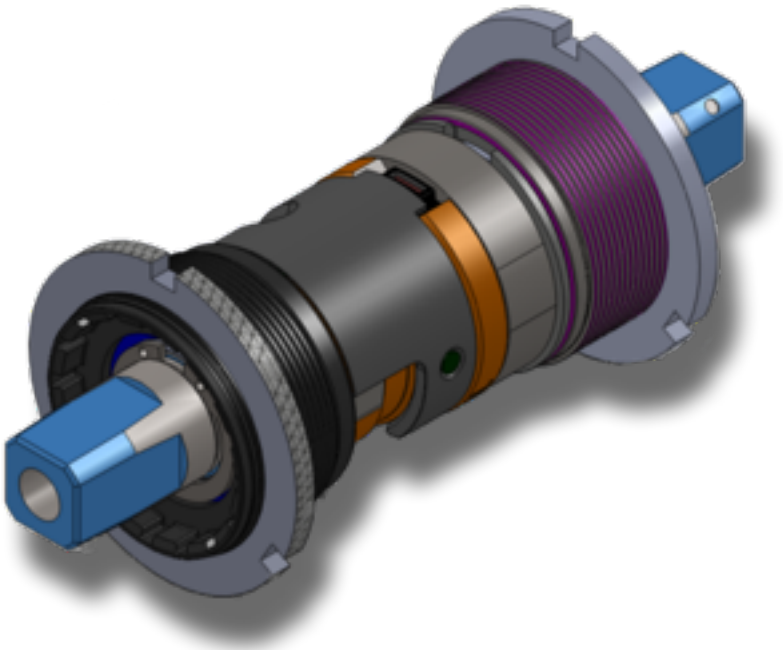
TDCM I BB Torque Sensor

Installation & Operation Guide I 2015



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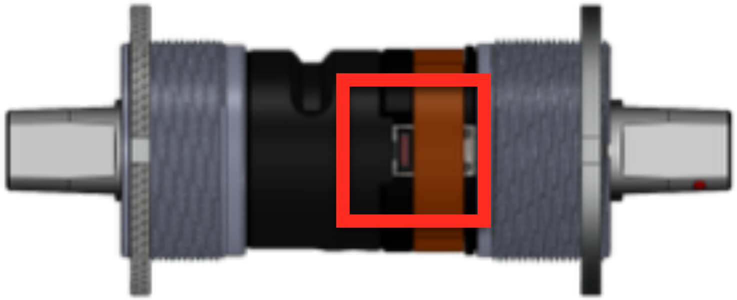
TDCM COMPANY INFORMATION

TDCM currently outputs 250,000 motors per year and is diversified across numerous industries including electric mobility (ebikes, escooters); car & scooter automotive (starter engines, fan belt motors, air-conditioning motors); and medical (wheelchair, bed, lift) and as result is both economically healthy and strategically safe company to do business with.

In the electric mobility sector TDCM works with high end ebike manufacturers to produce unique concepts and industry leading designs. TDCM offers services that no other motor companies offer in terms of customisation, and is strategically placed to produce European quality engines at an Asian price.

TDCM has operations in both Asia (Taiwan) and Europe (Germany), and can provide timely global service to all markets. For queries and sales quotes please contact our sales team on: **sales@tdcm-motor.com.**

CRITICAL INFORMATION

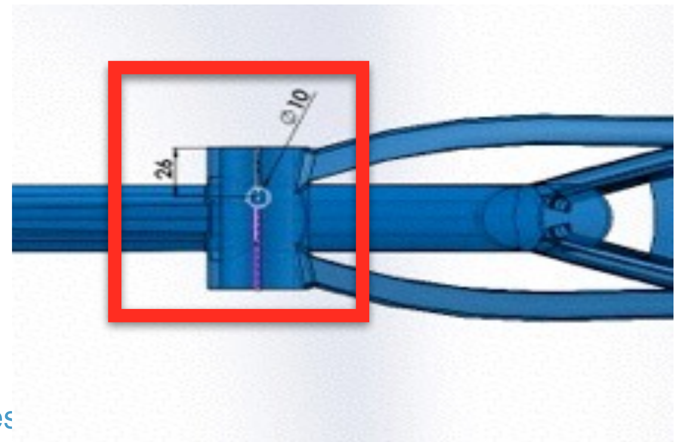


Sensor Plate

During installation and handling of the sensor please ensure this area is avoided. Heavy pressure on this sensor plate will influence the operation of the sensor.

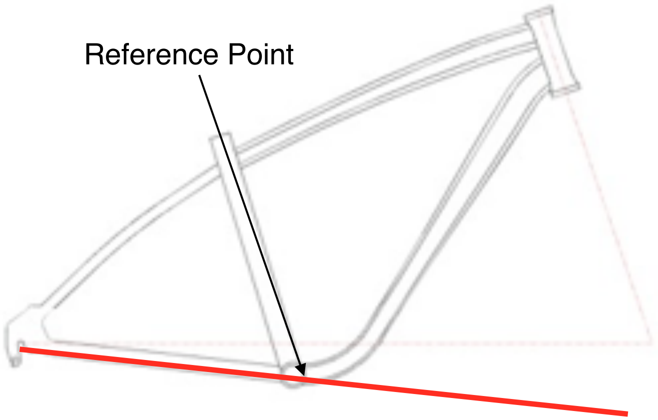
Signal Consistency

For the installation process ensure that every sensor remains with it's original parts, especially the right adjustment cap (highlighted). Each sensor is specifically programmed to match the dimensional variations and changing parts between sensors gives the potential to influence the torque signal.



Cable Hole

For easy installation and reduced risk of damage to the cable it is important the BB shell has a hole 26mm from the left side of the frame. For the standard connection connector a 10mm diameter hole is recommended.

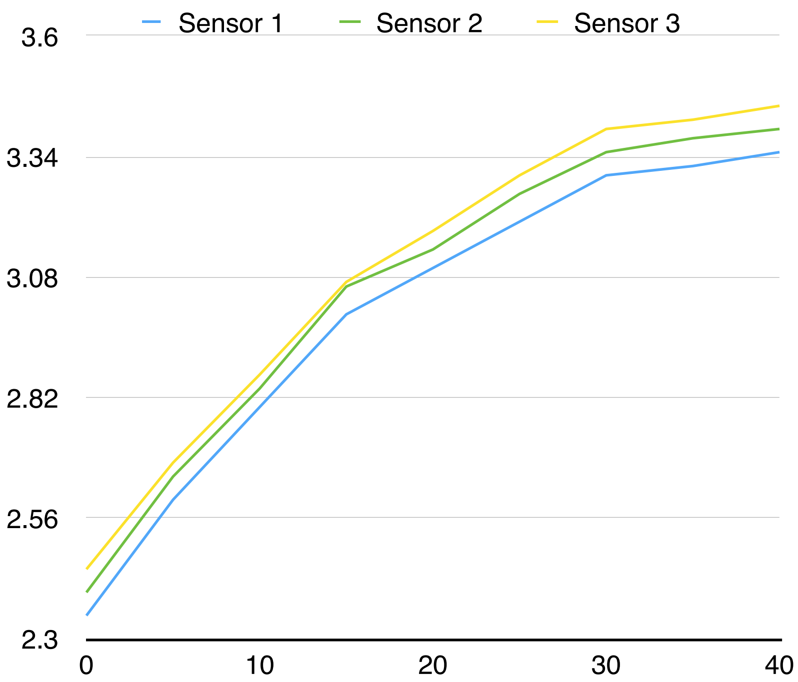


Sensor installation angle

On the BB shell it is important to create a horizontal reference point so that the sensor is installed facing the correct direction. This point can be made with a marker or a simple metal punch.

This reference point should be based on the angle between the rear hub and the BB shell as illustrated.

This point can have a 20° tolerance however it is recommended to keep the installation as precise as possible.



