

Matthew Bros bitumen spray truck uses *dataTaker* data logger system

The data logging system is based on a *dataTaker DT50* data logger, a small low power data logger that has 5 analog channels, 5 digital state channels, and 3 digital counter channels. The data is stored in a removable memory card that is inserted into the logger. Two 4 MB memory cards were supplied with the system.

The data stored on the memory cards is downloaded to a computer for analysis and archiving using a *dataTaker MCI-04* Memory Card Interface, which is also supplied with the system.

The logger is installed in the truck cabin in a protective enclosure. All power and signal wires are routed into the enclosure in protective conduits.

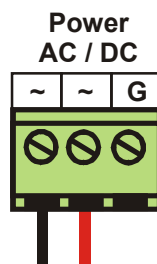
The data logger is specifically programmed for the task, and the program is stored in non-volatile flash memory in the logger. When the logger is powered up, the program executes automatically – the logger never needs to be programmed unless program changes are required. If the program needs to be changed, then the complete new program must be ‘burned’ into the flash memory - the existing program cannot be edited in-situ. Programs are burned into and erased from flash memory using the DeLoad™ utility that is provided on the Resources CD supplied with the logger. Refer to the DeLoad Manual for details of the procedures.

The *dataTaker* data logger does not require direct operation by the driver – the data logging process is initiated by the same switch that the driver uses to begin spraying, and is stopped by the same switch that the driver uses to stop spraying.

Powering of the Data Logger

The data logger is powered directly from the truck 24VDC battery. The data logger is permanently powered, however if loss of power does occur the program is protected in the non-volatile flash memory, and any stored data is protected in the non-volatile memory cards.

Power is connected to the logger via the Power AC/DC ~ and ~ terminals on the top of the logger. The polarity does not matter.



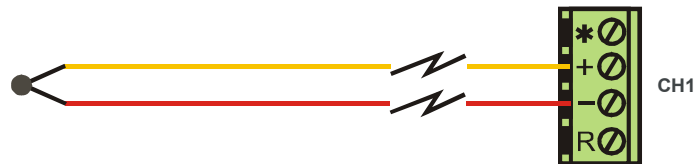
The data logger has a 0.5 Amp Hour internal battery, which will power the logger approximately 4 hours if actively collecting data, and for weeks if inactive.

Sensors

The sensors that are installed around the truck and are connected to the data logger are as follows:

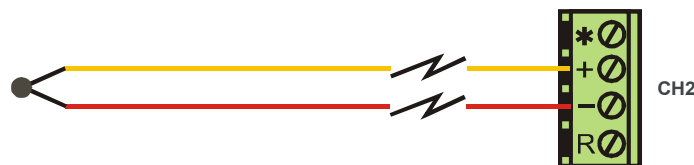
1. Air Temperature Sensor – a Thermocouple Type K installed immediately below the exterior front cowling of the truck, to measure the air temperature at the start of each bitumen-spraying run.

This sensor is connected to analog channel 1 of the logger as follows



2. Bitumen Temperature Sensor - a Thermocouple Type K installed in the bitumen tank, to measure the temperature of the bitumen at the start of each bitumen spraying run.

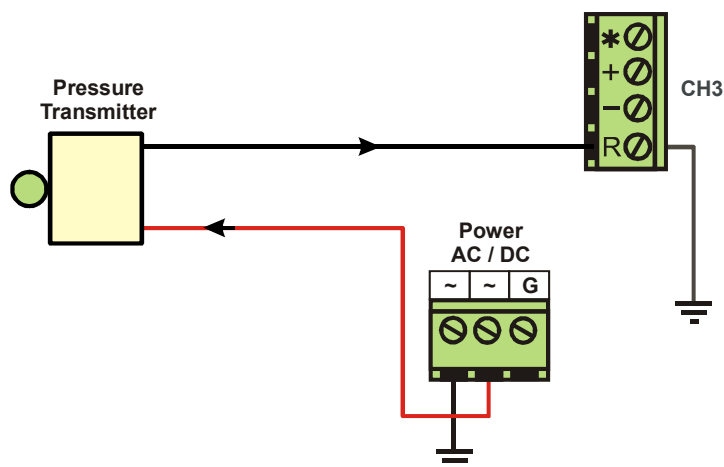
This sensor is connected to analog channel 2 of the logger as follows



3. Spray Bar Pressure Sensor – this pressure sensor is mounted in the spray bar at the rear of the truck. Spray bar pressure is measured every second during spray runs.

