User manual
Strainbuster V0.0

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1 Introduction

There is an increasing tendency to investigate the behavior of large constructions under varying load conditions. Examples are: bridges, wind turbines, tower cranes, etc. Usually it is quite inconvenient to apply half- or full straingauge bridges onto such constructions, for which reason mostly single (1/4 bridge) gauges are utilized. This, however, usually implies cumbersome wiring to the inputs of the (remote) measuring amplifiers.
STRAINBUSTER has been developed to overcome these problems by placing the measuring circuit in the direct vicinity of each point of measuring. Here all signal conditioning is done, after which all measured values are being transported via a CAN bus to one convenient central place, thus building one decentralized system. In this way, up to 120 measured values can be transported very reliably over longer distances.
One STRAINBUSTER module has 2 separate input channels.
The single straingauge, or the Pt100 sensor, is connected through a 3-wire connection, eliminating cable losses at the input side.
The CAN bus speed can be set between 10 and 1000Kbit/sec, allowing a maximum network cable length of some 30 meters at 1000 Kbit/sec and 5 Kilometers at 10 Kbit/sec when the correct cable is being used. Each module has 2 identical sets of CAN bus connection terminals, to enable easy installation of a so-called Daisy Chain Network.
A maximum of 60 units can be connected to one bus.

1.1 Principle of operation

A simplified block schematic diagram gives an idée of how the Strainbuster unit is build.

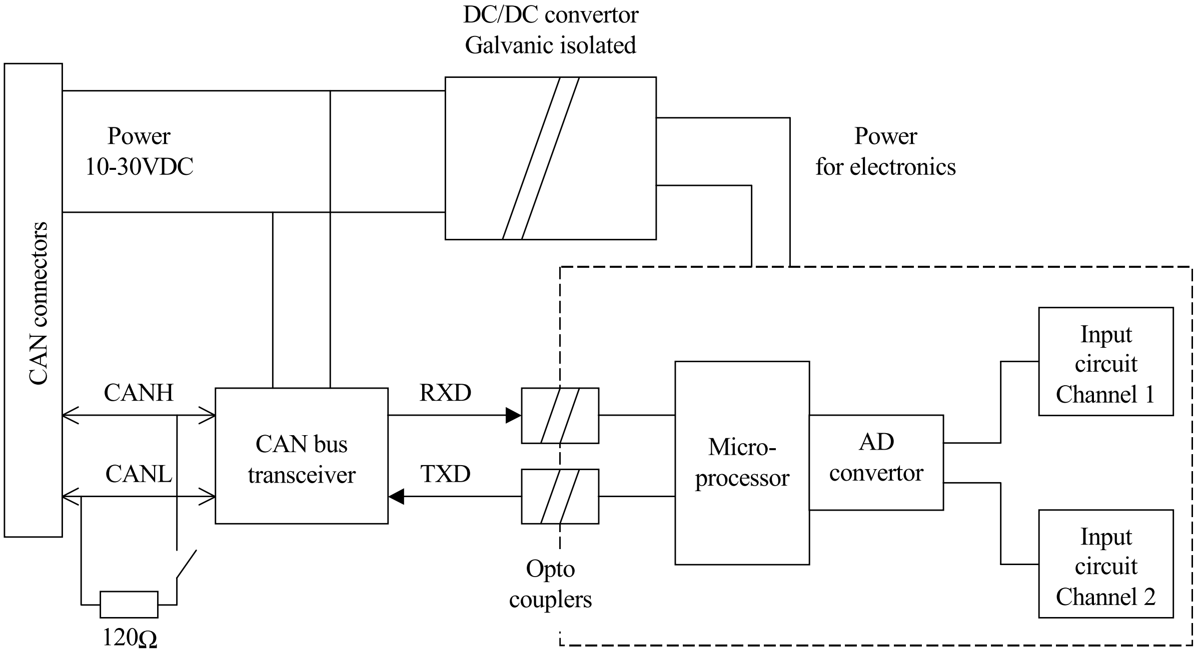


Figure 1-1: **Block schematic diagram**

Essential in the Strainbuster is that the measurement electronics is galvanic separated from the CAN bus and the power which is connected to the connector. The two input channels are not galvanic separated to each other.
Due to this build-up multiple Strainbuster units can be connected to the same power supply, without any problems that all the input channels are, galvanic, connected to each other.
A simple terminator resistor is mounted on the Strainbuster. If other termination is required, this must be done on the connector.