Torque Signal Variation

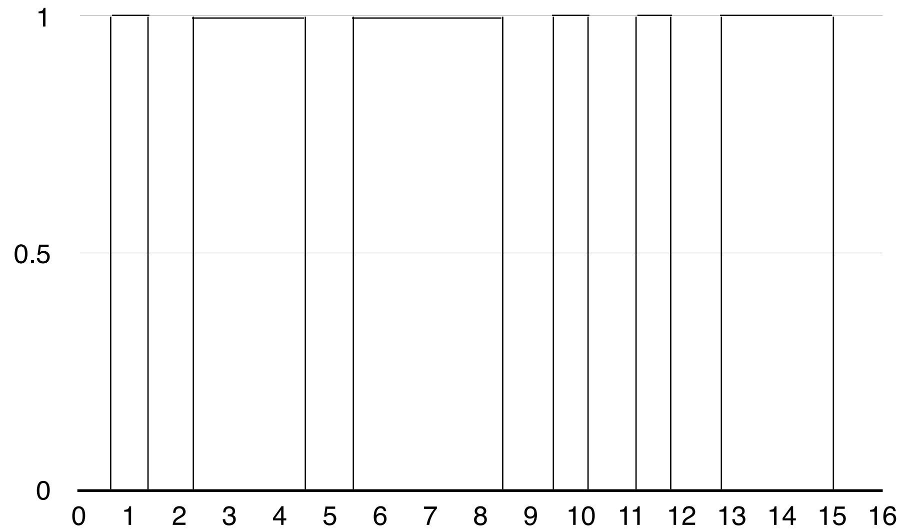
The torque signal may vary across different sensors and therefore controller systems need to be able to automatically calibrate for each sensor. TDCM standard ranges are with a starting voltage of 2.4V (± 0.05V) and an operating range of 1V (±0.05V).

The graph opposite illustrates potential variations in the torque signal.

The left and right torque signals may also vary slightly and therefore controllers should also be able to distinguish between the signals and multiply appropriately to level the signals.

Auto-calibration each time the system is turned on is advised.

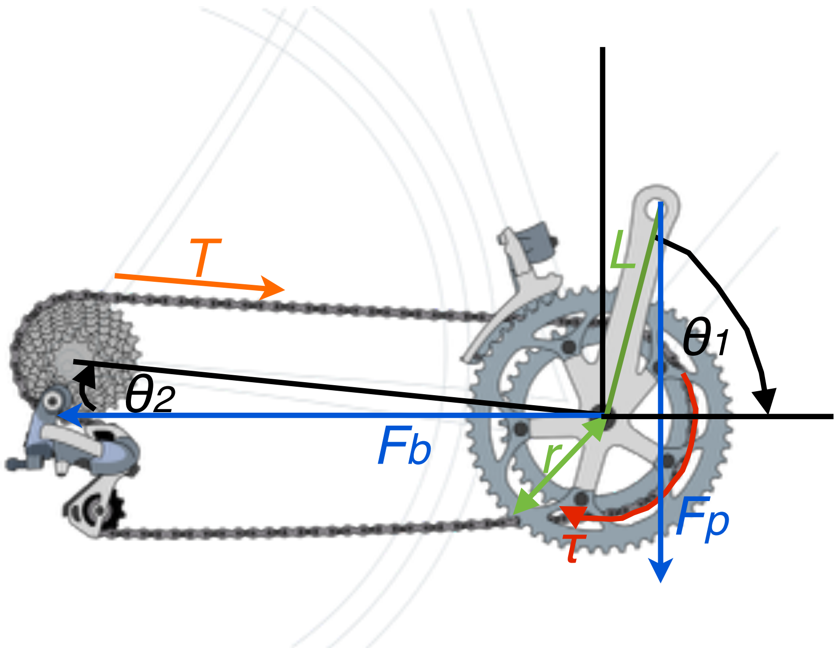
Please ask TDCM sales team for more information on controller programming if required. Also see page 8-9.



To offer an alternative and to reduce the impact of this signal variation the signal TDCM offers a digital format rather than analogue format signal sensor.

The digital signal is in PWM digital format.

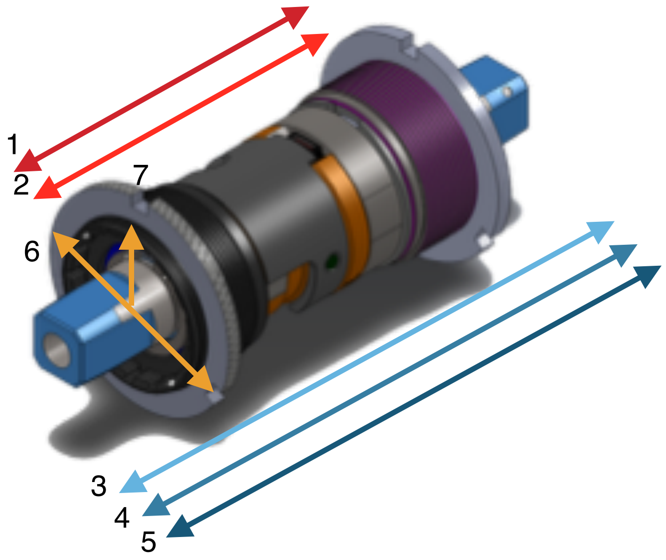
Please make sure TDCM sales team knows whether you require digital or analogue signal.



Operating Characteristics

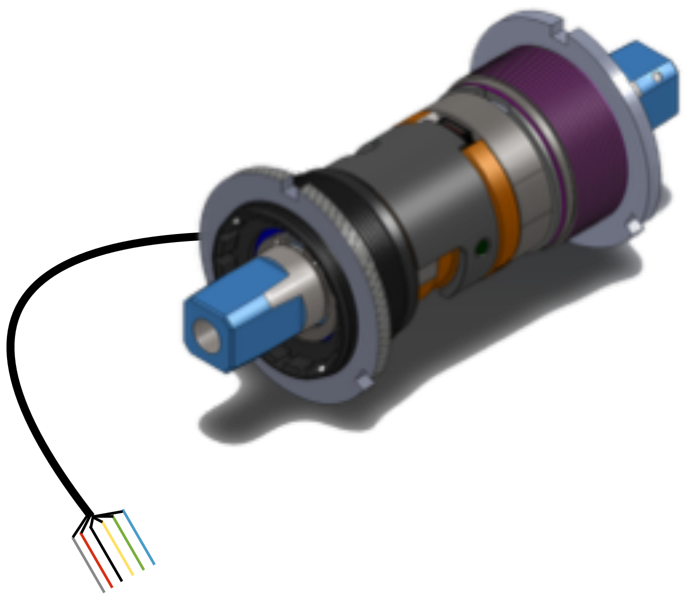
TDCM's sensor using spring gauge technology, this requires that there is some movement and space between the sensing unit and the mechanical BB. This space is 0.01mm at the sensor point, however based on axel length and pedal type this movement may be amplified. This movement can be felt underfoot.