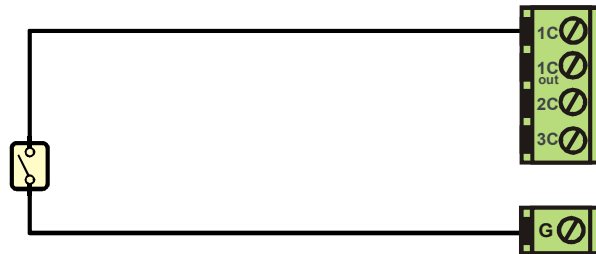
The pressure sensor has a 4-20mA current loop output signal, representing 0 – 10 Bar or 0 – 1000 kPa of pressure.

The sensor loop power is provided from the 24VDC truck battery, and taken from the power supply input of the logger. The sensor is connected to analog channel 3 as follows



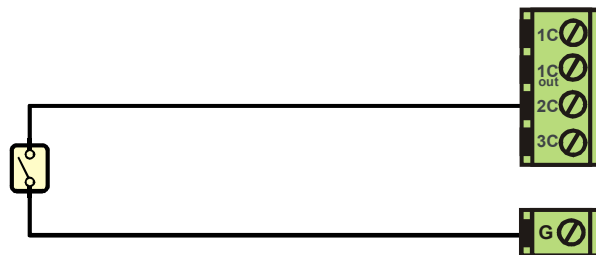
4. Bitumen Pump RPM – a digital pickup sensor mounted over a 60-tooth gear wheel on the pump drive shaft. The sensor returns 60 pulses per revolution, and the RPM at the end of each second is $1/60 * 60 = 1$ RPM. The bitumen pump RPM is measured every second during spray runs.

The sensor is connected to High Speed Counter channel 1 as follows:



5. Engine RPM - a digital pickup sensor mounted over the 145-tooth ring gear in the bell housing at the rear of the engine. The sensor returns 145 pulses per revolution, and the RPM at the end of each second is $1/145 * 60 = 0.414$ RPM. The engine RPM is measured every second during spray runs.

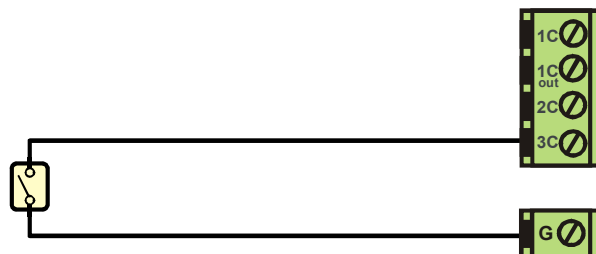
The sensor is connected to High Speed Counter channel 2 as follows:



Note: Input frequency is >1 KHz, and so removed capacitor from counter input.

6. Road Speed - a digital pickup sensor mounted over a gear wheel on the output shaft from the truck transmission gearbox. The sensor returns 23856 pulses for 100 metres of travel, or each pulse represents 0.0042 meters of travel. The engine RPM is measured every second during spray runs.

The sensor is connected to High Speed Counter channel 3 as follows:

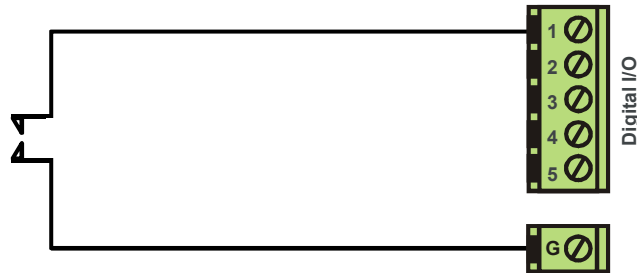


Note: Input frequency is >1KHz, and so removed capacitor from counter input.

Controlling Data Logging

The logging of data from the sensors is controlled by the **SPRAY ON** and **SPRAY OFF** push buttons on the driver's panel beside the steering wheel. This provides a voltage free contact closure input to the data logger, which is normally closed. Pressing the **SPRAY ON** button activates the data logging relay and opens the contacts. Pressing the **SPRAY OFF** button deactivates the data logging relay and closes the contacts.

