

# User's Manual

**DT50, DT500, DT600 Series dataTakers Series 3**



A concise reference to:

- data acquisition
- data logging
- programming
- sensor wiring
- communications

## Warranty

dataTaker Pty Ltd warrants the instruments it manufactures against defects in materials or 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 dataTaker Pty Ltd or to one of its authorized dealers. This warranty excludes all other warranties, express or implied, and is limited to a value not exceeding the purchase price of the instrument. Where dataTaker Pty Ltd supplies equipment or items manufactured by a third party, then the warranty provided by the third party manufacturer remains.

dataTaker Pty Ltd shall not be liable for any incidental or consequential loss or damages resulting from the use of the instrument, or for damage to the instrument resulting from accident, abuse, improper implementation, lack of reasonable care, or loss of parts.

## Warning

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## Trademarks

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Windows is a trademark of Microsoft Corp.

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## Firmware Versions

This manual is applicable to the Series 3 dataTaker 50, 500 and 600 series data loggers that have firmware version 7.xx installed. The firmware version number is returned in the first line of the TEST command (see the section "More Commands").

## Related Documents

Getting Started with **DT50, DT500**  
and **DT600** series **dataTakers**  
Advanced Communications Manual

## Related Products

- ❖ DeLogger 4
- ❖ DeLogger Pro 4
- ❖ DeTransfer and DePlot
- ❖ PMD-01 Panel Mount Display
- ❖ SS-500 Sensor Simulation Panel
- ❖ MC-1024, MC-2048 and MC-4096  
SRAM Memory Cards
- ❖ MCI-04 Memory Card Interface
- ❖ PE-500 Portable Enclosure
- ❖ SIE-500 Small Industrial Enclosure
- ❖ LIE-500 Large Industrial Enclosure

[www.datataker.com](http://www.datataker.com)

### EUROPE



This product complies with the requirements of European Directives 89/336/EEC and 73/23/EEC, and conforms with EN55022 Class A (emissions) and EN50082-1 (susceptibility).

Mains adaptors used to power this product must comply with EN60950, EN60742 or EN61010.

### AUSTRALIA & NEW ZEALAND



This product complies with the requirements of Australian and New Zealand standard for EMC emissions AS/NZS 3548:1992 Class A.

### USA

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

### CANADA

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus as set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la Classe A prescrites dans les règlements sur le brouillage radioélectrique édictés par le Ministère des Communications du Canada.

### CAUTION — USE APPROVED ANTI-STATIC PROCEDURES

The input circuitry of this device is extremely sensitive and therefore susceptible to damage by static electricity. Always follow approved anti-static procedures when working with this device.

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**DT50**



**DT500**



**DT600**



**DT505**



**DT605**



**DT515**



**DT615**

# Getting Started ... also see *Getting Started with DT50, DT500 and DT600 Series dataTakers*

## The *dataTaker* ...

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

The *dataTaker* can be programmed and data can be plotted, tabulated, archived and exported using DeLogger 4 software (included) or DeLogger Pro 4 software (purchased separately). This only requires a brief knowledge of the *dataTaker* commands described in this manual.

Alternatively, the *dataTaker* can be programmed and data can be plotted, archived and exported to spreadsheets and graphing tools using DeTransfer and DePlot software (included). This requires a good working knowledge of the *dataTaker* commands described in this manual.

You'll require at least a 200MHz (for DeTransfer) or 500MHz (for DeLogger 4) computer running Windows 98 Second Edition, Windows NT4 with SP5 or later, Windows 2000 or Windows XP to supervise the *dataTaker*.

## Getting Started - 1, 2, 3 ...

The *Getting Started with DT50, DT500 and DT600 Series dataTaker* manual is recommended for new users, and will teach you to supervise *dataTaker* with DeLogger.

If you intend to supervise *dataTaker* with DeTransfer, then read on! Set up your logger and computer as follows

1. Connect the communications cable between the RS232 Comms of your *dataTaker*, and COM1 or COM2 of your computer.

2. Install the DeTransfer software from the Software CD DeTransfer is a terminal style interface to program and supervise *dataTaker*, and to receive data.

3. Connect the 12Vdc output from the 240Vac or 110Vac power adaptor, to the screw terminals marked ~ and ~ (DT50) or AC/DC (DT500/600). Polarity is not important.

**Caution** – do not connect power to the terminals labelled **Battery** (DT50) or **Bat** (DT500/600). These are reserved for an external battery, and are limited to 9Vdc - see the section "Power and Battery Connection" for further information.

When power is turned on, the Converting LED will flash every second as the logger runs internal checks.

4. Launch DeTransfer. Click on Active Connection to drop down the connections list, and select 'DT500 Auto'. Click on Connections, and select 'Connect' from the list. DeTransfer will configure your computer's COM port to match the communications settings of the logger, and establish a software connection with the logger. You may see the message /B/M/R in the Receive (upper) window.

If DeTransfer does not connect to the logger, then check the communications cable and COM port settings. Ensure that *dataTaker* RS232 Comms settings (see Appendix for your model) and DeTransfer's settings are the same.

5. Click in the Send (lower) window to establish a cursor and type the command

**RESET** (All uppercase)

then hit the Enter or Return key to send the command to the logger to execute. The logger will reset and respond with

**Datataker 0 Version 7.xx  
Initializing...Done**

Set the *dataTaker* realtime clock by the command

**Time=15:30:00** (Logger has 24 hour clock)  
or **T=15:30:00**  
or **T=\T** (Sets logger to computer time)

Read the *dataTaker* time by the command

**Time**  
or **T**

Note that lower case characters can be used to document and clarify commands. For example **Time** is the same as **T**.

With *dataTaker*, data acquisition/data logging is made easy. For example entering the command from DeTransfer

**RA5S 1..5TK LOGON**

sets up a reporting schedule (**RA5S**) which is to report every five seconds (**RA5S**) the temperatures on five Type K thermocouples (**1..5TK**), and to log or store the readings in memory (**LOGON**).

Recovering logged data is even simpler. The command

**U**

returns the data in the default format

**1TJ 384.7 Deg C**  
**2TJ 335.2 Deg C**  
**3TJ 367.1 Deg C**

The *dataTaker* has the flexibility to handle complex tasks, and so if you want to perform more complex tasks you'll need to learn about the *dataTaker* command set. The more familiar you are with the *dataTaker*, the better you'll be able to use it. Explore in detail the features that are of most interest.

## 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 Vdc 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 wiring configurations from pages 19 and 20. Connect the sensors accordingly.

Use Channel Options to modify the channel function. Channel Options are listed in brackets immediately after the Channel Type. The table on page 5 details channel options. Test each sensor with a simple schedule. For example

**RA1S 2PT385 (4W)**

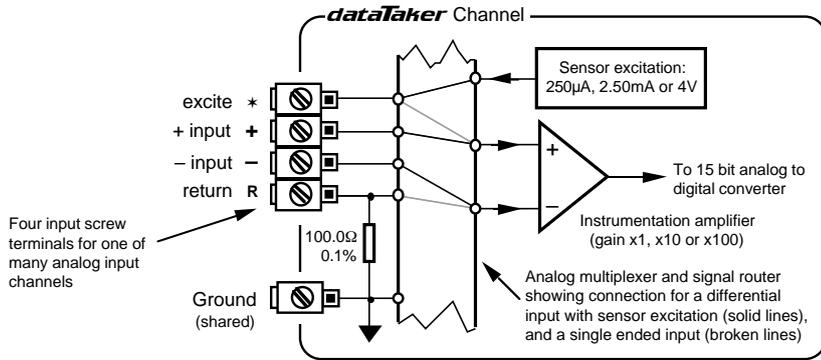
will return every 1 second (**RA1S** - see page 3) the temperature of a platinum resistance temperature sensor (**PT385** - see page 4) connected as a four wire resistance (**4W** channel option - see page 5) on channel 2.

## Analog Input Channels

Each 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 channel's - terminal to the amplifier's - input. This patching is achieved by defining the Channel Number and Channel 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 is 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 is then measured.

The *dataTaker* has three excitation sources - 250µA, 2.50mA and 4V. These are output from 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 Channel Option.

## Analog to Digital Conversion

The *dataTaker* converts 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 the section "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 necessary (for example, temperature usually changes 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 channel data to engineering units using polynomials, spans, intrinsic functions and intra-channel or inter-channel calculations. Statistical functions including averaging and histograms can also 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 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* automatically wakes 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 in internal memory (166,530 readings) and in a Memory Card (almost 1.4 million readings). The internal memory acts as a buffer for the Memory Card, so that data is not lost during card changes.

The *dataTaker* stops logging when both memories are full. Overwrite mode allows continuous logging, with the oldest data 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 after you issue a 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 internal memory or Memory Card can be retrieved via the RS232 Comms or Network ports. Data stored in a Memory Card can also be retrieved using a Memory Card Reader or the PC-Card slot in a notebook PC.

## 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* gets 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.

*dataTaker* operates over a wide temperature range, however accuracy can be reduced. While the electrical zero is stable with temperature, the scale factor can drift slightly. Endeavour to minimise exposure to temperature extremes.

## Operating Scenarios ...

You can deploy *dataTaker* in many ways depending on factors such as location, data volume, power availability

- on-line to a 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  
Channels (page 4). Sensors can be wired to channels, calibrated and tested prior to full program entry. → 2TT 451.9 Deg C  
...

/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 ... collect some data

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

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

CSCANS CALARMS CLEAR CDATA 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.

/n/u/S/e Switches (page 11) determine system function (upper case is ON and lower case is OFF).

P22=44 Parameters (page 11) are internal system settings which determine system function. Most can be set and all can be read.

Y10=4.5,0.213"KPa" 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.

S1=0,50,0,100" L/m"

ALARM1(1V>2.25)3DSO  
ALARM2(4TT>110.0)3DSO,1DSO"Over temp.?[RB5S]" Alarms (page 9) detect out of range conditions. Can also be used to change logger function, schedule timing, control outputs and event annunciation.

ALARM3(4TT<100.0)"[RB1M]"

BEGIN BEGIN & END see Schedules on page 3

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

END

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

G Scan control commands - see page 3

## Data Retrieval ... show me my data

/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.

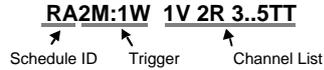
CLEAR Clears data from the *dataTaker's* internal memory and disables logging.

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.



## 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

- nS** seconds
- nM** minutes
- none** as rapidly as possible
- nD** days
- nH** hours

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" in column 3 beside).

OR

## Trigger on Events

Digital inputs **nDS** (excluding CEM), low speed counters **nC** and high speed counters **nHCS** can also trigger scans

- nE** 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
- nC(c)** trigger after *c* counts on a low speed counter
- nHSC** trigger after ANY counts on a high speed counter

where *n* is a digital channel (can also be a channel sequence *n..m*). For example **RA1+E** will scan every 0 to 1 transition of digital input 1, **RA2..3-E** will scan every 1 to 0 transition of digital input channel 2 OR 3. Transitions can also be generated by **ALARMS** (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

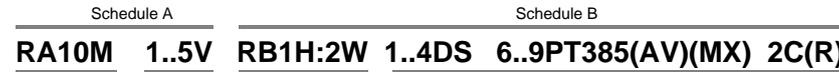
## Trigger While (condition is true)

A schedule's trigger can be enabled or disabled by the state of one or more digital input channels (**nD**), by appending a **While** to either a **Time Interval** or an **Event**.

- :nW** enable while digital input *n* is high
- :n..mW** enable if ANY digital input *n* to *m* is high.

Note that the colon is required. For example the schedule **RA1E:2W** will scan on every transition of digital input one (**1D**) only while digital input two (**2D**) is high.

**NOTE:** Digital inputs are not read while the logger is asleep, and so **nE**, **nC** and **:nW** triggers will not be detected. High speed counter triggers (**nHSC**) will be detected on next wake.



## 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 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")
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 Halted, 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 *dataTaker* commands (these are executed on entry). When the **END** is received, the original **Halt - Go** 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. An immediate scan should be given time to execute before a **BEGIN** command is issued. If requests for immediate scans are too rapid, then data may be appended. Set **P22=13** to overcome this by ensuring a return character after each data.

## Statistical Sub-schedule

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

The statistical scan is a sub-schedule. Channels to be statistically scanned must have a Channel Option to indicate the statistical data required (see "Channel Options" on page 5, "Statistical Channels" on page 6). If two or more statistical data is required, 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 "Error Messages" on 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

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

If synchronization is disabled (See "Switches - /s" on page 11), scanning is then relative to the time that 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 scans every 10 minutes (**RA10M**), reporting channels 1 through 5 as voltage data.
- Schedule B 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 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 command (see "Switches /F" 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 Going) 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 "Error Messages" on page 21). You cannot erase individual schedules.

# Channel Types ... how to specify channels

## Introduction

The analog and digital channels of the **dataTaker** are multipurpose. Channel specification determines the internal signal routing, excitation, sampling method and data processing. A channel is defined by a 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 color to the channel number. eg. **2:5V** indicates channel 5 on the second CEM.

