

Technical manual for

# HP8451

6 channel analog to CAN (mode = 0)

or

6/8 key inputs to CAN (mode = 1)

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## 1) CAN bus protocol

CAN bus speed = 500 Kbit or 1Mbit/s (default= 1Mbit/s)

## 2) Analog conversion specifications

### 2.1.1) Channel 1..4

Range	: 0..5V
Internal sample rate (4 channels)	: 260us / 3,84KHz
Resolution	: 10bit (LSB= 4,9mV)
Accuracy	: +/-4%.
Input impedance, channel 1+3	: > 1M Ohm.
Input impedance, channel 2+4	: 4,7k Ohm pull-up to +5V.
Input capacitance	: < 50pF (approx.)
Average filter	: 1..4095 samples (up to 1 second).
Readout on CAN bus	: [mV].

### 2.1.2) Channel 5+6

Range	: 0..15,6V
Internal sample rate (2 channels)	: 520us / 1,92KHz
Resolution	: 10bit (LSB= 15,3mV)
Accuracy	: +/-5%.
Input impedance	: 14,7k Ohm
Input capacitance	: < 15pF approx.
Average filter	: 19..4863 samples (10ms to 2,5 sec.).
Readout on CAN bus	: [mV].

## 2.2) CAN setup message (to HP8451)

CAN ID= 0x0FF0001 (fixed, extended CAN ID)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	CAN bus sample rate for channel 1..4. Low byte.							
1	CAN bus sample rate for channel 1..4. High byte.							
2	CAN bus sample rate for channel 5 + 6.							
3	CAN output base ID. Low byte.							
4	CAN output base ID. Mid byte 1.							
5	CAN output base ID. Mid byte 2.							
6	CAN output base ID. High byte.							
7	Default settings	Word format	Mode			CAN bus speed		

Sample rate for channel 1..4: Samples between each readout to CAN bus in [260us] step.

Example 100 -> Readout each  $100 * 260\mu s = 26ms$ .

Default 38 (=9,9ms).

Note: In Analog mode 2, only the following values are allowed: 1, 2, 4, 8, 32, 64, 128, 256, 512, 1024, 2048, and 4096.

Sample rate for channel 5 + 6: Samples between each readout to CAN bus in [9,9 ms] step

Example 100 -> Readout each  $100 * 9,9ms = 990ms$

Default 50 (=494ms)

Note: In Analog mode 2 the steps are [8,32ms] and only the following values are allowed: 1, 2, 4, 8, 16, 32, 64, 128.

CAN output base ID

Base ID for transmitting analog values to CAN bus.

Channel 1..4 send at ID + 0

Channel 5 + 6 send at ID + 1

If base ID below 0x800 Standard ID used.

If base ID 0x800 or above Extended ID used.

Default 0x460

CAN bus speed

1= 1 Mbit

2= 500 Kbit

3= 250 Kbit.

Mode

0= 6 analog inputs, read out in [mV] (default mode).

1= 6 key input mode.

2= 6 analog inputs, full range = 0xFFFF.

Word format

Format for analog output:

0= Low byte, High byte (default).

1= High byte, low byte.

Default

1= Reset all settings to default factory.

2.2.1) Setup example using “WGSoft.de – CAN Monitor Pro Ver. 2.2”

Data #	0	1	2	3	4	5	6	7
Field	Sample rate Channel 1..4		Sample rate channel 5 + 6	CAN base ID			Mode & Speed	
Setting	9,9ms		990ms	Analog channel 1..4 Analog channel 5 + 6			500h 501h	Analog 1MBit
Value(hex)	<b>26</b>	<b>00</b>	<b>32</b>	<b>00</b>	<b>05</b>	<b>00</b>	<b>00</b>	<b>01</b>

Screen dump from “WGSoft.de – CAN Monitor Pro Ver. 2.2”:

The screenshot shows a 'Send Message' dialog box with the following fields and values:

- CAN ID:** 00FF0001
- DLC:** 8
- Data:** 26 00 32 00 05 00 00 01
- Extended:**  Extended
- RTR:**  RTR
- Send Button:** Send

## 2.2.2) Setup examples, analog mode

Data #	0	1	2	3	4	5	6	7
Field	Sample rate Channel 1..4		Sample rate channel 5 + 6	CAN base ID			Mode & Speed	
Setting	260us		990ms	Analog channel 1..4 Analog channel 5 + 6			500h 501h	Analog 1 1Mbit
Value(hex)	<b>01</b>	<b>00</b>	<b>32</b>	<b>00</b>	<b>05</b>	<b>00</b>	<b>00</b>	<b>01</b>