The voltage free contact closure is input to digital channel 1 of the data logger as follows:



The digital inputs of the *dataTaker DT50* would seem to be the reverse of what would be expected. When the relay contacts are open an internal pull-up resistor forces the channel to +5VDC and the logger reads the channel as logic 1. When the relay contacts are closed the channel is forced to ground and the logger reads the channel as logic 0.

Internal Counters

Two internal software counters are used as follows

1. Run Number – this counter begins at zero, and is incremented by 1 each time the **SPRAY ON** button is pressed. The Run Number is logged into the memory card at the beginning of each run, and is used in combination with the date to identify each run on each day of operation.

The Run Number counter is reset to zero each midnight, so that the first run each day is Run Number 1.

2. Elapsed Spray Time – this counter is set to zero when the **SPRAY ON** button is pressed, and is incremented each second during a spray run. The Elapsed Spray Time is logged each second along with the sensor data for that second.

Real Time Clock

The data logger has a real-time clock calendar that will run for approx 5 years on an internal lithium battery. The real-time clock calendar is used to date stamp and timestamp each record of data, and to clock the repetitive collection of data.

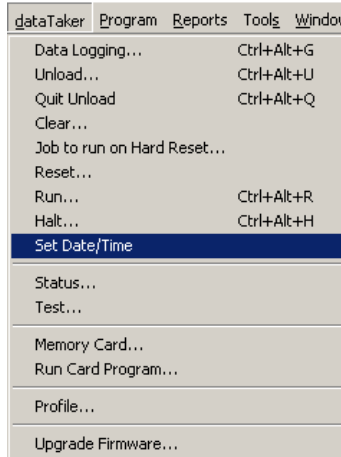
At installation the real time clock was set to Daylight Saving Time for Melbourne. To change the time and /or date of the real-time clock, a computer running DeTransfer™ or DeLogger™ 4 must be connected to the RS232 port, and the clock set by command.

Using DeTransfer™, the real time clock is set by the commands

D=\d
T=\t

Which sets the data logger clock to the same setting as the computer clock.

Using DeLogger™, the real time clock is set by pulling down the **dataTaker** item on the main menu bar, and selecting Set Date/Time as follows:



This also sets the data logger clock to the same setting as the computer clock.

The Data Logger Program

The data logger program is listed below for reference. Follow the comments and refer to the *DT50 Users Manual* to understand how the program works.

```
'Bitumen Sprayer Program  
'Matthew Brothers Pty Ltd  
'November 2004  
,  
BEGIN  
'Enable Timestamps  
/D/T  
'Force returns  
/Y  
  
'Bar Pressure Calibr  
S1=0,1000,4,20"KPa"  
'Pump RPM Calibr  
Y10=0,1"RPM"  
'Engine RPM Calibr  
Y11=0,0.414"RPM"  
'Road Speed Calibr  
Y12=0,0.0042"m/sec"  
'Elapsed Time Units  
Y13=0,1"secs"  
  
'Initialize Accumulators  
1CV(W)=0  
10CV(W)=0
```

```

'SPRAY ON Pressed
RA1+E
'Increment Run Number
10CV("Run Number",FF0)=10CV+1
'Reset Elapsed Spray Timer
1CV(W)=0
'Read Temperatures
1TK("Air Temp")
2TK("Bitumen Temp")

'Collect Data During Run
RB1S:1W
'Increment Elapsed Spray Timer
1CV("Elapsed Time",Y13,FF0)=1CV+1
'Spray Bar Pressure
3#I("Bar Pressure",S1,FF2)
'Pump RPM
1HSC("Pump RPM",R,Y10,FF2)
'Engine RPM
2HSC("Engine RPM",Y11,FF2)
'Road Speed
3HSC("Road Speed",R,Y12,FF2)

'SPRAY OFF Pressed
RC1-E

'At Midnight
RD1D
'Reset Run Number
10CV(W)=0

END

LOGON

```

The program is stored in non-volatile flash memory in the data logger. When the logger is powered up, the program executes automatically – the logger never needs to be programmed unless program changes are required. If the program needs to be changed, then the complete new program must be ‘burned’ into the flash memory - the existing program cannot be edited in situ. Programs are burned into and erased from flash memory using the DeLoad utility that is provided on the Resources CD supplied with the logger. Refer to the DeLoad Manual for details of the procedures.