**This Example** declares a thermocouple type J, connected to channel 5 as a single ended input. 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**) 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	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. <b>3#I</b> , <b>5#L(S2)</b> .	
	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(I)	(I)	-	1mΩ	Ohms	9, 10, 11, 12	Four wire configuration requires ( <b>4W</b> ) 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 ( <b>4W</b> ) 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 ( <b>2V</b> ) option for 0 – 5 volt single ended inputs, but for low level (100mV) input to 300kHz. Geologger DT515 and DT615 models only.	
	Period (analog channels, 50µS to 9.8S).	10/30	5/10	10/30	*, +, -	P	2-P(X)	(30.0, T*)	longest period mS	1µS	µS	1, 2, 3, 4, 5, 6		
	Vibrating wire sensor - frequency **	10/30	-	10/30	*, +, -	FW **	3-FW	(ES9, 200.0)	delay in mS	0.01Hz	Hz	2		
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 ( <b>1ST</b> ), min ( <b>2ST</b> ), hr ( <b>3ST</b> ), day ( <b>4ST</b> ).
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°C	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°C resistance Ω	0.1°C	DegC***	9, 10, 11, 12		} Three wire is the default connection (see "RTDs" on page 16), however a 4 wire connection ( <b>4W</b> ) can be used for greater measurement accuracy.
	Nickel RTD's (α = 0.005001).	10/20	5/10	10/20	+, -	NI	1NI(50)	(1000.0, I)	0°C resistance Ω	0.1°C	DegC***	9, 10, 11, 12		
	Copper RTD (α = 0.0039)	10/20	5/10	10/20	+, -	CU	CU(135)	(100, II)	0°C resistance Ω	0.1°C	DegC***	9, 10, 11, 12		
	Thermistors (Yellow Springs 400XX series).	10/20	5/10	10/20	+, -	YS01..07,16,17	2YS04	(1e10, I)	parallel resistor Ω	0.1°C	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°C	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°C	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°C	DegC***	20, 21, 1, 2, 3		Calibration slope correction relative to 0°C or 0°F.
Digital	State input on a digital channel.	4	5	20	none	DS	4DS	( )	-	1	State	22	If averaging, increase precision with FFnooption. Result is 0 to 15 (or 32). Channel No. = LSB of byte.	
	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		
	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 FFnooption. Delay < 65.535mS, nDSO(delay,R) will generate pulses. 0's in mask not modified. Channel No. = LSB of byte
	Output on a single digital channel. "1" = ON & low	4	5	10	none	DSO	3DSO=1	(0)	delay or width (mS)	-	-	23,24		
	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		
	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. Presetting a counter outside of the maximum count range (eg. 1C(5)=8) will cause an error (99999.9).	
	Phase encoder up-down counter (connect 3D,4D).	1	1	-	none	PE	1PE	(65536)	range	1	Counts	22		
	High speed counter (1KHz maximum).	3	3	-	none	HSC	3HSC	(65536)	range	1	Counts	22		
	High speed counter prescaler output.	1	1	-	none	HSCO	1HSCO(0)	(2)	prescaler mode	1	none	CMOS level		Set high speed counter <b>1HSC</b> 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	\$	\$	( )	-	-	-	-	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 °F, °K, °R - see P36 on page 11

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

Channel Number

Channel Type Label

Channel Options (see page 5) and default options column

# 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. Channel 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°C. The channel is labelled "Steam Temp" for output, and FF0 sets the output resolution to 1°C. 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
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.	
	X						Use SE Ref terminal as common
Single ended input	2V		Use internal 2.500 Vref as common		1	Input applied between + or - or * and SE Ref. (Single Ended Reference) terminals.	
	GL,n						Gain Lock
Gain	A, NA		Attenuation, No Attenuation	1,10,100	1	Inhibits auto-ranging and presets amplifier gain to 1, 10 or 100 respectively.	
	G						Guard signal
Excite terminal (output current or voltage)	V		Voltage source approx. 4.5V via 1KΩ		1	Provides a voltage equal to the input common mode voltage via approx. 6KΩ. For high impedance signal sources where cable leakage is a problem.	
	I						Current source 250.0μA
	II						Current source 2.500mA
	N						Open circuit excite terminal (no excitation)
Special	Mx:y	all above	Special input signal routing	0 to 255	1	e.g. 0%V(M18:156, 101.0) returns battery voltage and 0%(M18:188, -0.20) returns battery current (positive indicates charging, negative discharging).	
	ESn						Extra samples
Resetting (to zero)	R		Reset counter, timer, variable after reading		2	Valid only for counters, system timers, variables e.g. nCV(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).	
	Yn						Polynomial
	Sn						Span
	Fn						Intrinsic functions
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
	RS						Reading / time difference in seconds x/Δt
	IB						"Integrate" ( x_units.seconds) (x - Δx/2)*Δt
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
	BR						Bridge excitation voltage channel
Statistical (cannot be used in Alarms)	AV		Average of channel readings		6	Average	
	SD						Standard deviation of channel readings
	MX						Maximum channel reading
	MN						Minimum channel reading
	TMX						Time of maximum channel reading
	TMN						Time of minimum channel reading
	DMX						Date of maximum channel reading
	DMN						Date of minimum channel reading
	INT						Integral for channel
	Hx:y;n..mCV						Histogram x = lower limit, y = upper limit
Variables	=nCV		Assign channel reading to variable		7	Assign	
	+=nCV						Add channel reading to variable
	-=nCV						Subtract channel reading from variable
	*=nCV						Multiply variable by channel reading
	/=nCV						Divide variable by channel reading
Output format	FFn		Fixed point n = decimal places	0 to 6	8	e.g. FF2 returns 71.46 mV	
	FE n						Exponential, n = significant digits
	FMn						Mixed FF and FE, n = decimal places
	"text"						User defined channel name text
	NR						No return
	NL						No log (cannot be used in Alarms)
	ND						No display
	W						Working or intermediate channel
BGx:y	Bar graph						

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 (Yn) before a difference (DF).

Config Line - see "Multiple Reports" on page 4

# Time and Other Channels ... channels on the inside

## Realtime Clock

The **dataTaker** has a hardware clock, that is backed up by the system lithium battery. The clock maintains time and date during RESET and power down.

A Time and Date stamp can be added to real time data (see "Switches /T and /D" on page 11). Time and Date stamp are automatically logged whenever data is stored.

## Time

Time is based on a 24 hour clock, with a resolution of one second. Time is read in the same way as any channel, but without a Channel Number

T returns Time 11:45:10

The time format is defined by Parameter 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. Parameter P40 defines the separator in the hh:mm:ss format, which defaults to ASCII 58 (:).

The Time must be set in the time format defined by P39 and P40. For example if P39=2 (in this case P40 does not matter), then the time must be set as a decimal value

T=11.7528

## Date

The realtime clock also maintains the Date that is read in the same way as a channel, without a Channel Number

D returns Date 25/12/2001

The date format is set by Parameter P31 as follows

P31	Format	Example
0	Day number dddd	724
1	European dd/mm/yyyy	25/12/2001
2	N America mm/dd/yyyy	12/25/2001

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 Appendix for your model). Set date format by Parameter P31, for example P31=0 sets date format as number of days since 1/1/1989.

The Date must be set in the current Date format, for example if P31=1 (European format) then Date is set by

D=25/12/2001 or D=25/12/01

## Internal Channels

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

Internal Channel	Command
Logger temperature	1%LM35
CEM (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 (M18:156,101)
Battery current	0%I (M18:220,-0.20)

## Text String

A Text channel of 80 characters is available for labelling, data headings, site identification, logger identification, etc.

The string is defined by \$="text string", and the current string is returned (or Unloaded) whenever \$ is included in a channel list. Control characters are entered in the format ^M for carriage return, ^J for line feed (see list on page 23).

## System Variables - nSV

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
- 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 FFn option to increase the resolution.

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

7SV=15

sets the ADC settling time to 15mS (see "ADC Details" on page 18). 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 once immediately.

## System Timers - nST

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

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 System Timers re-initialize to the new time and date if the realtime clock is changed. For example if the time and date are set to 13:45:53 and 25/12/01, the System Timers are set to 1ST=53, 2ST=45, 3ST=13 and 4ST=2 (Tuesday).

System Timer range and initial value can be changed

nST(range, R)=initial

Timer range can be set between 1-65535. If a new range is set, the timer is initialised to a value calculated from the previous midnight or Sunday. Timers can also be assigned an initial value or expression. If the initial value is greater than the range, then the timer is set to zero at the next increment. The R resets the timer to zero when it is read.

# Statistical Operations ... great for reducing data

## Introduction

Channels and Variables can be sampled frequently and statistical data returned at longer intervals (see "Statistical Sub-schedule" on page 3). The channels are sampled at the RS schedule interval (default is 1 second) for the period between report times, and the statistical data 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 Channel 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)
(Hx:y:n.mCV)	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 over one minute (RA1M) for the type T thermocouple which is connected to channel 3 (3TT). 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 error E53 (see "Error Messages" on page 20) is reported 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 that the first option list (I,500,AV) must include the options required for managing and sampling the channel. This rule applies to any options above the "Config Line" in the Channel Options table on page 5, because the channel is sampled and scaled according to the first option list.

Statistical results can be 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. Averaging is very useful for 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.

## Maximum and Minimum

Maximum and minimum is a measure of the range of the data. The time and date of the maximum and minimum can also be useful. Display of maximum and minimum can be progressive (see "Switches - /X" on page 11).

## Integration (INT)

Integration returns the integral (or "area under the curve") with respect to time in seconds using a trapezoidal approximation. The units of integration are those of the original reading multiplied by seconds, or "units.secs".

When applied to a flow rate sensor

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

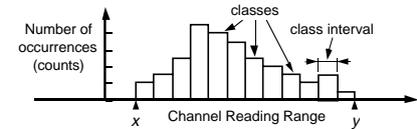
integration returns the volume of the flow

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 in litres per second.

## Histogram (Hx:y:n.mCV)

The dataTaker can generate a histogram (frequency distribution) of channel samples. When the channel is sampled at report time, the channel value is returned and the respective range class for the reading is incremented. The class frequencies are stored in Channel Variables, and are returned, logged and cleared in another schedule.



A histogram is specified as a Channel Option as follows

Hx : 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 (nCV) to store counts
- m is the last Channel Variable (mCV) 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)
- mCV = 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°C as follows:

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

The Channel Variables are read and logged in a schedule

RB1H 1..13CV(R)

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

Note: There is only 100 Channel Variables, and 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 , °C (see "Channel Types" on page 4). Most sensors output one of these basic signals.

## Channel Factor ... a floating point number

Many channel types have a channel factor as a Channel Option, which usually provides a linear scaling. For example

```
1V 1V(101.0)
```

1V returns true millivolts, and 1V(101.0) returns the reading multiplied by 101.0 in units of millivolts thus

```
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 mutually exclusive Intrinsic Functions, which are applied as a Channel Option.

The Intrinsic Functions available are

Function	Description	Appended to Units
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)

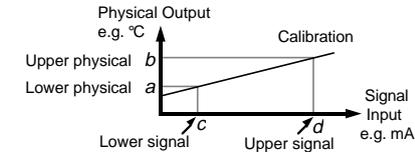
Channels with an Intrinsic Function applied will return data with labels in the right-hand column appended to units. For example 1V(F2) will return the square root of the reading

```
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 linear calibrations for sensors. Spans are particularly suited to 4–20mA loop inputs.



A total of 20 Spans and Polynomials can be defined. A span is defined by the command

```
Sn=a,b,c,d "text "
```

where n = 1 to 20, and text is units text (replaces the original 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.

A 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 define non-linear calibrations for sensors

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

where x is the channel reading, and the k's are coefficient terms. A polynomial is defined by its coefficient terms

```
Y n = k0, k1, k2, k3, k4, k5 "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 **dataTaker** treats Spans as a first order polynomial). The text replaces the default units text for the channel. Polynomials are applied 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 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 - nCV

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 results 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 the 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 (+, -, \*, /) 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 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))V1.141
```

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(FF2)=6CV+7CV
```

assigns to 5CV the sum of 6CV+7CV, and returns the result as a floating point value to 2 decimal places.

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)"Excess variability"
```

tests standard deviation of temperatures read over a minute.

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

## Calculations ... only at report time

The **dataTaker** has a powerful expression evaluation capability. Results are 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<100))+(1CV*4*(1CV>=100))
```

which returns a value of 2\*1CV if 1CV is less than 100, or a value of 4\*1CV if 1CV is greater than or equal to 100.

## 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 w 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** stores data in the internal memory (166,530 data points) and in a memory card (almost 1.4 million data points in a 4Mbyte card) if one is inserted.

The management for the internal memory and memory card varies according to the state of the inserted card

- if insert an empty memory card, data in internal memory is transferred to the card, and logging continues to the card
- if insert a memory card containing data from the same program, then data in the internal memory is appended to the card, and logging continues to the memory card
- if insert a memory card containing data from another program, then data is not transferred from internal memory, and logging continues to internal memory. A **CDATA** command will clear the card, then data will be transferred.

## Lithium Battery - Replacement

The ½AA lithium battery maintains the internal memory and real time clock when **dataTaker** is not powered. This battery must be replaced every 2 years. The lithium battery is located on the lower printed circuit board, and the logger must be disassembled to replace the battery.

## Data Logging Commands

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

Data is logged as 24 bit (16 bit mantissa) floating point values. Internal calculations are 32 bit floating point.

Schedules store a three byte header with the data for each scan, which contains scan 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** or **CDATA**.

## Stop When Full Mode - /o

Data logging stops when memory is full – oldest data is retained and new data is lost. If a memory card is used, data is not logged in internal memory until memory card is full. This is the default mode for data storage.

## Overwrite Mode - /O

Oldest data is overwritten with newest data when the memory is full. This mode is invoked by the **/O** switch (see "Switches - /O" on page 11). The internal memory is not used in overwrite mode when a memory card is used.

## Storage Capacity

Data storage capacity is difficult to calculate because of the 3 byte header per schedule per scan. If you consider the header as a data reading, the following provides a guide

Memory	Capacity (readings)	Total (card+internal)
Internal	166,530	166,530
1M PC Card	343,980	510,510
2M PC Card	693,420	859,950
4M PC Card	1,392,300	1,558,830

Time and Date in a channel list are logged same as any other channels, i.e. 3 bytes each. It is more efficient to use the **/T** and **/D** switch commands - see pages 6 and 11.

## Not Logging Channels

All channels and channel variables in **RA**, **RB**, **RC**, **RD** and **RX** schedules are logged after the **LOGON** command is issued. The **NL** (No Log) and **W** (Working) Channel Options prevent logging of individual channels.

## 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 memory card, then if same data set, from internal memory

**schedule**

- A, B, C, D, or X** - unload single 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

**U** unload all data, oldest first  
**U(LAST)** unload data since last unload  
**UA(BEGIN) (LAST)** unload schedule **A** from beginning to last data previously unloaded  
**UMB(12:00,19/1/02)(12:00,20/1/02)** unload **B** schedule from memory card between the times and dates

The oldest data is unloaded first, and schedules are merged chronologically in order **X, A, B, C** then **D**. Unloaded data format is the same as real-time data (see page 5). During unloads the **/r** (return), **/e** (echo), **/m** (error messages) and **/z** (alarm messages) switches are disabled, and returned to their previous state after the 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

Scan Time and Date stamps can be prefixed to unload records by enabling **/T** and **/D** switches, even after data has been logged. Time and Date stamp defaults OFF (**/t /d**).

## Logging Status

Internal and card memory status can be checked by

**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

Logged data can be cleared at any time by

- CLEAR** clears all data logged in the internal memory and disables logging (**LOGOFF**)
- CLAST** clears data in internal memory or memory card that has been unloaded by **U** command (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 4Mbyte in capacity can be used.

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

Do not expose the memory card to temperatures over 45°C for extended periods, to ionising radiation or to static discharge. Memory cards with a lithium battery should have it replaced every year. Memory cards with a rechargeable battery should be placed in a powered logger for >24 hours every 6 months.

## 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** Destructive memory test of 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 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 in the logger, and given the default **CARDID="xxxXB"** 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 store a **dataTaker** program of up to 4090 characters. Commands are entered into the logger in the normal way, except that each line must begin with a semi-colon. The logger copies lines prefixed by a semi-colon into the program area of a memory card. For example

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

The syntax of the card program is not checked until the program is first 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 – 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 also 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 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 and tests entire card
```

