSO** and **DBO**) and (low speed) Counter (**C** and **UDC**) Channels ~ 2V threshold for input (see page 4)

100KΩ

The digital inputs are sampled every debounce period (see "**P13**" on page 11) which defaults to 50mS. No sampling occurs while the logger sleeps. The (low speed) Counters are implemented in software.

Isolation

Ground

30V

Zener protection on outputs

Digital interface circuit

Electrical isolation to 500V

2

Output driver -200mA at 30V max, 1.0V saturation
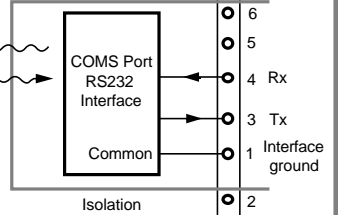
COMMS Port

Glossary ... what it means!

Actuator – a device which converts a voltage or current input into a mechanical output.

Analog to Digital Converter (ADC) – a device which converts a smoothly varying signal to a quantised digital value. Linearity, resolution, noise rejection and speed are important characteristics.

Auto-Ranging – the process of changing amplifier gain automatically so that the signal is amplified as much as is possible without exceeding output limits.

Auto-Zero – a stabilisation method for removing errors due to a drift in the input offset of a measuring system.

Bridge – providing input offset and potentially temperature compensation, bridges are a sensitive and stable means to measure small changes in resistances. They are particularly useful when applied to strain gauges as found in pressure sensors and load cells. Four elements connected in a circular fashion.
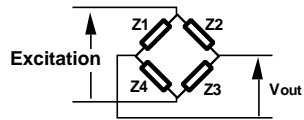
Arms of the bridge may be "active" sensors or "passive" for bridge "completion" and "nulling".

Common Mode Rejection Ratio (CMRR) – a measure of the influence of common mode voltage on the output of the instrumentation amplifier.

$$CMRR = 20 \log \left(\frac{Vcm}{Vout \times Av} \right)$$

where Vcm is an applied common mode voltage
$Vout$ is the resulting output voltage
Av is the amplifier's voltage gain

Common Mode Voltage – is the average of the voltages between the measurement system's ground and the two input terminals:

$$V_{CM} = \frac{V_1 + V_2}{2}$$
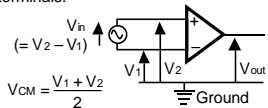
The term only has meaning for differential inputs.

Data Acquisition – the process of scanning a range of analog and digital channels, converting to digital format and forwarding to a host system.

Data Logging – is a data acquisition system with on-board data storage facilities.

Datataker – the best little data-logger in the world! First appeared in 1983 as the Datataker DT100, then the DT200 in 1987 and the current generation of DT500 , DT600 and DT50's in 1990.

Differential Input – the two wire input is not referenced to a system ground and is essentially floating.
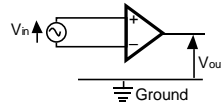
The common mode range limits must considered.

Ground Loop – more often that not, grounds in a system are not at the same electrical potential. Differences may be from microvolts to many volts. If signal wires are used to connect grounds, then ground currents will flow and unpredictable errors will occur. This situation is referred to as a ground loop. See page 18.

Guard – an actively driven shield around input signal conductors that is maintained at the common mode voltage of the input signal. Signal guarding is used when a sensor has a high output impedance and cable capacitance and insulation leakage are significant. The diagram below is an extension to Config. 1 on page 18 and shows a full guard and shield implementation:

Examples
2V(G)
5F(G)
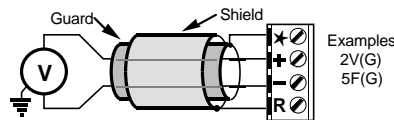
Input Bias Current – The input terminals of the instrumentation amplifier require a very small current. This current can be sourced via input termination resistors or by the signal source. If a source for this current is not provided then measurement errors will occur.

Input Noise – unwanted voltage or current generally with an AC component superimposed on the wanted signal.

**LED** – Light Emitting Diode.

LSB – least significant bit in a byte.

Monolithic Sensors – sensors that are constructed on a single piece of silicon using integrated circuit fabrication techniques. Available sensors include those for measuring temperature (see page 16), pressure, acceleration and concentration of various compounds in gases and liquids.

MSB – most significant bit in a byte.

Multiplexer – is a device used to increase the number of channels by sequentially routing multiple channels to a single signal processing system.

Phase Encoder – a position sensor with two digital output lines with a quadrature phase relationship that provide distance and direction information.
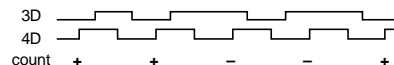
The Datataker uses an up-down counter to provide the position indication.

PID – Proportional, Integral, Derivative. A three mode control algorithm commonly used in industrial control. A PID loop with two state output can be programmed on the Datataker using the difference, integration and calculation facilities.

Port – a communications connector on a computer or other device.

RAM – Random Access Memory - Memory that allows data to be read or written at a particular location without having to pass sequentially through preceding locations.

ROM – Read Only Memory - Memory that can be randomly read but not written.

Settling Time – The time allowed for an input signal to stabilise after selection and gain changing. (See **P10** on page 10 and **7SV** on page 6).

Single-ended Input – the input is referenced to a system ground or other signal common.
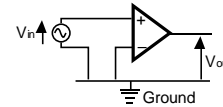
In a multi-channel system only one input terminal is needed in addition to the shared common terminal

RTD – Resistance Temperature Detector - A resistive sensor that changes resistance with changes in temperature - see page 15.

Resolution – is defined as the number of bits that the ADC uses to represent the analog signal. The greater the resolution the smaller the changes in the input signal that can be resolved.

Sample Speed – is the maximum rate at which analog to digital conversions can be done. This must include any channels selection time, settling time (for the signal to stabilise) and processing time (if required).

Shield – a conductor surrounding input signal wires that is generally connected to a data logger's ground. The purpose is to shield the input signal from capacitively coupled electrical noise. Such a shield provides little protection from magnetically induced noise.

Thermocouple – a temperature sensing device constructed from dissimilar metals. See page 15.

Transducer – a device which converts a physical parameter such as temperature into an electrical voltage or current. It is usually a sensor with additional electronics for signal conditioning and scaling.

Voltage to Frequency Converter – a device which converts an analog voltage into a train of digital pulses with a frequency proportional to the input voltage. The frequency is then measured digitally. This method (which is used by the Datataker) provides integration over the sampling time and good noise rejection.

ASCII - Decimal Equivalents
(special characters only)

Decimal	ASCII	Control	Description	Decimal	ASCII	Description
0	NUL	^@	null	38	&	
1	SOH	^A		39	'	
2	STX	^B		40	(	
3	EXT	^C		41	)	
4	EOT	^D		42	*	
5	ENQ	^E		43	+	
6	ACK	^F	acknowledge	44	,	comma
7	BEL	^G	bell	45	–	
8	BS	^H	backspace	46	.	period
9	HT	^I	tab	47	/	
10	LF	^J	line feed	48	0	
11	VT	^K	vertical tab	49	1	
12	FF	^L	form feed	50	2	
13	CR	^M	carriage return	51	3	
14	SO	^N		52	4	
15	SI	^O		53	5	
16	DLE	^P		54	6	
17	DC1	^Q	xon	55	7	
18	DC2	^R		56	8	
19	DC3	^S	xoff	57	9	
20	DC4	^T		58	:	colon
21	NAK	^U	not acknowledge	59	;	semicolon
22	SYN	^V		60	<	
23	ETB	^W		61	=	
24	CAN	^X		62	>	
25	EM	^Y		63	?	
26	SUB	^Z		64	@	
27	ESC	^[	escape	91	[	
28	FS	^]		92	\	
29	GS	^]		93	]	
30	RS	^^		94	^	
31	US	^_		95	_	underline
32			space	96	`	
33	!			98	b	" (alarms)
34	"			123	{	
35	#			124			
36	$			125	}	
37	%			126	~	
				127	DEL	delete

4-20mA Loop – a common measurement standard in industry. A transmitter controls a current in the range of 4 to 20mA as a function of a measurement parameter. Any receiver(s) or indicator(s) placed in series can output a reading of the parameter. Prime advantage is two wire connection and high immunity to noise pick-up. Generally powered from a 24 volts supply.

50 / 60 Hz Rejection – The most common source of noise is that induced by AC power cables. This noise is periodic at the line frequency. Datatakers are able to reject most of this type of noise by integrating the input for exactly one line cycle period (20.0 or 16.7mS).

Appendix — Datataker DT50

Introduction

Each model in the Datataker data logger range has a number of characteristics that differentiate it from the other models. This page describes these characteristics for the Datataker 50.

Analog Inputs

- 5 differential or 10 single ended, can be used in any mix.
- Sampling rate 25 samples/sec
- Input impedance 1MΩ, or >100 MΩ selectable
- Common mode range ±3.5 VDC
- Common mode rejection >90 db (110 db typical)
- Series mode line rejection >35 db
- Sensor excitation of 4.5V, 250.0µA or 2.500mA each channel.
- Full, half and quarter bridges, voltage or current excitation.
- Multiplexer type: solid state (CMOS)

For each analog input type, the Datataker 50 provides three decade ranges which are selected automatically:

Input Type	Channels DE SE	Range Units	Reso-lution
DC Voltage	5 10	±25 mV	1µV
		±250 mV	10µV
		±2500 mV	100µV
DC Current	5 15	±0.25 mA	200nA
		±2.5 mA	1µA
		±25. mA	10µA
Resistance	5 10	10 Ohms	0.5mΩ
		100 Ohms	5mΩ
		500 Ohms	50mΩ
		7000 Ohms	500mΩ
Frequency	5 10	0.1-20,000 Hz	0.01%

DE refers to double ended or differential channels and SE refers to single ended channels (see Glossary on page 23). Accuracy is expressed as percentage of reading at 25℃ (see page 17).

Digital Inputs and Outputs

- 5 TTL/CMOS compatible digital input channels for digital state, digital events, low speed counters (10 Hz, 16 bit, presettable). Digital input terminals are shared with digital output channels
- 5 Digital open collector outputs rated to 200mA at 30V
- 3 high speed counters, (1KHz or 1MHz, 16 bit, presettable).
- All analog channels may also be used as digital inputs, with a user definable threshold.

Input Type	Channels	Range
Digital Bit	5	0 or 1 State
Digital Nibble	1	0 to 31 State
LS counter	5	65535 Counts
HS counter	3	65535 Counts

Power Supply and Battery also page 15

The Datataker 50 can be powered from a variety of sources:

Source	Range	+ Terminal	– Terminal
AC	9 – 18Vac	AC/DC~	AC/DC~
DC	11 – 24Vdc	AC/DC~	Gnd
9V Alkaline Battery	6.2 – 10Vdc	Alkaline +	Bat. –
6V Gel Cell Battery	5.6 – 8Vdc	Lead +	Bat. –

The external 6 Volt gel cell connection provides temperature compensated charging with voltage (6.90V) and current (1A) limiting for a three cell battery, when an external AC or DC power supply is also connected.

When the Datataker 50 is powered by a 9V alkaline battery and an external AC or DC source, the 6.9V regulator's (see schematic) output is increased to 10V so that power is drawn from the external source in preference to the battery.

COMMS Port also page 13

The Datataker 50's COMMS Port is serial RS232 compatible. The output signal level is approximately ±4 Volts, allowing communications over distances in access 100 meters at 1200 baud. Greater distances are possible at 300 baud. The maximum practical distance is also dependent on the host computer's RS232 characteristics. (Note: the RS232 "standard" specifies 2000pF maximum cable capacitance, and no maximum distance).
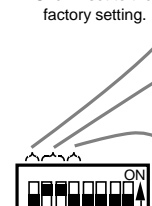
The Datataker 50's COMMS Port is electrically isolated to 500V.
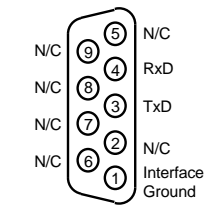
RS232 COMMS

N/C	5	N/C
N/C 9	4	RxD
N/C 8	3	TxD
N/C 7	2	N/C
N/C 6	1	Interface Ground

Dip Switch

Shown set to the factory setting.