The Memory Cards

The memory cards are plugged into the Memory Card socket on the top of the logger. The cards are plugged in with the label outwards.

The 4 MB cards can store approximately 1.4 million data values. During a run the data logger stores 6 data values per second to the memory card. Therefore the card can store data from approximately 230,000 seconds, or 770 runs of 5 minutes duration.

The memory card can be removed from the logger at any time, even during a run if necessary. If the logger needs to store data while there is no memory card in the socket, then the data is

stored into internal memory and will be automatically written to a memory card when one is next plugged in.

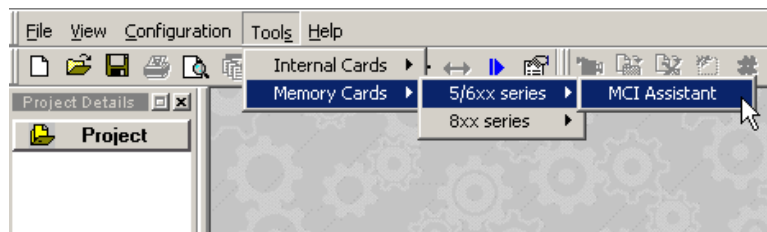
When the data has been downloaded from the memory card (see below), the memory card **MUST** be cleared of data before plugging back into the data logger.

The internal memory can store approximately 166,000 data values, and so can store data from approximately 27,000 seconds, or 92 runs of 5 minutes duration. Several days of data can be logged into internal memory if a memory card is unavailable, and can be collected simply by plugging a blank memory card in at a later time.

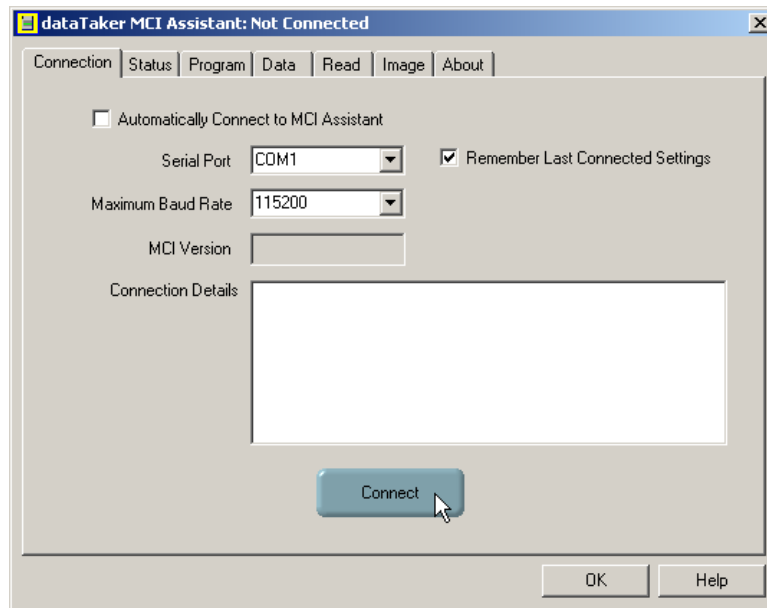
Downloading Data into a Computer

Data is downloaded from the memory cards into a computer using the MCI-04 Memory Card Interface supplied. The procedure is as follows:

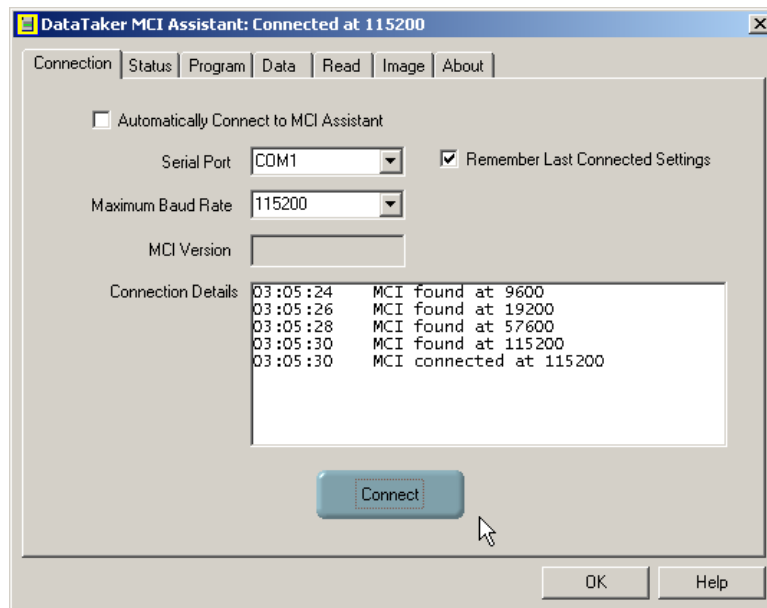
1. Power the Memory Card Interface. The Memory Card Interface has an internal battery, and can be powered either from the adaptor, or from the internal battery in field situations. The internal battery is automatically recharged when the external power is connected.
2. Connect the serial cable between the RS232 interface of the Memory Card Interface and any COM port on the computer, usually COM 1.
3. Run DeLogger on the computer, and close the first dialog asking if you want to Start New Project or Open Existing Project – downloading data from the memory card is not a project related task.
4. Click Tools on the Main Menu Bar, and select Tools | Memory Cards | 5/6xx series | MCI Assistant



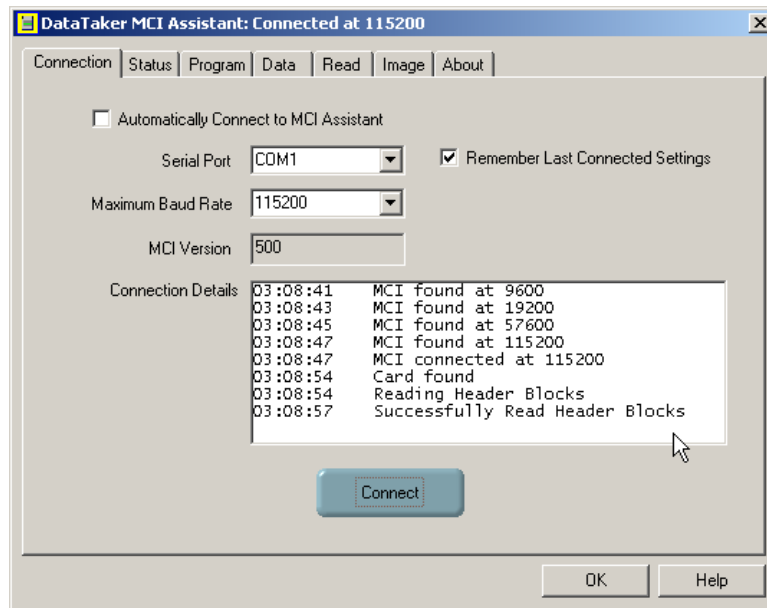
This will open the first dialog for MCI Assistant



5. Select the COM port that the Memory Card Interface is connected to, then click the Connect button at the bottom. MCI Assistant will then connect to the interface at the fastest baud rate possible, and the progress is shown in the Connection Details field.

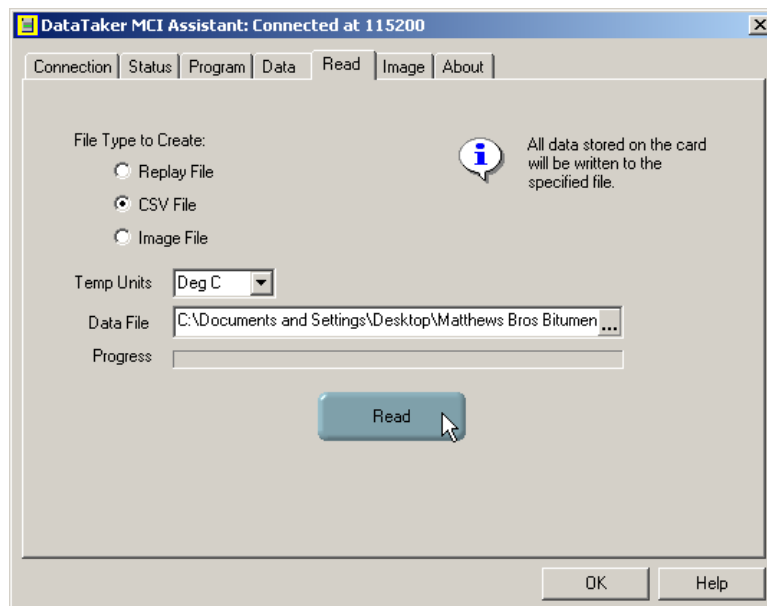


6. Insert the memory card to download into the Memory Card Interface. The Memory Card Interface will automatically detect the card, and read the header blocks.