**CDATA** and **CPROG** commands can be executed from a card program. **CPROG** must be the last command (otherwise 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 command will make decisions about input channels, timers, clock, variables, etc. Digital outputs can be set, messages issued, or commands executed if an Alarm is true. There are two types of Alarm command

- **ALARM** or **IF** - acts once on transition from false to true
- **ALARMR** and **IFR** - acts repeatedly while 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)

<b>RZ</b>	rapidly as possible (default)	} where <i>n</i> is an integer in range 1 to 65535
<b>RZnS</b>	seconds	
<b>RZnM</b>	minutes	
<b>RZnH</b>	hours	
<b>RZnD</b>	days	
<b>RZnE</b>	event on either transition	} where <i>n</i> is a digital channel number
<b>RZn+E</b>	event on positive transition	
<b>RZn-E</b>	event on negative transition	
<b>RZnC(count)</b>	counter event after <i>count</i>	
<b>RZnHSC</b>	event on <i>any</i> HSC counts	
<b>HZ, GZ</b>	Halt and Go for all Alarm scanning	
<b>HZn, GZn</b>	Disable and enable Alarm number <i>n</i>	

Note: an Alarm disabled by an **HZn** command will not be enabled by the global **GZ** command. Only the **GZn** 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 is in upper case (ALARM) for enabled alarms and in lower case (alarm) for disabled alarms. Channels in the alarm list do not show their channel options.

## Erasing Alarms

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

## Polling Alarm Data

Return the most recent data from an Alarm input channel by the Alarm query command

<b>?n</b>	returns data for Alarm number <i>n</i>
<b>?ALL</b>	returns data for all Alarms

The data format is the same as for channel data, except that 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 **HZn**, **GZn** and **CALARMn** commands.

### Channel Definition

Any input channel type with options (see "Channel Types" on page 4), or Channel Variable, or System Timer, Time, Date, 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

<b>nDSO</b>	General purpose digital output
<b>nWARN</b>	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.

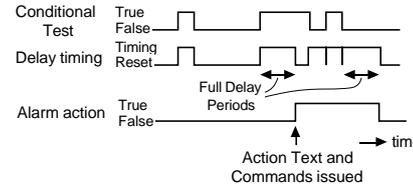
### Delay Period (optional)

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

<b>/nS</b>	Seconds
<b>/nM</b>	Minutes
<b>/nH</b>	Hours
<b>/nD</b>	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 computer and display whenever an **ALARMn** or an **IFn** 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

<b>!</b>	insert <b>dataTaker</b> address and alarm number ( <i>a:n</i> )
<b>?</b>	insert current data value
<b>#</b>	insert day or date (in <b>P31</b> format)
<b>@</b>	insert time (in <b>P39</b> and <b>P40</b> format)

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 computer (see "Switches - /Z" 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 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, and give 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 ... how your data is presented

## Introduction

The **dataTaker** has many ways to format data returned to the 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 Comms 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:

```
RA55 1V 3PT385 1C("Widgets") /T /D
returns
```

```
Date 25/12/01
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

```
4741, 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=L3** (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:

- FFn** Fixed point, n = number of decimal places (n = 0 - 7)
- FE<sub>n</sub>** Exponential, n = number of significant digits (n = 0 - 7)
- FM<sub>n</sub>** 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 "Error Messages" on page 21).

Parameter **P33** allows returned data to be in fixed fields. All data is placed into fields of the same width defined by **P33**, space padded 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 ... getting system information

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

```
Datataker 0 Version 7.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 DeTransfer 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 computer. Typical returned information

	n
<b>Datataker 0 Version 7.xx</b>	1
<b>A,none Scan Schedules Active,Halted</b>	2
<b>0,0 Alarms Active,Halted</b>	3
<b>0 Polynomials/Spans Defined</b>	4
<b>Logging is OFF</b>	5
<b>166530,0 Internal Data Points Free,Stored</b>	6
<b>343980,0 Card Data Points Free,Stored</b>	7
<b>4090,0 Program Characters Free,Stored</b>	8
<b>/A/C/d/E/Ē/h/J/K/L/M/N/o/Q/R/S/t/U/v/w/x/y/Z</b>	9

The first line shows the **dataTaker's** address (see "Networking" on page 14) and Firmware 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 **HZN** command - see page 9):

```
2,1 Alarms Active,Halted
RZ5S
ALARM1(3V>105)1DSO
ALARMR2(4V<75)2DSO [1DSO=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/Ē/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 **dataTaker** 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 "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 "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 05/03/2002,00:13:00 on 19/03/2001 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 05/03/2002,00:13:00 on 19/03/2002 External
data Start,End times
```

These and other **STATUSn** commands are described fully in the "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 data 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	2.500V volt reference trim	10µV	0µV	-30,000 to 30,000	Software trim of 2.500V 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 <b>P7=22</b> corresponding to 300mS
P9	Remote network error	# errors	0	0 to 30,000	Network errors have occurred if <b>P9&gt;0</b> .
P10	ADC settling period	mS	10mS	0 to 30,000	Time between channel selection and beginning of ADC (see also <b>7SV</b> 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 <b>8SV</b> 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 display keys), determines minimum detectable pulse width. <b>P13=0</b> disables digital input.
P14	Password timeout	seconds	300S	1 to 30,000	If a password is defined, <b>dataTaker</b> will automatically <b>SIGNOFF</b> 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	125mS	1 (125mS)	1 to 255	Minimum time from wake-up to first ADC in 125'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. <b>P21=address</b> . <b>P21</b> 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 Unload 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.
P27	Define input to counter1HSC	mode	0	0 to 3	0 = external input, 1 = internal 32768Hz, 2 = external input gated, 3 = internal 1024Hz. See "High Speed Counters" on page 18.
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 <b>P32&gt;5</b> 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 Unload 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 "Advanced Communications Manual" for a complete description.

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. <b>5PT392</b> instead of 5 (see "Output Formats" on page 10).
/D	/d	Prefix date to data	/d	Prefix date to logged data – equivalent to a <b>D</b> at beginning of a schedules channel list.
/E	/e	Echo	/E	Enables echo of commands to host. Useful in terminal mode communications with the <b>dataTaker</b> .
/F	/f	Fix schedules	/f	Prevents a logger's scan schedules (trigger or channel list) being modified (see "Schedules" on page 3). A <b>RESET</b> 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 "Advanced 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. <b>dataTaker</b> always calibrates during a <b>RESET</b> .
/L	/l	Logger number prefix	/L	Prefixes the logger number to a schedule's returned data e.g. <b>dataTaker 19 5PT385 232.5</b> indicating the data is from logger 19.
/M	/m	Messages	/M	Enables error and warning messages to be returned to host (see "Error Messages" 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 RS232 COMS port. Switching returns off (/r) can reduce power consumption.
/S	/s	Synchronise	/S	Synchronises all schedules' time intervals to midnight (e.g. <b>RA1M</b> 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 <b>T</b> 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 errors are verbose (see "Error Messages" 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 <b>W</b> 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 <b>dataTaker</b> 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 ... a local view of your data

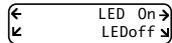
## Introduction

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.

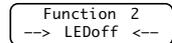
You cannot program the **dataTaker** from the display panel, however you can issue pre-defined commands by pressing a panel key combination (function key).

**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:



These are the default assignments. When a function key is pressed, the display identifies the key and its label:



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:

```
Kn="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",[RA10S 1..5TT]
```

places **RA10S 1..5TT** on function key F2. The command sequence can be up to 255 characters and must be entered in a single line.

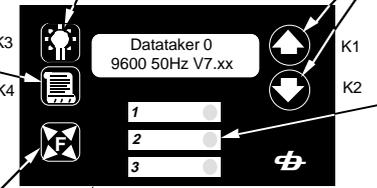
The default function key assignments are:

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

The function keys can be very useful. For example the keys can be used to completely reprogram the **dataTaker**, with a different program assigned to each key. The key functions can also 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 setting **5WARN=1** flashes it. When the **dataTaker** is asleep the back-light is off.

In conjunction with the 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.

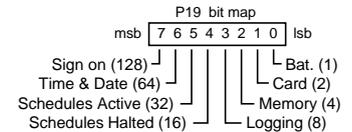


**Label Area:** You can label the warning LEDs with a felt tipped pen.

## 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 enabled/disabled for display by **P19**. Each bit in this parameter value represents a status screen. A "1" enables and "0" disables. The bit mapping is



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.

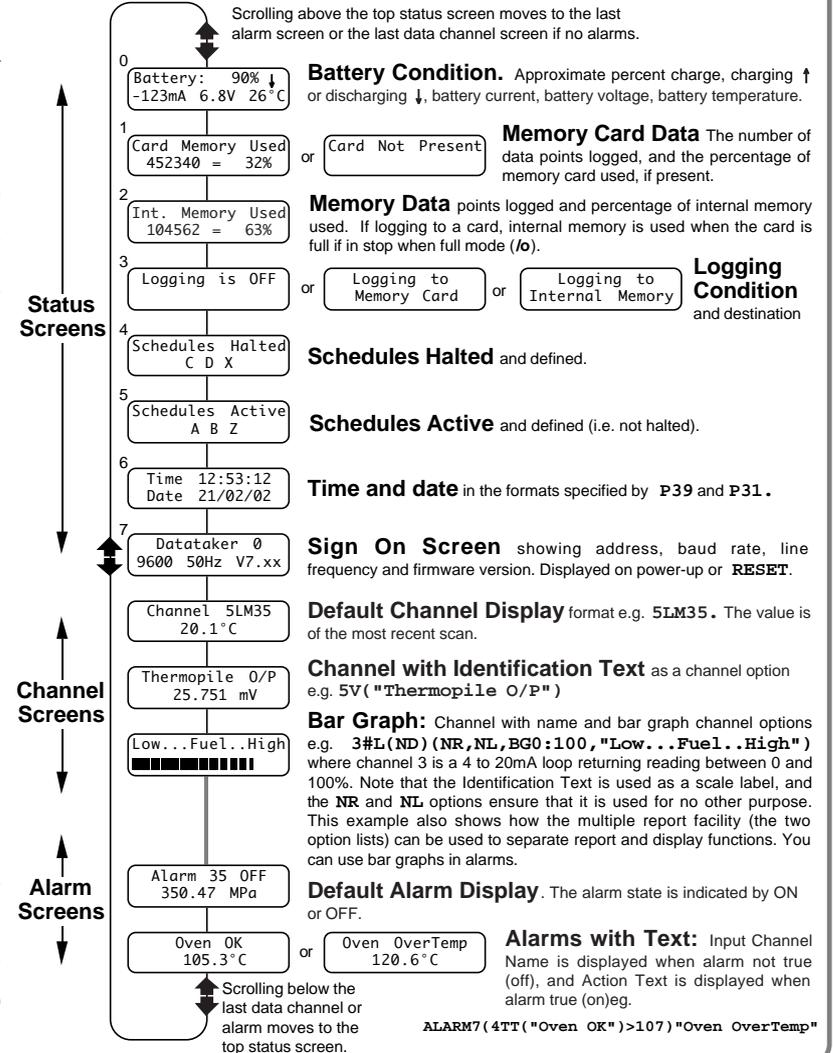
- First level - the programmer uses
W intermediate working channel option
P19 status screen enable
ND no display channel option.

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**.