Country	s1
US (60Hz)	on
Other (50Hz)	off

Baud Rate	s2	s3	s5	Add. Range
1200	off	off	x	0 - 15
9600	off	on	on	0 - 7
300	off	on	on	0 - 7
2400	on	off	x	0 - 15
4800	on	on	x	0 - 15

x = don't care

Mux Power	s4
permanent	on
switched	off

Address	s5	s6	s7	s8
0	off	off	off	off
1	off	off	off	on
2	off	off	on	off
3	off	off	on	on
4	off	on	off	off
5	off	on	off	on
6	off	on	on	off
7	off	on	on	on
8	on	off	off	off
9	on	off	off	on
10	on	off	on	off
11	on	off	on	on
12	on	on	off	off
13	on	on	off	on
14	on	on	on	off
15	on	on	on	on

See text to right

Country Setting

The Country Setting determines the default integration period (16.7mS for US and 20mS for others) for the analog to digital converter, and the default date format (see "Time and Other Channels" on page 6).

Baud Rate

The Datataker 50 COMMS port baud rate must match that of the host computer. See "COMMS Port" on page 13. Note that if either 300 or 9600 baud is selected, the logger address range is reduced to 0 -7.

Multiplexer Power

The power consumption of the Datataker 50 can be kept to a minimum if the input multiplexer is powered down while the logger is in the sleep state. For the Datataker 50 this is set using DIP switch s4.

The factory preset is for the multiplexers to power down while the Datataker 50 asleep. The current saving is approximately 150µA, which is the current draw of the 4 CMOS multiplexer integrated circuits (CD4052).

See "Multiplexer Powering" on page 15 for more details on the this subject.

Datataker 50 Address

The Datataker 50 can be given an address, however it is not particularly useful because the logger does not support networking.
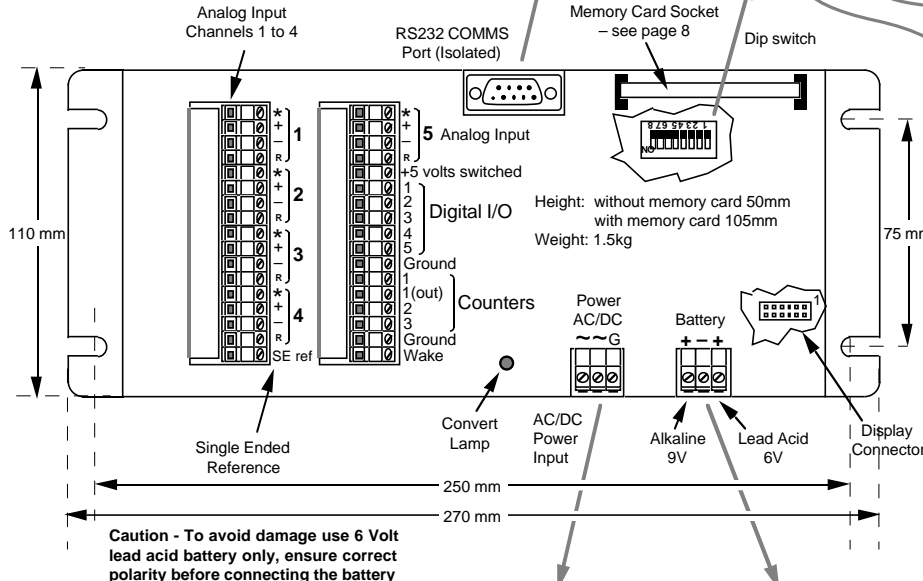
The only use for an address on a Datataker 50 is for identification using the **STATUS** or **STATUS1** commands. The first line returned by these commands includes the address. See "STATUS" command on pages 10 and 22.

Note: The Dip switch position five is unavailable if 300 or 9600 baud rates are selected. This halves the address range to 0 - 7.
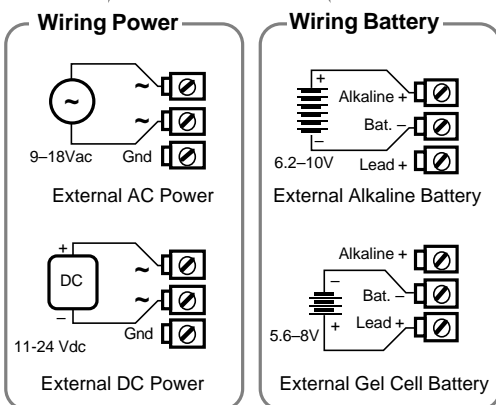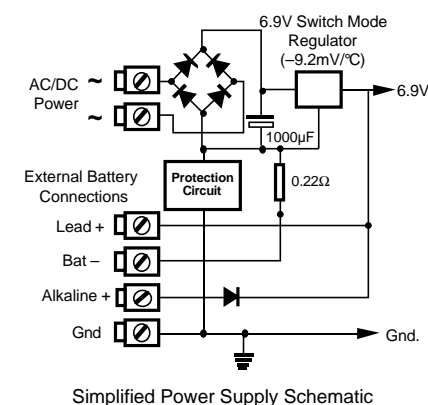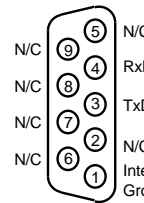
Power Consumption

The Datataker 50 will consume very little power if it is allowed to sleep. Less power is consumed if the Datataker 50 is powered through the battery terminals, rather than through the AC/DC terminals, because the battery charger circuit draws additional current, especially if it needs to charge a depleted battery.

Power Source	Condition	Current (typical)
battery	awake	100mA
battery	sleep	0.36mA
AC/DC	awake	105mA
AC/DC	awake & charging	600mA
AC/DC	sleep	5mA
AC/DC	sleep & charging	500mA

Diagram labels

Analog Input Channels 1 to 4

RS232 COMMS Port (Isolated)

Memory Card Socket – see page 8

Dip switch

110 mm

5 Analog Input
+5 volts switched
Digital I/O
1 2 3 4 5
Ground
1(out) Counters
2 3
Ground
Wake

Height: without memory card 50mm
with memory card 105mm
Weight: 1.5kg

75 mm

Single Ended Reference

SE ref

Convert Lamp

AC/DC Power Input

Power AC/DC ~~G

Battery

Alkaline 9V   Lead Acid 6V

Display Connector

250 mm

270 mm

Caution - To avoid damage use 6 Volt lead acid battery only, ensure correct polarity before connecting the battery

Simplified Power Supply Schematic

6.9V Switch Mode Regulator (−9.2mV/℃)

AC/DC ~ Power ~

1000µF

Protection Circuit

0.22Ω

6.9V

External Battery Connections

Lead +
Bat –
Alkaline +
Gnd

Gnd.

Simplified Power Supply Schematic

Wiring Power

9–18Vac   Gnd
External AC Power

DC
11-24 Vdc   ~ ~ Gnd
External DC Power

Wiring Battery

Alkaline +
Bat. –
6.2–10V   Lead +
External Alkaline Battery

Alkaline +
Bat. –
5.6–8V   Lead +
External Gel Cell Battery

Appendix — Datataker DT500 and DT600

Introduction

Each model in the Datataker data logger range has a number of characteristics that differentiate it from the other models. This page describes the characteristics for the Datataker 500 and the Datataker 600:

- 10 analog and 7 digital channels
- Network support
- Channel expansion socket

Analog Inputs

- 10 differential or 30 single ended, can be used in any mix.
- Sampling rate 25 samples/sec
- Linearity <0.05%
- Input impedance 1MΩ, or >100 MΩ selectable
- Common mode range ±3.5 Vdc
- Common mode rejection >90 db (110 db typical)
- Series mode line rejection >35 db
- Sensor excitation of 4.5V, 250.0µA or 2.500mA each channel.
- Full, half and quarter bridges, voltage or current excitation.
- Multiplexer type: solid state (CMOS)

For each analog input type, the Datataker 500 and Datataker 600 provides three decade ranges that are selected automatically:

Input Type	Channels DE SE	Range Units	Reso-lution
DC Voltage	10 30	±25 mV	1µV
		±250 mV	10µV
		±2500 mV	100µV
DC Current	10 40	±0.25 mA	200nA
		±2.5 mA	1µA
		±25. mA	10µA
Resistance	10 20	10 Ohms	0.5mΩ
		100 Ohms	5mΩ
		500 Ohms	50mΩ
		7000 Ohms	500mΩ
Frequency	10 30	0.1-20,000 Hz	0.01%

DE refers to double ended or differential channels and SE refers to single ended channels (see Glossary on page 23). Accuracy is expressed as percentage of reading at 25℃ (see page 17).

Digital Inputs and Outputs

- 4 TTL/CMOS compatible digital input channels for digital state, digital events, low speed counters (10 Hz, 16 bit, presettable). Digital input terminals are shared with digital output channels
- 4 Digital open collector outputs rated to 200mA at 30V
- 3 high speed counters, (1KHz or 1MHz, 16 bit, presettable).
- All analog channels may also be used as digital inputs, with a user definable threshold.

Input Type	Channels	Range
Digital Bit	4	0 or 1 State
Digital Nibble	1	0 to 15 State
LS counter	4	65535 Counts
HS counter	3	65535 Counts

Network

The Datataker 500 and Datataker 600 both have an RS485 network. A proprietary network protocol supports error free communications between up to thirty two Datataker 500 and Datataker 600 series data loggers. See page 14 for more details.

COMMS Port also page 13

The Datataker 500 and Datataker 600 COMMS Port is serial RS232 compatible. The output signal level is approximately ±4 Volts, allowing communications over distances in access 100 meters at 1200 baud. Greater distances are possible at 300 baud. The maximum practical distance is also dependent on the host computer's RS232 characteristics. (Note: the RS232 "standard" specifies 2000pF maximum cable capacitance, and no maximum distance).

