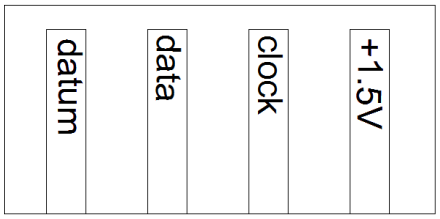
Harbor Freight® 6" Digital Caliper Model 47257 Data Port Characterization, version 1.3

By R. G. Sparber

It has been a long time since I bought a 6" digital caliper from Harbor Freight. My last one was labeled with the name CEN-TECH. My new version is labeled PITTSBURGH. This may seem like a silly change since both manufacturer names are probably fake. But it does signal a warning that the data port of the caliper has changed. This article documents what I found.

Pinout



Pull the cover off of the top of the slider and you will see four strips of copper. The first strip on the left is the datum which is connected to the frame of the caliper. Some would call this a negative ground system.

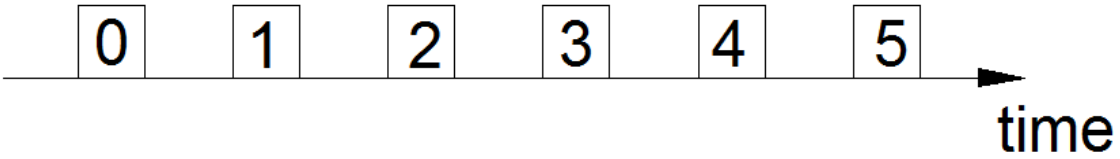
The strip of copper all the way to the right is power. This is where I found my first surprise. The power pin is positive with respect to datum. Previous models of this caliper had the opposite polarity (i.e. positive ground system). This means that the new caliper design has clock and data signals that go between zero and a positive voltage rather than a negative voltage. This will make interfacing to a processor easier.

The second strip from the left is the data node. To its right is clock.

Clock and data are always running regardless of the state of the caliper. If the display is dark, you cannot zero the caliper. But in all other regards, nothing changes between power being on or off. If you move the jaws of the caliper when in the off state, the display will come on and show the correct value.

[1] You are free to copy and distribute this document but not change it.

Data Layout



Each data burst consists of 6 nibbles (4 bit quantities). Nibble 0 arrives first. It is the least significant nibble. The least significant bit in each nibble arrives first.

Thousandths of an Inch Mode

nibble	bit	value in thou
0	0	0.5
	1	1
	2	2
	3	4
1	0	8
	1	16
	2	32
	3	64
2	0	128
	1	256
	2	512
	3	1024
3	0	2048
	1	4096
	2	8192
	3	16384
4	0	32768
	1	65536
	2	131072
	3	262144
5	0	sign: 0= +, 1= -
	1	always 0
	2	always 0
	3	1 for thou

Nibbles 0 through 4, form a binary number representing distance.

Nibble 5 contains a 1 in the most significant bit position if the caliper is set to thou. The table shows thou.

The least significant bit of nibble 5 is the sign of the binary number. If this bit is 0, the value is positive. If this bit is 1, the value is negative.

This is where I ran into my second surprise. The data represented by these 6 nibbles is the same as the data displayed on the slider. Previous models let you see 0.1 thou steps. Of course, it was very jittery, but was there. Part of this same surprise was the fact that zeroing the display also zeros the data. Previous models output a number with a range far in excess of the scale. It was up to you to define zero.

nibble	bit	value in thou
0	0	0.5
	1	1
	2	2
	3	4
1	0	8
	1	16
	2	32
	3	64
2	0	128
	1	256
	2	512
	3	1024
3	0	2048
	1	4096
	2	8192
	3	16384
4	0	32768
	1	65536
	2	131072
	3	262144
5	0	sign: 0= +, 1= -
	1	always 0
	2	always 0
	3	1 for thou

Assuming you set zero with the jaws closed, the largest valid value you will see is 6000 thou, or 6". This means that about half of nibble 3 and all of nibble 4 will always be zero.

Here are a few examples of how to read the data. I will only show nibbles 0 and 1 with the least significant bit first:

1) Nibble 0 [1101] = 0.5 + 1 + 4; nibble 1 [0110] = 16 + 32. The total is 53.5 thou. If nibble 5, bit 0 is 0 and bit 3 is 1, then the value is +53.5 thou.

2) Nibble 0 [1001] = 0.5 + 4; nibble 1 [0101] = 16 + 64. The total is 84.5 thou. If nibble 5, bit 0 is 1, then the value is -84.5 thou.