SENSOR CONFIGURATIONS & SPECIFICATIONS

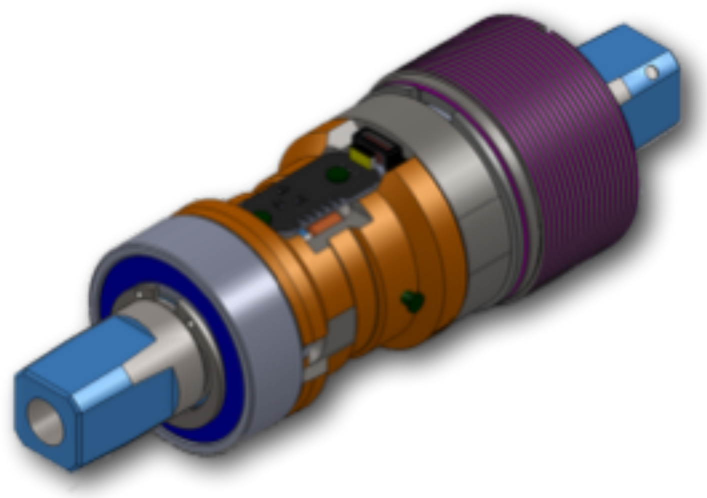


Mechanical Options	A	B	C
BB Shell	68mm	73mm	
Spindle Length	114mm	120mm	128mm
Adjusting Cap Diameter	45mm		
Internal Radius	17mm		

Pin Define	Colour	Signal	6	5	4
	White	Left / Right Pedal			
	Red	+5/6 VDC			
	Black	GND			
	Green	Torque			
	Yellow	CoSine (12 pulse)			
	Blue	Sine (12 pulse)			
	Blue	24 pulse rpm			



Specification	Digital	Analogue
Format	PWM	Voltage
No Load Output	0	2.4V (±0.05V)
Frequency	1 kHz	1V (+0.2V)
6 pin	N/A	Y
5/4 pin	Y	Y
Balanced Left / Right Signal	Y	Y (exclu. 6pin)
No signal when reverse pedalling	Y	Y (exclu. 6pin)



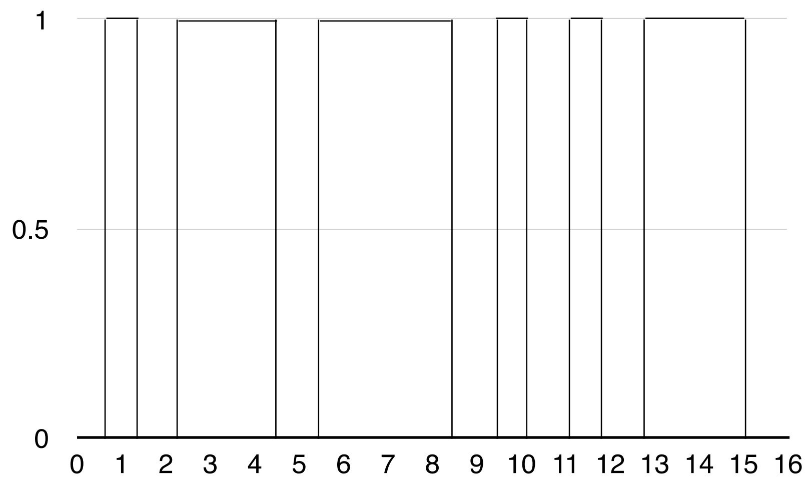
Order Code	Pin Number	Spindle Length	BB Dimension	Digital / Analogue
TS3-68-114-06	6	114mm	68mm	A
TS3-68-114-**06**	**6**	114mm	68mm	A
TS3-68-114-**05/04**	**5/4**			
TS3-68-**114**-06	6	**114mm**	68mm	A
TS4-68-**120/128**-06		**120/128mm**		
TS3-**68**-114-06	6	114mm	**68mm**	A
TS3-**73**-114-06			**73mm**	
TS3-68-114-06	6	114mm	68mm	**A**
TS4-68-114-06				**D**

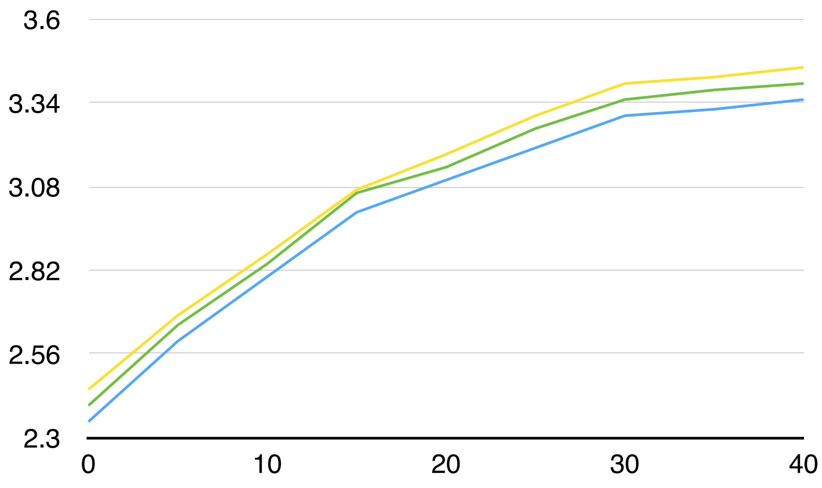
PROGRAMMING INFORMATION

Turning on the system, auto-calibration

Due to changes to chain tension across the life of the bike and sensor, the torque signal should be read each time the system turns on. This will inform the controller the starting voltage of the torque signal e.g. 2.4V. Any force applied to the pedal after this signal can be interpreted as power from the rider. For digital signal this is not required as the signal will always be at 0 when no torque is applied to the pedals.

<u>Graph to show example of the torque signals (analogue and digital PWM)</u>





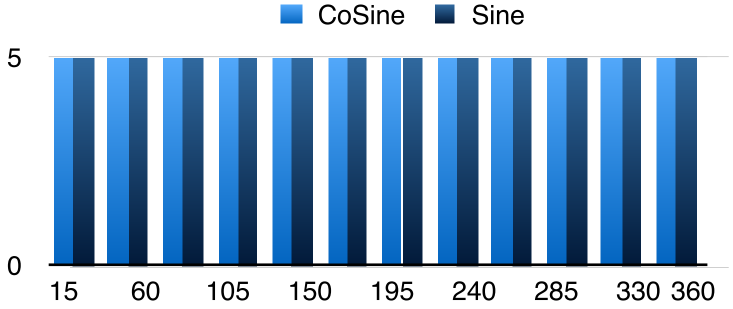
Chain tension / Ghost riding

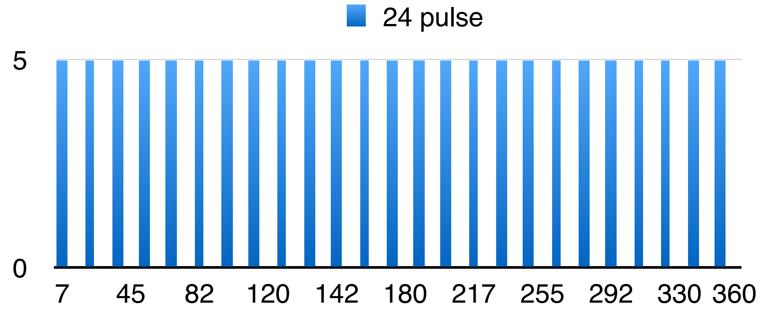
Any torque applied to the chain or pedal axel will create a torque signal. This means a signal can be produced even without pedalling. Therefore the torque and speed (rpm) signals should be read in unison so that if a torque signal is being produced but the axel isn't turning the controller can ensure power isn't provided to the motor.

Backwards peddling

Similar to point 2 the controller needs to be adapted to not provide motor support when the pedals are being rotated backwards. In A-type connector this can be done by ensuring the correct combination of sine -> cosine -> sine signals from the rpm signals (see diagram pulse signals). For G and J-type the sensor already has inbuilt programming to cancel backwards pedalling.

Graphs to show example of cosine, sine and 24 pulse signals



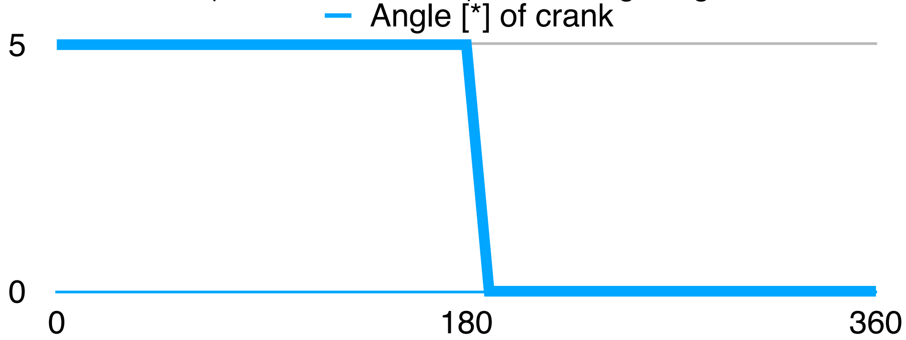


Signal amplification

The torque signal can be amplified based on the rider requirements. A rider who wants more response from their sensor can have a controller programmed to amplify the torque signal. A rider who wants less response can not have this amplification.