The Datataker 500 and Datataker 600 COMMS Port is electrically isolated to 500V.
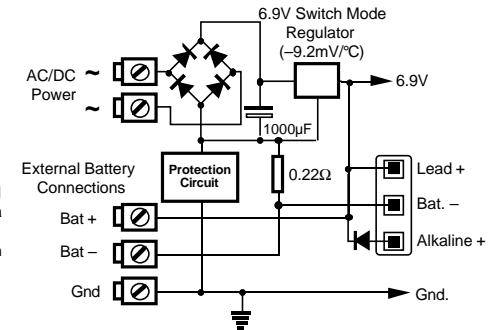
RS232 COMMS Connector

	5	N/C
N/C 9	4	RxD
N/C 8	3	TxD
N/C 7	2	N/C
N/C 6	1	Interface Ground

Address	s4	s5	s6	s7	s8
0	off	off	off	off	off
1	off	off	off	off	on
2	off	off	off	on	off
3	off	off	off	on	on
4	off	off	on	off	off
5	off	off	on	off	on
6	off	off	on	on	off
7	off	off	on	on	on
8	off	on	off	off	off
9	off	on	off	off	on
10	off	on	off	on	off
11	off	on	off	on	on
12	off	on	on	off	off
13	off	on	on	off	on
14	off	on	on	on	off
15	off	on	on	on	on
16	on	off	off	off	off
17	on	off	off	off	on
18	on	off	off	on	off
19	on	off	off	on	on
20	on	off	on	off	off
21	on	off	on	off	on
22	on	off	on	on	off
23	on	off	on	on	on
24	on	on	off	off	off
25	on	on	off	off	on
26	on	on	off	on	off
27	on	on	off	on	on
28	on	on	on	off	off
29	on	on	on	off	on
30	on	on	on	on	off
31	on	on	on	on	on

See "Baud Rate and Address"

Dip Switch

Shown set to the factory setting

Country	s1
US (60Hz)	on
Other (50Hz)	**off**

Baud Rate	s2	s3	s4	Add. Range
1200	off	off	x	0 - 31
9600	off	off	off	0 - 15
300	off	on	on	0 - 15
2400	on	off	x	0 - 31
4800	**on**	**on**	x	0 - 31

x = don't care

default
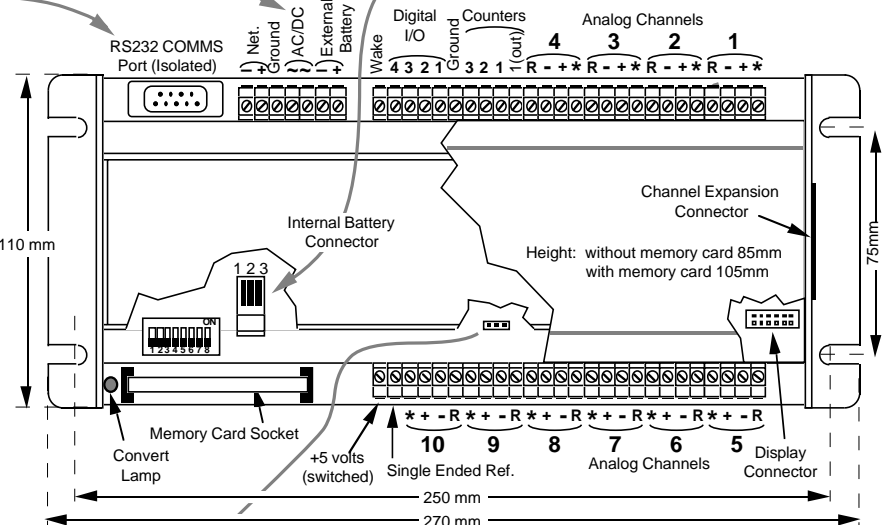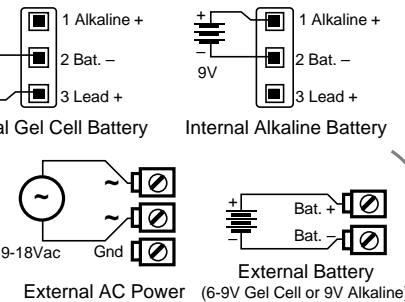
Country Setting

The Country Setting determines the default integration period (16.7mS for US and 20mS for others) for the analog to digital converter, and the default date format (see "Date" on page 6).
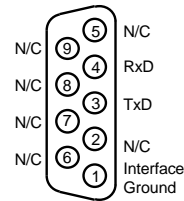
Baud Rate and Address

Dip switch position four (s4) is not available for setting the address if 300 or 9600 baud rate is selected. This reduces the address range to 0 – 15.

Power Supply and Battery

The Datataker 500 and 600 can be powered as follows:

Source	Range	+Terminal	−Terminal
AC	9 – 18Vac	AC/DC~	AC/DC~
DC	11 – 24Vdc	AC/DC~	Gnd
9V Alkaline Battery	6.2 – 10Vdc	Alkaline +	Bat. −
6V Gel Cell Battery	5.6 – 8Vdc	Lead +	Bat. −

The gel cell connection provides temperature compensated charging with voltage (6.90V) and current (1A) limiting for a three cell battery, when an AC or DC supply is also connected.

It is not recommended to connect both an internal and an external battery. If two batteries are required it is better that the external battery is a larger capacity 12V battery, and is connected as External DC Power.

6V — Internal Gel Cell Battery
1 Alkaline +
2 Bat. −
3 Lead +

9V — Internal Alkaline Battery
1 Alkaline +
2 Bat. −
3 Lead +

DC 11-24Vdc Gnd — External DC Power

9-18Vac Gnd — External AC Power

Bat. + Bat. − — External Battery (6-9V Gel Cell or 9V Alkaline)

Power Consumption

The DT500 and 600 will use little power if allowed to sleep. Less power is consumed if the logger is powered via the battery terminals, rather than the AC/DC terminals, because the battery charger circuit draws additional current.

Power Source	Condition	Current (typical)
battery	awake	100mA
battery	sleep	0.36mA
AC/DC	awake	105mA
AC/DC	awake & charging	600mA
AC/DC	sleep	5mA
AC/DC	sleep & charging	500mA

Caution - To avoid damage use 6Volt lead acid battery only, ensure correct polarity before connecting the battery

AC/DC ~ Power — 6.9V Switch Mode Regulator (−9.2mV/℃) — 6.9V

1000µF

0.22Ω

Protection Circuit

External Battery Connections
Bat +
Bat −
Gnd

Lead +
Bat. −
Alkaline +
Gnd.

RS232 COMMS Port (Isolated)

Net. Ground AC/DC External Battery Wake Digital I/O Ground Counters Analog Channels

4 3 2 1 3 2 1 1(out) 4 3 2 1 R - + * R - + * R - + * R - + *

110 mm

75mm

Internal Battery Connector

Channel Expansion Connector

Height: without memory card 85mm with memory card 105mm

Memory Card Socket

Convert Lamp

+5 volts (switched)

Single Ended Ref.

* + - R * + - R * + - R * + - R * + - R * + - R
10 9 8 7 6 5
Analog Channels

Display Connector

250 mm
270 mm

Powering the Multiplexer

The Datataker 500 and 600 have an option to maintain multiplexer power in low power mode. This is achieved by moving the **Mux. Power** link located under the top cover near channel 9, as shown on the right.

SW USW
Mux Power
Power-down Position

SW USW
Mux Power
Power maintained Position
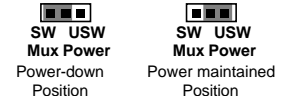
Appendix — Datataker DT505 and DT605

Introduction

Each model in the Datataker data logger range has a number of characteristics which differentiates it from the other models. This page describes the characteristics for the Datataker 505 and the Datataker 605:

- 10 analog and 7 digital channels
- Relay Multiplexer (±100V input)
- Network support (as for DT500/600)
- Channel expansion socket

Analog Inputs

- 10 differential or 30 single ended, or any mix.
- Switchable attenuator that allows high voltage measurement.
- Sampling rate 25 samples/sec.
- Channels have 500 volt isolation while not being read.
- Input impedance 1MΩ, or >100 MΩ selectable.
- Common mode range ±3.5 Vdc, ±100 Vdc attenuators on.
- Common mode rejection >90 db (110 db typical).
- Series mode line rejection >35 db.
- Sensor excitation of 4.5V, 250.0µA or 2.500mA each channel.
- Full, half and quarter bridges, voltage or current excitation.
- Multiplexer type: relay

Input Type	Channels DE SE	Range Units	Reso-lution
DC Voltage	10 30	±25 mV	1µV
		±250 mV	10µV
		±2500 mV	100µV
		±7 V	250µV
		±70V	2.5mV
		±100V	25mV
DC Current	10 40	±0.25 mV	200nA
		±2.5 mA	1µA
		±25. mA	10µA
Resistance	10 20	10 Ohms	0.5mΩ
		100 Ohms	5mΩ
		500 Ohms	50mΩ
		7000 Ohms	500mΩ
Frequency	10 30	0.1-20,000 Hz	0.01%

DE refers to double ended or differential channels and SE refers to single ended channels (see Glossary on page 23). Accuracy is expressed as percentage of reading at 25℃ (see page 17).

All analog input channel terminals except for the Return (R) terminals are capable of withstanding 1.5KV for 10µS, 500V for 50mS and 100V indefinitely. The return terminal can withstand only 5 % of these voltages.

These withstanding voltages **only apply to unselected channels**. While a channel is actually being read (a process that typically takes 30mS), these withstanding voltages are reduced to that of the return terminal.

Digital Inputs and Outputs

- 4 TTL/CMOS compatible digital input channels for digital state, digital events, low speed counters (10 Hz, 16 bit, presettable). Digital input terminals are shared with digital output channels
- 4 Digital open collector outputs rated to 200mA at 30V
- 3 high speed counters, (1KHz or 1MHz, 16 bit, presettable).
- All analog channels may also be used as digital inputs, with a user definable threshold.

Input Type	Channels	Range
Digital Bit	4	0 or 1 State
Digital Nibble	1	0 to 15 State
LS counter	4	65535 Counts
HS counter	3	65535 Counts

COMMS Port also page 13

The Datataker 505 and Datataker 605 COMMS Port is serial RS232 compatible. The output signal level is approximately ±4 Volts, allowing communications over distances in access 100 meters at 1200 baud. Greater distances are possible at 300 baud. The maximum practical distance is also dependent on the host computer's RS232 characteristics. (Note: the RS232 "standard" specifies 2000pF maximum cable capacitance, and no maximum distance).

The Datataker 505 and Datataker 605 COMMS Port is electrically isolated to 500V.

RS232 COMMS Connector

Pin	Signal
5	N/C
9	N/C
4	RxD
8	N/C
3	TxD
7	N/C
2	N/C
6	N/C
1	Interface Ground

Address	s4	s5	s6	s7	s8
0	off	off	off	off	off
1	off	off	off	off	on
2	off	off	off	on	off
3	off	off	off	on	on
4	off	off	on	off	off
5	off	off	on	off	on
6	off	off	on	on	off
7	off	off	on	on	on
8	off	on	off	off	off
9	off	on	off	off	on
10	off	on	off	on	off
11	off	on	off	on	on
12	off	on	on	off	off
13	off	on	on	off	on
14	off	on	on	on	off
15	off	on	on	on	on
16	on	off	off	off	off
17	on	off	off	off	on
18	on	off	off	on	off
19	on	off	off	on	on
20	on	off	on	off	off
21	on	off	on	off	on
22	on	off	on	on	off
23	on	off	on	on	on
24	on	on	off	off	off
25	on	on	off	off	on
26	on	on	off	on	off
27	on	on	off	on	on
28	on	on	on	off	off
29	on	on	on	off	on
30	on	on	on	on	off
31	on	on	on	on	on

See "Baud Rate and Address"

Country	s1
US (60Hz)	on
Other (50Hz)	off

default

Baud Rate	s2	s3	s4	Add. Range
1200	off	off	x	0 - 31
9600	off	on	off	0 - 15
300	off	on	on	0 - 15
2400	on	off	x	0 - 31
4800	on	on	x	0 - 31

x = don't care

Dip switch Shown set to the factory setting

Country Setting

The Country Setting determines the default integration period (16.7mS for US and 20mS for others) for the analog to digital converter, and the default date format (see "Date" on page 6).

Baud Rate and Address

Dip switch position four (s4) is not available for setting the address if 300 or 9600 baud rate is selected. This reduces the address range to 0 – 15.

Power Supply and Battery

The Datataker 505 and 605 can be powered as follows:

Source	Range	+ Terminal	– Terminal
AC	9 – 18Vac	AC/DC~	AC/DC~
DC	11 – 24Vdc	AC/DC~	Gnd
9V Alkaline Battery	6.2 – 10Vdc	Alkaline +	Bat. –
6V Gel Cell Battery	5.6 – 8Vdc	Lead +	Bat. –

The gel cell connection provides temperature compensated charging with voltage (6.90V) and current (1A) limiting for a three cell battery, when an AC or DC supply is also connected.

It is not recommended to connect both an internal and an external battery. If two batteries are required it is better that the external battery is a larger capacity 12V battery, and is connected as External DC Power.

The simplified schematic on page 25 for the Datataker 500 and 600 is also applicable to the Datataker 505 and 605.