2 Strainbuster configuration

The operation of the Strainbuster depends on several settings. By changing these settings the user can influence the operation of the Strainbuster.
The settings are made by software through the CAN bus and by jumpers on the Strainbuster.
The following settings can be made by software:

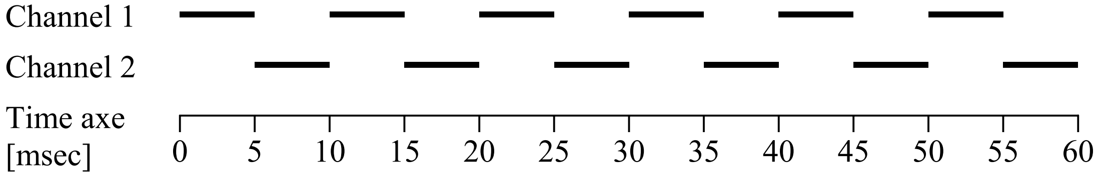
Type of measurement:	
	Quarter bridge
	PT100 temperature
	Full bridge
	DC input

	Quarter bridge	PT100 temp.	Full bridge	DC input
Gain setting:	+/- 5000 um/m		-1 - +1 mV/V	- 2.5 - +2.5 mV
	+/- 20000 um/m		-4 - + 4 mV/V	-10 - +10 mV
	+/- 100000 um/m	-90 - +110 °C	- 20 - +24 mV/V	-50 - +60 mV
		-100 - +300 °C	-40 - +72 mV/V	-100 -+180 mV

2.1 Measurement speed

The measurement speed can be set between 10msec and 1 second, is steps of 10 mseconds.
At maximum speed both the channels are measured every 10 msec. This measured value is an average of four values measured direct after each other. The total duration of these 4 measured values is 5 msec.
When the measurement speed is decreased, more values will be used to determine the average. So still both the channels will be measured every 10 msec, but these values will be used to calculate an average over the measurement time.

Assume a measurement speed of 50 msec



During the fat lines a channel is measured. After 50 milli seconds an average value is calculated for each channel.

2.2 Automatic measurement

Each 10 mille seconds both the channels are measured by the Strainbuster. When a values is requested through the CAN bus the latest average value is read.

It is also possible to set the Strainbuster is a “Auto send” mode. When this mode is active, the Strainbuster will send its channel values after each measurement period. So when this period is set at 60 msec, every 60 mille seconds both the average channel values will be send over the CAN bus.

It is the responsibility of the receiving unit, to handle al those channel values. When more Strainbuster units are present on the CAN bus, the load on the CAN bus will get higher when the measurement interval is shorter. This can result in a load which is too high, or even 100%. In this case the Strainbuster units with the lowest priority (that is with the highest address) will not be able to send there channel values on the bus.

2.3 CAN bus dip switch settings

On the Strainbuster several jumpers and dipswitches are present.

The dipswitches are used to set the node address on the CAN bus and the speed of the CAN bus.

The CAN bus speed is set by S3:

S3-1 On	S3-2 On	S3-3 On	CAN bus speed		Maximum cable length
			1000 Kb/sec		30 m
		X	800 Kb/sec		50 m
	X		500 Kb/sec		100 m
	X	X	250 Kb/sec		250 m
X			125 Kb/sec		500 m
X		X	50 Kb/sec		1000 m
X	X		20 Kb/sec		2500 m
X	X	X	10 Kb/sec		5000 m

Just for reference the maximum cable length is mentioned in this table.