```
ALARM7(4TT("Oven OK")>107)"Oven OverTemp"
```

# COMMS Port ... let's talk

## Introduction

All *dataTaker* models have a 9 pin female (DE9) connector for RS232 or RS423 communications with a computer. This interface, the RS232 COMMS port, is the means by which you program the *dataTaker*, or a network of *dataTakers*, from a computer. The RS232 COMMS port of the *dataTaker* is electrically isolated. Refer to the Appendix for details of the RS232 COMMS port of your *dataTaker*.

## RS232 COMMS Parameters

The RS232 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 settings. The *dataTaker* is shipped with the baud rate set to 9600 baud.

## Operation

All communications with the *dataTaker* use 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 computer). This action is disabled by the echo switch /e.

## Special Characters

XOFF	stops <i>dataTaker</i> transmitting
XON	allows <i>dataTaker</i> 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 Flow Control

If *dataTaker* returns data faster than the computer can receive it, then the computer (software) can send an XOFF character which will stop data transmission within two character periods, giving the computer time to process its buffered data. When the computer is ready to receive data, it sends an XON character to *dataTaker* to resume transmission. A *dataTaker* in XOFF state can also auto-XON (see Parameter 26 on page 11). The *dataTaker* issues XOFF when its input buffer is 50%, 75% and 90% full and XON when the input buffer is empty.

## Special Commands

The *dataTaker* has three special serial interface commands to assist in managing communications

- ^ZCMSRST clear the input and output buffers, and set XON state
- ^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 or telemetry devices 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. 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 flow control, or by time delays between transmissions.

## Waking From Sleep Mode

If characters are received while the *dataTaker* is in Sleep Mode, the logger wakes. Characters received in the first 75mS are lost. Characters received between 55 and 125mS may generate communications errors.

To reliably wake the *dataTaker* if communicating manually (eg. Windows HyperTerminal or other terminal applications), send a carriage return or line feed and wait 300mS before sending commands. DeTransfer and DeLogger have a setting in their respective connection definitions to [X] Wake Logger, which performs this task.

## Password Protection

The *dataTaker* has password protection on the RS232 COMMS port. When a password is enabled, communications is only possible after the password is entered. Password protection is particularly useful when the *dataTaker* is connected via a modem, to prevent unauthorized access and to eliminate line noise being interpreted as commands during call establishment. The password is set by assignment

PASSWORD="password text"

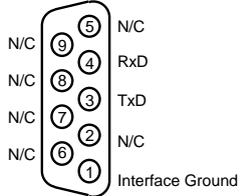
The password text may be any string (except command keywords) up to 10 case sensitive characters. Assigning a null string by PASSWORD="" removes a password.

To establish communications, enter the password followed by a carriage return at any time. If the password is accepted, the logger responds "Accepted" and the RS232 COMMS port is open for communications. If there is no communications for a period of time defined by P14 (default 300 seconds), then the RS232 COMMS port will timeout and is closed. The port can also be closed at any time by the SIGNOFF command.

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

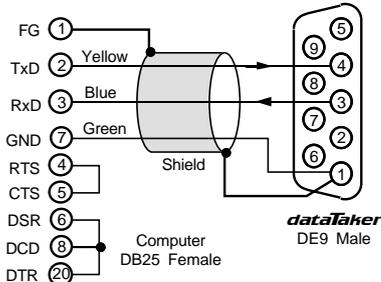
## The RS232 COMMS Port

The *dataTaker* RS232 COMMS port connector is detailed below

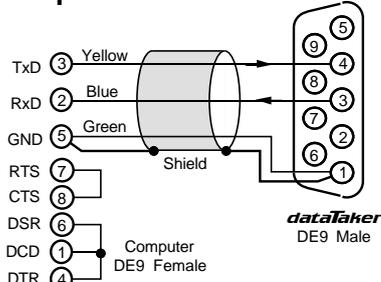


The configuration of communications cables to connect the *dataTaker* to computers and modems are detailed below.

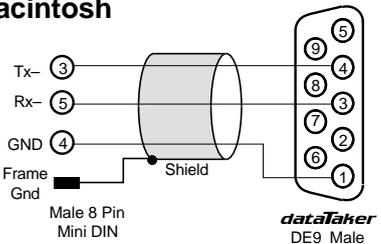
### PC - 25 pin



### PC - 9 pin



### Macintosh



## RS232 COMMS Port Isolation

The RS232 COMMS port of all models of the *dataTaker* Series 2 and 3 data loggers are electrically isolated to 500V.

## Using Modems with *dataTaker*

These comments relate to the Remote Modem (at the *dataTaker* end). The Local Modem (at the computer end) should be "Added" into your Windows operating system, where it can be accessed by DeTransfer and DeLogger.

Enter the following commands into the *dataTaker* using a computer running DeTransfer or other communications program, before connecting the Remote Modem

- /e *dataTaker* echo OFF
- /m *dataTaker* error messages OFF
- /r *dataTaker* returns OFF

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

The DTR input of the Remote Modem may need to be asserted. This can be done in the cabling by tying DTR high, or by using the AT&D0 command.

Enter the following commands into the Remote Modem with a computer running DeTransfer 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 command echo)
- ATY1 (Enable Break disconnect)
- AT&W0 (Save settings in User Profile 0 - sometimes AT&W)

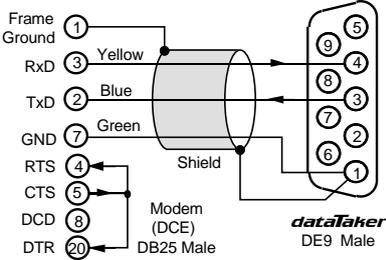
It is important that the RS232 port of the Remote Modem is locked to a baud rate the same as the *dataTaker*. Consult your modem manual for the command to set the RS232 port baud rate.

For a more comprehensive discussion about use of modems refer to the "Advanced Communications Manual", or to the Technical Notes series at [www.dataTaker.com](http://www.dataTaker.com).

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.

Once the remote modem has been set up, connect it to the *dataTaker* using a MOD-3 cable, or the cable diagrammed below. Use DeTransfer or DeLogger to call the remote site.

## Modem (DCE) Cable

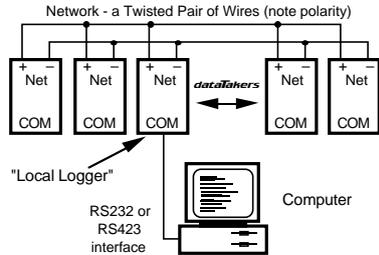


## Introduction

*dataTaker* models with an RS485 network port can be connected in a local area network (LAN) with up to 32 loggers. Network cable is limited to 1000 meters total.

DeLogger 3 supports the *dataTaker* network, however DeLogger 4 does not support the network.

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



The computer can be connected to any *dataTaker* (referred to as the local logger) in the network through its RS232 COMMS port. Data is returned to the COMMS port of the local logger. **P21** will allow this return address to be over ridden (see "Parameters" on page 11).

You can connect 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 *dataTaker*

The computer can issue commands to any *dataTaker* in the network 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 wildcard address **##** when the command returns data, as the data from the loggers may be mixed and not easily separated. The wildcard 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

Data is returned to the RS232 COMMS port that made the request, unless changed by **P21**. It is recommended that all loggers in a network have the **/L** address switch set, so that the logger address is prefixed to data and responses.

For example, for channels 1..3TT with switches set to **/n/c/u/L** and **P22=32** (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 name **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 $="PumpHouse 19"
#19 $ 1..3TT P22=44 /n/u
```

will return data to the computer

```
PumpHouse 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 Network Address

The *dataTaker* network 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.

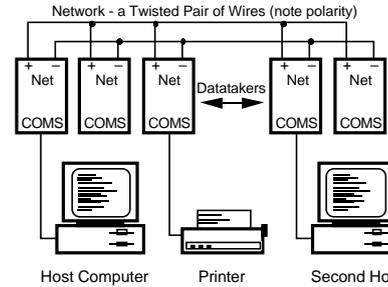
The network turn-around time can be adjusted by parameter **P7** in increments of 14mS. For example setting **P7=22** would set the turn-around time to 300mS.

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 "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 COMMS Ports

You can connect other devices to the remaining *dataTaker* RS232 COMMS ports, such as a printer, a terminal or another computer.



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 RS232 COMMS 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 (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 (using **ALARM** commands) 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 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 specifically address commands for 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 21 156.54 23.5 28.9
poll logger 29 #29 X
receive 29 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 Unloads (see "Data Logging and Retrieval" on page 8). This method uses the *dataTaker* data memory as an expanded output buffer, that is cleared after each unload by the **CLAST** command. For example

```
program all loggers ## /u/n P25=42
program logger 21 #21 RA10S 2V 3..4TT LOGON
logger 29 #29 RA10S 3R 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**. 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 sophisticated 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" on page 10, and the "Advanced Communications Manual".

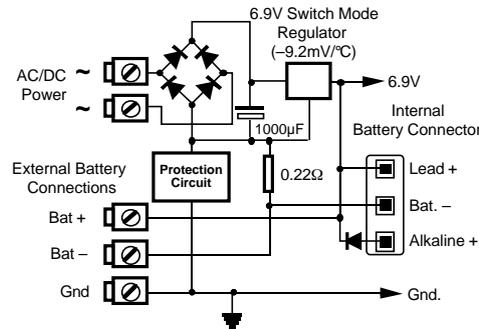
# Power and Battery Connection ... take care

## 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 also 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 more than a year if precautions are taken to avoid excessive current draw.

The *dataTaker* has two power 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 high speed counters, clock and the wake circuit are 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 RS232 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

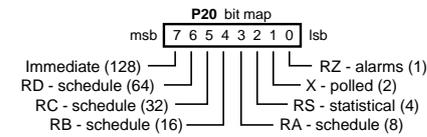
**P15** is used to set the power mode, as follows

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 period (secs) that *dataTaker* remains awake after activity on RS232 COMMS, network, keypad or wake terminal ceases. Default is 30 secs.

**P20** masks schedules from waking a sleeping logger



Default **P20=0** means all schedules wake the logger when they become due, while **P20=65** (i.e. 64 + 1) means the **RD** and **RZ** schedules will not wake the logger. **P20** does not disable schedules if the logger 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 details.

Powering down the multiplexer 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 current draw from sensors, and possibly inject some of this current into other sensors.

DT505,605,515 and 615 with relay multiplexers do not have these issues, since relays are open circuit when off.

## The Wake Terminal

A low state (< 0.7V) on the Wake terminal will wake the logger within 300mS. This can be from a relay closure or open collector NPN transistor to ground. The Wake signal line has an internal 1800Ω pull-up resistor to +5V.

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

## A Low Power Program!

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

```

P15=1          'sleep if not busy
P17=5          'go to sleep quickly
/u/n          'disable chan no and units
S1=0,100,0,1000 "%RH" 'define spans, etc. here
BEGIN
RS15M         'scan as infrequently as possible,
RALH         'especially for statistical schedules
1V("Humidity",S1,AV)
2PT385("Air temp",4W,AV,=1CV)
RZ1H         'set alarm rate if using alarms
IF(1CV>25) ["LOGON"]
IF(1CV<20) ["LOGOFF"]
END
    
```

RS232 COMMS activity can be reduced to save power by setting the **/R** switch (see "Switches - /R" on page 11).

## Lithium Battery - Replacement

The ½AA lithium battery maintains the real time clock and internal data memory when *dataTaker* is not powered. This battery must be replaced every 2 years. The lithium battery is located on the lower printed circuit board, and the logger must be disassembled to replace the battery.

## Battery Life

The battery life that can be achieved by the *dataTaker* depends on

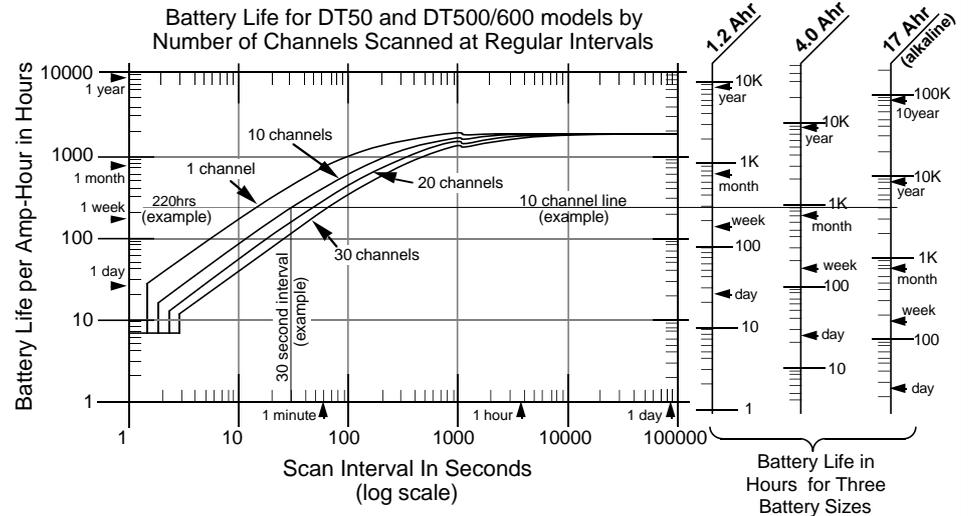
- scan interval (including alarm and statistical scans)
- number of analog channels
- number of digital channels
- number of alarms
- sensor excitation power draw
- complexity of any calculations
- baud rate

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.



## 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:

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

where

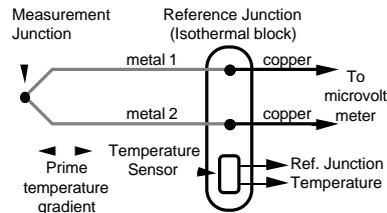
- $I_w$  is the amp-hours per week consumed by the logger
- $T_w$  is the hours per week of full sunlight
- $\eta$  is the efficiency - a combination of battery charge absorption and the cosine effect. Typical 0.65.

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

## 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°C to 120°C.

### 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°C, and thermocouple responses are determined with a 0°C 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 °C
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 *dataTaker*

Thermocouples are wired to the *dataTaker* as for any voltage signal. The channel type is a **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 **1LM35** on the logger and **n:1LM35** on Channel Expansion Modules) as the reference junction sensor. The internal sensor has an accuracy of ±0.5°C, and may be trimmed by **P2** (in units of 0.001°C).

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 converts V to temp.
- 11SV (TR)** use when thermocouple 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)**).

### Accuracy

The accuracy of temperature measurement with thermocouples is dependent on the:

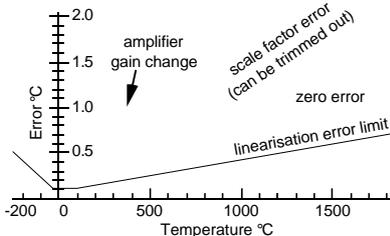
- reference junction isothermal characteristics
- reference temperature sensor accuracy
- induced electrical noise
- quality of the thermocouple wire
- drift in the wire, especially at high temperatures.
- basic measurement accuracy of the *DataTaker*
- linearisation accuracy of the *DataTaker*

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°C this can result in an error of ±0.2°C, climbing to ±0.5°C at 400°C. Note also that the error is dependent on thermocouple sensitivity. For example the K type thermocouple at 1200°C the error can be as high as 2.1°C.

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

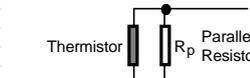
### Introduction

Thermistors are semiconductor devices that change their electrical resistance with temperature. Thermistors measure temperatures from -80°C up to 250°C. They are sensitive but highly nonlinear. *DataTakers* support all two wire YSI<sup>®</sup> thermistors. The response is

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

The constant terms are those recommended by YSI<sup>®</sup>.

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/°C 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:

$$\alpha = \frac{R_{100} - R_0}{100 \times R_0} \Omega/\Omega/^\circ\text{C}$$

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

The three RTD channel types are connected as for a resistance. The 0°C 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°C) device.

# Sensors 2 ... understanding helps

## Hints for Successful Measurement ... some tips for good data

### 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.

Where ground loops are suspected of causing errors then connecting all grounds in a system together can correct the problem.

### 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 **ESn** 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	<b>nAD590</b>	18, (7, 8)
LM34**	10mV/°F	<b>nLM34</b>	20, 21, (1, 2, 3)
LM35**	10mV/°C	<b>nLM35</b>	20, 21, (1, 2, 3)
LM335**	10mV/°K	<b>nLM335</b>	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 T <sub>p</sub>	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<sub>p</sub>, 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:

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

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

$$= 99.544$$

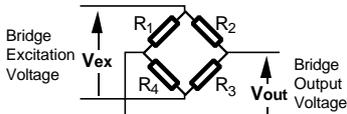
The correction can be applied e.g. **5AD590(99.544)**.