External DC Power External AC Power External Battery Internal Gel Cell Battery Internal Alkaline Battery
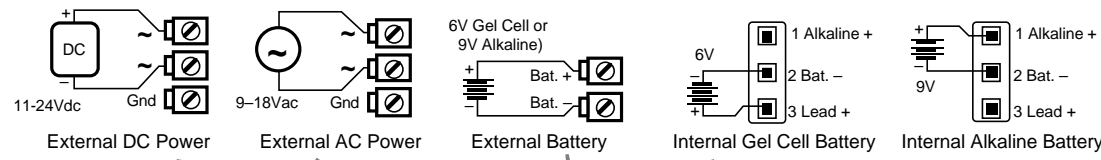
Power Consumption

The Datataker 505 and 605 will consume very little power if it is allowed to sleep. Less power is consumed if the logger is powered via the battery terminals rather than the AC/DC Power terminals. This is because the battery charger circuit draws additional current.

Power Source	Condition	Current (typical)
battery	awake	220mA
battery	sleep	0.36mA
AC/DC	awake	230mA
AC/DC	awake & charging	600mA
AC/DC	sleep	5mA
AC/DC	sleep & charging	400mA

Battery life for the Datataker 505 and 605 is about one third longer than that of the Datataker 500 and 600 for slow scan rates (i.e. >30 minutes). See "Battery Life" on page 15.

High Voltage Measurement

The Datataker 505 and 605 models have a switchable four wire (on the ★, +, – and **SERef.** lines) attenuator after the input multiplexer. In each case attenuation is relative to ground. The attenuators on the differential inputs (+ and –) are matched to ensure high common mode rejection.

By default two channel types automatically switch in the attenuators – nHV and nL. See "Channel Types" on page 4 for more details. For other channel types use the **A** channel option to switch in the attenuators e.g **2AS(A)**. See "Channel Options" on page 5.

Auxiliary Dip Switch

The four way Auxilliary Dip Switch provides additional versatility.

Reserved: must be set in default position otherwise network operation will be impaired.

With s4 in the ON position a 19200 Hz frequency signal is applied to the High Speed Counter (**1HSC**) input.

Default positions for SW2 dip switch
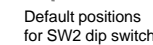
# Appendix — Geologger DT515 and DT615

Introduction

The Geologger is functionally similar to the Datataker 505 or Datataker 605 (see "Appendix – Datataker DT505 and DT605" on page 26) with the addition of an internal vibrating wire sensor support module. All electrical and programming characteristics are identical except the Geologger models have an extra channel type – *n* **FW** (Frequency of Wire) and a software speaker switch **/V**. The Geologger supports most vibrating wire gauges with resonances between 600Hz and 4.5KHz.

Vibrating Wire Support

The Geologgers use a pulse to pluck the wire in a vibrating wire gauge. The advantage of the pulse pluck method is that a fixed pulse is able to stimulate a wide range of gauges. This greatly simplifies channel programming for the user.

The balanced pluck pulse is approximately 150µS long and up to 36 volts in amplitude. The pulse has a current source characteristic that provides automatic cable length compensation. Sensors on long cable will be pulsed with the same energy as those on shorter cables.

The Geologger has a high gain low noise signal amplifier with transformer coupling on the input. The amplified signal is filtered using band pass filters (500Hz to 5KHz) and a phase lock loop (PLL) to reduce frequency noise before the frequency is measured by a precision frequency counter.
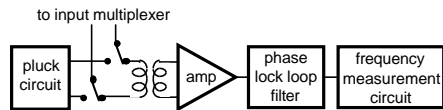
Signals in the order of tens of microvolts can provide useful reading. Transformer coupling ensures very high common mode rejection, a characteristic that is needed to reject 50/60 hertz and other interfering noise.

Differential Connection

The preferred method of vibrating wire sensor connection is differentially between the "+" and "−" inputs of a channel.

Differential VW Connection
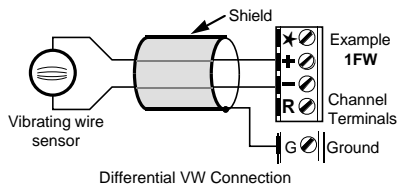
While the shield is optional it will often be found necessary when noise pick-up is a problem. The preferred shield connection point is one of the Geologger's ground terminals or a case ground terminal strip.

If the channels return terminal (R) is not used for other purposes it can be used as a shield terminal. However as the return terminal is internally connected to ground via a 100Ω resistor, its effectiveness is not as great as a direct connect to ground. Also, if lightning strike is possible, then the resistor may be destroyed.

Single Ended Connection

Vibrating wire gauges may also be connected single endedly – that is they can share a common terminal. A channels return terminal becomes the "common", and each of the channel's remaining three terminals become single ended input terminals. It is now possible to connect three sensors to each channel.
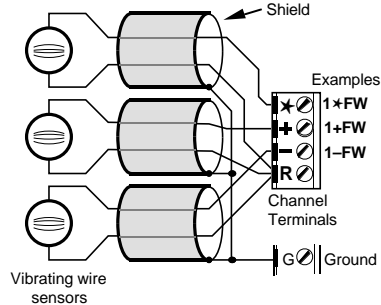
Single Ended VW Connection

As can be seen in the diagram, shielding is the same as for the differential connection.

The single ended input arrangement functions best where:

- cable lengths are relatively short (say < 100 meters)
- gauges have good sensitivity (signal to pluck ratio)

Because of the great range in gauge sensitivity it is difficult to predict the operating limits. We suggest that for cable lengths in excess of 100 meters that test be conducted with the gauges to be deployed.

Programming VW Channels

Channels connected to vibrating wire gauges are supported by the *n***FW** channel type (see "Channel Types" on page 4). This channel type tells the logger to configure the channel for vibrating wire, pluck the sensor, and to measure the frequency returned. For example the following differential channel specifications:

        1FW   5..8FW

will return

        1FW 3056.7 Hz
        5FW 1896.4 Hz
        6FW 2035.7 Hz
        7FW 1705.5 Hz
        8FW 1769.2 Hz

as data on channels 1, 5, 6, 7 and 8. Single ended channels are specified by adding a terminal identifier:

        2+FW 2−FW 2*FW

will return

        2+FW 4597.8 Hz
        2−FW 4445.2 Hz
        2*FW 3909.7 Hz

where the "**+**", "**−**" and "*****" indicate gauges connected single endedly between the return terminal and "**+**", "**−**" and "*****" terminals respectively.

Readings can be scaled into engineering units using the Geologgers functions, spans, polynomials and calculation facilities. See "Scaling and Calculations" on page 7.

Trouble Shooting

By design, most vibrating wire gauges are very reliable. If a gauge fails to return sensible results it can be due to:

- an open circuit
- a short circuit
- excessive cable leakage
- very high induced common mode noise levels
- direct noise pick up by gauge coil
- failed gauge
- excessive cable length for gauge sensitivity
- inappropriate use of single ended input.
- gauge frequency outside 500Hz to 5KHz range
- mechanical vibration of gage by external forces

The Speaker **/V /v**

The Geologger has a built in speaker and headphone jack (3.5mm mono or stereo, 8Ω) specifically for fault diagnosis. The speaker is enabled by the **/V** switch (see "Switches" on page 11). The speaker is connected to the high gain amplifiers output. Note that the frequency response of the small speaker is far from flat – the use of headphones is preferred.

For a good gauge and correct installation, the sound is a clean "ping", decaying over a period of a few seconds. Note the full decay can only be heard for the last channel in a channel list. Embedded channels can be heard but only for about half a second.

If there is no tone but only noise, check the channel type, wiring and resistance (below).

If a note can be heard but it is faint or buried in the noise, then the cable is too long or "leaky", or the gauge insensitive.

If the note is not clean and pure then the gauge is suspect. It may have been damaged during installation.

If you can hear a low frequency "hum", then noise pick is a problem. If the gauge is placed near a transformer, electric motor, high current power cables etc., either re-site or orientate gauge for minimum pickup. Ensure cable is shielded to prevent capacitive pickup.

Measure Resistance

Gauge and cable integrity is best determined by measuring the circuit resistance. This can be done using a multimeter or the Geologger (see "Resistance" on page 4). This resistance should be stable and not drift with time.

Measurement Delay *n***FW(200)**

If returned data is unstable to the extent that it varies by perhaps ±20Hz yet the speaker indicates a strong signal, the signal may contain harmonics. The harmonics generally decay more rapidly than the fundamental, so increasing the time between stimulation and frequency measurement can improve the results. The measurement delay can be adjusted by setting the channel factor in milliseconds (see "Channel Options" on page 5). For example **1FW(500)** will increase the delay from the default 200mS to 500mS.

### Extra Samples   *n***FW(ES9)**

By default the Geologger measures a vibrating wire frequency over a period of 10 line periods (167mS in 60Hz countries and 200mS in 50Hz countries). This has been found optimal for most gauge types. However for gauges with a rapid signal decay, this period can be reduced so that the measurement window does not extend into the noise. For example **1FW(ES4,100)** will allow sampling over 5 line periods and reduce the measurement delay to 100mS.

Measuring Gauge Temperature

Most vibrating wire gauges are sensitive to temperature fluctuations. Where a gauge's temperature is likely to change significantly, its temperature is usually measured. The Geologger supports all sensor types normally used including Thermistors (Yellow Springs 400XX series), platinum, nickel, and copper RTDs. See "Channel Types" on page 4 and "RTDs" on page 16 for more information.

Measuring Frequency and Temperature on one Channel

Depending on the gauge wiring, it is usually possible to measure the vibrating wire differentially and a resistance (temperature sensor) on a single channel.
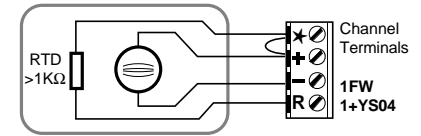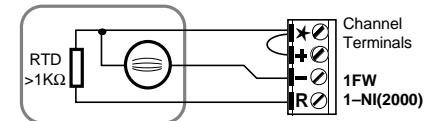
Vibrating wire sensor with two wire RTD

Temperature channel is read single endedly as for example **1+YS04** (a YSI 44004 sensor - see page 16) and the vibrating wire as **1FW**. Note the RTD sensor type must be of a relatively high resistance type (say >1000Ω) if errors due to cable resistance are to be avoided.

Similarly other configurations are possible. If the temperature sensor is of a low resistance type then the following is recommended:
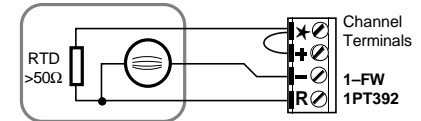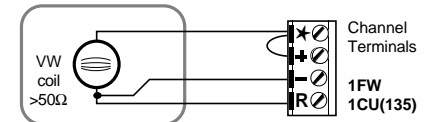
Single ended vibrating wire with three wire RTD

However this configuration has the disadvantages of a single ended vibrating wire connection. If the temperature sensor is of high resistance type then the following is preferred:

Differential vibrating wire with two wire RTD

It is possible to use the copper coil in the vibrating wire gauge as a temperature sensor provided a three wire connection is used:

Differential vibrating wire with three wire copper RTD

The gauge is read as **1FW** and the temperature as **1CU(135)** where the 135 channel factor is the coils resistance at 0℃.

Appendix — Channel Expansion Module

Introduction

The Channel Expansion Module provides increased channel capacity for Datatakers fitted with an expansion connector. The channel measurement specifications of the Datataker also apply to the Channel Expansion Module. This particularly applies to the analog input voltage ranges.

While the expansion module has a relay multiplexer capable of withstanding voltages in excess of 500 volts, if for example it is connected to a Datataker 500 and 600, the maximum allowable input voltage remains ±4 volts.

Analog Inputs

- 10 differential or 30 single ended, or any mix.
- Channel characteristics identical to Datataker to which the module is attached.
- Channels have 500 volt isolation while not being read.
- Input impedance 1MΩ, or >100 MΩ selectable.
- Sensor excitation of 4.5V, 250.0µA, 2.500mA or externally supplied source, to each channel.
- Full, half and quarter bridges, voltage or current excitation.
- Multiplexer type: relay

Digital Inputs and Outputs

- 20 TTL/CMOS/Voltage free contact compatible digital input channels for digital state and byte input
- 10 Digital output for digital state and byte output
  - 5 contact closures rated 110Vac/dc at 5A
  - 5 open collector outputs rated to 200mA at 30V
- All analog channels may also be used as digital inputs, with a user definable voltage threshold.