For riders with disability on one half of the body, the left (or right) side torque signal can be amplified to account for this disability. This can be done by combining both the torque signal and the left/right signal to determine which pedal is being used and to have an established amplify algorithm (e.g. 2x left, 1x right) to recognise this.

Graphs to show example of left/right signal



Combining both torque and speed signals

Different bikes require different performances. Therefore using a combination of the speed and torque signals TDCMs BB sensor can be programmed for unique purpose.

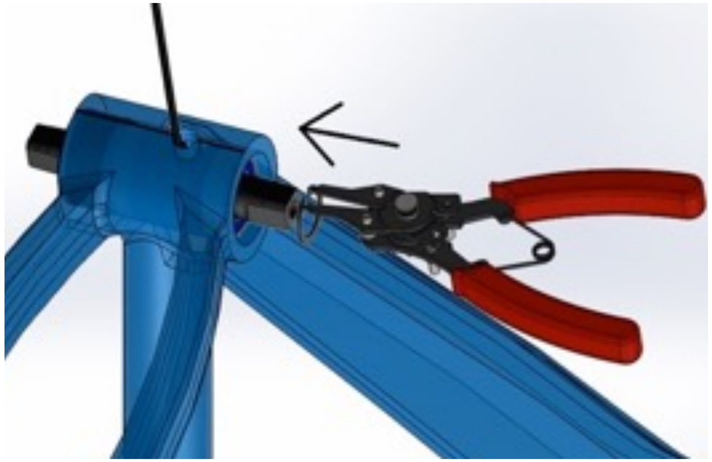
For example

- at low speed, torque signal high amplify (0 < rpm < 100 = 4 x torque signal)
- at medium speed, torque signal low amplify (100 < rpm < 200 = 2 x torque signal)
- at high speed, torque signal normal (200 < rpm < 300 = 1 x torque signal

INSTALLATION TOOLS

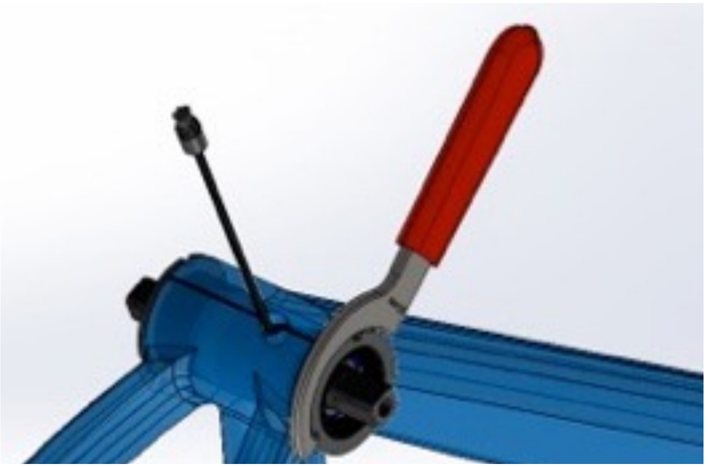
Recommended Tools

1) Snap Ring Tool



2) Pre-set Torque Wrench

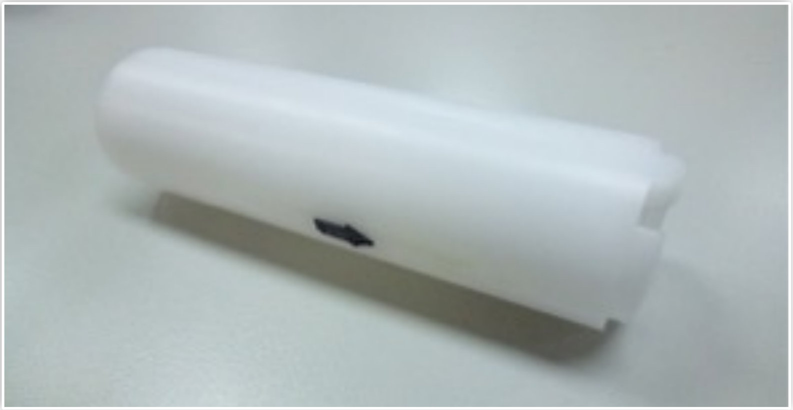
3) Left / Right Lock Tightening Tool



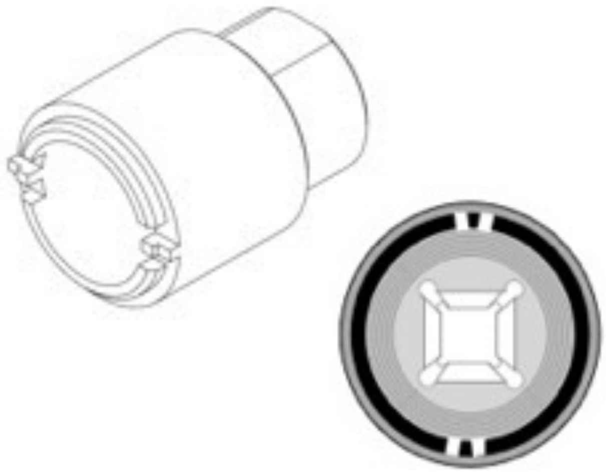
4) Crank-set Wrench

Additional Tools (please ask TDCM sales team if you wish to be provided with these tools)

1) Hand Tool for BB insertion into shell



2) Right side adjusting cap attachment



INSTALLATION PROCESS

Please ask TDCM for installation video

Explore Drawing for reference

1	Rubber Dust Seal	Disassemble for installation
2	Right Side Lock Ring	Disassemble for installation
3	Right Side Adjusting Cap	Disassemble for installation
4	Spindle	Do not disassemble
5	Torque Sensor Shell	Do not disassemble

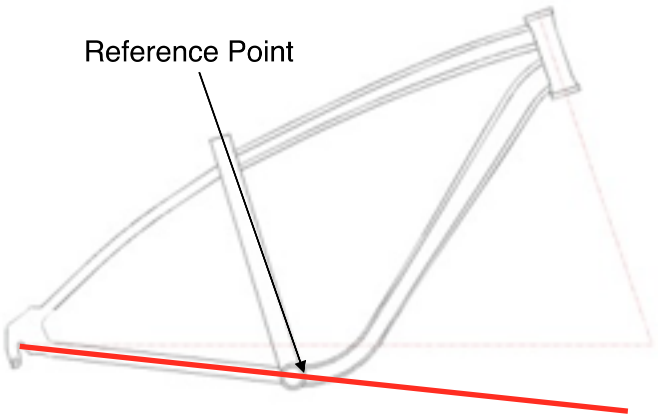
6	Roller Bearing / Ball Bearing	Disassemble for installation
7	Snap Ring	Disassemble for installation
8	Left Side Adjusting Cup	Disassemble for installation
9	Left Side Lock Ring	Disassemble for installation

1. Precaution on disassembly

Sensor Plate

During installation and handling of the sensor please ensure this area is avoided. Heavy pressure on this sensor plate will influence the operation of the sensor.

