Setting up an Inductive Pick-Up (IPU) Ignitions

The installation and set-up of the following common IPU ignition configurations will be explained in the following paragraphs.

IPU Ignition Types

1. ***Stand-alone IPU Distributor (Go to Type_1)***
2. ***Modified IPU Distributor (serving as the cam sync) with a Crank Trigger Setup (Go to Type_2)***
3. ***IPU Cam Sync Signal Distributor with a Crank Trigger Setup (Go to Type_3)***
4. ***All-in-One, Crank and Cam Sync Distributor (Go to Type_4)***

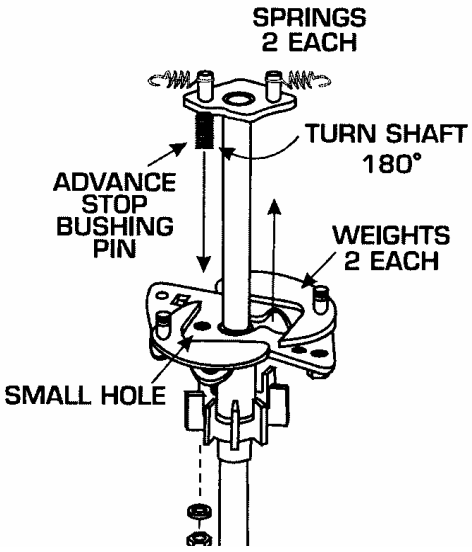
Type 1 - Stand-alone IPU Distributor (no cam sync signal and crank trigger used)

A stand-alone IPU distributor can be used with the GEN3 ECU for sequential fuel and spark control. With an IPU distributor, "Individual Cylinder" fuel control can still be implemented (controlled by the Individual Cylinder Fuel correction table in the BigComm software).

NOTE: A standalone IPU distributor is not setup to supply a camshaft synchronization (sync) signal to the ECU. Without the cam sync signal (every 360^{o} of cam rotation) there will be no way to take advantage of cylinder "fuel-phasing" (controlling the point, BTDC, when the fuel is injected into the cylinder) or individual cylinder "timing control". However, the injectors will fire sequentially (once per induction cycle), allowing the pulse width to be doubled compared to a Bank-to-Bank (B2B) system, which fires the injector twice (per cylinder) per induction cycle (2 revs). The bigger idle pulse width (roughly double the B2B) accomplishes better stroke to stroke repeatability of the injector resulting in better idle quality, with high flow injectors.

When using an IPU distributor, the centrifugal advance needs to be "Locked Out" (see below). The BigStuff3 ECU will control the timing advance via the spark map configured in the ECU.

LOCKING OUT THE CENTRIFUGAL ADVANCE



1. Remove the advance components including the springs, weights, and the advance stop bushing from the advance assembly.

2. Remove the roll-pin from the drive gear and remove the gear from the shaft.

3. Slide the shaft two inches out of the housing.

4. Rotate the shaft 180° and insert the advance stop bushing pin into the small hole on the advance plate (see illustration below).

5. Install the locknut and washer to the advance stop bushing pin. This locks the advance in place. Do not over tighten.

6. Install the drive gear and roll-pin.

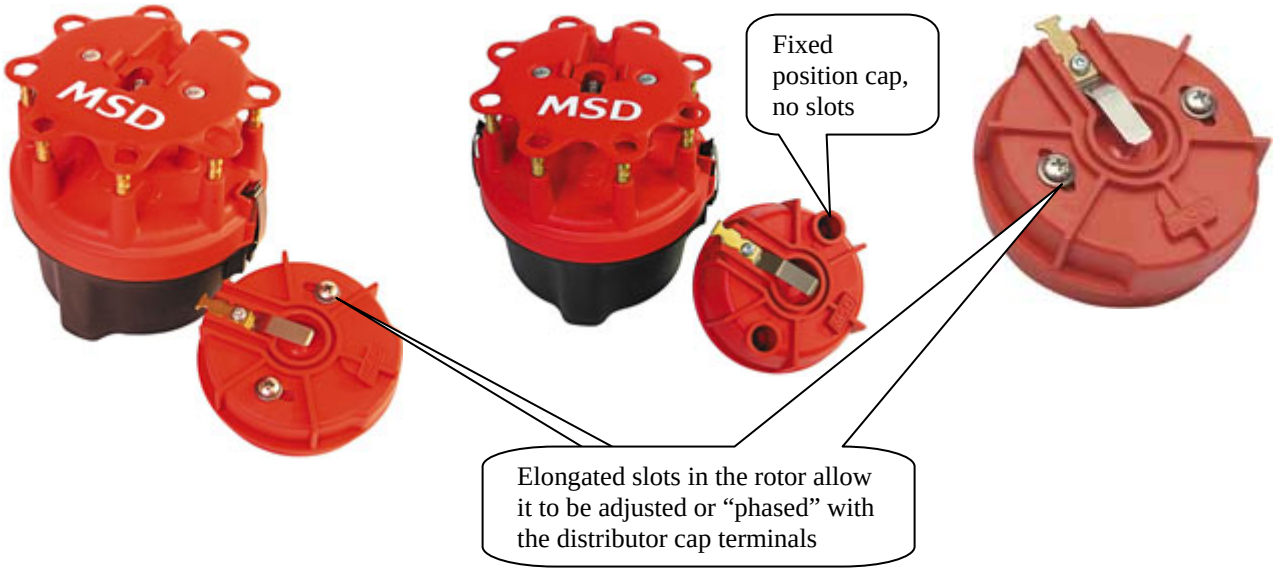
Rotor Phasing

Rotor phasing is important for regular OE ignition systems, but it is vital for high energy ignition systems where the spark has to jump or arc from the rotor tip to the distributor cap terminal. MSD distributors are designed with the rotor "in-phase" or aligned with the reluctor to work with their ignition systems (e.g. 6A box). With Bigstuff3's "delay back" ignition control strategy, having the rotor in-phase with the reluctor will not allow the rotor to be "in-phase" with the distributor cap terminal when peak power is being made. This out-of-phase condition causes the spark to jump back from the tip of the rotor to the distributor cap terminal.