Note: the expansion module digital inputs do not support any counter channel types.

Module Installation

The expansion module is connected to the Datataker via the 25 way expansion connector on the end of the logger's case. A 50 cm (1.6 feet) ribbon cable is provided. Additional expansion modules can be chained end to end:

Expander 2   Expander 1   Datataker
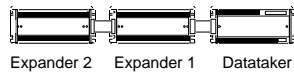
Up to 2 Channel Expansion Modules may be connected to a Datataker. The total cable length must be less than 2 meters (6 feet).

Before you install an expansion module, disconnect mains power and all batteries from the Datataker. After module connection, power up the Datataker and the new channels will become available. The first line returned by the **TEST** command will reflect the new hardware configuration. A "6" indicates a Channel Expansion Module.

Channel Addressing

Channel addressing on the expander follows the normal Datataker conventions except that an expander prefix is added. The prefix is the module number and a colon. The module connected to the Datataker is module number one, the next module in the chain is number two. Some examples are:

1:5V	module 1, analog channel 5 (voltage)
2:1..3DS	module 2, digital channels 1 to 3
2:4DSO=1	module 2, digital output channel 4

The module number is also attached to data returned by the Datataker. The above channels will return data as:

```
1:5V 23.452mV
2:1DS 1 State
2:2DS 0 State
2:3DS 1 State
```

As with all data returned by the Datataker, the channel identification can be switched off using the **/n** switch.

Internal Channels

Each Channel Expansion Module has two internal channels: a temperature and an electrical zero channel.

e **:1 %LM35**   expander temperature channel
e **:2 %V**   electrical zero channel

where *e* is the expander number and the percent symbol indicates an internal channel.

High Voltage Protection

The Channel Expansion Module does not include built in energy absorbing lightning protection. However with certain important conditions, all analog channel terminals except for the return (R) terminals are capable of withstanding 1.5KV for 10µS, 500V for 50mS and 100V indefinitely. The return terminal can withstand only 5 % of these voltages.

The above withstanding voltages apply **only to unselected channels**. While a channel is being read (a process that typically takes 30mS), these withstanding voltages are reduced to those of the Datataker. For non-isolated Datatakers this can be as low as 5 volts relative to ground.

In applications where scanning is infrequent (say not more than every 3 hours), the probability of a scan being co-incident with a lightning strike is very low.

Where lightning is frequent, we strongly recommend that external energy absorbing lightning protection be wired to each sensor line. Further, we recommend that Datatakers with higher withstanding voltages be used.

Thermocouples

The Channel Expansion Module has been designed to function with thermocouples. The module's temperature sensor is located so that it senses the temperature of the analog channel screw terminals. These terminals become the reference junction.

The Datataker will automatically measure the module's temperature and electrical zero when scanning a thermocouple channel on the module. These values are used for reference junction compensation.

The accuracy of thermocouple measurement is dependent on the isothermal condition of the reference junction. If a temperature gradient develops between the modules temperature sensor and the input terminals, the error will approximately equal the temperature difference.
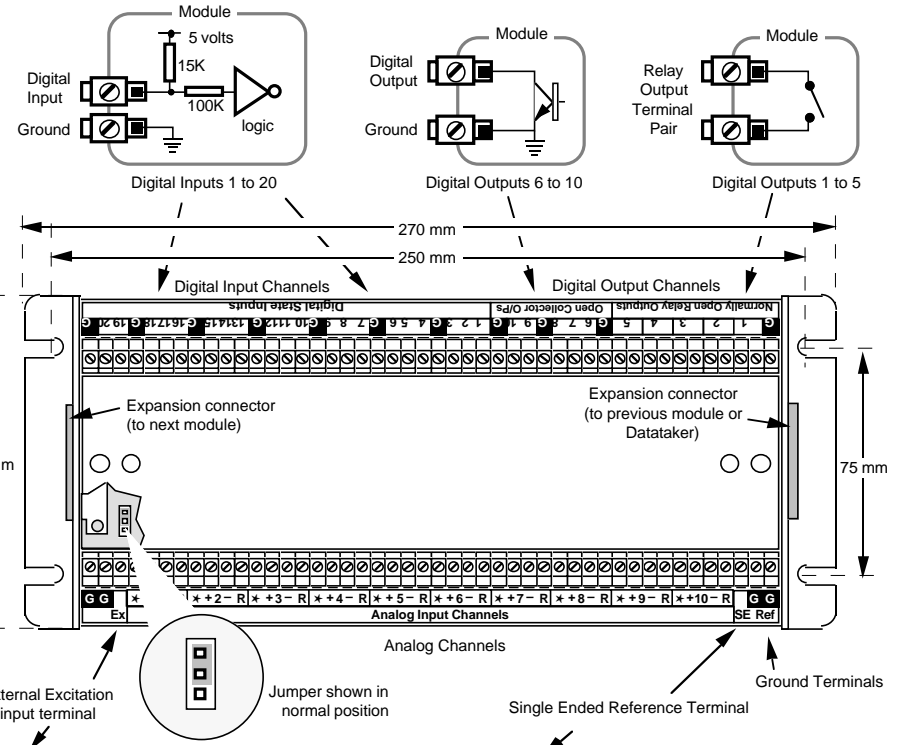
The module utilises relays for channel selection and digital output. These are a source of heat as each relay dissipates 150mW when switched on. For maximum thermocouple accuracy, you should ensure that these relays are not left on unnecessarily.

A not so obvious reason that a relay may be left on is that the last channel in a schedule remains selected if **P15** is set to 1 or 2. This can be resolved if **P15** is set to zero or a dummy channel is placed at the end of the schedule. A good choice would be **1 %V(M18:156,W).**

Power Consumption

The Expansion Module will consume very little power if the Datataker to which it is attached is allowed to sleep. While scanning channels on the expander, the current drawn from the Datataker will increase to 60mA. Additional current is required if the digital output relays are switched on. Each of the five relays will draw 35mA, however these relays are automatically switched off when the Datataker sleeps. A summary of current draw is tabulated to the right:

Condition	Current
sleep	100µA
awake, no scanning or digital I/O	100µA
digital inputs grounded	4mA
scanning module's channels	60mA
relay outputs set (**1..5DSO=1**)	175mA
worst case maximum	240mA

Digital Inputs 1 to 20

Digital Outputs 6 to 10

Digital Outputs 1 to 5

270 mm

250 mm

Digital Input Channels

Digital Output Channels

Expansion connector (to next module)

Expansion connector (to previous module or Datataker)

110 mm

75 mm

External Excitation input terminal

Jumper shown in normal position

Ground Terminals

Single Ended Reference Terminal

Analog Channels

External Excitation (EE)

For sensors that require non-standard powering or excitation, an External Excitation input terminal is able to direct power to the Excite (✳) terminal of a selected channel. This option can be enabled by moving a jumper to the outer two pins on a three pin header. The jumper is accessed by removing the module's top cover.

The normal position of the jumper (between the inner two pins) provides the standard Datataker 250µA, 2.5mA or 4.5V excitation. If the external excitation option is selected these are not available on any channel of the module. Care must be taken in assigning channels. If for example an Expansion Module is wired with a four wire RTD and several bridges requiring 12V excitation, then the 12V would be applied to the RTD when it is scanned. The RTD would probably be damaged.
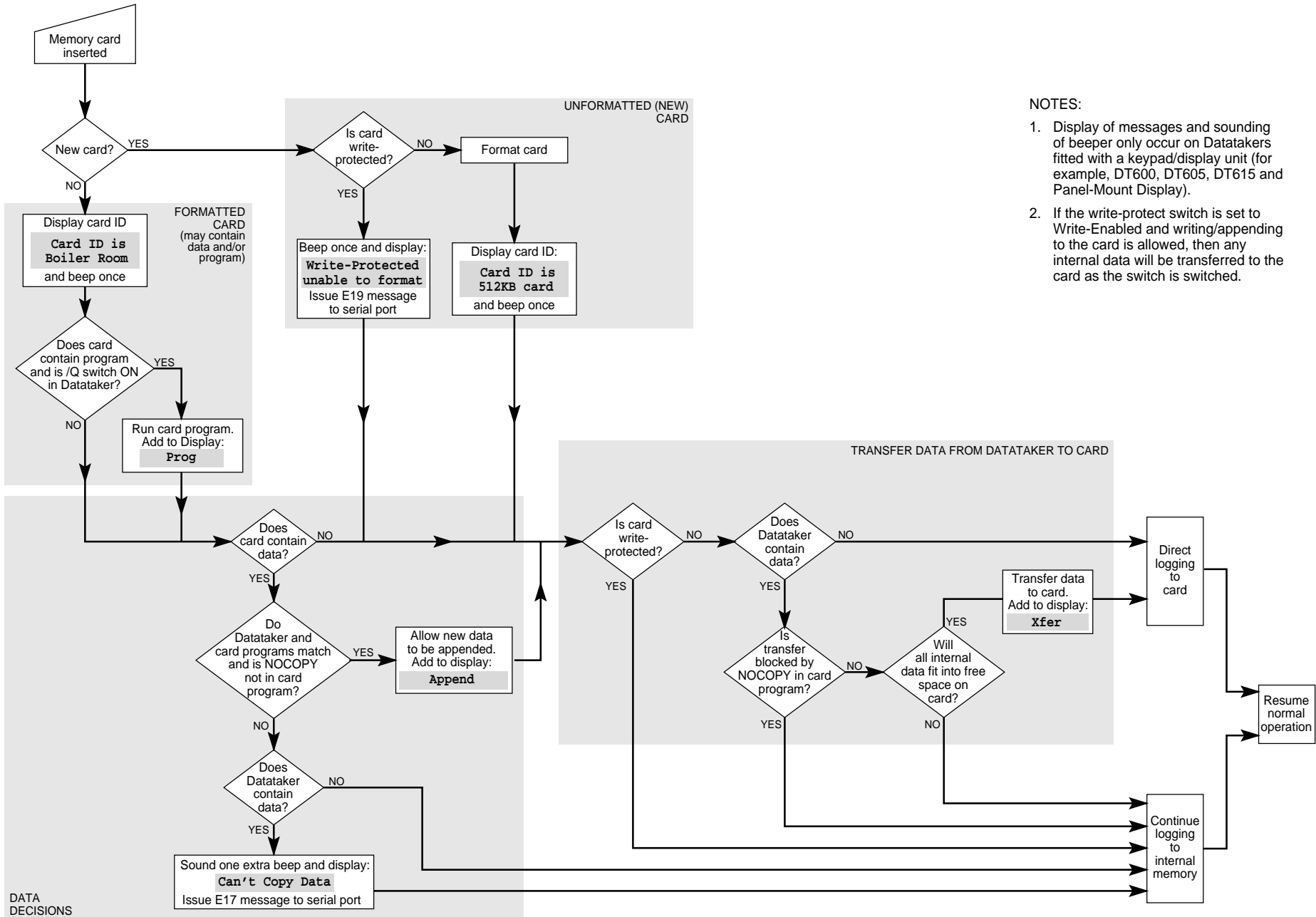
Single Ended Reference

The Channel Expansion Module has a SE Ref input terminal with an identical function to that found on the Datatakers. It provides a floating common for single ended input (see the "**X**" channel option on page 5).

The SE Ref input is switched on each module, but not on most Datatakers. (The DTxx5 series are the exception). This means that if the SE Ref terminal is used on one or more modules, it should not be used on the Datataker. The selected module's SE Ref input will appear as an output on the Datataker's SE Ref terminal.