When switch 4 of S3 is in the **‘ON’** position, the internal termination resistor of 120 Ω is connected to the CAN bus lines.

The CAN address is set by S1 & S2:

	ON	OFF		
S1/S2-7			**1**	**LSB**
S1/S2-6			**2**	
S1/S2-5			**4**	
S1/S2-4			**8**	
S1/S2-3			**16**	
S1/S2-2			**32**	
S1/S2-1			**64**	**MSB**

This address is binairy coded, when switch is in the **’ON’** position the corresponding bit is **‘1’**. Switch 7 is the **L**east **S**ignificant **B**it of the address.

The switches are mounted on the printed circuit board in the following way:

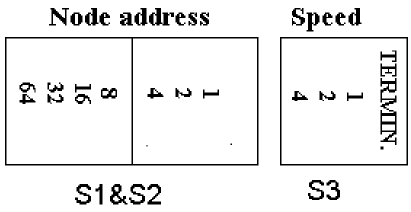


Figure 2-1: Layout dip switches

2.4 Input jumper settings

The bridge compensation of the input circuit can be altered by setting a jumper. The type of measurement is determined by the jumper setting. The following settings can be made:

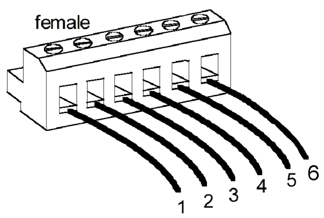
type of Measurement:	Channel 1	Channel 2
Full Bridge	none	none
Quarter bridge 350 Ω	JP6 & JP4	JP3 & JP1
PT100	JP6 & JP5	JP3 & JP2

3 Measurement input

3.1 Measure connector

On the other site of the Strainbuster there are two 6 pins connectors present. Those are the connectors for the connection of the input signals

The cable will be connected to the counter part of this connector. The numbering of the connector pins is shown on the next picture:



1	Screen
2	Gnd
3	-Vin
4	+Vin
5	¼ bridge
6	Vexc.

Figure 3-1: Input connector pinout

The bridge supply is present on pin 2 and 6 on the connector. This is 2.5VDC, with a maximum output current of 20 mA. (min impedance 120 Ω).
On pins 3&4 the differential input is measured. In case of jumpering to a half and/or quarter bridge, pin 3 will hold the voltage of the mid point of the internal half bridge.

At a quarter bridge measurement the internal complementation resistor is connected to pin 5 of the connector.

When a screened cable is used, the screen can be connected to pin 1. This pin is connected on the PCB at pin 1 & 3 of the Can bus connector.

For each input channel a separate input connector is present.

Signal connections:

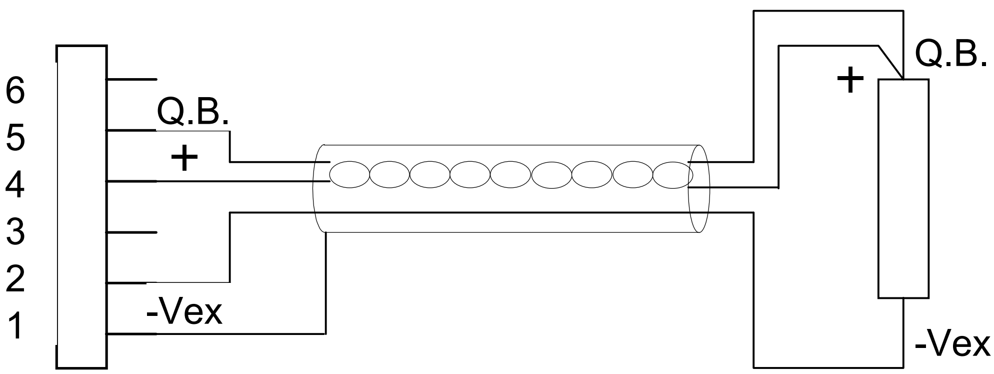


Figure 3-2: Quarter bridge connection

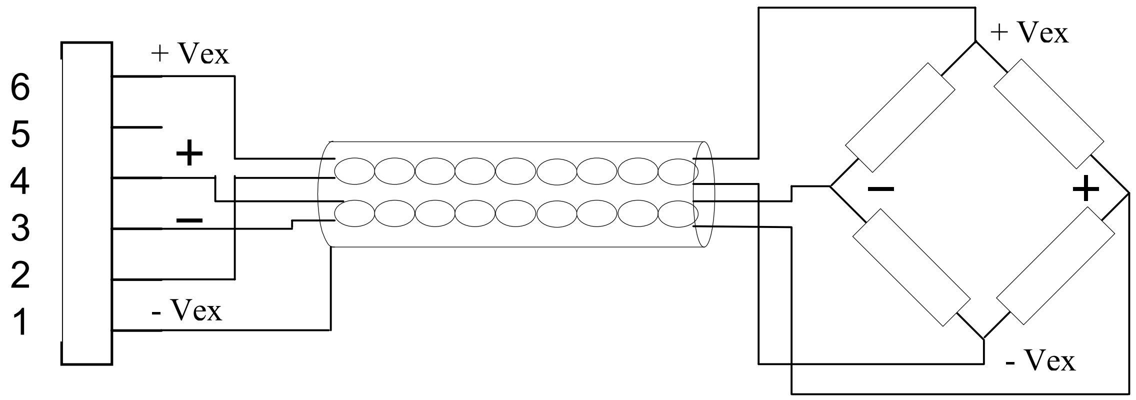


Figure 3-3: Full bridge connection

4 CAN bus communication

For the communication between the PC and the Strainbuster nodes, the CAN bus is used. This bus can be used with high speed over a short distance or with low speed over a long distance.
The maximum CAN bus speed depends on the total cable length and the cable specifications.
On the other side the CAN bus speed will limit the measuring speed of the Strainbuster node.

4.1 Bus speed versus Measure interval

As mentioned before the CAN bus speed will limit the maximum number of channel values it can transfer every second.
The next table gives an idea of the number of channels which can be supported at different CAN bus speeds and measurement speeds:

CAN bus speed	Maximum cable length	Measurement speed			
		100 Hz	20 Hz	10 Hz	1 Hz
1000 kbit /s	30 m	91 channels	120 channels	120 channels	120 channels
800 kbit/s	50 m	73 channels	120 channels	120 channels	120 channels
500 kbit /s	100 m	45 channels	120 channels	120 channels	120 channels
250 kbit /s	250 m	22 channels	110 channels	120 channels	120 channels
125 kbit /s	500 m	11 channels	55 channels	110 channels	120 channels
50 kbit /s	1000 m	4 channels	22 channels	54 channels	120 channels
20 kbit /s	2500 m	1 channels	9 channels	18 channels	120 channels
10 kbit /s	5000 m	0 channels	4 channels	9 channels	90 channels

In the gray area the channel count is 120. The limit here is not the CAN bus speed, but the number of nodes connected to the CAN bus. At maximum this is 60 nodes.
In the above table a CAN bus load is at maximum 80%. This is possible when there are only a few bus errors. The CAN bus will respond with error frames when those error occur. There must be room in time on the bus to send these frame.

If the CAN bus load is to high, caused by bus error(s) or just too much channel values (say 100 channels at 1000KB/sec), the Strainbuster nodes with the lowest priority will not be able to send there channel values. On the receiving device (mostly a PC) this is seen as missed channel values.
In this case the CAN bus load must be made smaller. This can be done by one or more of the following actions:

- Increase CAN bus speed (beware of the maximum cable length!!)
- Set measurement speed at a lower rate
- decrease the number of channel.

4.2 CAN bus termination

The cables, connectors, and termination resistors used in the CAN network must meet the requirements defined in ISO 11898. In addition, here are given some guidelines for selecting cables and connectors.