2. Reference Point for assembly



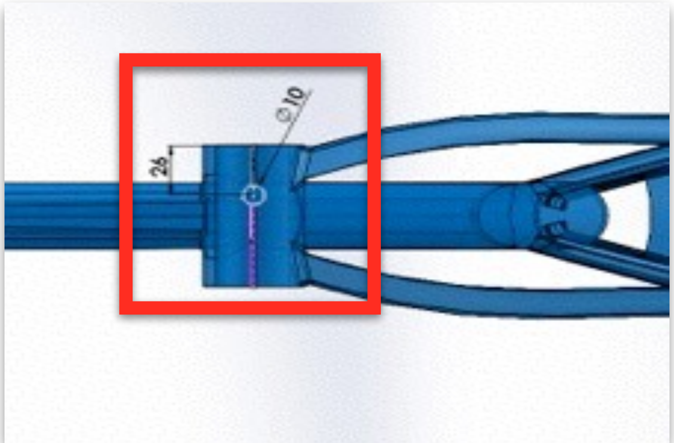
Sensor installation angle

On the BB shell it is important to create a horizontal reference point so that the sensor is installed facing the correct direction. This point can be made with a marker or a simple metal punch.

This reference point should be based on the angle between the rear hub and the BB shell as illustrated.

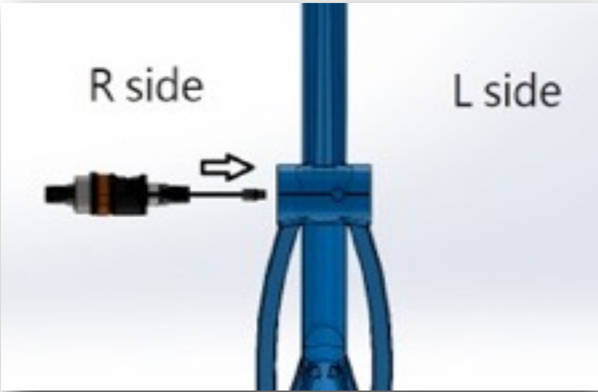
This point can have a 20° tolerance however it is recommended to keep the installation as precise as possible.

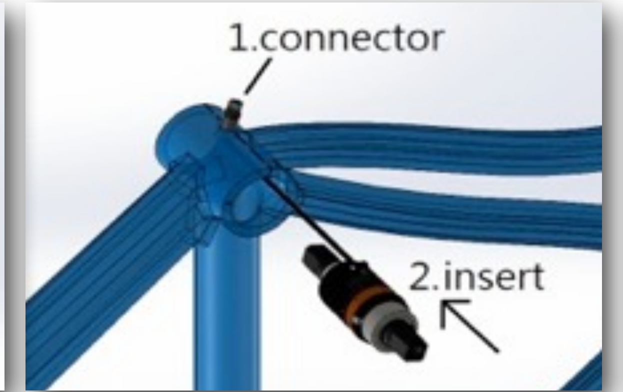
3. Drill hole for cable connector exit

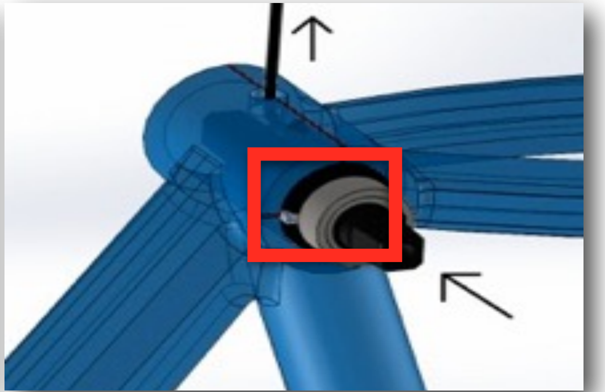


For easy installation and reduced risk of damage to the cable it is important the BB shell has a hole 26mm from the left side of the frame. For the standard connection connector a 10mm diameter hole is recommended.

4. Insert disassembled sensor into frame

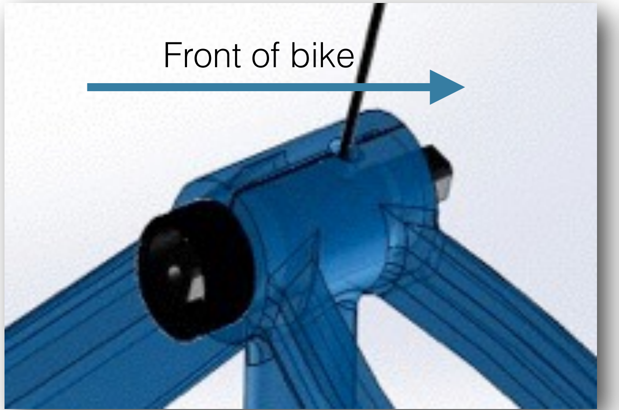


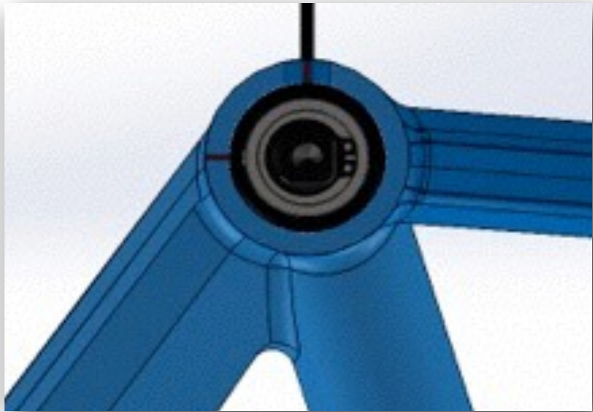


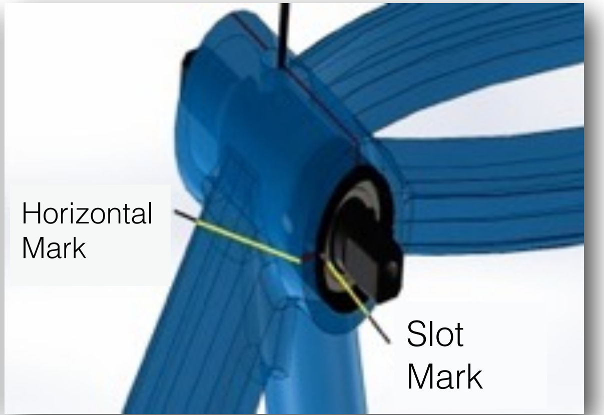


1. Simply insert the torque sensor into the bottom bracket as in the photos from bike right side to bike left side.
2. Carefully insert connector cable into the 10mm drilled hole and pull the cable through as the torque sensor is inserted to take up the slack.
3. Throughout assembly keep the key as highlighted in red aligned with the horizontal reference point (see point 3) for the best consistency in sensor reading.