The input voltage range of the SE Ref input is identical to that of the Datataker to which the Channel Expansion Module is attached. This ranges from ± 3.5V for the Datataker 500 and 600 models to ±100V for the Datataker 505 and 605 and Datataker 515 and 615 models.

Appendix — Memory Card Processing (Flow Chart)

Memory card inserted

New card? — YES

NO

UNFORMATTED (NEW) CARD

Is card write-protected? — NO → Format card

YES

Beep once and display:

`Write-Protected unable to format`

Issue E19 message to serial port

Display card ID:

`Card ID is 512KB card`

and beep once

FORMATTED CARD (may contain data and/or program)

Display card ID

`Card ID is Boiler Room`

and beep once

Does card contain program and is /Q switch ON in Datataker? — YES

NO

Run card program. Add to Display:

`Prog`

NOTES:

1. Display of messages and sounding of beeper only occur on Datatakers fitted with a keypad/display unit (for example, DT600, DT605, DT615 and Panel-Mount Display).

2. If the write-protect switch is set to Write-Enabled and writing/appending to the card is allowed, then any internal data will be transferred to the card as the switch is switched.

TRANSFER DATA FROM DATATAKER TO CARD

Does card contain data? — NO

YES

Do Datataker and card programs match and is NOCOPY not in card program? — YES → Allow new data to be appended. Add to display: `Append`

NO

Does Datataker contain data? — NO

YES

Sound one extra beep and display:

`Can't Copy Data`

Issue E17 message to serial port

Is card write-protected? — NO → Does Datataker contain data? — NO → Direct logging to card

YES

YES

Is transfer blocked by NOCOPY in card program? — NO → Will all internal data fit into free space on card? — YES → Transfer data to card. Add to display: `Xfer`

YES

NO

Continue logging to internal memory

Resume normal operation

DATA DECISIONS

Appendix — Specifications

Introduction

The Datataker range of data loggers are all microprocessor-based battery powered or mains powered data loggers which can measure all of the fundamental signal types, and have direct support built in for a wide range of commonly used sensors.

Data manipulation includes sensor calibrations, real-time statistical functions, and real-time calculations. The acquired data can either be returned to a host computer in real time, or can be logged into memory for later recovery. Data can be stored in battery backed internal memory, or in PC Card (PCMCIA) memory cards which can be periodically removed from the logger to transport the data.

Alarms can be set for all input channels, and can be annunciated by switching of digital outputs, returning alarm messages to a host computer, and displaying alarm states.

The Datataker models differ only in the number of input channels, the type of analog channel multiplexing, and expansion and display options.

All models support the same signal types and sensors, and have the same capabilities for acquiring, manipulating and logging data.

The Datataker data loggers are suitable for applications in industry, science, agriculture, the environment, hydrography, and the public utilities.

The Datataker data loggers can be installed locally and communicate directly with a local host computer, or can be installed in remote locations and communicate to a base host computer by various telemetry options including PSTN, cellular networks and radio.

The Geologger 515 and 615 data loggers have the same specification as the Datataker series. However, these loggers also support vibrating wire strain gauges, which are the active elements of a wide range of pressure sensors, load sensors, displacement sensors, etc. that are commonly used in geotechnical, mining and structural applications.

Features Comparison of the Datataker Data Loggers

	Datataker 50	Datataker 500	Datataker 600	Datataker 505	Datataker 605	Geologger 515	Geologger 615
Analog Channels - Differential	5	10	10	10	10	10	10
or - Single Ended	10	30	30	30	30	30	30
Multiplexer	Solid State	Solid State	Solid State	Relay	Relay	Relay	Relay
Resolution	15 bit/1µV	15 bit/1µV	15 bit/1µV	15 bit/1µV	15 bit/1µV	15 bit/1µV	15 bit/1µV
Common Mode Range	±3.5V	±3.5V	±3.5V	±100V	±100V	±100V	±100V
Volts, Current, 4-20mA, Resistance	✔	✔	✔	✔	✔	✔	✔
Frequency, Period	✔	✔	✔	✔	✔	✔	✔
Thermocouple Support	11 types	11 types	11 types	11 types	11 types	11 types	11 types
RTD Support (Pt, Cu, Ni)	✔	✔	✔	✔	✔	✔	✔
Bridges, Strain Gauge Support	✔	✔	✔	✔	✔	✔	✔
Vibrating Wire Support	✘	✘	✘	✘	✘	✔	✔
Digital Channels - Input/Output	5/5	4/4	4/4	4/4	4/4	4/4	4/4
Counter Channels - Fast/Slow	3/5	3/4	3/4	3/4	3/4	3/4	3/4
Channel Expansion	✘	✔	✔	✔	✔	✔	✔
Isolated RS232	✔	✔	✔	✔	✔	✔	✔
Max Baud Rate	9600	9600	9600	9600	9600	9600	9600
Supports Datataker Network	✘	✔	✔	✔	✔	✔	✔
Integral Display	✘	✘	✔	✘	✔	✘	✔
Panel Mount Display Option	✔	✔	✘	✔	✘	✔	✘
Internal Battery	✘	✔	✔	✔	✔	✔	✔

| DT50 | DT500 | DT600 | DT505 | DT605 | DT515 | DT615 |

Appendix — Specifications (cont.)

Analog Input Channels

Datataker 50
- 5 differential or 10 single-ended, can be used in any mix.
- Solid state multiplexers.
- Common mode range ±3.5VDC.

Datataker 500, 600
- 10 differential or 30 single-ended, can be used in any mix.
- Solid state multiplexers.
- Common mode range ±3.5VDC.
- Expansion by Channel Expansion Modules (CEMs) with 10 differential or 30 single-ended analog channels. Maximum of two CEMs.

Datataker 505, 605 and Geologger 515, 615
- 10 differential or 30 single-ended, can be used in any mix.
- Relay multiplexers.
- Common mode range ±100VDC.
- Input withstanding voltages for analog channels:
  Unselected channels   ±1.5KVDC for 10µS
    ±500VDC for 50mS
    ±100VDC continuously
  Selected channels   ±100VDC continuously
- Expansion by Channel Expansion Modules with 10 differential or 30 single-ended analog channels. Maximum of two CEMs.

Analog to Digital Conversion

All Models
- Autocalibrating
- Autoranging over 3 decades.
- Resolution 15 bit plus sign, 1 µV.
- Sampling rate 25 samples/second.
- Accuracy better than 0.15% of full scale.
- Linearity better than 0.05%
- Input impedance 1MΩ, or >100MΩ selectable.
- Common mode rejection >90db, 110db typical.
- Series mode line rejection >35db
- Floating common input for single-ended measurements.

Analog Sensor Support

All Models
- 4, 3 and 2 wire resistance, RTD and thermistor measurement.
- Sensor excitation of 4.5V, 250.0µA or 2.500mA each channel.
- Full, half and quarter bridges, voltage or current excitation.
- 4-20 mA current loops, internal or external shunts
- Thermocouple types B, C, D, E, G, J, K, N, R, S and T, with cold junction compensation and linearization.
- Platinum RTDs, a=0.003850Ω/Ω/°C, any resistance.
- Platinum RTDs, a=0.003916Ω/Ω/°C, any resistance.
- Nickel RTDs, a=0.005001Ω/Ω/°C, any resistance.
- Copper RTDs, a=0.0039Ω/Ω/°C, any resistance.
- Thermistors, Yellow Springs YSI 400xx series.
- Semiconductors, AD590, LM335, LM34 and LM35.

Analog Sensor Support

Geologger 515, 615
- Vibrating wire sensor support:
  30V for 100µS pulse excitation
  50 to 300Ω coils
  0.5 to 5KHz frequency range
  phase lock loop filtering
  loudspeaker for troubleshooting

Digital Channels

Datataker 50
- 5 digital input/output channels.

Datataker 500, 600, 505, 605 and Geologger 515, 615
- 4 digital input/output channels.
- Expansion by Channel Expansion Modules with 20 digital input and 10 digital output channels. Maximum of two CEMs.

Digital Input Channels
- Accept voltage-free contact closure inputs (inbuilt 15K pullups) and TTL/CMOS inputs.
- Measure the logic state of individual channels (bit) or of groups of channels (byte).
- Generate digital transition events to trigger data acquisition.
- Also provide low speed counter functions to 10Hz sensitivity, 0 to 65535 range, presettable (not available on CEM).
- Digital input channels share with the digital output channels.
- Analog channels can be used to read digital state, with user definable state threshold.

Digital Output Channels
- TTL/CMOS-compatible digital output channels.
- Open collector lines, rated to +30VDC @ 200mA.
- Used for switching logic states, for relay control, for alarm annunciation, and sensor support.
- Digital output channels share with the digital input channels.

Counter Channels
- 3 separate high speed counter channels on all models.
- Count at up to 1KHz normally, or up to 500KHz optionally.
- 0 to 65535 range, presettable.
- Count even when logger is asleep

Time and Date

- Hardware clock, independent 10 year lithium battery.
- Resolution 1 second, accuracy 2 seconds/day (0 to 50°C).
- Date in formats
  Date   DD/MM/YYYY
  Date   MM/DD/YYYY
  Day number   DDDDD
  Decimal day   DDDDD.DDD
- Time in HH:MM:SS, decimal hour HH.HHHH and seconds SSSSS
- 4 auto-incrementing internal timers (second, minute, hour and day of week) for use in sequencing, alarms, calculations, etc.
- Real-time clock used for scan scheduling, date and time stamping of data, alarm timing and within calculations.

Measuring Ranges

Input Type	Range	Units	Resolution	Accuracy at 25°C
DC Voltage	±25.000	mV	1µV	
	±250.00	mV	10µV	
	±2500.0	mV	100µV	
	±7.000	V	250µV	Note 1
	±70.00	V	2.5mV	Note 1
	±100.00	V	10mV	Note 1
Attenuated DC Voltage	Any range	mV		
DC Current	±0.2500	mA	200nA	
Internal Shunts	±2.500	mA	1µA	
	±25.00	mA	10µA	
External Shunts	Any range	mA		
4-20mA Loop	0 to 100	Percent	0.01%	
Resistance	10.000	Ohms	1mΩ	
	100.00	Ohms	1mΩ	
	500.0	Ohms	5mΩ	
	7000.0	Ohms	50mΩ	
Frequency	0.1 to 300,000.0	Hz	0.01Hz	
Period	30,000 to 3	µSec	1µS	
Vibrating Wire	500.00 to 5000.00	Hz	0.01Hz	Note 2
Temperature	−250.0 to 1800.0	Deg C	0.1%	
	-420.0 to 3200.0	Deg F	0.1%	
Strain Gauges	-10^4 to 10^4	ppm	1ppm	
and Bridges	-10^5 to 10^5	ppm	10ppm	
	-10^6 to 10^6	ppm	100ppm	
Digital Bit	0 or 1	State	1	
Digital Byte (4/5 bits)	0-15/0-31	State	1	
Digital Average	0.00 to 1.00	State	0.01	
Counter	0 to 65535	Counts	1	
Phase Encoder	−32768 to 32767	Counts	1	
Analog State	0 or 1	State	1	
Polynomials	$\pm9.9e^{-18}$ to $\pm9.9e^{18}$	User	0.0001	
Linear Spans	$\pm9.9e^{-18}$ to $\pm9.9e^{18}$	User	0.0001	
Calculations	$\pm9.9e^{-18}$ to $\pm9.9e^{18}$	User	0.0001	

Note 1: Datataker 505, 605 and Geologger 515, 615 only

Note 2: Geologger 515, 615 only

Appendix — Specifications (cont.)

Scanning of Input Channels

- 1 immediate scan schedule, can include one or more channels.
- 4 repetitive scan schedules, can include one or more channels.
- Time based scanning in increments of 1 sec, 1 min, 1 hour, 1 day.
- Event based scanning on digital channel events.
- Event based scanning on counter channel events.
- Poll based scanning initiated by direct host requests.
- Conditional scanning when inputs exceed setpoint values.
- Conditional scanning while any digital input is high.