Data #	0	1	2	3	4	5	6	7
Field	Sample rate Channel 1..4		Sample rate channel 5 + 6	CAN base ID			Mode & Speed	
Setting	1,04ms		990ms	Analog channel 1..4 Analog channel 5 + 6			500h 501h	Analog 1 1Mbit
Value(hex)	<b>04</b>	<b>00</b>	<b>32</b>	<b>00</b>	<b>05</b>	<b>00</b>	<b>00</b>	<b>01</b>

Data #	0	1	2	3	4	5	6	7
Field	Sample rate Channel 1..4		Sample rate channel 5 + 6	CAN base ID			Mode & Speed	
Setting	4,94ms		49,5ms	Analog channel 1..4 Analog channel 5 + 6			510h 511h	Analog 1 1Mbit
Value(hex)	<b>13</b>	<b>00</b>	<b>04</b>	<b>10</b>	<b>05</b>	<b>00</b>	<b>00</b>	<b>01</b>

Data #	0	1	2	3	4	5	6	7
Field	Sample rate Channel 1..4		Sample rate channel 5 + 6	CAN base ID			Mode & Speed	
Setting	1,04ms		990ms	Analog channel 1..4 Analog channel 5 + 6			100000h 100001h	Analog 1 500Kbit
Value(hex)	<b>04</b>	<b>00</b>	<b>32</b>	<b>00</b>	<b>00</b>	<b>10</b>	<b>00</b>	<b>00</b>

Data #	0	1	2	3	4	5	6	7
Field	Sample rate Channel 1..4		Sample rate channel 5 + 6	CAN base ID			Mode & Speed	
Setting	1,04ms		990ms	Analog channel 1..4 Analog channel 5 + 6		100000h 100001h	High, low byte Analog 1 500Kbit	
Value(hex)	<b>04</b>	<b>00</b>	<b>32</b>	<b>00</b>	<b>00</b>	<b>10</b>	<b>00</b>	<b>40</b>

Data #	0	1	2	3	4	5	6	7
Field	Sample rate Channel 1..4		Sample rate channel 5 + 6	CAN base ID			Mode & Speed	
Setting	1,04ms		990ms	Analog channel 1..4 Analog channel 5 + 6		100000h 100001h	High, low byte Analog 2 500Kbit	
Value(hex)	<b>04</b>	<b>00</b>	<b>32</b>	<b>00</b>	<b>00</b>	<b>10</b>	<b>00</b>	<b>50</b>



### 2.2.3) Setup examples, keyboard mode

Data #	0	1	2	3	4	5	6	7
Field	<i>Sample rate Channel 1..4</i>		<i>Sample rate channel 5 + 6</i>	CAN base ID			Mode & Speed	
Setting	<i>Not used</i>		<i>Not used</i>	Key 1..8			502h	Analog 1MBit
Value(hex)	<b>00</b>	<b>00</b>	<b>00</b>	<b>00</b>	<b>05</b>	<b>00</b>	<b>00</b>	<b>09</b>

Data #	0	1	2	3	4	5	6	7
Field	<i>Sample rate Channel 1..4</i>		<i>Sample rate channel 5 + 6</i>	CAN base ID			Mode & Speed	
Setting	<i>Not used</i>		<i>Not used</i>	Key 1..8			200002h	Analog 500KBit
Value(hex)	<b>00</b>	<b>00</b>	<b>00</b>	<b>00</b>	<b>00</b>	<b>02</b>	<b>00</b>	<b>08</b>

## 2.3) CAN analog channel 1..4 (from HP8451)

CAN ID= Base ID + 0 (default= 0x460).

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Analog channel 1.							
1	Low byte, High byte is default. If "Word format" = 1 then High byte, Low byte.							
2	Analog channel 2.							
3	Low byte, High byte is default. If "Word format" = 1 then High byte, Low byte.							
4	Analog channel 3.							
5	Low byte, High byte is default. If "Word format" = 1 then High byte, Low byte.							
6	Analog channel 4.							
7	Low byte, High byte is default. If "Word format" = 1 then High byte, Low byte.							

If Mode = 0            Analog voltage in [mv]

If Mode = 2            Analog voltage: 0..5V = 0x0000..0xFFFF

## 2.4) CAN analog channel 5 + 6 (from HP8451)

CAN ID= Base ID + 1 (default= 0x461).