7. Click on the Data Tab to preview the amount of data and the time spread of data in the memory card.

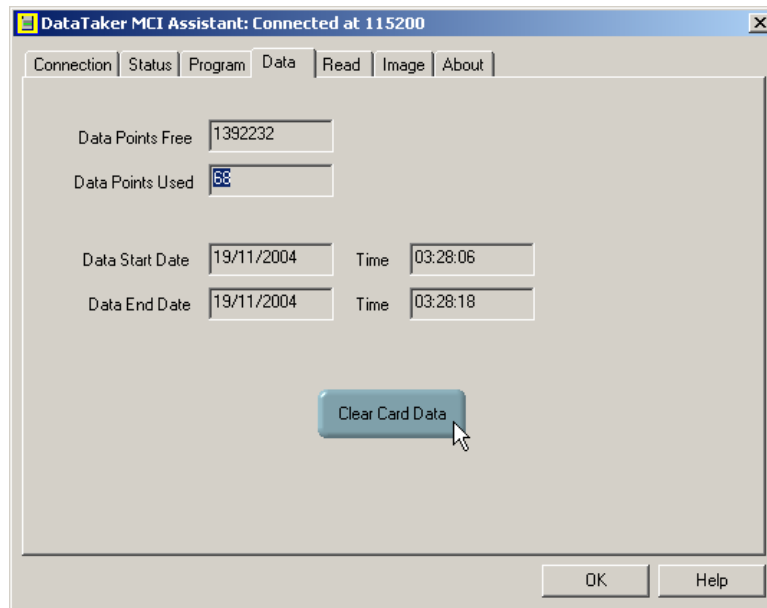
8. Click on the Read Tab. Select CSV File Type, then click on the browse button at the end of the Data File field and enter the folder and filename for the file to receive the data. Click on the Read button to read the data from the memory card.



The download process is reasonably slow, and may take 30-40 minutes to download data from a 4MB memory card.

9. When the data is downloaded, and you are satisfied that you have a good copy of the data in file, then the memory card must be cleared before using again.

Click on the Data Tab again, and click on the Clear Card Data button to clear



Wait for the memory card to be cleared, and ensure the fields on this dialog box are reset to zero or initial values.

10. Click on the OK button of Close box to quit the session of MCI Assistant, and then quit DeLogger.

The Data File

The CSV data file produced by downloading the data from a memory card has the following format for each run:

```

Run Number      Air Temp      Bitumen Temp
19 Nov 2004,03:45:49,4,15.6,15.5
19 Nov 2004,03:45:50,1,615.5,65.23,1203.33,0.34
19 Nov 2004,03:45:51,2,611.4,65.12,1219.20,0.32
19 Nov 2004,03:45:52,3,612.8,65.09,1217.77,0.33
19 Nov 2004,03:45:53,4,599.6,65.11,1208.45,0.35
19 Nov 2004,03:45:54,5,601.2,65.19,1209.73,0.34
19 Nov 2004,03:45:55,6,598.1,66.01,1203.58,0.34
19 Nov 2004,03:45:56,7,610.0,65.88,1200.39,0.35
19 Nov 2004,03:45:57,8,609.8,65.65,1199.23,0.34
19 Nov 2004,03:45:58,9,601.4,65.70,1205.92,0.32
19 Nov 2004,03:45:59,10,599.9,65.44,1209.86,0.33
Elapsed time (secs)  Spray Bar Press (Kpa)  Pump RPM  Engine RPM  Road Speed

```

The CSV data files can be opened directly in Microsoft Excel.

Viewing Data in Real Time

Data can be viewed in real time during spray runs if desired, by connecting a computer running DeTransfer (supplied on the Resources CD supplied with the data logger) to the data logger's RS232 Comms connector. Viewing data in this way does not disrupt saving the data to the memory card as well.