\* 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<sub>ex</sub>** to have been previously sampled in the same schedule by a voltage channel with a **BR** (bridge reference) channel option e.g. **nV(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. **nBGV(-325)** which will subtract 325 ppm from the reading. This is useful for zeroing out 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<sub>ex</sub>**.

For full and half bridge constant current excitation use the **nBGI(R<sub>a</sub>)** channel type where **R<sub>a</sub>** 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 **nBGI(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<sub>out</sub>** term is measured as a voltage while the **V<sub>ex</sub>** term is measured by a reference channel for voltage excitation but is calculated for constant current excitation.

Convert to other engineering units with a Polynomial, Span or 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

$$\mu S = k \cdot B_{out} \text{ where } k = \frac{4}{G \cdot N}$$

and μS is micro-strain, B<sub>out</sub> 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<sub>ex</sub> 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
<b>BGV</b> full bridge	5V	120	0.07	±1,500
	quarter bridge	5V	120	0.26
<b>BGI</b> full Bridge	2.5mA	120	0.6	±12,500
	quarter bridge	2.5mA	120	2.2
<b>BGI</b> full Bridge	2.5mA	350	0.2	±4,300
	quarter bridge	2.5mA	350	0.7

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

# Sensors 3, Other Subjects

## Humidity Measurement ... at low cost

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
Y2=0,100%"
BEGIN
  RA55
  1PT385("Dry bulb",4W,=1CV)
  2PT385("Wet bulb",4W,=2CV)
  3CV(Y1,W)=1CV
  4CV(Y1,W)=2CV
  5CV("RH",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 fundamental measuring process

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 are sampled 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 analog 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 of 16.67 or 20.0mS depending on the DIP switch country setting (see 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 measurement resolution proportionally.

### Extra Samples

The number of samples per reading is controlled by the ESn 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 (FW) 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 chan)	/τ
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
combined with above methods will allow up to 75Hz rates.
```

## Program "Branching" ... manage flow

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

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

```
2CV=(1CV*2*(1CV<100))+(1CV*4*(1CV>100))
```

which returns a value of 2\*1CV if 1CV is less than 100, or a value of 4\*1CV if 1CV is greater than or equal to 100. The Boolean expressions (1CV<100) and (1CV>100) 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 by a pair of alarms

```
IF1(1CV<1000)"[2CV=1CVS2]"
IF2(1CV>1000)"[2CV=1CVS4]"
```

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

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

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

## Counters ... 0 to 65535 and back

The dataTaker has low speed (nC) and high speed (nHSC) counters. Both are 16 bit, and accept 0 - 30VDC and contact closure inputs. Range can be set between 1 and 65535 by channel option, after which counters roll over to zero. Eg 1C(3) sets 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 reset channel option R can also be used with counters to reset the counter to zero when 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 initialized by a value or expression
1C=15
2HSC(10)=1CV/100*SQRT(2CV/3CV)
```

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

### Low Speed Counters nC

The low speed counters are software counters that share input terminals with the digital inputs D1, D2, D3, etc).

The digital inputs are sampled every 50mS, or as defined by P13 (range 10 - 100mS), and counters increment on negative transitions. If P13 is set towards the lower end of the range, the logger can become slow in executing other tasks. Pulses shorter than P13 mS cannot be counted reliably. The low speed counters only operate while the logger is awake.

### High Speed Counters nHSC

The high speed counters are hardware counters, the function when the logger is awake or asleep. They have dedicated terminals C1, C2 and C3, increment on positive transitions, and count at rates of up to 500Hz. The maximum count speed is limited by a 1mS debounce circuit.

### Input to 1HSC

- The input to 1HSC is determined by P27 as follows
- P27=0 External input via C1, gate permanently enabled
- P27=1 Internal 32767Hz input, gate is ext signal on C1
- P27=2 External input via C1, gate is ext signal on C2
- P27=3 Internal 1024Hz input, gate permanently enabled

The counter gate is active low, and can be enabled by contact closure to ground.

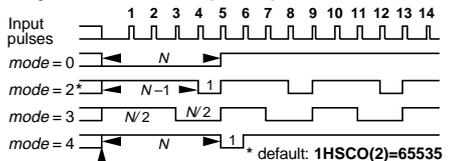
### High Speed Counter Output 1HSCO(mode)

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. 1HSCO(mode)=N where N=4

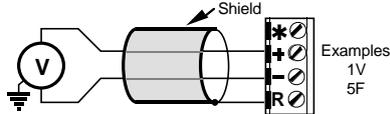
## Placing Program in FLASH

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

See the Application Note "Installing a dataTaker Program in Flash Memory" which is available from your dataTaker supplier or from the web site at [www.datataker.com](http://www.datataker.com)

# Analog Input Configurations 1 ... its all in the wiring

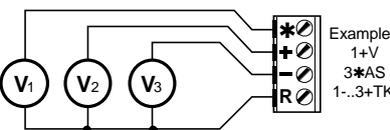
**Config 1**



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**

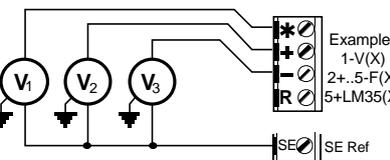
**Config 2**



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

**Single Ended Inputs**

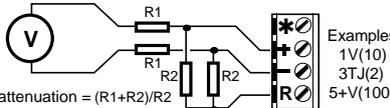
**Config 3**



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

**Single Ended Inputs with External Reference**

**Config 4**

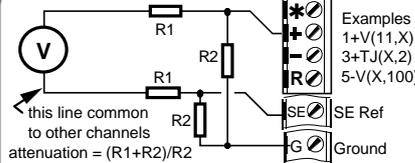


Attenuated voltage inputs let you measure large voltages, extend the common mode range and provides greater input protection. Differential or single ended measurement is possible.

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

**Attenuated Input**

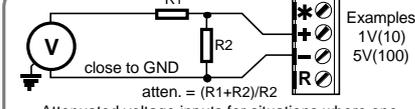
**Config 5**



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**

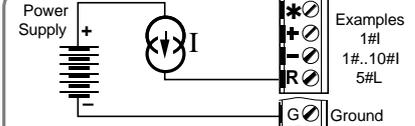
**Config 6**



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

**Half Attenuated Differential Input**

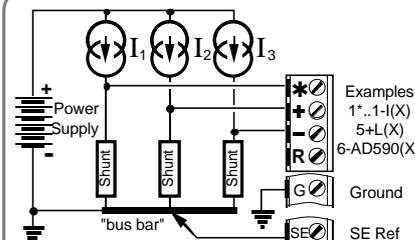
**Config 7**



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**

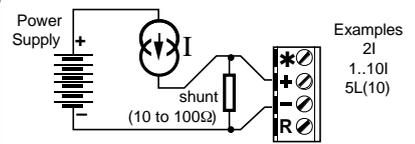


To avoid cross channel coupling, connect the bottom of the shunts with the minimum of shared resistance to the SE ref. take-off point.

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

**Single Ended Current with External Shunt**

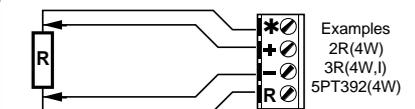
**Config 8a**



Note: Common mode voltage limits must be adhered to for correct operation. For models with CMOS multiplexers this is  $\pm 4$  volts relative to **dataTaker** ground.

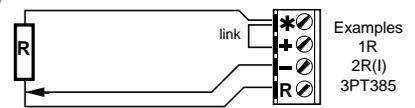
**Differential Current Input with External Shunt**

**Config 9**



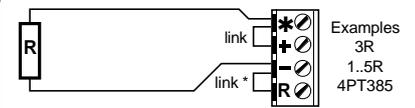
**Four Wire Resistance Input**

**Config 10**



**Three Wire Resistance Input**

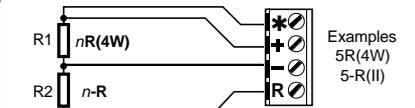
**Config 11**



\* 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 > 500 $\Omega$

**Two Wire Resistance Input**

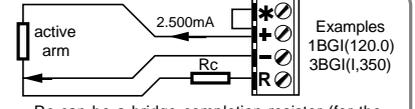
**Config 12**



The measurement current passes through both resistors. By definition  $nR(4W)$  and  $n-R$  will measure R1 and R2 respectively. This configuration does not provide lead compensation for R2.

**Mixed Resistance Input**

**Config 13**

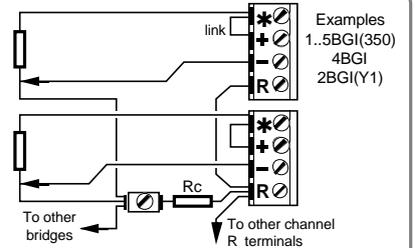


Rc can be a bridge completion resistor (for the same value as the active arm) located near the logger, or preferably an active arm of the bridge.

This configuration compensates for lead resistance, and in the case of a half bridge, temperature compensation. For quarter bridge 120 $\Omega$  foil strain gauge the resolution is 2 $\mu$ Strain. 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 ( $\leq 5K\Omega$ ) eg 2BG(1,2000).

**Three Wire, Half and Quarter Bridge Input**

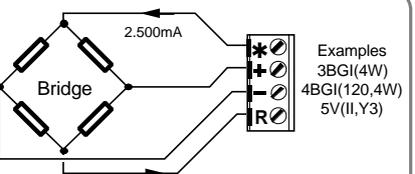
**Config 14**



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**

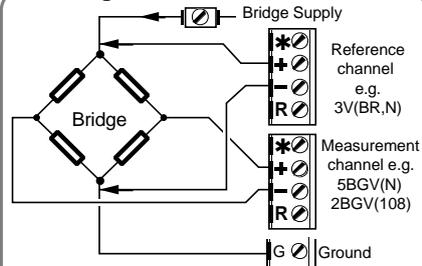


The bridge is powered by the 2.500mA constant current source, resulting in readings independent of lead length (resistance). This arrangement has a sensitivity of approximately 1 ppm per active arm.

**Full Bridge, Constant Current Excitation**

## Analog Input Configurations 2 ... its all in the wiring

**Config 16**

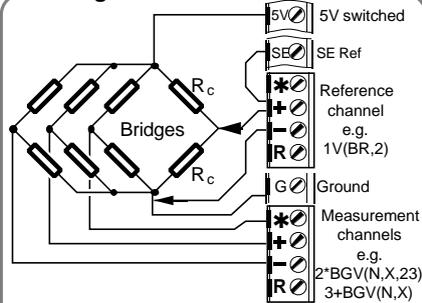


The (external) bridge supply should not exceed 2.5V unless the reference channel input is attenuated.

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**

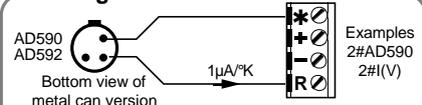


This is a combination of Config 1 for the reference channel and Config 3 for measurement channels.

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**

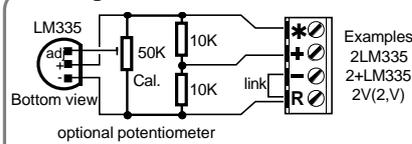
**Config 18**



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**

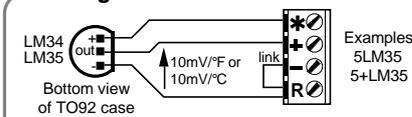


With internal sensor power as illustrated, the upper response is limited to approx. 70°C. External power should be current limited.

Be aware of self heating effects - a 500µA sensor current can cause 1.5°C 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**

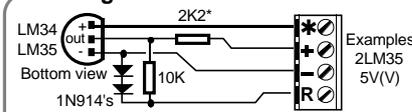


This configuration limits the sensor's lower range to approx. 10°F and 10°C for the LM34 and LM35 respectively due to the lack of a pull-down capacity.

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**



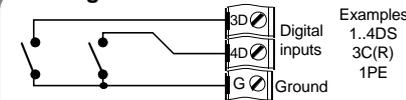
This arrangement allows full range measurement. Multiple single ended sensor connection (Config 3) is possible by connecting the LM35 negative pins to SE ref. The diodes can be shared. Sensor power can also be derived from external sources.

\* 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**

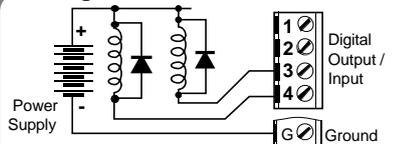


The digital and counter inputs both employ 10KΩ pull-up resistors to 5 volts, allowing the use of voltage free contacts. The thresholds are <1.5V for a "0" and >3.5V for a "1". During sleep mode the digital inputs are inoperative, however the high speed counters remain active.

Example above also shows wiring for the one phase encoder up-down counter.

**Digital and Counter Input**

**Config 23**

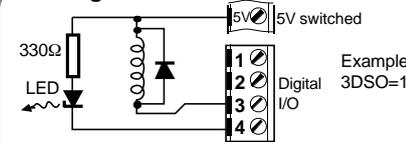


The bidirectional digital channels can sink 200mA from up to a 30 volt supply. The solid state switch is not protected against sustained over currents.

For inductive loads parallel reverse diodes are recommended although not essential because the *dataTaker* has internal transient protection.

**Relay Connection - Externally Powered**

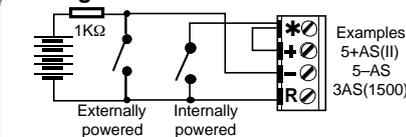
**Config 24**



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**



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 the *dataTaker* common mode range.

**Digital Input via Analog Inputs**

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Voltage Input 1, 2, 3, 4, 5, 6

Note: the number references relate to the wiring configuration.



# Simplified Circuit ... the guts of the *dataTaker*

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  $\pm 3.5$  volts relative to ground. Exceeding these limits is likely to cause measurement errors.