For example, at peak power, the maximum timing advance a forced induction engine is likely to operate at is 20° BTDC. If the rotor is not properly aligned with the distributor cap terminal, at 20° of advance, the spark will have to jump back, or worse, it could jump to the wrong distributor cap terminal and cause damage to the engine.

The easiest solution to this problem is to use a cap and adjustable rotor system like MSD's "Cap-a-Dapt". MSD's "Cap-a-Dapt" kits adapt a large, Ford style cap onto an MSD distributor. The Two Piece Rotor allows the rotor tip to be adjusted so that it can be in alignment or "in-phase" with the cap terminal when peak power is being made. The "Cap-A-Dapt" kits will install on most MSD Billet and Pro-Billet Distributors (except the Ford FE, PN 8594).

MSD's Cap-A-Dapt, Small Diameter Distributors - PN 8441
Cap-A-Dapt, Adjustable Rotor PN 8420



Reluctor Re-positioning

MSD's Cap-A-Dapt system may not package with every engine configuration. If this system will not physically fit in your application the alternative is to reposition the reluctor on the distributor shaft so that the rotor and cap terminals are aligned at peak power, typically around 20° timing advance (for forced induction applications).

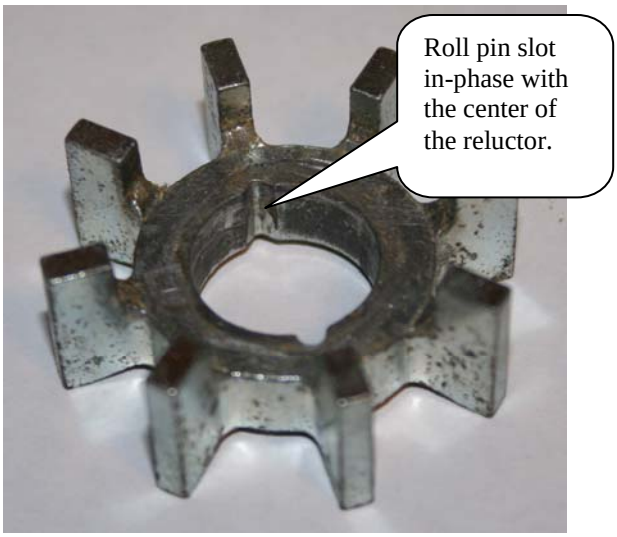
For example, with the Crank Reference set to 50° BTDC, the rotor needs to be retarded by 30° (crankshaft degrees) to achieve good rotor phase for a desired advance of 20°. The table below outlines how this number was derived.

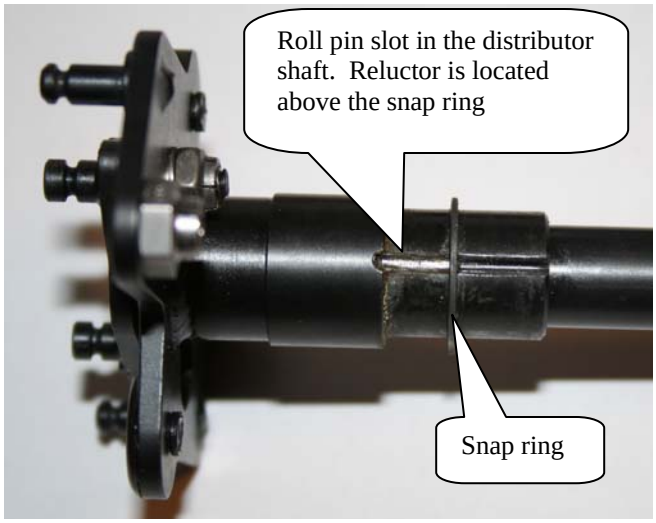
Reluctor Repositioning Calculations for IPU Distributor		
Boosted Engine		
	BTDC	
Maximum Timing Advance Engine will See	45°	
Plus 5° timing advance (buffer for ECU)	5°	
Equals Crank Reference (angle) Value Inputted Into BigComm Software	50°	The distributor needs to be installed in the engine at 50° BTDC. **The installation process is further explained below**.
Less Total Timing Advance Engine Will Operate at, at Peak Power	-20°	
Total Degrees (Crankshaft)	30°	
Total Degrees (Camshaft) the reluctor needs to be advanced on the distributor shaft for rotor and cap terminal to be "in-phase" at peak power	**15°**	Cam degrees is one half of crank degrees

The following paragraphs explain how to reposition the reluctor on the distributor shaft of an MSD Pro-Billet distributor so that cap and rotor are in-phase at peak power.