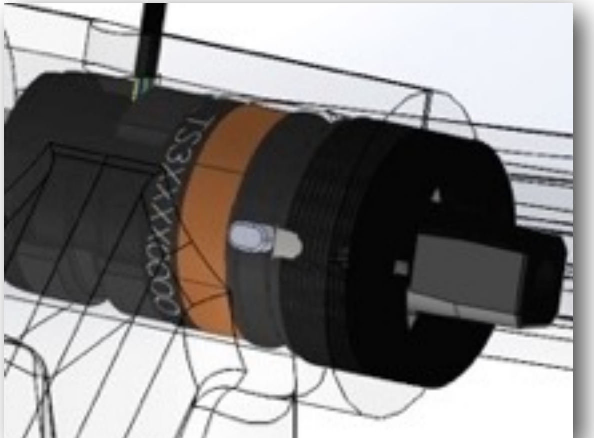
5. Installation of right adjusting cap

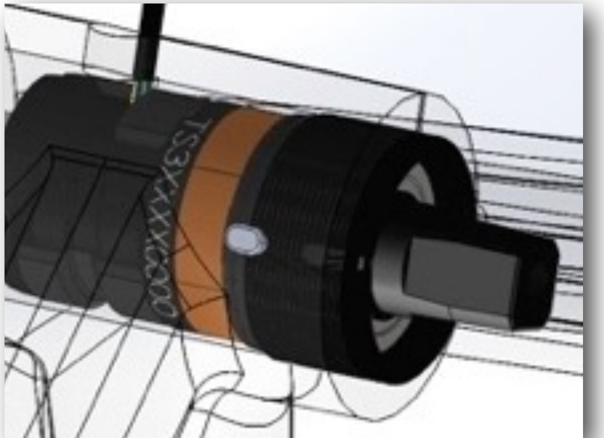




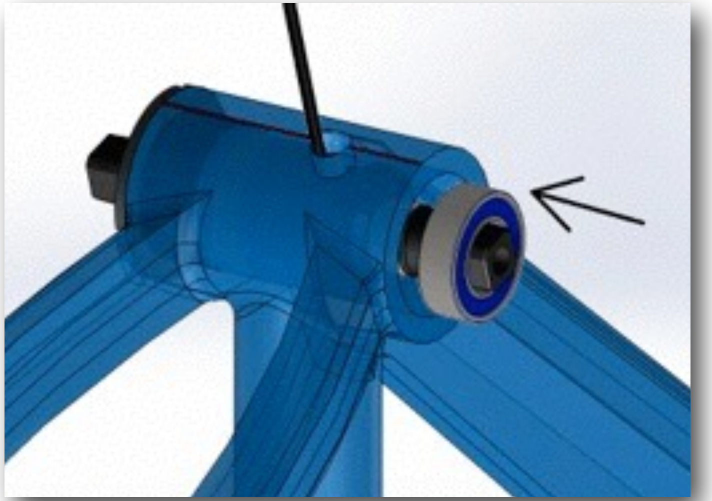


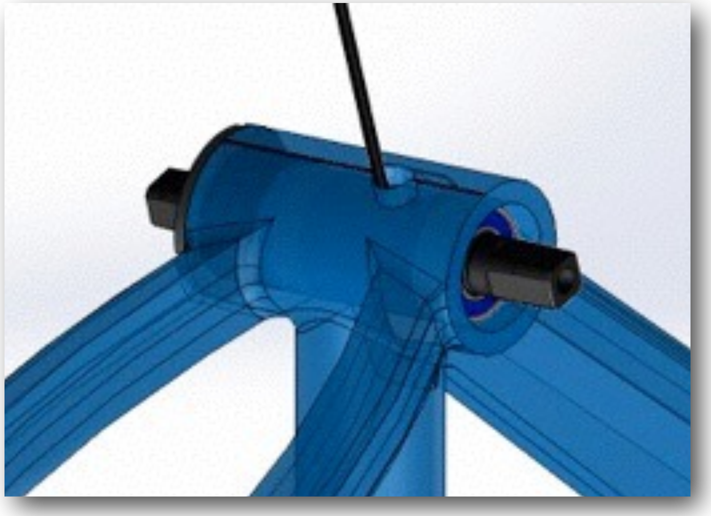
1. Use a light coating of grease on the treads of the Right Side Adjusting Cup.
2. Screw the Right Side Adjusting Cup into the bottom bracket shell (please note the Right Side Adjusting Cup has left-hand threads).
3. Screw the cup until only ~5mm of thread is outside of the bottom bracket (see images below).
4. Find the position key and slowly push the sensor backwards to fit. There will be a click sound on connection and it should be obvious there is now a connection between the sensor and the cap. Evidence of this will be when the cap is now adjusted the cable and the sensor main body will also move.





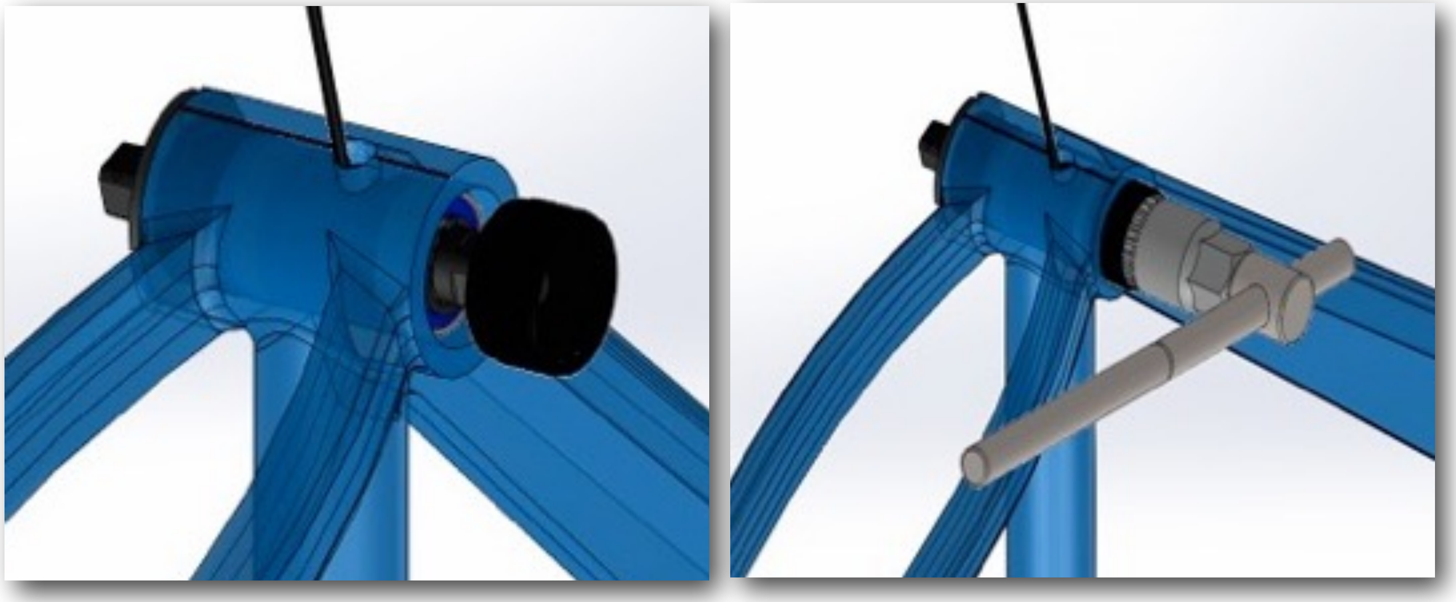
6. Installation of rotor bearing and snap ring





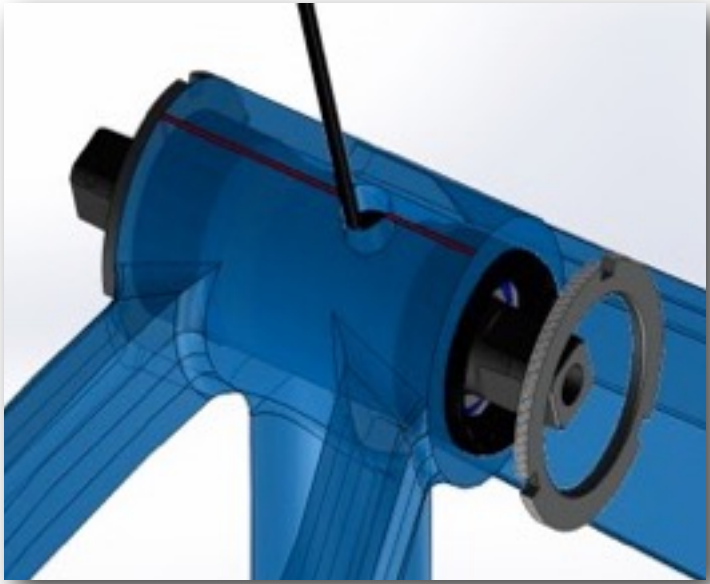
1. Insert rotor bearing into position
2. Using external snap ring pilers place snap ring into position to hold the bearing.