Ground is locally sampled

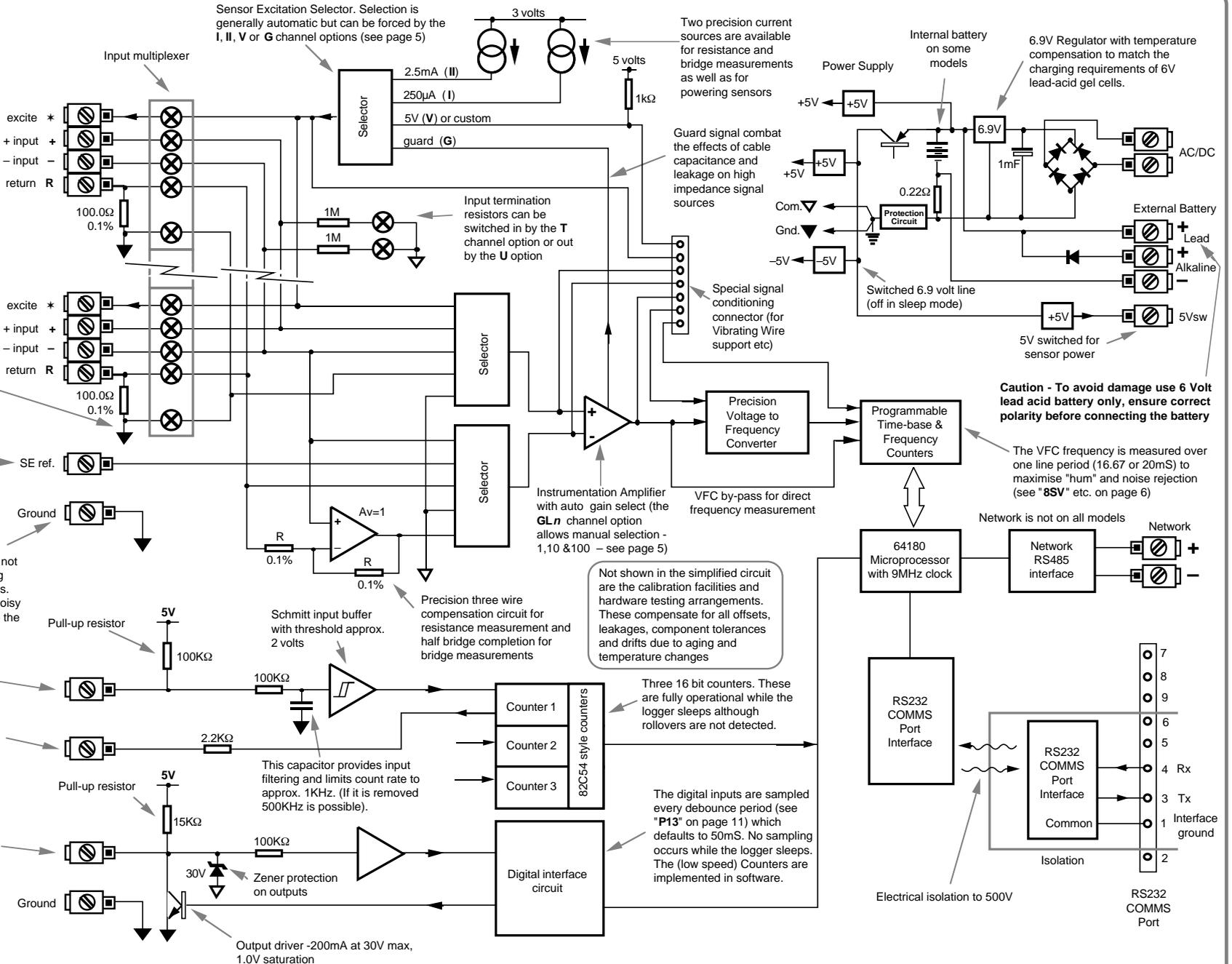
The SE Ref. terminal can be internally routed to the negative input of the instrumentation amplifier by using the X channel option for single ended inputs. This can provide many of the benefits of differential input for single ended input.

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.

High Speed Counter Channels ~ 2V threshold (see HSC on page 4)

1HSC has a square wave overflow output that can be applied to the input of another counter. The 1HSCO= $n$  output channel assignment sets the counter's divisor to  $n$  (with  $n = 1$  to 65,535).

Digital Input (DS and DB) - Output (DSO and DBO) and (low speed) Counter (C and UDC) Channels ~ 2V threshold for input (see page 4)



Sensor Excitation Selector. Selection is generally automatic but can be forced by the I, II, V or G channel options (see page 5)

Two precision current sources are available for resistance and bridge measurements as well as for powering sensors

Guard signal combat the effects of cable capacitance and leakage on high impedance signal sources

Input termination resistors can be switched in by the T channel option or out by the U option

Power Supply

Internal battery on some models

6.9V Regulator with temperature compensation to match the charging requirements of 6V lead-acid gel cells.

External Battery

Caution - To avoid damage use 6 Volt lead acid battery only, ensure correct polarity before connecting the battery

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)

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

Three 16 bit counters. These are fully operational while the logger sleeps although rollovers are not detected.

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.

Electrical isolation to 500V

RS232 COMMS Port

# Glossary ... what it means!

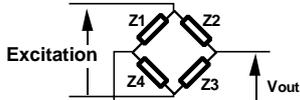
**Actuator** – a device which converts a voltage or current input into a mechanical output.

**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.



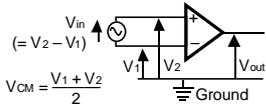
Arms of the bridge may be "active" sensors or "passive" for bridge "completion" and "nulling".

**Common Mode Rejection Ratio (CMRR)** – a measure of the influence of common mode voltage on the output of the instrumentation amplifier.

$$CMRR = 20 \log \left( \frac{V_{cm}}{V_{out} \times A_v} \right)$$

where  $V_{cm}$  is an applied common mode voltage  
 $V_{out}$  is the resulting output voltage  
 $A_v$  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:



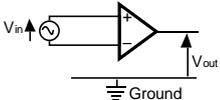
The term only has meaning for differential inputs.

**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, then the DT50, DT500, DT600 series in 1990, which was revised in 1996 and 2002, and then the DT800 in 2000 . . .

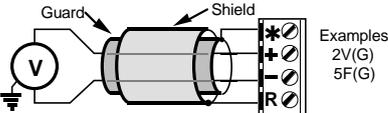
**Differential Input** – the two wire input is not referenced to a system ground and is essentially floating.



The common mode range limits must be considered.

**Ground Loop** – more often than 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:



**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.

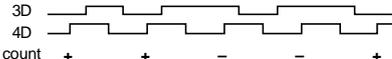
**LSB** – least significant bit in a byte.

**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.

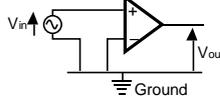
**Port** – a communications connector on a computer or other device.

**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 Appendix 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	Range Units	Resolution
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

Diff refers to differential or double ended channels, and SE refers to single ended channels (see "Glossary" on page 23).

## 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

The *dataTaker 50* can be powered as follows

Source	Range	+ Terminal	- Terminal
AC	9 – 18Vac	AC/DC-	AC/DC-
DC	11 – 24Vdc	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.

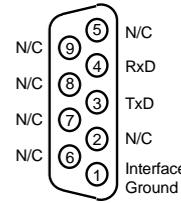
When the *dataTaker 50* is powered by a 9V alkaline battery and an external AC or DC source, the 6.9V regulator's (see schematic) output is increased to 10V so that power is drawn from the external source in preference to the battery.

## COMMS Port

also page 13  
The *dataTaker 50* RS232 COMMS Port is serial RS232 compatible. The output signal level is approximately ±4 Volts, allowing communications over distances in excess 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).

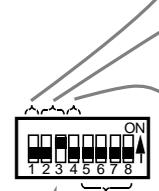
The *dataTaker 50* RS232 COMMS Port is electrically isolated to 500V.

## RS232 COMMS



## Dip Switch

Shown set to the factory defaults



Country	s1
US (60Hz)	on
Other (50Hz)	off

Baud Rate	s2	s3	s5	Add. Range
1200	off	off	x	0 - 15
9600	off	on	off	0 - 7
300	off	on	on	0 - 7
2400	on	off	x	0 - 15
4800	on	on	x	0 - 15

x = don't care

## 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

The *dataTaker 50* RS232 COMMS port baud rate must match that of the host computer. See "COMMS Port" on page 13. If either 300 or 9600 baud is selected, the logger address range is reduced to 0 - 7.

Mux Power	s4
permanent	on
switched	off

## 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* is sleep. The current saving is approximately 150µA, which is current draw of the 4 CMOS multiplexer integrated circuits (CD4052). See "Multiplexer Powering" on page 15.

## dataTaker 50 Address

The *dataTaker 50* can be given an address, despite the fact that the logger does not support networking.

The address of a *dataTaker 50* can be used for

- ◆ identification in the **STATUS** or **STATUS1** commands (see "STATUS" on page 10)
- ◆ identification of returned data if /L Address Switch is enabled (see "Switches - /L" on page 11)

If 300 or 9600 baud rate is selected, then the address range is limited to 0 - 7.

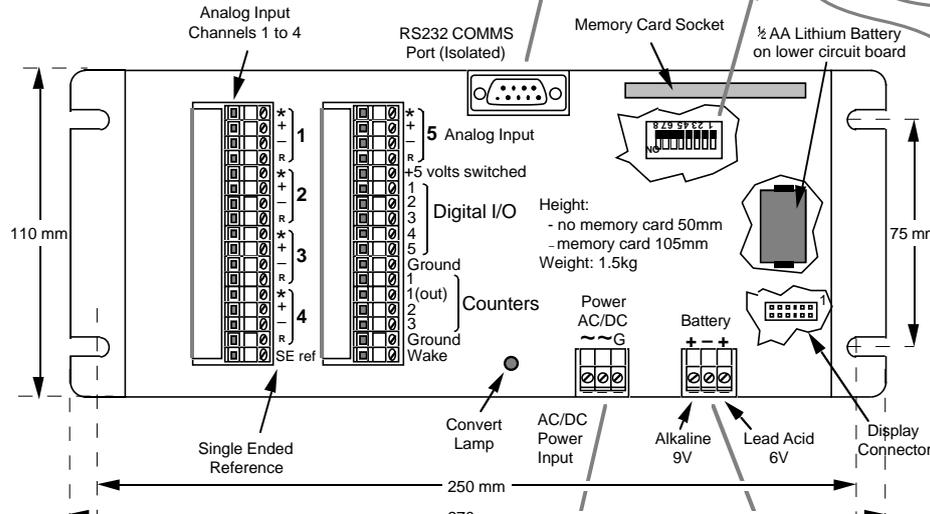
Address	s5	s6	s7	s8
0	off	off	off	off
1	off	off	off	on
2	off	off	on	on
3	off	off	on	on
4	off	on	off	on
5	off	on	off	on
6	off	on	on	off
7	off	on	on	on
8	on	off	off	off
9	on	off	off	on
10	on	off	on	off
11	on	off	on	on
12	on	on	off	off
13	on	on	off	on
14	on	on	on	off
15	on	on	on	on

See text to right

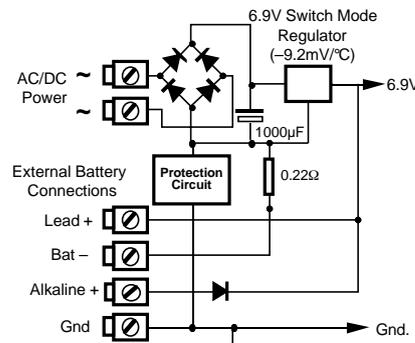
## Power Consumption

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 is charging 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

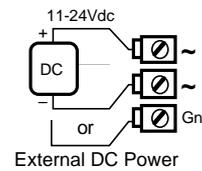
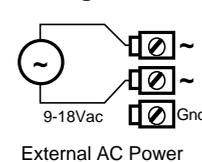


**Caution - To avoid damage use 6 Volt lead acid battery only, ensure correct polarity before connecting the battery**

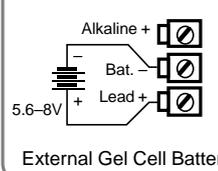
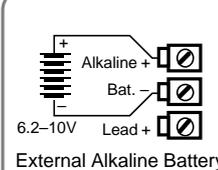


Simplified Power Supply Schematic

### Wiring Power



### Wiring 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 Appendix 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 1M $\Omega$ , or >100 M $\Omega$  selectable
- Common mode range  $\pm$ 3.5 Vdc
- Common mode rejection >90 db (110 db typical)
- Series mode line rejection >35 db
- Sensor excitation of 4.5V, 250.0 $\mu$ A 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	Range Units	Resolution
	Diff SE		
DC Voltage	10 30	$\pm$ 25 mV	1 $\mu$ V
		$\pm$ 250 mV	10 $\mu$ V
		$\pm$ 2500 mV	100 $\mu$ V
DC Current	10 40	$\pm$ 0.25 mA	200nA
		$\pm$ 2.5 mA	1 $\mu$ A
		$\pm$ 25. mA	10 $\mu$ A
Resistance	10 20	10 Ohms	0.5m $\Omega$
		100 Ohms	5m $\Omega$
		500 Ohms	50m $\Omega$
Frequency	10 30	7000 Ohms	500m $\Omega$
		0.1-20,000 Hz	0.01%

Diff refers to differential or double ended channels, and SE refers to single ended channels (see "Glossary" on page 23).

## 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

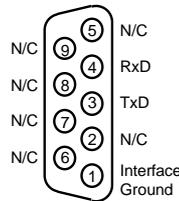
The *dataTaker 500* and *dataTaker 600* both have an RS485 network. A proprietary network protocol supports error free communications between up to thirty two *dataTaker 500* and *dataTaker 600* series data loggers. See "Networking" on page 14.

## RS232 COMMS Port

The *dataTaker 500* and *dataTaker 600* RS232 COMMS Port is serial RS232 compatible. The output signal level is approximately  $\pm$ 4 Volts, allowing communications over distances in excess 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* RS232 COMMS Port is electrically isolated to 500V.