The table below shows some standard values for DC parameters for this network:

Bus length [m]	Bus cable (1)		Termination resistance [Ω]	Baudrate [Kbit/s]
	Length-related resistance [mΩ/m]	Cross-section [mm^2]		
0 ... 40	70	0.25...0.34	124	1000 at 40 m
40 ... 300	<60	0.34...0.6	150 ... 300	>500 at 100 m
300 ... 600	<40	0.5... 0.6	150 ... 300	>100 at 500 m
600 ... 1000	<26	0.75...0.8	150 ... 300	>50 at 1 km

(1)Recommended cable AC parameters:

- 120-W impedance
- 5-ns/m specific line delay

For drop cables a wire cross-section of 0.25 to 0.34 mm^2 would be an appropriate choice in many cases.

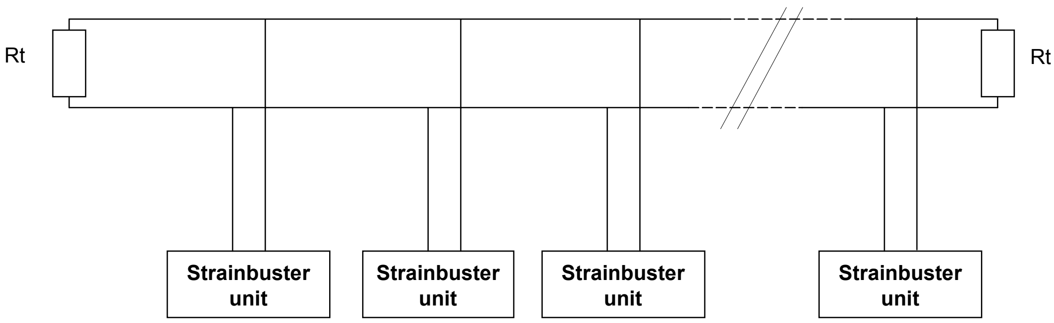


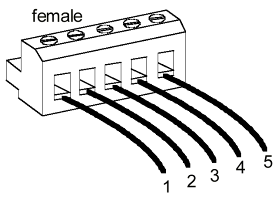
Figure 2: normal CAN bus layout

note: Rt is bus termination resistor with a value of 120Ω

4.3 CAN bus connector

On one site of the Strainbuster there are two 5 pins connectors present. Those are the connectors for the connection of the power and CAN bus signals.

The cable will be connected to the counter part of this connector. The numbering of the connector pins is shown on the next picture:



1	Ground
2	CAN L
3	screen
4	CAN H
5	+10-30V

Figure 4-1: CAN bus connector pinout

The two 5 pin connectors are connected pin by pin on the printed circuit board. In this way an simple daisy chain connection can be made.

4.3.1 Strainbuster – CAN cable

To connect the Strainbuster to the CAN interface, a special cable must be used. The CAN interfaces Peekel Instruments deliver are all using the connector pinout defined by CAN OPEN.
This cable must have the following connections:

Strainbuster	Description	Sub D9 female
1	Gnd	
2	CAN L	2
3	Gnd	3
4	CAN H	7
5	+10-30V	

Figure 4-2: Strainbuster CAN Cable connection

5 Specifications

General
Linearity accuracy: < 0.1%
Bandwidth (-3dB): 20 Hz
Sample rate: 100 samples / second / channel
Operating temperature: -20 °C...+50 °C
Max. sensor cable length: 3 m
Bridge supply:2.5V(fixed), +/- 0.1%

Measuring input (2 for each module)
Galvanically separated from CAN bus
and power supply

- 3-wire single 350W strain gauge
- 3-wire Pt100 temp. sensor
- 4 wire full bridge

On-board microcontroller
A/D converter resolution: 18 bits

Communications
1 x CAN interface
Bus speed selectable between 1 Mbit/sec and 10Kbit/sec
Power supply 24 V DC, 1,6 VA
Housing dimensions 30 x 105 x 68 (mm, h x l x w)