Reluctor Re-positioning Procedure

Start by removing the cam gear at the bottom of the distributor shaft by removing the roll pin with a 1/8" punch. Pull the shaft out of the distributor housing. Remove the snap ring just below the reluctor. Using a hammer and non-destructive punch, strike the reluctor circumferentially until it slides down the shaft, fully exposing the roll pin used to hold it in place (see the photos below).





BigStuff3 offers a reluctor with two (2) additional roll pin slots (see photo) **PN JMI-007-012**, shifted approximately 10^{o} from the center of the reluctor tabs. One slot is 10^{o} (camshaft degrees) clockwise (CW) while the other is 10^{o} (camshaft degrees) counter clockwise (CCW). Reinstall the reluctor on the distributor shaft, using the correct slot (one of two the 10^{o} offset slots) for the engine ROTATION you have. Remember you want to advance the reluctor/pole piece while retarding the rotor.

Reassemble the distributor and install it in the engine.

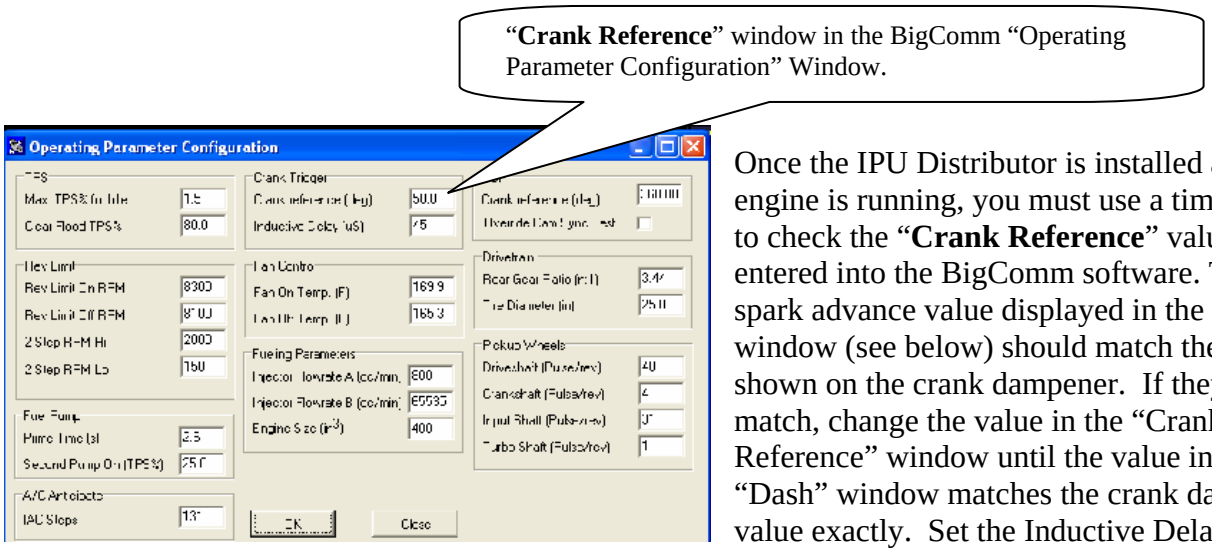
Installing the IPU Distributor

Once the reluctor is re-positioned on the distributor shaft, start by rotating the engine so that the number 1 cylinder is Top Dead Center (TDC) (compression stroke). Rotate the engine back or **B**efore TDC (**B**TDC) the number of crankshaft degrees equal to the maximum timing advance the engine will run at, plus 5^{o}. Keeping with the example from above, assume the maximum advance you plan to run is 45^{o} (high speed/light load), add 5^{o} to this number. So rotate the engine to 50^{o} BTDC #1 compression. Drop the distributor into the engine, then "bump" the starter until it engages the oil pump drive while applying a light downward pressure. Once the oil pump drive is engaged, rotate the engine back to 50^{o} BTDC #1 compression. Turn the base of the distributor so that the center of the reluctor aligns with the distributor pole piece. In a MSD distributor, the pole piece is the BLUE magnetic assembly with the 2 wires running out of it.. Once aligned, tighten down the distributor, reinstall the cap and wires.

The MSD distributor 2 wire connector must be changed to the 2 way black male Metripack connector (included in IPU kits). Crimp the seals and female terminals on with the correct crimping tool. Use Packard crimper, PN 12014254 or MSD's Pro-Crimp Tool, PN 35051, with Weathertight Dies, PN 3509. Install the MSD distributor violet/black wire into cavity "A" of the black Metripack connector and plug it into the 2 wire black connector labeled "Crank" on the BS3 harness.

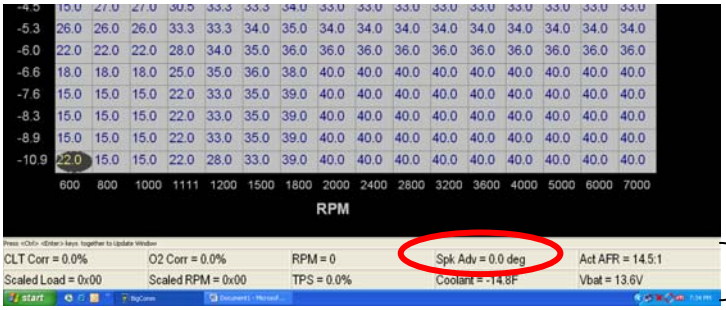
"Crank Reference" Input

The "**Crank Reference**" input is perhaps the most important timing value entered into the BigComm software (see Operating Parameter Configuration screen print below). The crank signal tells the ECU where the engine is in relation to TDC compression, cylinder number 1.