## RS232 COMMS Connector



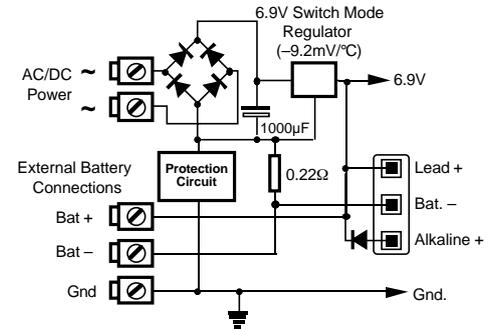
## Power Supply and Battery

The *dataTaker 500* and *600* can be powered by

Source	Range	+Terminal	-Terminal
AC	9 – 18Vac	AC/DC-	AC/DC-
DC	11 – 24Vdc	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 6V/9V battery. Better that the external battery is a larger capacity 12V battery connected as External DC Power.



## Power Consumption

The *dataTaker 500* and *600* use little power if allowed to sleep. Less power is used 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**

Address	s4	s5	s6	s7	s8
0	off	off	off	off	off
1	off	off	off	off	off
2	off	off	off	on	off
3	off	off	off	on	on
4	off	off	off	on	off
5	off	off	off	on	on
6	off	off	on	off	off
7	off	off	on	off	on
8	off	on	off	off	off
9	off	on	off	off	off
10	off	on	off	off	on
11	off	on	off	off	on
12	off	on	off	off	on
13	off	on	off	on	off
14	off	on	off	on	off
15	off	on	off	on	on
16	on	off	off	off	off
17	on	off	off	off	on
18	on	off	off	off	on
19	on	off	off	off	on
20	on	off	off	off	on
21	on	off	off	off	on
22	on	off	off	off	on
23	on	off	off	off	on
24	on	on	off	off	off
25	on	on	off	off	on
26	on	on	off	off	on
27	on	on	off	off	on
28	on	on	off	off	on
29	on	on	off	off	on
30	on	on	off	off	on
31	on	on	off	off	on



**Dip Switch**  
Shown set to the factory defaults

Country	s1
US (60Hz)	on
Other (50Hz)	off

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

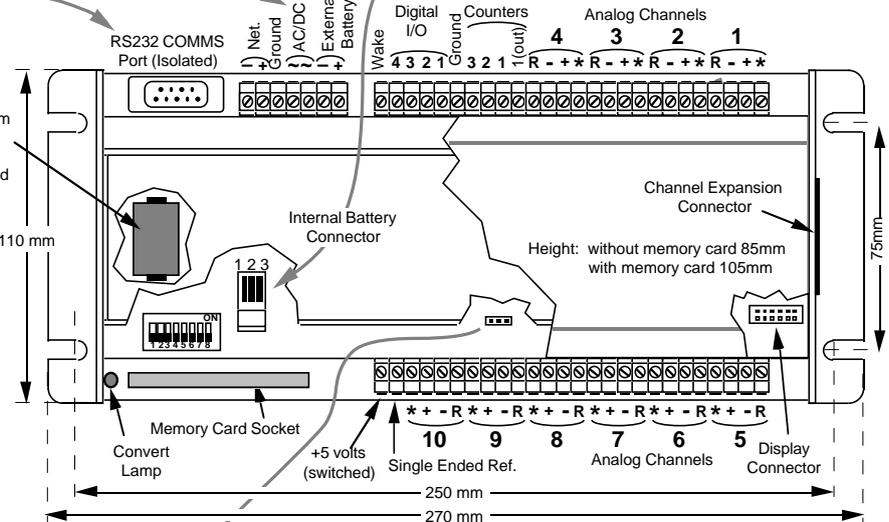
x = don't care

## 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 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.



## Powering the Multiplexer

The *dataTaker 500* and *600* have an option to maintain multiplexer power when asleep. This is achieved by moving the **Mux. Power** link located under the top cover near channel 9.



# 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 ( $\pm 100V$  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 1M $\Omega$ , or >100 M $\Omega$  selectable.
- Common mode range  $\pm 3.5$  Vdc,  $\pm 100$  Vdc attenuators on.
- Common mode rejection >90 db (110 db typical).
- Series mode line rejection >35 db.
- Sensor excitation of 4.5V, 250.0 $\mu$ A or 2.500mA each channel.
- Full, half and quarter bridges, voltage or current excitation.
- Multiplexer type: relay

Input Type	Channels	Range	Units	Resolution
DC Voltage	10 30	$\pm 25$ mV		1 $\mu$ V
		$\pm 250$ mV		10 $\mu$ V
		$\pm 2500$ mV		100 $\mu$ V
		$\pm 7$ V		250 $\mu$ V
DC Current	10 40	$\pm 70$ V		2.5mV
		$\pm 100$ V		25mV
		$\pm 0.25$ mA		200nA
		$\pm 2.5$ mA		1 $\mu$ A
Resistance	10 20	$\pm 25$ mA		10 $\mu$ A
		10 Ohms		0.5m $\Omega$
		100 Ohms		5m $\Omega$
		500 Ohms		50m $\Omega$
Frequency	10 30	7000 Ohms		500m $\Omega$
		0.1-20,000 Hz		0.01%

Diff refers to differential or double ended channels and SE refers to single ended channels (see Glossary on page 23).

All analog input channel terminals except for the Return (R) terminals are capable of withstanding 1.5KV for 10 $\mu$ s, 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.

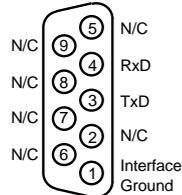
Input Type	Channels	Range
Digital Bit	4	0 or 1 State
Digital Nibble	1	0 to 15 State
LS counter	4	65535 Counts
HS counter	3	65535 Counts

## COMMS Port also page 13

The *dataTaker 505* and *dataTaker 605* RS232 COMMS Port is serial RS232 compatible. The output signal level is approximately  $\pm 4$  Volts, allowing communications over distances in excess 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* RS232 COMMS Port is electrically isolated to 500V.

## RS232 COMMS Connector



## Power Supply and Battery

The *dataTaker 505* and *605* can be powered by

Source	Range	+ Terminal	- Terminal
AC	9 - 18Vac	AC/DC-	AC/DC-
DC	11 - 24Vdc	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 6V/9V battery. Better that the external battery is a larger capacity 12V battery connected as External DC Power.

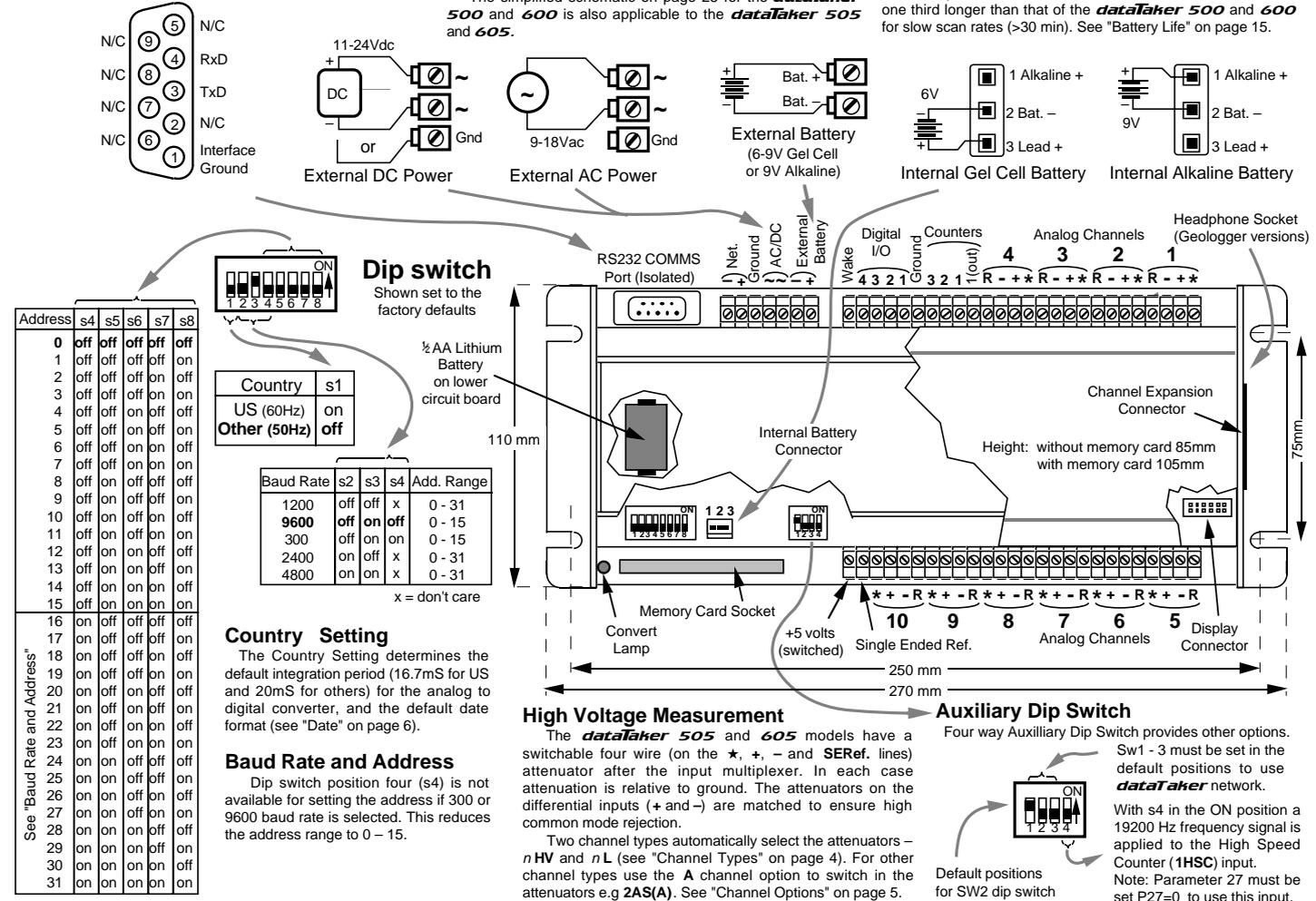
The simplified schematic on page 25 for the *dataTaker 505* and *605* is also applicable to the *dataTaker 505* and *605*.

## 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 (>30 min). See "Battery Life" on page 15.



Address	s4	s5	s6	s7	s8
0	off	off	off	off	on
1	off	off	off	on	off
2	off	off	on	off	off
3	off	off	on	on	off
4	off	off	on	off	off
5	off	off	on	on	off
6	off	off	on	on	off
7	off	off	on	on	off
8	off	on	off	off	off
9	off	on	off	off	off
10	off	on	off	off	off
11	off	on	off	off	off
12	off	on	off	off	off
13	off	on	off	off	off
14	off	on	off	off	off
15	off	on	off	off	off
16	on	off	off	off	off
17	on	off	off	off	off
18	on	off	off	off	off
19	on	off	off	off	off
20	on	off	off	off	off
21	on	off	off	off	off
22	on	off	off	off	off
23	on	off	off	off	off
24	on	on	off	off	off
25	on	on	off	off	off
26	on	on	off	off	off
27	on	on	off	off	off
28	on	on	off	off	off
29	on	on	off	off	off
30	on	on	off	off	off
31	on	on	off	off	off

Country	s1
US (60Hz)	on
Other (50Hz)	off

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

**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.

**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.

Two channel types automatically select the attenuators - nHV and nL (see "Channel Types" on page 4). 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**  
Four way Auxilliary Dip Switch provides other options. Sw1 - 3 must be set in the default positions to use *dataTaker* network.

With s4 in the ON position a 19200 Hz frequency signal is applied to the High Speed Counter (1HSC) input. Note: Parameter 27 must be set P27=0 to use this input.

# Appendix — Geologger DT515 and DT615

## Introduction

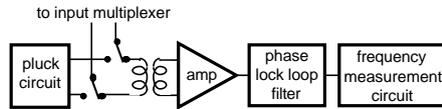
The **Geologger** is functionally similar to the **dataTaker 505** and **dataTaker 605** (see "Appendix – dataTaker 505 and 605" on page 26) with the addition of support for vibrating wire sensors. All electrical and programming characteristics are identical except the Geologger models have an extra channel type – **nFW** (Frequency of Wire) and a software speaker switch **IV**. 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.

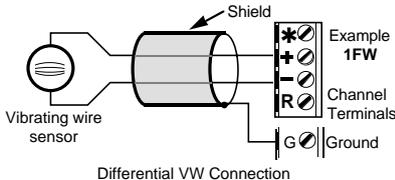
The **Geologger** has a high gain low noise signal amplifier with transformer coupling on the input. The amplified signal is filtered using band pass filters (500Hz to 5KHz) and a phase lock loop (PLL) to reduce frequency noise before the frequency is measured by a precision frequency counter.



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.

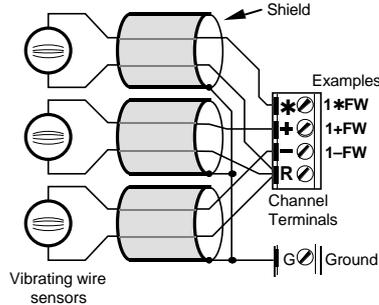


While the shield is optional it will often be found necessary when noise pick-up is a problem. The preferred shield connection point is one of the **Geologger's** ground terminals or a case ground terminal strip.

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 **nFW** 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	
<b>1FW</b>	3056.7 Hz
<b>5FW</b>	1896.4 Hz
<b>6FW</b>	2035.7 Hz
<b>7FW</b>	1705.5 Hz
<b>8FW</b>	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		
<b>2+FW</b>	4597.8 Hz	
<b>2-FW</b>	4445.2 Hz	
<b>2*FW</b>	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 calculations. 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 IV

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 **IV** 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 nFW(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 nFW(ES9)

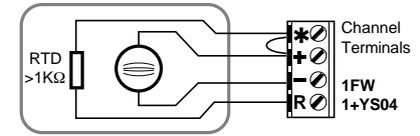
By default the **Geologger** measures a vibrating wire frequency over a period of 10 line periods (167ms in 60Hz countries and 200ms in 50Hz countries). This has been found optimal for most gauge types. However for gauges with a rapid signal decay, this period can be reduced so that the measurement window 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

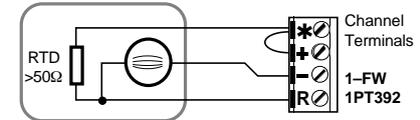
Depending on the gauge wiring, it is usually possible to measure the vibrating wire differentially and a resistance (temperature sensor) on a single channel.