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Analog channel 5							
1	Low byte, High byte is default. If "Word format" = 1 then High byte, Low byte.							
2	Analog channel 6							
3	Low byte, High byte is default. If "Word format" = 1 then High byte, Low byte.							
4	Not used (reserved) = 0.							
5	Not used (reserved) = 0.							
6	Not used (reserved) = 0.							
7	Firmware version= 1							

If Mode = 0            Analog voltage in [mv]

If Mode = 2            Analog voltage: 0..15,6V = 0x0000..0xFFFF

## 2.5) CAN key input 1..8 (from HP8451)

Send on each change of key inputs and periodic each 500ms.

Key inputs have internal pull resistors.

To activate key input, connect corresponding input signal to ground (0V).

For 8 key inputs, external resistors need on input 2, 4, 7 and 8.

See wiring diagram for details.

Key debounce filter = 33ms

CAN ID= Base ID + 2 (default= 0x462).

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Key 1							
1	Key 2							
2	Key 3							
3	Key 4							
4	Key 5							
5	Key 6							
6	Key 7							
7	Key 8							

One byte for each key, which hold the follow data:

Bit 0 : Momentary (1 when key active).

Bit 1 : Toggle on each key activation.

Bit 2..3 : 3 step sequence on each key activation.: 00 -> 01 -> 10 -> 00....

Bit 3..6 : 4 step sequence on each key activation.: 000 -> 001 -> 010 -> 100 -> 000....

Bit 7 : Left/right direction & Wiper/fan signals, details on next page.

This gives the following sequence:

Reset value : 00h x000 0000b

Key activated : 17h x001 0111b

Key idle : 16h x001 0110b

Key activated : 29h x010 1001b

Key idle : 28h x010 1000b

Key activated : 43h x100 0011b

Key idle : 42h x100 0010b

Key activated : 43h x000 0101b

Key idle : 42h x100 0100b

etc...

### 2.5.1) Signals for Left/right direction.

Bit 7 of Byte 0 and 1 hold signals designed for controlling Left / Right indicators, controlled by Key-1 & Key-2:

Sequence:

Key activated	Byte 0, bit 7	Byte 1, bit 7
(Power On)	0	0
Key 1 (L)	1	0
Key 1 (L)	0	0
Key 1 (L)	1	0
Key 2 (R)	0	1
Key 2 (R)	0	0
Key 2 (R)	0	1
Key 1 (L)	0	0

### 2.5.2) Signals for Wiper / Fan control

Bit 7 of Byte 2, 3, and 4 hold signals designed for controlling Wipers and fans, controlled by Key-2 & Key-3:

Sequence:

Key activated	Byte 2, bit 7	Byte 3, bit 7	Byte 4, bit 7
(Power On)	0	0	0
Key 2 (+)	1	0	0
Key 2 (+)	0	1	0
Key 2 (+)	0	0	1
Key 2 (+)	0	0	1
Key 3 (-)	0	1	0
Key 3 (-)	1	0	0
Key 2 (+)	0	1	0
Key 3 (-)	1	0	0
Key 3 (-)	0	0	0

## 2.6) CAN key preset (to HP8451)

Set key sequence registers to specified value.

CAN ID= Base ID + 3 (default= 0x463).

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0								Key 1
1								Key 2
2								Key 3
3								Key 4
4								Key 5
5								Key 6
6								Key 7
7								Key 8

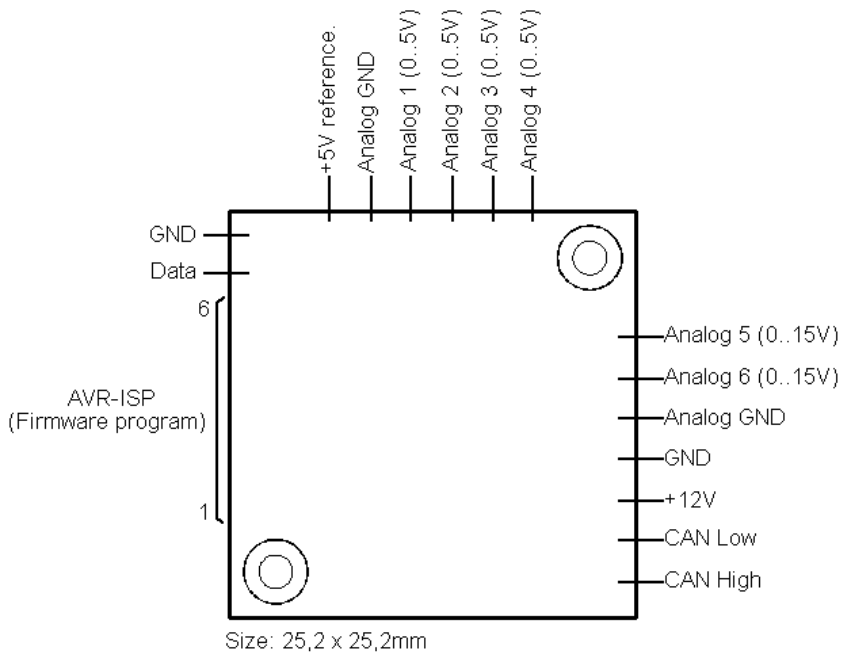
For each Key register value:

- Key register not changed if value 0x7F or higher.
- Bit 7 and 0 not used.