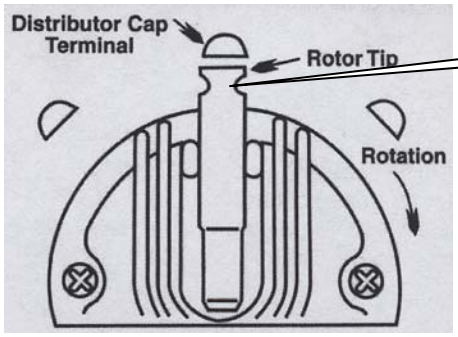
Once the IPU Distributor is installed and the engine is running, you must use a timing light to check the "**Crank Reference**" value entered into the BigComm software. The spark advance value displayed in the "Dash" window (see below) should match the value shown on the crank dampener. If they do not match, change the value in the "Crank Reference" window until the value in the "Dash" window matches the crank dampener value exactly. Set the Inductive Delay to 13 uS for 2 wire pickups.

"Dash" Window



Next, check for correct rotor phasing.

Dynamically Checking Rotor Phasing



To check rotor phasing dynamically, the distributor cap will need to be modified so that the position of the rotor tip to the cap terminal can be observed when the engine is running. To do this, a large hole must be made in the distributor cap, near a terminal that can be easily observed. To help see the rotor tip, mark the top of it with white correction fluid. Install the modified distributor cap. Connect the timing light inductive lead on the plug wire going to the terminal with the hole near it. Start the engine and run it at a 3,000 RPM. Make sure the "Dash" timing value reads the desired timing for maximum power. You may have to set the values in the timing map to correspond to this. In our boosted timing example, make the all the values 20^{o}. Shine the timing light into the hole in the cap. The light from the timing light should show the rotor tip in-phase with the cap terminal at the timing for peak power (20^{o} in our boosted example above). See the illustration above. Most timing lights have somewhere around a degree of propagation delay so keep that in mind when looking at the tip.

Type 2 - Modified IPU distributor (to serve as the cam sync) to be used with a crank trigger setup

This section describes how to modify an existing MSD IPU distributor to create the cam sync signal. The modified sync signal distributor will be used with a crank trigger setup.

Description of Events - Cam and Crank Input Signals

The cam sync signal, references the start of an injection or ignition firing sequence, and needs to occur 10^{o} - 20^{o} before the crank trigger signal.

The cam sync signal informs the ECU of the position of the number 1 cylinder and provides a signal to the ECU once per 360° of cam rotation. After the cam sync signal, the next input received by the ECU is the crank signal from the crank trigger.

The Advantage of Delay-Back vs. Feed-Forward Ignition Strategies

BigStuff3's GEN3 ECU uses a **"delay-back"** ignition control strategy.

Many competitive systems use a "feed-forward" strategy, where the ECU has to forecast, or predict, the next timing event, 90^{o} before it will occur. The ECU predicts the next timing event based on a constant engine speed assumption. If there is a transient event, and the engine accelerates or decelerates the ECU's timing forecast or prediction becomes inaccurate, resulting in retarded or advanced timing.

BS3 employs a "**delay-back**" strategy, where the ignition timing forecast or prediction occurs within several degrees of the actual "Crank Reference" signal, thus significantly reducing timing fluctuations during transient events. The difference may not seem significant, but it can result in timing inaccuracies during conditions when accurate timing is critical!

The Crank Trigger setup will be described before explaining how to modifying the distributor to create a "cam sync". An understanding of the "Crank Reference" (angle) is needed when considering the cam sync (modified IPU distributor) position.

Crank Trigger (wheel, and sensor assembly) Considerations

The number of magnets (or raised metal studs) the crank wheel should have is based on the number cylinders the engine has as shown below:

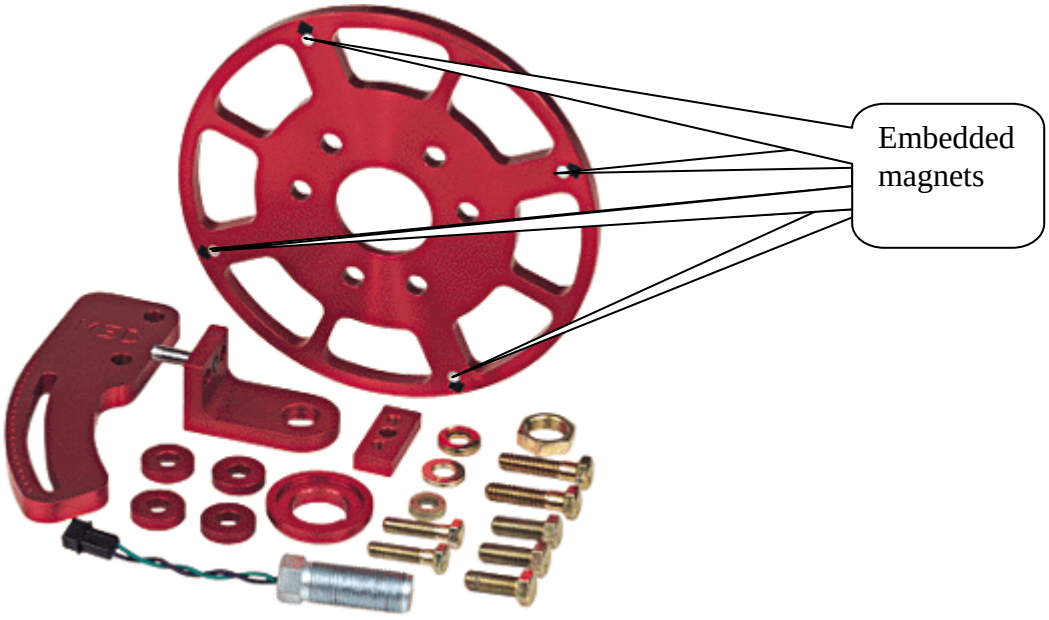
4-Cylinder Engine Example

The typical firing order for a 4 cylinder, 4 stroke engine is 1-3-4-2. To complete a 4-stroke cycle, the crankshaft rotates 720 degrees, or two turns. The camshaft (ignition distributor), rotates at half-speed or 1 turn for every 360° of crank rotation. A four cylinder has 720/4 = 180 degrees between ignition firings.

Engine Cylinders	Number of Magnets in Crank Wheel	Magnet Spacing on Crank Wheel
8	4	90^o
6	3	120^o
4	2	180^o

Some crank trigger assemblies use a crank wheel, with steel studs protruding from the wheel. As the crankshaft turns the steel studs pass by a stationary **magnetic** pickup, creating a sinusoidal wave, which is used to trigger the ignition. The potential exists for the magnetic pickup to false trigger. Other steel objects like bolts, debris and even vibrations can cause magnetic pickups to false trigger. False triggers can cause a loss of power and potentially damage the engine.

In order to avoid this problem BigStuff3 recommends using a system that has four magnets (for a V8) embedded in the trigger wheel. As the magnets pass by a stationary **non-magnetic** pickup a sine wave is created, which is used to trigger the ignition. The magnet-in-the-wheel design produces a more accurate trigger signal and will not create a false trigger, like magnetic pickups have to potential to do. MSD's "Flying Magnet Crank Trigger" system is an example of a magnet-in-wheel design, preferred by BS3.



The MSD Flying Magnet wheel and sensor assembly has a two-piece mounting bracket, used to secure the non-magnetic pickup that in most cases will work on either the passenger side or driver's side of the engine. The aluminum bracket is slotted to provide a wide range of timing adjustability to ensure the assembly can be set at between 45^{o} – 50^{o} BTDC (without further modifications).

Note: It is important that the pickup being used is compatible with crank wheel. If the crank wheel has non-magnetic studs, a magnetic pickup needs to be used. If the crank wheel has magnets, a non-magnetic pickup needs to be used. Do not use a magnetic sensor with a crank wheel that has magnets! Also, do not use a non-magnetic pickup with a crank wheel that has steel (ferrous metal) studs!

Crank Trigger Set-up

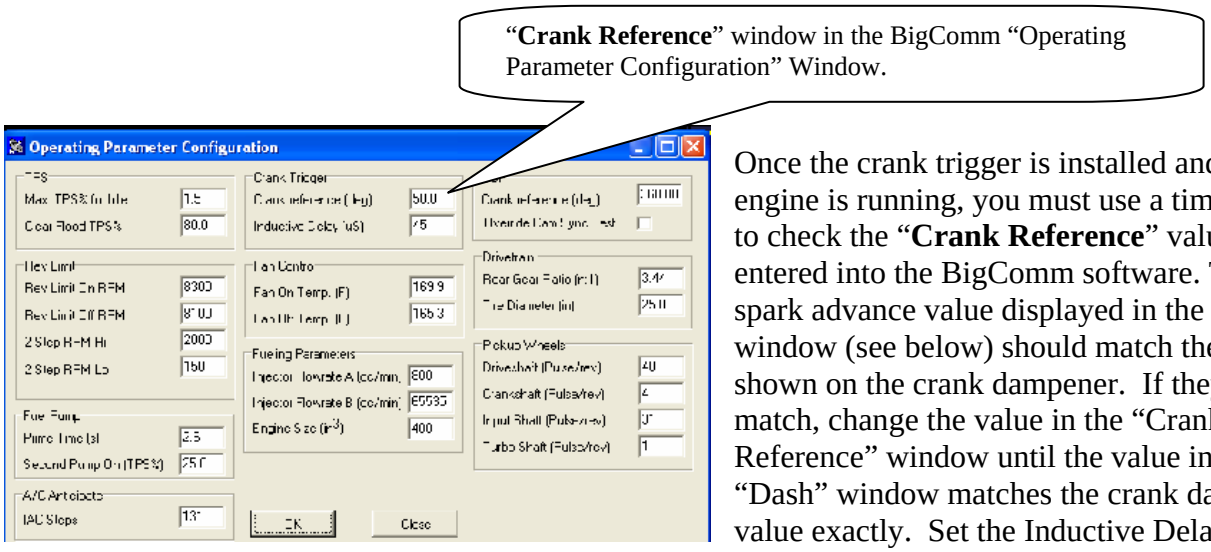
The easiest way to mount the bracket and non-magnetic pick-up assembly is to rotate the crankshaft clockwise until Top Dead Center (TDC) number 1 cylinder compression is determined. Next, rotate the engine back the number of degrees (BTDC) equal to the maximum timing advance the engine will run at, plus 5^{o}. For example, rotate the engine back 45^{o} (max timing advance of engine), plus 5^{o} or 50^{o} Before Top Dead Center (BTDC), number 1 cylinder compression. Next, mount the wheel, bracket and sensor assembly so that the crank wheel magnet and sensor are aligned or in phase. The air gap between the sensor tip and face of the crank wheel should be between .050" - .075". The crank trigger 2 wire connector must be changed to the 2 way black male Metripack connector (included in IPU kits). Crimp the seals and female terminals on with the correct crimping tool. Use Packard crimper, PN 12014254 or MSD's Pro-Crimp Tool, PN 35051, with Weathertight Dies, PN 3509. Install the crank trigger pickup green wire into cavity "A" of the black Metripack connector and plug it into the 2 wire black connector labeled "Crank" on the BS3 harness.