Vibrating wire sensor with two wire RTD

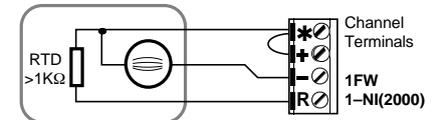
Temperature channel is read single endedly as for example **1+YS04** (a YSI 44004 sensor - see page 16) and the vibrating wire as **1FW**. Note the RTD sensor type must be of a relatively high resistance type (say >1000Ω) if errors due to cable resistance are to be avoided.

Similarly other configurations are possible. If the temperature sensor is of a low resistance type then the following is recommended:



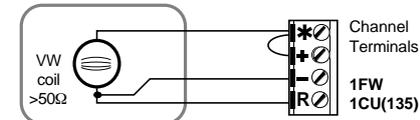
Single ended vibrating wire with three wire RTD

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°C.

# 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  $\pm 4$  volts.

## Analog Inputs

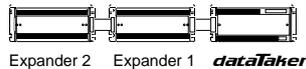
- 10 differential or 30 single ended, or any mix.
- Channel characteristics identical to *dataTaker* to which the module is attached.
- Channels have 500 volt isolation while not being read.
- Input impedance 1M $\Omega$ , or >100 M $\Omega$  selectable.
- Sensor excitation of 4.5V, 250.0 $\mu$ A, 2.500mA 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 110V $\Delta$ c/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:



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 **h** 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 10 $\mu$ S, 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.

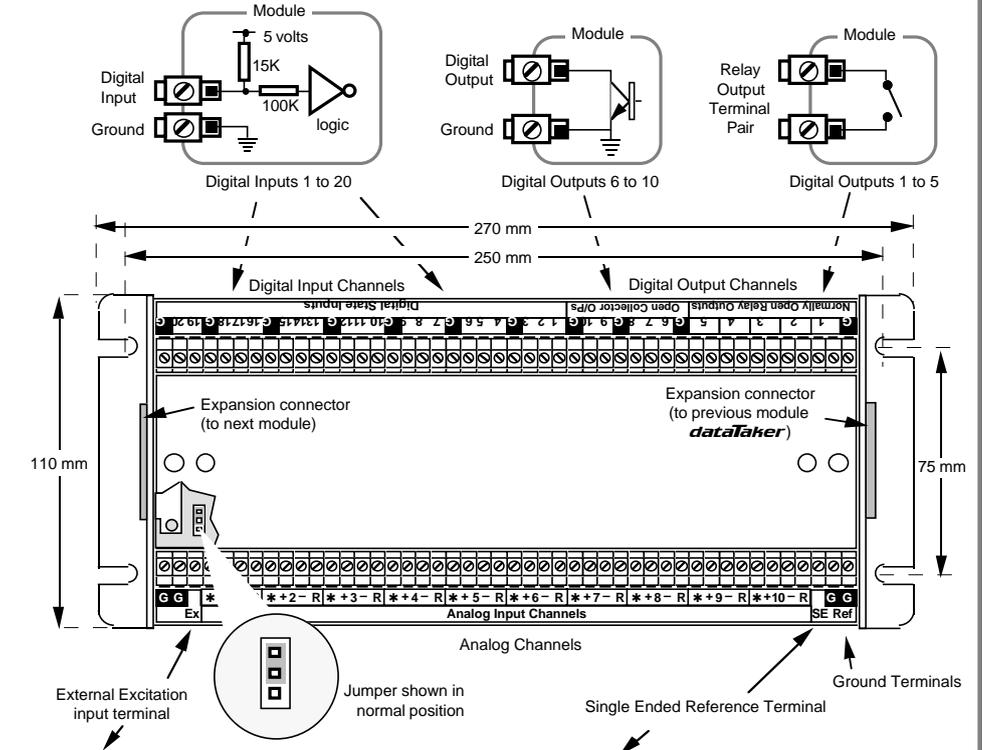
The module utilises relays for channel selection and digital output. These are a source of heat as each relay dissipates 150mW when switched on. For maximum thermocouple accuracy, you should ensure that these relays are not left on unnecessarily.

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	100 $\mu$ A
awake, no scanning or digital I/O	100 $\mu$ A
digital inputs grounded	4mA
scanning module's channels	60mA
relay outputs set (1..5DSO=1)	175mA
worst case maximum	240mA



## 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* 250 $\mu$ A, 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.

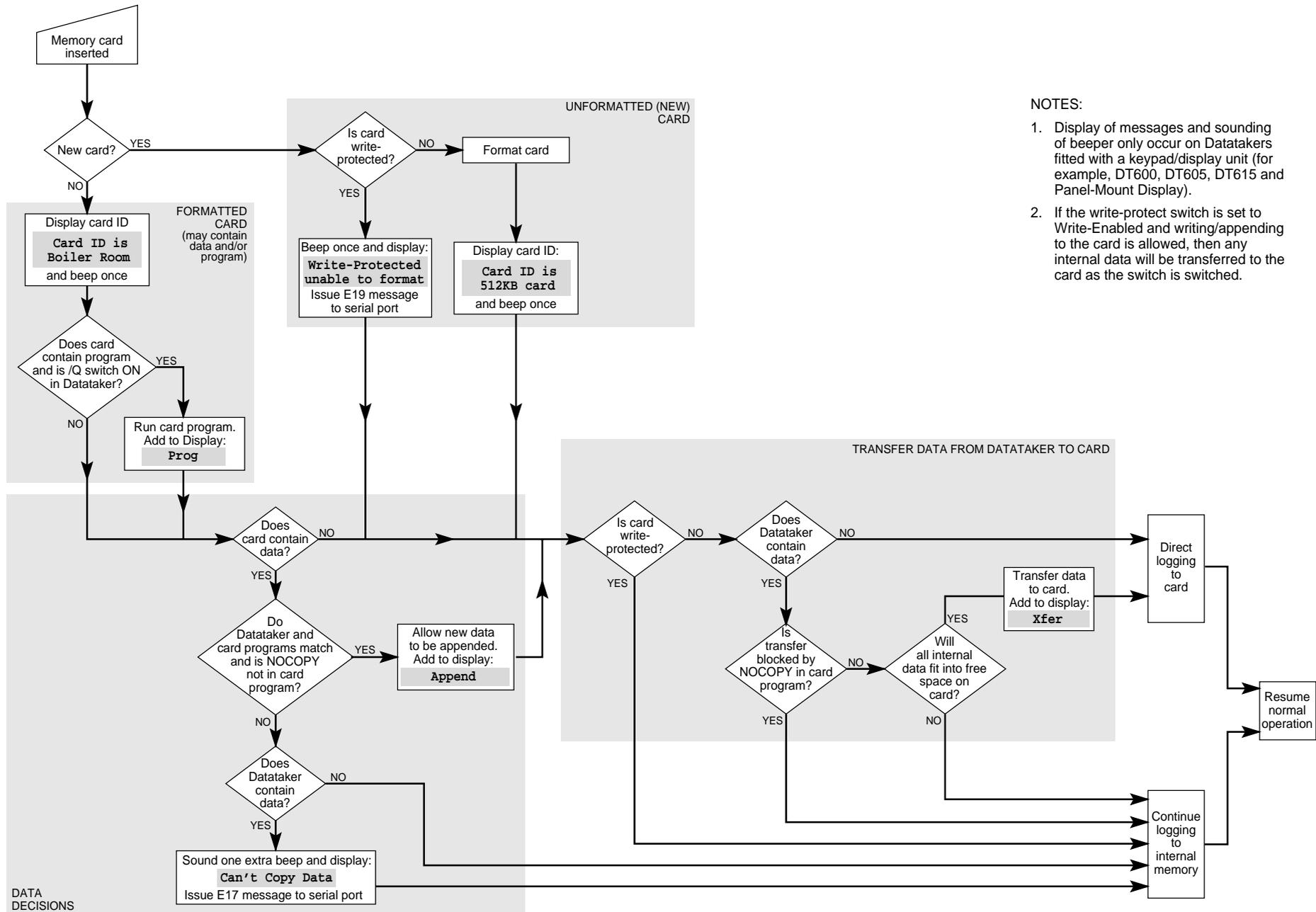
## Single Ended Reference

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 is  $\pm 3.5$ V for the *dataTaker 500* and *600* models,  $\pm 100$ V for the *dataTaker 505* and *605* and *Geologger 515* and *615* models.

# Appendix — Memory Card Processing (Flow Chart)



**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.

# 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

	<b>dataTaker 50</b>	<b>dataTaker 500</b>	<b>dataTaker 600</b>	<b>dataTaker 505</b>	<b>dataTaker 605</b>	<b>GeoLogger 515</b>	<b>GeoLogger 615</b>
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  $\pm 3.5$ VDC.

### *dataTaker 500, 600*

- 10 differential or 30 single-ended, can be used in any mix.
- Solid state multiplexers.
- Common mode range  $\pm 3.5$ VDC.
- 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  $\pm 100$ VDC.
- Input withstanding voltages for analog channels:
 

Unselected channels	$\pm 1.5$ KVDC for 10 $\mu$ S
	$\pm 500$ VDC for 50mS
	$\pm 100$ VDC continuously
Selected channels	$\pm 100$ VDC 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  $\mu$ V.
- Sampling rate 25 samples/second.
- Accuracy better than 0.15% of full scale.
- Linearity better than 0.05%
- Input impedance 1M $\Omega$ , or >100M $\Omega$  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, 250.0 $\mu$ A 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,  $a=0.003850\Omega/\Omega/^\circ\text{C}$ , any resistance.
- Platinum RTDs,  $a=0.003916\Omega/\Omega/^\circ\text{C}$ , any resistance.
- Nickel RTDs,  $a=0.005001\Omega/\Omega/^\circ\text{C}$ , any resistance.
- Copper RTDs,  $a=0.00399\Omega/\Omega/^\circ\text{C}$ , 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 100 $\mu$ S pulse excitation
  - 50 to 300 $\Omega$  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 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 2 year lithium battery.
- Resolution 1 second, accuracy 2 seconds/day (0 to 50 $^\circ$ C).
- Date in formats

Date	DD/MM/YYYY
Date	MM/DD/YYYY
Day number	DDDD
Decimal day	DDDD.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	
DC Voltage	$\pm 25.000$	mV	1 $\mu$ V	
	$\pm 250.00$	mV	10 $\mu$ V	
	$\pm 2500.0$	mV	100 $\mu$ V	
	$\pm 7.000$	V	250 $\mu$ V	Note 1
	$\pm 70.00$	V	2.5mV	Note 1
	$\pm 100.00$	V	10mV	Note 1
Attenuated DC Voltage	Any range	mV	Depends on Attenuators	
DC Current	$\pm 0.2500$	mA	200nA	
	$\pm 2.500$	mA	1 $\mu$ A	
	$\pm 25.00$	mA	10 $\mu$ A	
External Shunts	Any range	mA	Depends on Shunt	
4-20mA Loop	0 to 100	Percent	0.01%	
Resistance	10.000	Ohms	1m $\Omega$	
	100.00	Ohms	1m $\Omega$	
	500.0	Ohms	5m $\Omega$	
	7000.0	Ohms	50m $\Omega$	
Frequency	0.1 to 300,000.0	Hz	0.01Hz	
Period	30,000 to 3	$\mu$ Sec	1 $\mu$ S	
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 and Bridges	$-10^4$ to $10^4$	ppm	1ppm	
	$-10^5$ 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	$\pm 9.9e^{-18}$ to $\pm 9.9e^{18}$	User	0.0001	
Linear Spans	$\pm 9.9e^{-18}$ to $\pm 9.9e^{18}$	User	0.0001	
Calculations	$\pm 9.9e^{-18}$ to $\pm 9.9e^{18}$	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 scaled to engineering units. Subsequent manipulations performed on 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 166,530 readings.
- Supports removable PC Card (PCMCIA) memory cards
  - 1Mbyte stores up to 343,980 readings
  - 2Mbyte stores up to 693,420 readings
  - 4Mbyte stores up to 1,392,300 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 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 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™ and compatibles.
- Getting Started Manual and User's Manual.
- DeTransfer, DePlot and DeLogger software packages for Windows.

### 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.
- 1, 2 and 4 Mbyte PC Card (PCMCIA) memory cards.
- Memory card reader; connects to computer via serial port.
- Modem Manager for intelligent supervision of remote modems.
- Telephone, cellular and spread spectrum radio modems
- DeLogger Pro software package for Windows.

## Appendix — Specifications (cont.)

### Channel Expansion Module



The Channel Expansion Module connects to **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. All input signals and sensors supported by the **dataTaker** are 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 **dataTaker**
  - SIC - 1 **dataTaker** plus 2 CEMs, or three **dataTaker**
- 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 — Accuracy of the *dataTaker* Data Loggers

ABSOLUTE ACCURACY										
Range	Full Scale	Units	Resolution	Units	Tolerance at 25°C			Tolerance -20 to 70°C		
					% of Full Scale	Plus Offset	Units	% of Full Scale	Plus Offset	Units
<b>VOLTAGE</b>										
100V ▲	642	V	28.0	mV	±0.26%	±150	mV	±0.31%	±150	mV
70V ▲	64.2	V	2.8	mV	±0.26%	±14	mV	±0.31%	±14	mV
7V ▲	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
<b>RESISTANCE</b>										
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
<b>RESISTANCE, 3-Wire Compensation (Lead Resistance 10Ω)</b>										
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
<b>CURRENT</b>										
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
<b>FREQUENCY</b>										
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
<b>TIME</b>										
	24	hrs	1	sec	0.03 sec per day 0.78 sec per month			6.3 sec per day 3.16 min per month		
<b>TEMPERATURE (LM35)</b>										
		°C	0.013	°C	±0.00%	±1.5	°C	±2.00%	±1.5	°C
<b>THERMOCOUPLES, Reference Un-Trimmed ◆</b>										
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
<b>THERMOCOUPLES, Reference Trimmed ◆</b>										
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
<b>RTDs, 3-Wire</b>										
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.

ABSOLUTE ACCURACY										
Range	Full Scale	Units	Resolution	Units	Tolerance at 25°C			Tolerance -20 to 70°C		
					% of Full Scale	Plus Offset	Units	% of Full Scale	Plus Offset	Units
<b>RTDs, 4-Wire</b>										
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
<b>BRIDGES, FULL, Voltage</b>										
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
<b>BRIDGES, FULL, Current</b>										
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
<b>BRIDGES, HALF-, Current</b>										
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

### 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.



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