### 3) Wiring

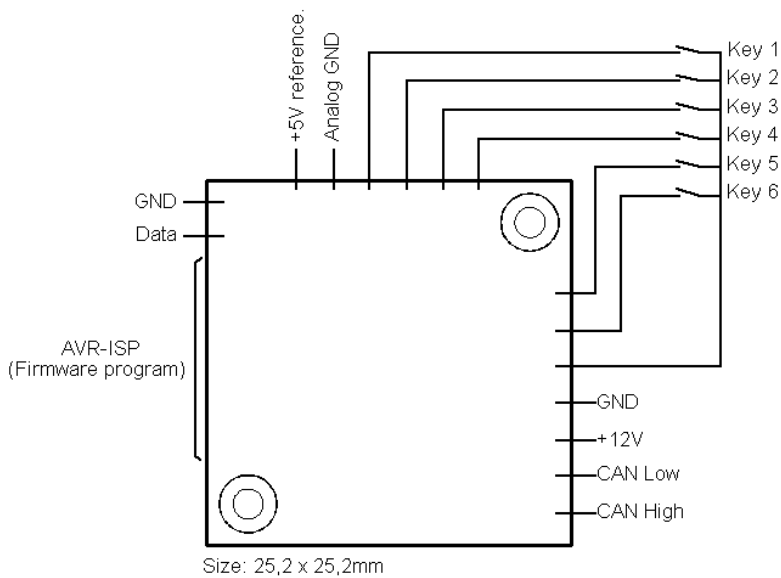
#### 3.1) Analog input mode

##### HP8451 wiring Analog input mode



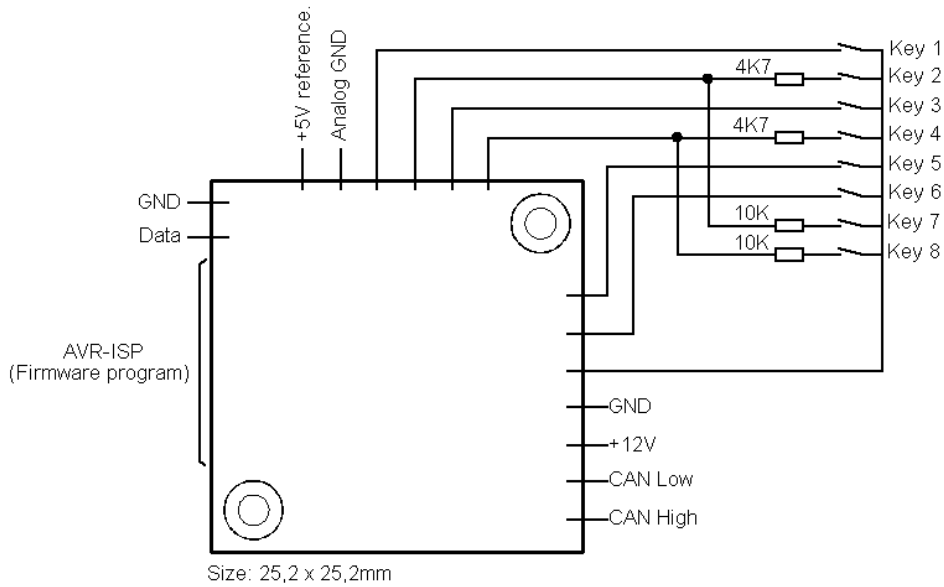
#### 3.2) 6 Key input mode

##### HP8451 wiring 6 Key input mode



### 3.3) 8 Key input mode

#### HP8451 wiring 8 Key input mode



### 4) Firmware version history

Version	Date	Init	
1	2014-11-05	KT	First version with 6 analog inputs.
2	2015-05-25	KT	6/8 key input mode added.
3	2015-06-17	KT	Special key-sequence handling for direction indicator + fan control.
4	2015-10-22	KT	New analog mode, full scale read out= 0xFFFF
5	2016-02-25	KT	High byte, low byte analog data format added.
6	2017-04-08	KT	250Kbit CAN added.