This crankshaft position (BTDC) is known as the "**Crank Reference" (angle)**. The "Crank Reference" (angle) is defined as the distance, in crankshaft degrees, between the crank wheel reference magnet, when it is aligned with the crankshaft position sensor, and Top Dead Center compression, number 1 cylinder.

For example, if the reference magnet is aligned with the crankshaft sensor when the crankshaft is 50^{o} BTDC compression number 1 cylinder, the crankshaft position value entered into the Crank Reference window must be 50^{o}. The "Crank Reference" (angle), needs to be inputted into the BigComm software Operating Parameters Configuration window, explained below.

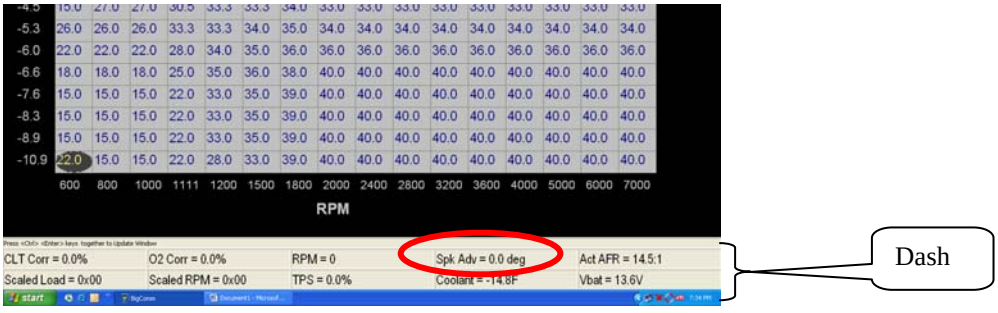
"Crank Reference" Input

The "**Crank Reference**" input is perhaps the most important timing value entered into the BigComm software (see Operating Parameter Configuration screen print below). The crank signal tells the ECU where the engine is in relation to TDC compression, cylinder number 1.



Once the crank trigger is installed and the engine is running, you must use a timing light to check the "**Crank Reference**" value entered into the BigComm software. The spark advance value displayed in the "Dash" window (see below) should match the value shown on the crank dampener. If they do not match, change the value in the "Crank Reference" window until the value in the "Dash" window matches the crank dampener value exactly. Set the Inductive Delay to 13 uS for 2 wire pickups.

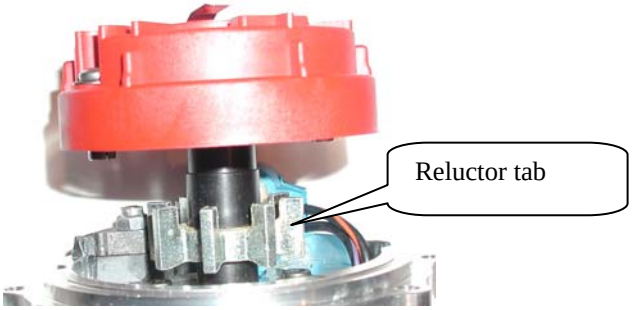
"Dash" Window



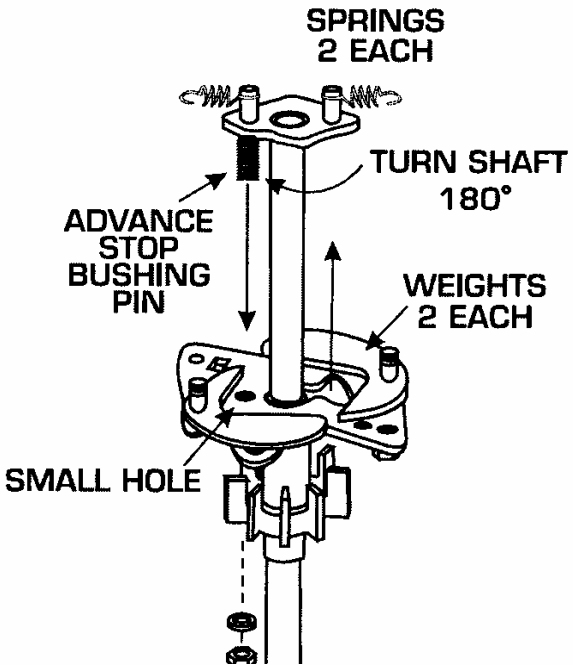
Modifying an Existing Distributor to Create a CAM Sync Signal

If you already have an IPU distributor, the possibility exists to modify it so that it can be used to provide the cam sync signal. If the distributor has reluctor tabs (interrupts for each cylinder), 7 of the 8 reluctor tabs (for a V8) can be removed to create a cam sync distributor. Please carefully read this section before removing the reluctor tabs from the distributor.