7. Installation of left side adjusting cap



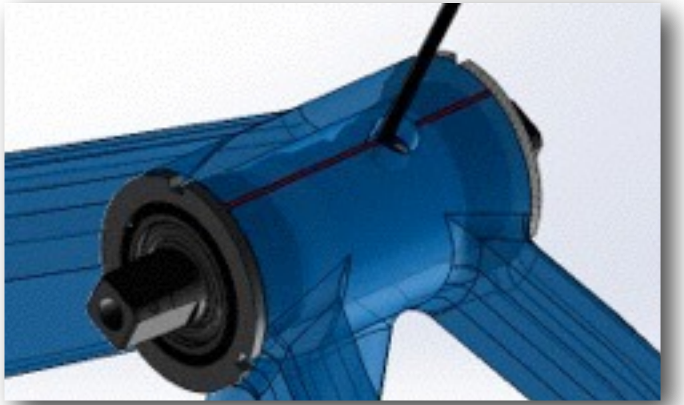
1. Screw the left side cup clockwise into the bottom bracket shell.
2. Ensure the cups are both tightly secured.
3. Optimum tightness is around 70 Nm. It is recommended the caps are first tightened to 60 Nm and then slowly adjusted. Using a pre-set torque wrench will provide the most consistency in the torque signal.

8. Installation of the left and right lock rings.

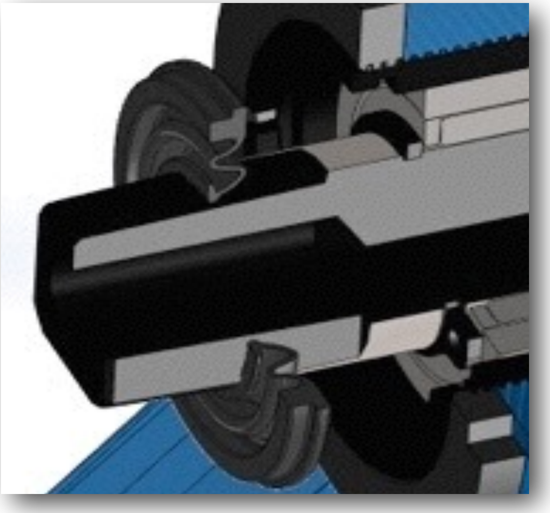


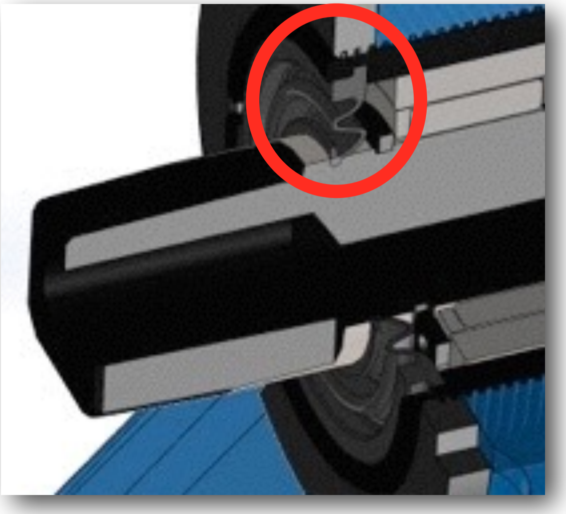
1. Tighten left side lock ring onto cup and tighten until it is secure against bottom bracket shell. Repeat for the right side.

9. Installation of rubber dust seal



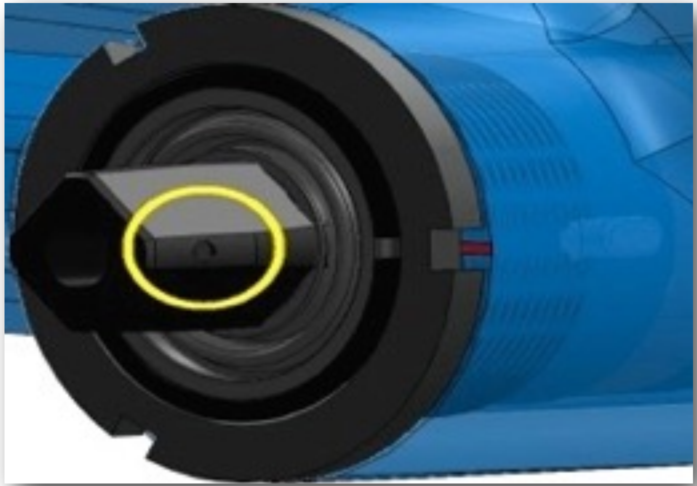
1. Install the rubber dust seal from by sliding it over the Torque Sensor Shaft from the right side.
2. Insure that the inside diameter of the rubber dust seal nests into the outermost grove on the Torque Sensor Shaft.
3. Ensure that the outside diameter of the rubber dust seal nests in the grove on the inner diameter of the Right Side Adjusting Cup.

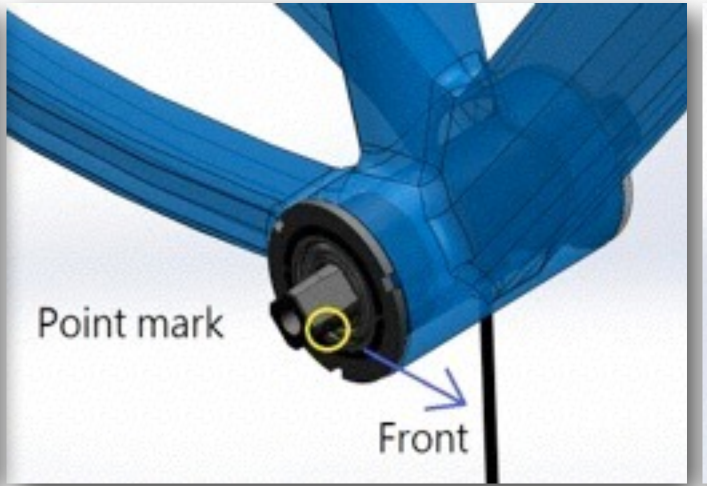


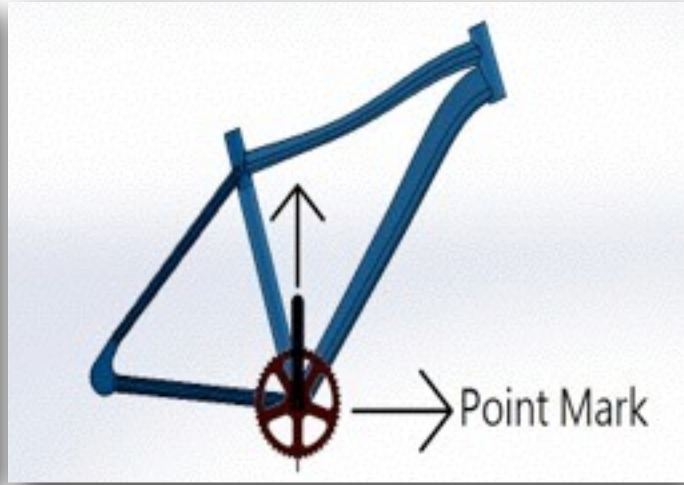


10. Installation for the crank installation and positioning

1. Turn the spindle until the dented round dot (see yellow circle) is in line with the horizontal make made earlier.
2. Insert right crank in upwards position .
3. Insert opposite side crank.







SIGNAL ERROR RESOLUTION

If there is a signal error in the function of the sensor for a quick resolution check the following conditions and adjust accordingly. If the issue is still present after checking this list and using the TDCM IQC tool signal check (if this is available) please consult your sales representative.

1. Left Adjusting Cap Tightening

Refer to stage 7 (page 17) for instruction. The left side adjusting cap should be optimally tightened to 70Nm using a pre-set torque wrench. If such a device is not available please try tightening the cap manually and seeing if the initial torque value varies.

2. Sensor Installation Position

Refer to stage 4 (page 14) for instruction. The sensor needs to be aligned so the 'key' links with the horizontal reference point, facing the front of the bike. There is a degree of variation allowed for this installation but optimally the alignment should be as accurate as possible.