Data Scaling

- Data read from the input channels in electrical units can be automatically scaled to engineering units. All subsequent data manipulation is performed on this scaled data.
- Calibrations for individual sensors can be declared by
  - up to 20 definable linear spans, declared as span co-ordinates.
  - up to 20 definable polynomials, from 1st to 5th order.
  - mathematical expressions.

Data Manipulation

- Statistical data including average, standard deviation, minimum and maximum with date and time of min and max, and integral.
- Delta, rate of delta (differential) and integral between scans.
- Histogram, with definable number of classes.
- Expression evaluation using channel data and constants, with arithmetic, logical and relational operators, log, trig, and other intrinsic functions.

Alarms

- Alarms for monitoring channels and variables for high and low alarm, inside and outside of range alarm, with definable setpoints.
- Alarms can be combined by AND, OR and XOR operators.
- Optional delay period before an out of range condition is considered a true alarm, or recovery considered a true recovery.
- Alarms can switch digital outputs, control display panel LEDs, return alarm messages to the host, trigger scanning, and execute Datataker commands.

Data Storage

- Battery backed internal RAM, stores up to 13,650 readings.
- Supports removable PC Card (PCMCIA) memory cards
  - 512Kbyte stores up to 170,000 readings
  - 1Mbyte stores up to 340,000 readings.
- Stack and circular buffer (overwrite) data storage modes.
- No data loss when memory cards are exchanged.
- Stored data can be returned for individual scanning schedules, and for selectable date and time periods.

Data Format

- All data in ASCII floating point, fixed point or exponential formats.
- Data format is user configurable for channel identification, data resolution, units text and delimiters.
- Selectable host computer data format with bi-directional error detection protocol.

Data Compatibility

- Compatible with spreadsheets, graphics and statistical packages.
- Compatible with most computers, modems, radio, and satellite.

Programming

- All programming is by simple descriptive commands, which are entered from a host computer via the host serial interface.
- Commands can be pre-recorded into a memory card, and these are automatically executed whenever a memory card is inserted.

Display and Keypad

- LCD type, 2 line x 16 character, backlit, alphanumeric.
- Displays the most recent channel data, alarm status and system information including time, battery status, amount of data stored.
- 5 key keypad for display selection, scrolling, and backlight.
- Keypad also used as 4 user definable function keys.
- 3 LEDs, a beeper and a flashing LCD backlight provide for local warnings by alarms, etc.
- Operating temperature range for LCD is –5 to 65°C.
- Integral in the Datataker 600 and 605, and Geologger 615.
- Also available as a separate Panel Mount Display for mounting into instrument panels and enclosure doors, which connects to the Datataker 50, 500 and 505, and the Geologger 515.

Host Communications

- RS232, full duplex, isolated to 500Volt.
- 300, 1200, 2400, 4800 and 9600 baud, switch selectable.
- Bi-directional XON/XOFF protocol.
- Selectable high level protocol with 16 bit CRC checking.
- Compatible with computers, terminals, modems, satellite ground terminals, serial printers, etc.

Network Communications (Not DT50)

- RS485, with error correcting protocol.
- Connected via a twisted pair, maximum 1000 metres.
- Up to 32 loggers can be in a Datataker network, with one host.

Power Supply

- Voltage 9 – 18VAC or 11 – 24VDC external power.
- Mains powered from 12VAC/DC mains adaptor.
- Automatically selects low power standby (sleep) mode.
- Current draw 120mA normal power mode, 400mA when charging internal battery, <350µA low power (sleep) mode.

Datataker 500, 600, 505, 605 and Geologger 515, 615
- A 1.2Ah gel cell battery is installed in the logger chassis, and is recharged whenever external power is available.

All Models
- An external 6V gel cell battery can be connected to the logger, and is recharged whenever external power is available.
- A 9V alkaline battery pack can be used to power the loggers.

Battery Life

Sampling 10 channels every	1.2Ah Gel Cell Battery	17 Ah Alkaline Battery
Continuously	5 hours	3 days
1 minute	12 days	160 days
15 minutes	60 days	800 days
1 hour	90 days	900 days

Mechanical Specification

- Robust modular construction using powder-coated steel.
- Can be used directly, or housed in fixed or portable enclosures.
- Signal input/output connection by screw terminals.
- Operating temperature –20 to 70°C, humidity 95%.
- LCD display –5 to 65°C

Datataker 50
- Length 270mm (10.5 inches), Width 110mm (4.3 inches).
- Height 50mm (2.0 inches) with no memory card inserted.
- Height 105mm (4.2 inches) with a memory card inserted.
- Weight 1.5kg.

Datataker 500, 600, 505, 605 and Geologger 515, 615
- Length 270mm (10.5 inches), Width 110mm (4.3 inches).
- Height 85mm (3.3 inches) with no memory card inserted.
- Height 105mm (4.2 inches) with a memory card inserted.
- Weight 2.4kg.

Accessories Included

- 110/240VAC mains/line power adaptor.
- RS232 communications cable for IBM[TM] and compatibles.
- Getting Started Manual and User's Manual.
- DeTerminal for Windows, DeTerminal for DOS and DeLogger software packages for IBM[TM] and compatibles.

Options

- Panel-Mount Display (for Datataker 50, 500, 505, 515 only)
- Channel Expansion Module (see page 33)
- Enclosures (see page 33)
- 4Ah rechargeable gel cell battery.
- 17Ah alkaline battery.
- Solar panels for remote site powering.
- 512Kbyte and 1Mbyte PC Card (PCMCIA) memory cards.
- Memory card reader; connects to computer via serial port.
- Memory card reader; connects to computer via parallel port.
- Modem Manager for intelligent supervision of remote modems.
- Telephone, cellular and spread spectrum radio modems
- DeLogger Pro software package for IBM and compatibles.
- DASYLab software package for IBM and compatibles.
- DeCopy/DeImage software package to read PC Card (PCMCIA) memory cards via PC Card ports in IBM and compatibles.

Appendix — Specifications (cont.)

Channel Expansion Module

The Channel Expansion Module (CEM) connects to the Datataker 500, 505, 600, 605 and Geologger 515, 615 to increase the number of analog and digital channels. One or two Channel Expansion Modules can be connected to these loggers. All input signal types and sensors supported by the Datataker are also supported by the Channel Expansion Module.

Analog Inputs
• 10 differential or 30 single-ended, can be used in any mix.
• Relay multiplexer.
• Common mode range is dependent on the Datataker model.
• Input withstanding voltage is dependent on the Datataker model.
• Sensor excitation of 4.5V, 250.0µA, 2.500mA each channel.
• Provision for externally-supplied sensor excitation.
• Sensor support is dependent on the Datataker model.
• Local internal temperature sensor monitors CEM temperature for thermocouple reference junction compensation.

Digital Channels
Digital Inputs
 • 20 TTL/CMOS-compatible digital inputs for digital state and digital byte (the digital inputs do not count).
 • Accept voltage-free contact closure inputs.
Digital Outputs
 • 5 normally-open relay outputs, rated to 110VAC/DC at 5A.
 • 5 open collector outputs, rated to 30VDC @ 200mA.

Power Supply
• Powered directly from the Datataker power supply.
• Enters low power mode (sleeps) when Datataker sleeps.
• Current draw 100µA when asleep, 60mA when scanning, 175mA when all output relays activated.

Connection to the Datataker
• One or two modules can be daisy-chained to a single Datataker.
• Interconnection by screened cable, 500mm (20 inches) length
• Maximum total cable length 2 metres (6 feet).

Mechanical Specification
• Robust modular construction using powder-coated steel.
• Can be used directly, or housed in fixed or portable enclosures.
• Length 270mm (10.5 inches), width 110mm (4.3 inches), height 50mm (2.0 inches), weight 1.0kg.
• Signal input/output connection by screw terminals.
• Operating temperature –20 to 70 Deg C, humidity 95%.

Datataker Enclosures

Four standard enclosures are available for housing Datataker data loggers and/or Channel Expansion Modules. The enclosures are suitable for industrial, weatherproof and portable applications.

Industrial Enclosures
• The industrial enclosures are constructed of powder-coated sheet steel, have a polyurethane door seal, and are rated to IP-65 or NEMA 5.
• The capacity of each enclosure is
   SIE - 1 Datataker or 1 CEM.
   LIE - 1 Datataker plus 1 CEM, or two Datatakers.
   SIC - 1 Datataker plus 2 CEMs, or three Datatakers.
• Each enclosure also houses a 4Ah gel cell or 17Ah alkaline battery.
• Panel-Mount Display modules can be factory installed into the door of any enclosure by special order.
• Cable entry is completed by the user by drilling holes and fitting cable glands.
• Three sizes of industrial enclosures are available

Dimensions (mm)	Height	Width	Depth	Weight
Small Indust Enclosure (SIE)	400	200	120	4.5kg
Large Indust Enclosure (LIE)	300	380	155	7.0kg
Small Indust Cabinet (SIC)	600	380	210	15.0kg

Portable Enclosure
• Allows Datataker to be used in a portable mode, and protects the logger from water, dust and mechanical damage. Rated to IP-67 or NEMA 6, and can be submersed for short periods.
• Clamshell design, constructed of black ABS plastic with stainless steel hinge. The lid has a neoprene seal, and can be padlocked.
• Withstands 800kg stacking loads, and does not dent or warp.
• Houses one Datataker, and a 4Ah gel cell or 17Ah alkaline battery. The logger and battery are mounted into a supporting frame which locates in the base of the enclosure. The frame can be lifted out for easy access to the screw terminals and connectors of the logger.
• Optional subassembly to also install a CEM.
• A Panel-Mount Display module can be factory installed into the lid of the enclosure by special order.
• Normally used with the lid open, however cable for cable entry can be installed by the user.
• Size of portable enclosure is

Dimensions (mm)	Length	Width	Depth	Weight
Portable Enclosure (PE)	355	260	155	3.5kg