Note: If you decide to modify a distributor to provide the cam sync signal, the mechanical advance must also to be locked out! The BigStuff3 ECU will control the timing advance via the spark map configured in the ECU. "Locking Out" the distributor is described below.



LOCKING OUT THE CENTRIFUGAL ADVANCE



1. Remove the advance components including the springs, weights, and the advance stop bushing from the advance assembly.

2. Remove the roll-pin from the drive gear and remove the gear from the shaft.

3. Slide the shaft two inches out of the housing.

4. Rotate the shaft 180° and insert the advance stop bushing pin into the small hole on the advance plate (see illustration below).

5. Install the locknut and washer to the advance stop bushing pin. This locks the advance in place. Do not over tighten.

6. Install the drive gear and roll-pin.

Setting Up the IPU Distributor to be used as the Cam Sync

Once the distributor has been "locked out" (the mechanical advance capabilities have been removed), it needs to be installed in the engine to determine which reluctors (7 of 8 for a V8) need to be removed to create the cam sync signal.

The cam sync (signal) must occur before the "Crank Reference" angle, typically 10^o – 20^o before the "Crank Reference" angle (see Crank_Reference described above). For example, if the "Crank Reference" angle is set to 45^o BTDC (#1 cylinder, compression stroke), the cam sync (modified IPU distributor) should be installed between 55^o and 65 degrees BTDC.

Start by rotating the crank to 10^o – 20^o before the "Crank Reference" angle described above (this could be up to 70^o BTDC with a 50^o "Crank Reference"). Install the distributor making sure that it is installed in the engine in an orientation that allows the plug wires to be easily routed to their respective cylinders and that the leads (wires from the pickup) can be easily connected to the main wire harness. NOTE: On engines with the distributor mounted in the front, an extension jumper will be needed to connect to the "Cam" connector on the BS3 harness. Remove the distributor cap and rotor and align the pickup pole piece with reluctor. The distributor may need to be loosened so that the base of the distributor can be moved slightly to ensure an exact alignment between the senor pole piece and reluctor. The reluctor and pole piece are said to be "in-phase" when they are perfectly aligned.

Use a permanent black marker and clearly identify (mark) the reluctor that is lined up or in-phase with the sensor pole piece. Remove the distributor and remove the reluctors that were not marked, **making sure that the reluctor that was identified/marked is not removed**!

The residual metal, that was once a reluctor tab, needs to be completely removed from the reluctor ring to avoid false triggering. If the magnetic pickup unintentionally senses any of the residual reluctor material, a false signal could result with potentially significant consequences!

Reinstall the modified distributor (with one reluctor tab now) back into the engine. Make sure the distributor is seated fully. "Bump", the engine if need be to engage the oil pump drive. Once fully seated, rotate the engine back to the 10-20 degrees before the "Crank Reference" value (this could be up to 70^o BTDC with a 50^o "Crank Reference"). Align the single reluctor tab with the center of the pole piece, now tighten down the base of the distributor. Next you'll need to check/verify your rotor phase. Rotate the engine now to the timing desired for max power (20^o in our example above) note where the rotor is in relation to the distributor cap terminal. It should be directly across. If not, and space allows, use a MSD "Cap-a Dapt" to correct the rotor phase. If space does not allow for a "Cap-a Dapt" then you'll need to modify the reluctor position as explained below.

The MSD modified distributor 2 wire connector must be changed to the 2 way grey male Metripack connector (included in IPU kits). Crimp the seals and female terminals on with the correct crimping tool. Use Packard crimper, PN 12014254 or MSD's Pro-Crimp Tool, PN 35051, with Weathertight Dies, PN 3509. Install the MSD modified distributor violet/black wire into cavity "A" of the grey Metripack connector and plug it into the 2 wire grey connector labeled "Cam" on the BS3 harness.

Cap/Rotor Phasing by Repositioning the Reluctor

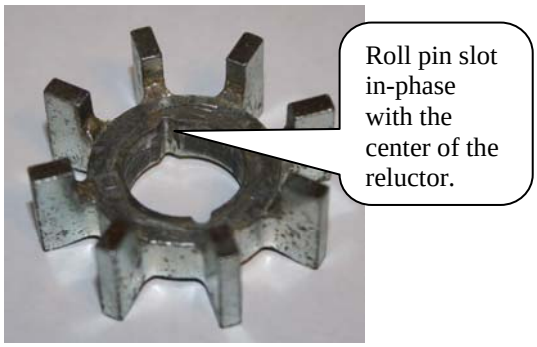
By re-positioning the reluctor on the distributor shaft, the rotor can be made to be in-phase with the distributor cap terminal at peak power. The table below provides two examples of how many camshaft degrees the reluctor needs to be ADVANCED on the distributor shaft.