3. Cable Damage

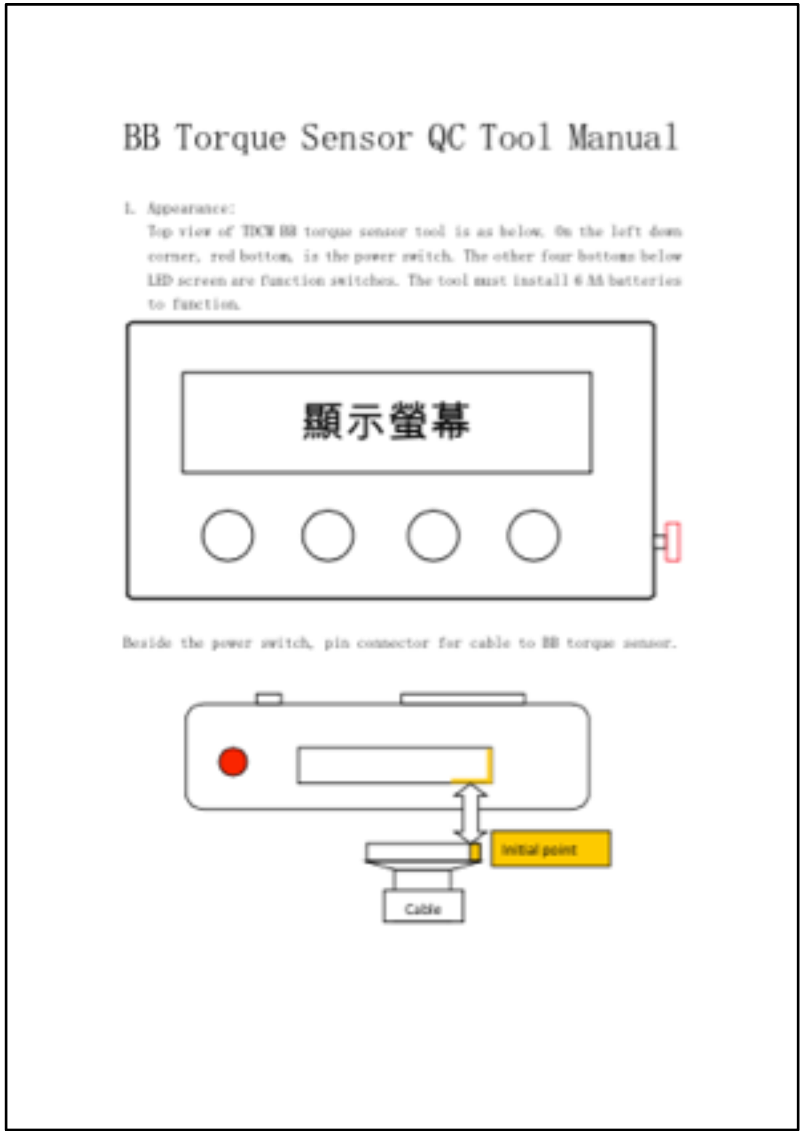
Refer to stage 3 (page 14) for instruction. The most common error to signals occurs due to cable damage. This can be avoided by carefully handling of the cables and appropriate drilling of the BB shell cable hole. It is advised, especially for samples/prototypes where the sensor may be installed multiple times, that sand paper is used to reduce the sharpness of edges, and a larger hole for the cable to pass through is potentially drilled. If under inspection there is some cable damage, this can be a repaired through soldering, however this is not always easy and may be required to handle from TDCM's side.

4. Sensor Section Avoidance

Refer to stage 1 (page 13) and critical information (page 3) for instruction. Is is important that during handing of the sensor that the sensor plate is avoided as much as possible, if not completely. Interference to this sensor will cause a disruption to the signal / cause signal failure. If this has occurred TDCM can easily conduct recalibration. Please contact TDCM to see how best to proceed.

TDCM IQC Tool

- please ask sales representative for sample



BB Torque Sensor QC Tool Manual

1. Appearance:
   Top view of TDCM BB torque sensor tool is as below. On the left down corner, red bottom, is the power switch. The other four bottoms below LED screen are function switches. The tool must install 6 AA batteries to function.

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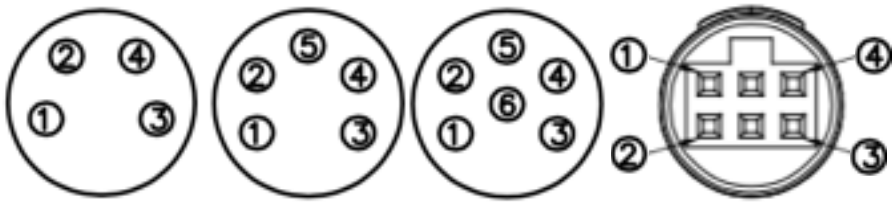
Beside the power switch, pin connector for cable to BB torque sensor.

Initial point

Cable



Pin Define

1. White	5V - 0V	Left / Right	4. Yellow	5V - OV	RPM (12)
2. Red	5V	Power Supply	5. Green	2.4V - 3.4V	Torque
3. Black	0V	Ground	6. Blue	5V - OV	RPM (12/24)

Signal check with multimeter

1. Connect the mating connectors.
2. Connect + 5V (red) and GND (black) to power supply.
3. Check output of torque signal (green) using a multimeter set to V (dc). The reading on the torque should be between 2.45 and 2.55V.
4. Hand turn the spindle checking the left & right signal (white) is working. It should give 5V and 0V signals as rotated, changing every 180°.
5. Hand turn the spindle checking both sine and cosine signals (blue and yellow) are working. Again it should give 5V and 0V signals, changing through every 15°.

Checking maximum torque value

1. Install chain
2. Connect the mating connectors
3. Connect + 5V (red) and GND (black) to power supply.
4. Place left peddle forwards and parallel to the ground.
5. Check the crank position signal (white wire)
6. Hold the brake tight and stand or place 35 kg weight on the peddle.
7. Measure the torque out (green wire) to record the maximal output (approximately 3.4V).
8. Repeat procedure 4-7 for right peddle.

ORDERING PROCESS REQUIREMENTS

When ordering a sensor from TDCM sales team please list the following requirements:

1. Quantity required
2. Mechanical dimensions
   a) 114mm spindle
   b) 120mm spindle
   c) 128mm spindle
3. Pin setup
   a) 6-pin
   b) 5-pin
   c) 4-pin
4. Signal type
   a) Analogue
   b) Digital

NOTE: Points 2-4 can be confirm in product code (see page 7)

5. Cable Length
   a) Sensor to connector length: ___ mm
   b) Controller to connector length: ___ mm

6. Special requests on connector type or IP

LABELLING FOR MASS PRODUCTION

Sensor Label

Part No: **010-29-068-00**	| PO Number
Serial Number: **TS314232258**	| Model Type: TS3
	| Year: 14 (2014)
	| Week: 23
	| Production Number: 2258

Length of Spindle: **120mm**
Length of Cable: **300mm**

Box Label

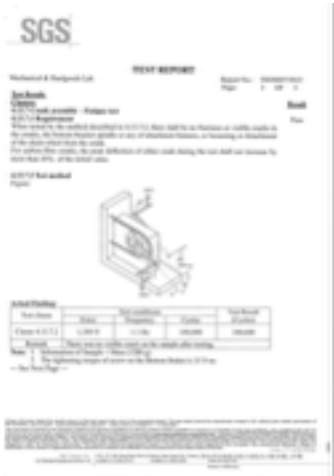
Part No: **010-29-068-00**
Serial Number Series: **2258 - 2358**
Number of Pieces: **100pc**

QUALITY ASSURANCE AND TESTING

Please ask a TDCM sales representative for SGS testing, quality assurance and RoHS certification.


SGS

TEST REPORT


SGS

TEST REPORT


TDCM


SGS

TEST REPORT