Appendix — Firmware Change History

Version and Date / Description	Card	Network	Operational	New Feature	Page
1.00 12/4/90					
DT50 & DT500 released					
1.10 26/7/90 Major Revision					
Syntax changes to schedules & commands			*		3, 8
Card operation changed	*				8
/A, /C, /S, /Y switch changes			*		11
New sensor support Ni RTD's, Thermistors				*	4, 16
1.11 to 1.20 4/6/91					
Various minor bug fixes	*	*			
PASSWORD added			*		13
Improved 3 wire resistance calibration			*		
2.00 2/5/91 Major Revision					
Card operation changed	*				8
BEGIN & END added and append dropped			*		3
Expression evaluation added			*		7
Difference, integrate & rate functions added			*		5, 7
Minor syntax changes		*			
Changes to /C, /G, /N, /Z switches		*			11
Channel ID text added			*		5
LCD display support added			*		12
2.01 to 2.03 24/5/91					
Various bug fixes	*	*			
DEL character processing change			*		13
2.10 23/8/91 Significant Revision					
Time and date automatically stored			*		8
UNLOAD from date to date added			*		8
Histograms added			*		5
Counter operation changed			*		4, 18
Variables as ALARM setpoints allowed			*		9
Floating point rounds rather than truncate			*		7
2.11 and 2.12 20/9/91					
Minor bug fixes			*		
2.90 to 2.99 24/12/91 Significant Rev					
Memory card changes - incompatible	*				8
/L, /U, /Z switches changed			*		11
UNLOAD selectable from card or internal	*		*		8
STATUS10-13 added			*		10
Several ALARM bugs fixed			*		
3.00 24/12/91 Consolidation Release					
Old checksum UNLOAD /P removed			*		8
Network performance improved		*			
3.01 to 3.05 15/5/92					
DT505 support added			*		
Vibrating wire sensor support added			*		4, 5
Internal channel addressing change (2+%V)			*		4
ES extra samples channel option added			*		5
Baud rate switch function changed slightly			*		13
/J, /V, /X switches added			*		11
Serial port commands added			*		13
CEM support added			*		27
Repeating ALARMR added			*		9
3.10 4/6/92					
Allow program to be placed in EPROM			*		18
New switch /A to control ALARMs display			*		11,12
ES9 default channel option for FW channels			*		4
P7 - network turnaround time for radio links			*		11
P22 - maximum number of significant digits			*		10, 11
6WARN for backlight without flashing added			*		12
3.11 15/6/92					
1#..5# addressing bug fixed			*		4
Modification to 3 wire calibration			*		
3.12 to 3.24 21/10/92					
Various bug fixes	*	*			
3.30 15/2/93					
Reduced lower frequency limit to 0.1Hz			*		4
Modify scaling of bridge channel types			*		17
Baud rate selection change			*		13
TEST command extended			*		10
System timers synchronised if time reset			*		6
Grey code function F7 added				*	7
P21 data return address added				*	11, 14
3.31 25/3/93					
P33 field width added				*	10, 11
3.32 to 3.36 1/7/93					
Various bug fixes			*		
Bug fix to analog readings following delay			*		
4-20mA current loop restriction removed			*		
Vibrating wire settling delay changed			*		4
3.40 8/12/93					
PCMCIA card capability added	*			*	8
CTEST card check command added	*			*	8
3.42 26/04/94					
Some bug fixes			*		
XON / XOFF handling modified			*		11
Day of year added, accessed as 15SV			*		6
3.44 03/06/94					
Some minor bug fixes			*		
3.45 10/03/95					
Fixed bug where logger can get several commands behind			*		
4.00 01/09/95					
Added support for hardware clock		*	*		6
Added support for multiple insertions of memory cards for same program	*			*	8, 29
Changed some display messages for cards	*				8, 29
Added ^b for quote characters in alarm text			*		9, 23
Changed default function key settings			*		12
Various bug fixes					
4.01 and 4.02					
Minor bug fixes					
5.00 01/08/96					
Version ID change for Datataker Series 2 loggers. No changes to firmware.					

Explanation

The software built into the Datataker is referred to as firmware, and is placed in Read Only Memory or ROM. This ROM is mounted inside the Datataker, on the lower circuit board, and is socketed for easily replacement. Please contact your dealer for more information about ROM upgrades.

Note: When operating Datatakers in a network, it is advisable that all loggers in the network be running the same firmware version.

Notes ....

Appendix — Accuracy of the Datataker Data Loggers

Left Table

| | Full | | | | ABSOLUTE ACCURACY | | | | | |
| | | | | | Tolerance at 25°C | | | Tolerance –20 to 70°C | | |
Range	Full Scale	Units	Resolution	Units	% of Full Scale	Plus Offset	Units	% of Full Scale	Plus Offset	Units
VOLTAGE										
100V ▲	642	V	28.0	mV	±0.26%	±150	mV	±0.31%	±150	mV
50V ◆	64.2	V	2.8	mV	±0.26%	±14	mV	±0.31%	±14	mV
5V	6.42	V	0.28	mV	±0.26%	±1.2	mV	±0.31%	±1.2	mV
2.5V	3000	mV	130	µV	±0.06%	±700	µV	±0.16%	±700	µV
250mV	300	mV	13	µV	±0.06%	±63	µV	±0.17%	±63	µV
25mV	30	mV	1.3	µV	±0.06%	±5.7	µV	±0.16%	±5.7	µV
RESISTANCE										
7KΩ (4W,I)	8	kΩ	0.52	Ω	±0.20%	±2.0	Ω	±0.31%	±2.0	Ω
1KΩ (4W,I)	1.2	kΩ	0.052	Ω	±0.15%	±0.26	Ω	±0.24%	±0.26	Ω
100Ω (4W,I)	0.12	kΩ	0.0052	Ω	±0.10%	±0.023	Ω	±0.17%	±0.023	Ω
500Ω (4W,II)	800	Ω	52	mΩ	±0.15%	±280	mΩ	±0.24%	±280	mΩ
100Ω (4W,II)	120	Ω	5.2	mΩ	±0.10%	±26	mΩ	±0.17%	±26	mΩ
10Ω (4W,II)	12	Ω	0.52	mΩ	±0.15%	±2.3	mΩ	±0.24%	±2.3	mΩ
RESISTANCE, 3-Wire Compensation (Lead Resistance 10Ω)										
7KΩ (3W,I)	8	kΩ	0.52	Ω	±0.20%	±2.9	Ω	±0.31%	±2.9	Ω
1KΩ (3W,I)	1.2	kΩ	0.052	Ω	±0.15%	±0.32	Ω	±0.24%	±0.32	Ω
100Ω (3W,I)	0.12	kΩ	0.0052	Ω	±0.10%	±0.09	Ω	±0.17%	±0.09	Ω
500Ω (3W,II)	800	Ω	52	mΩ	±0.15%	±320	mΩ	±0.24%	±320	mΩ
100Ω (3W,II)	120	Ω	5.2	mΩ	±0.10%	±66.0	mΩ	±0.17%	±66.0	mΩ
10Ω (3W,II)	12	Ω	0.52	mΩ	±0.15%	±43	mΩ	±0.24%	±43	mΩ
CURRENT										
25mA	30	mA	1.3	µA	±0.16%	±7	µA	±0.25%	±7	µA
2.5mA	3	mA	0.13	µA	±0.16%	±0.7	µA	±0.26%	±0.7	µA
0.25mA	0.3	mA	0.013	µA	±0.16%	±0.06	µA	±0.25%	±0.06	µA
FREQUENCY										
300kHz	300	kHz	0.0022	%	±0.052%	±6.5	Hz	±0.061%	±6.5	Hz
30kHz	30	kHz	0.0022	%	±0.052%	±0.65	Hz	±0.061%	±0.65	Hz
3kHz	3	kHz	0.0022	%	±0.052%	±0.065	Hz	±0.061%	±0.065	Hz
300Hz	0.3	kHz	0.0022	%	±0.052%	±0.007	Hz	±0.061%	±0.007	Hz
TIME										
	24	hrs	1	sec	0.03 sec per day 0.78 sec per month			6.3 sec per day 3.16 min per month		
TEMPERATURE (LM35)										
			0.013	°C	±0.00%	±1.5	°C	±2.00%	±1.5	°C
THERMOCOUPLES, Reference Un-Trimmed										
25mV range		°C	0.04	°C	±0.06%	±2.7	°C	±0.16%	±2.7	°C
250mV range		°C	0.43	°C	±0.06%	±4.6	°C	±0.17%	±4.6	°C
THERMOCOUPLES, Reference Trimmed										
25mV range		°C	0.04	°C	±0.06%	±1.2	°C	±0.16%	±1.2	°C
250mV range		°C	0.43	°C	±0.06%	±3.1	°C	±0.17%	±3.1	°C
RTDs, 3-Wire										
Pt100 (100Ω)	<51	°C	0.01	°C	±0.10%	±0.17	°C	±0.17%	±0.17	°C
Pt100 (500Ω)	51-600	°C	0.13	°C	±0.15%	±0.82	°C	±0.24%	±0.82	°C
Ni1000 (7K)		°C	0.10	°C	±0.20%	±0.57	°C	±0.31%	±0.57	°C
Cu135 (500Ω)		°C	0.14	°C	±0.15%	±0.84	°C	±0.24%	±0.84	°C

▲ DT505, 605, 515 and 615 only.
◆ Thermocouple accuracy figure varies slightly with thermocouple type, and applies as percentage of Celsius scale.

Right Table

| | Full | | | | ABSOLUTE ACCURACY | | | | | |
| | | | | | Tolerance at 25°C | | | Tolerance –20 to 70°C | | |
Range	Full Scale	Units	Resolution	Units	% of Full Scale	Plus Offset	Units	% of Full Scale	Plus Offset	Units
RTDs, 4-Wire										
Pt100 (100Ω)	<51	°C	0.01	°C	±0.10%	±0.07	°C	±0.17%	±0.07	°C
Pt100 (500Ω)	51-600	°C	0.13	°C	±0.15%	±0.73	°C	±0.24%	±0.73	°C
Ni1000 (7K)		°C	0.10	°C	±0.20%	±0.56	°C	±0.31%	±0.56	°C
Cu135 (500Ω)		°C	0.14	°C	±0.15%	±0.73	°C	±0.24%	±0.73	°C
BRIDGES, FULL, Voltage										
2.5V	600000	ppm	26	ppm	±0.00%	±140	ppm	±0.00%	±140	ppm
250mV	60000	ppm	2.6	ppm	±0.05%	±13	ppm	±0.07%	±13	ppm
25mV	6000	ppm	0.26	ppm	±0.10%	±1.2	ppm	±0.12%	±1.2	ppm
BRIDGES, FULL, Current										
2.5V	3E+06	ppm	150	ppm	±0.16%	±800	ppm	±0.33%	±800	ppm
250mV	342857	ppm	15	ppm	±0.16%	±72	ppm	±0.34%	±72	ppm
25mV	34286	ppm	1.5	ppm	±0.16%	±6.5	ppm	±0.33%	±6.5	ppm
BRIDGES, HALF,Current										
2.5V	2E+06	ppm	74	ppm	±0.36%	±400	ppm	±0.62%	±400	ppm
250mV	171429	ppm	7.4	ppm	±0.36%	±36	ppm	±0.63%	±36	ppm
25mV	17143	ppm	0.74	ppm	±0.36%	±3.3	ppm	±0.62%	±3.3	ppm
BRIDGES, FULL (4 Active Gauges, Gauge Factor = 2.0), Voltage										
2.5V	150000	µS	6.50	µS	±0.00%	35	µS	±0.00%	35	µS
250mV	15000	µS	0.65	µS	±13.00%	3.2	µS	±13.00%	3.2	µS
25mV	1500	µS	0.07	µS	±15.50%	0.28	µS	±15.50%	0.28	µS
BRIDGES, FULL (4 Active Gauges, Gauge Factor = 2.0), Current										
2.5V	857143	µS	37.14	µS	±0.20%	200	µS	±0.34%	200	µS
250mV	85714	µS	3.71	µS	±0.25%	18	µS	±0.41%	18	µS
25mV	8571	µS	0.37	µS	±0.10%	1.6	µS	±0.17%	1.6	µS
BRIDGES, HALF (2 Active Gauges, Gauge Factor = 2.0), Current										
2.5V	857143	µS	37.14	µS	±0.40%	200	µS	±0.63%	200	µS
250mV	85714	µS	3.71	µS	±0.45%	18	µS	±0.70%	18	µS
25mV	8571	µS	0.37	µS	±0.30%	1.6	µS	±0.46%	1.6	µS

USING THE ACCURACY TABLE (ABOVE)

Example 1 — Calculate the resolution when measuring a frequency of 25kHz.

From the "Frequency \ Range 30kHz" row above,
Resolution = 0.0022% of Full Scale
= 0.022% of 30kHz
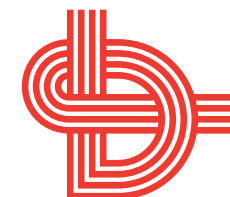= **0.66Hz** (minimum ADC step)

Example 2 — Calculate the tolerance in measuring a frequency of 25kHz at 25°C.

From the "Frequency \ Range 30kHz" row above,
Tolerance in the reading at 25°C =   (% of Full Scale)   +   (Offset)
= (±0.052% of 30kHz)   +   (±0.65Hz)
=   (±15.6Hz)   +   (±0.65Hz)
= **±16.3Hz**

That is, the reading is **25,000Hz ±16.3Hz** at 25°C.

Index ... where to find it!