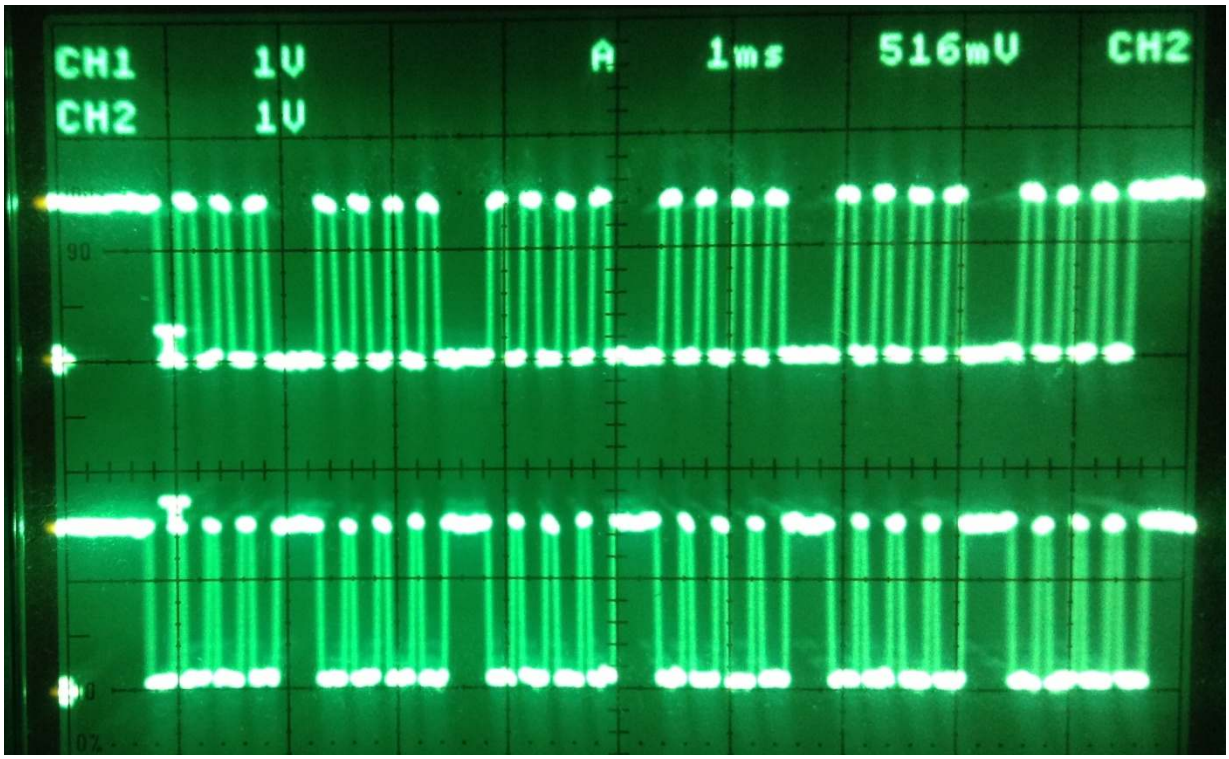
Hundredths of a Millimeters Mode

nibble	bit	value in mm
0	0	0.01
	1	0.02
	2	0.04
	3	0.08
1	0	0.16
	1	0.32
	2	0.64
	3	1.28
2	0	2.56
	1	5.12
	2	10.24
	3	20.48
3	0	40.96
	1	81.92
	2	163.84
	3	327.68
4	0	655.36
	1	1310.72
	2	2621.44
	3	5242.88
5	0	sign: 0= +, 1= -
	1	always 0
	2	always 0
	3	0 for mm

Here is the data layout for millimeters. Note that nibble 5, bit 3 is 0 which signifies that the binary value is to be interpreted as mm.

In thou mode, the smallest increment is 0.0005". In mm mode the smallest increment is 0.01 mm which equals about 0.0004". So if you want the highest resolution, use the mm mode.

Clock and Data Wave Shapes



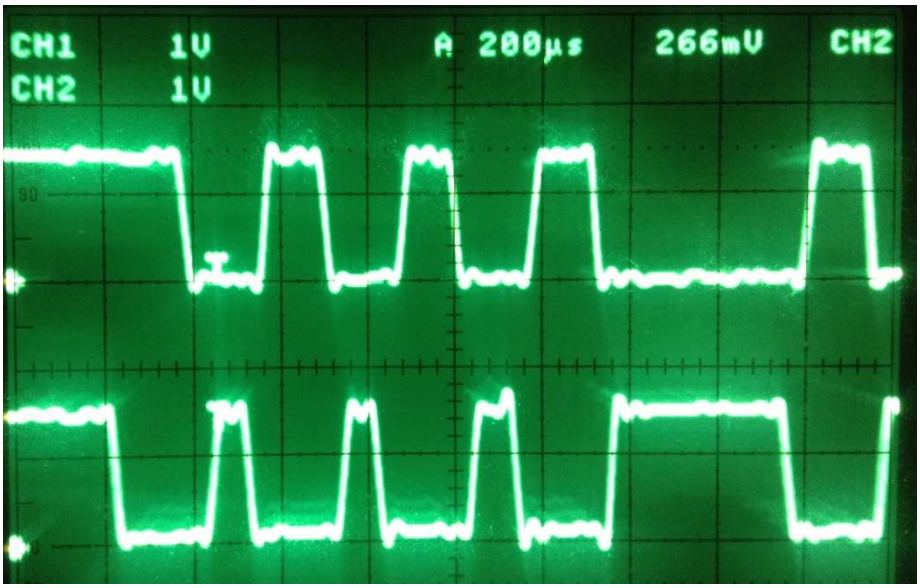
Data

Clock

Nibble 0 1 2 3 4 5

The clock and data are high except when there is a burst. Data are valid on the rising edge of the clock. I measured a clock period of 300 µs but there is no specification on its nominal and worst case. The time between nibbles was 430 µs. The entire burst took 8.9 ms. A burst arrives every 120 ms. This picture shows all zeros.

Analog tests on the clock and data nets tell me this is a totem pole driver circuit.



Data

Clock

Here is the first nibble. A logic zero is very close to zero volts. A logic one is about 1.5V which is the battery voltage. The load on these nets was just the scope so 10 Meg ohms.

Care should be taken when connecting to these nets because they are always active. You can drain the caliper's battery if your interface circuit draws current when off.

In previous versions of this caliper, it was possible to put it into "fast mode" where the data bursts would come more often. This was done by pulling both clock and data to the power rail. I tried that and other variations but was unable to get into this mode. I was also not able to find the Hold, Min, or Max modes by back driving the clock and/or data nets.

Thanks to Jan Kok for suggesting that I label clock and data on the scope pictures but found a mistake in the sequence of the nibbles.

Thanks to Bill Libecap for helping me clarify a confusing term.

I welcome your comments and questions.

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