Reluctor Repositioning Calculations for Cam Sync Applications		
Normally Aspirated Engine		
	BTDC	
Maximum Timing Advance Engine will See (high speed light load)	45^o	
Plus 5^o timing advance (buffer for ECU)	5^o	
Equals Crank Reference (angle) Value Inputted Into BigComm Software	50^o	
Cam Sync - Degrees Need Before Crank Reference	$+10^o$	Cam Sync and Crank Angle position cannot be the same or the engine will not run.
Equals Cam Sync signal Position	60^o	
Less Total Timing Advance Engine Will Operate under at Peak Power	-38^o	Want best rotor phase here!
Equals Total Degrees (Crankshaft)	22^o	
Total Degrees (Camshaft) the reluctor needs to be advanced on the distributor shaft for rotor and cap terminal to be "in-phase" at peak power	**11^o**	Convert Crank Degrees to Cam by dividing by 2
Boosted Engine		
Maximum Timing Advance Engine will See	40^o	
Plus 5^o timing advance (buffer for ECU)	5^o	
Equals Crank Reference (angle) Value Inputted Into BigComm Software	45^o	
Cam Sync - Degrees Needed Before Crank Reference	$+10^o$	Cam Sync and Crank Angle position cannot be the same or the engine will not run.
Cam Sync signal Position	55^o	
Less Total Timing Advance Engine Operate at	-20^o	Want best rotor phase here!
Total Degrees (Crankshaft)	35^o	
Total Degrees (Camshaft) the reluctor needs to be advanced on the distributor shaft for rotor and cap terminal to be "in-phase" at peak power	**18^o**	Convert Crank Degrees to Cam by dividing by 2

The following paragraphs explain how to reposition the reluctor on the distributor shaft of a MSD Pro-Billet distributor so that cap and rotor are in-phase at peak power.

Reluctor Re-positioning Procedure

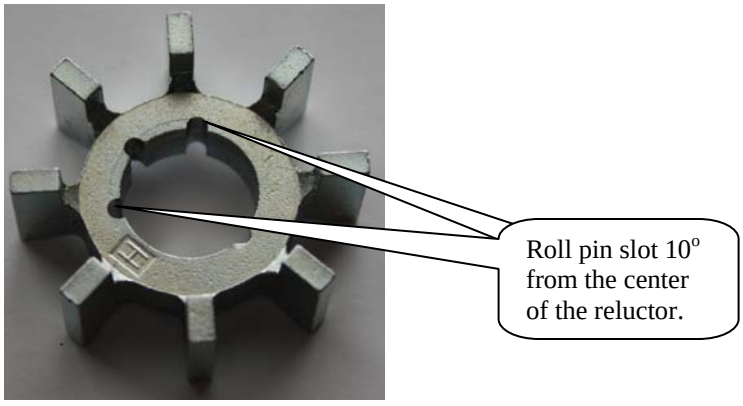
Start by removing the cam gear at the bottom of the distributor shaft by removing the roll pin with a 1/8" punch. Pull the distributor shaft out of the distributor housing. Remove the snap ring at just below the reluctor. Using a hammer and non-destructive punch, strike the reluctor circumferentially until it slides down the shaft, fully exposing the roll pin used to hold it in place. See the photos below.



BigStuff3 offers a reluctor with two (2) additional roll pin slots (see photo below **BigStuff3 Part Number JMI-007-012**), shifted approximately 10^{o} from the center of the reluctor tabs. One slot is 10^{o} (camshaft degrees) clockwise (CW) while the other is 10^{o} (camshaft degrees) counter clockwise (CCW).

If the number of degrees that the reluctor needs to be repositioned on the distributor shaft is more than 10^{o}, hand modifications will need to be made to the reluctor. The new pin slot needs to be the same width and depth as the original slot so that the reluctor does not move!

Reinstall the reluctor on the distributor shaft, using the correct slot for the engine rotation you have. Remember you want to ADVANCE the reluctor/pole piece while retarding the rotor. Then reverse the steps to disassemble the distributor to put it back together.



Installing the IPU Cam Sync (modified distributor)

Start by rotating the engine so that the number 1 cylinder is Top Dead Center (TDC) (compression stroke). Rotate the engine back or **B**efore TDC (BTDC) the number of crankshaft degrees equal to the "Crank Reference' value (crank trigger position BTDC described above) plus 10^o – 20^o. For example, assuming the "Crank Reference" is 45^o, plus an additional 10^o for the cam sync position, the engine needs to be rotated back to 55^o BTDC. Drop the cam sync (modified distributor) in, then "bump" the starter until it engages the oil pump drive while applying a light downward pressure. Once the oil pump drive is engaged, rotate the engine back to 55 degrees BTDC #1 compression. Turn the base of the distributor so that the center of the reluctor aligns with the pole piece. Once aligned, tighten down the distributor.

Note: The cam sync signal must never occur at the same time as the crank trigger signal. If this occurs, (due to belt stretch) the ECU will set the Cam_Sync error flag. You can record this in the Replay datalog. Once the Cam_Sync error is set, the individual cylinder timing corrections could jump to the wrong cylinder causing engine misfire.

The MSD modified distributor 2 wire connector must be changed to the 2 way grey male Metripack connector (included in IPU kits). Crimp the seals and female terminals on with the correct crimping tool. Use Packard crimper, PN 12014254 or MSD's Pro-Crimp Tool, PN 35051, with Weathertight Dies, PN 3509. Install the MSD modified distributor violet/black wire into cavity "A" of the grey Metripack connector and plug it into the 2 wire grey connector labeled "Cam" on the BS3 harness

Dynamically Checking Rotor Phasing

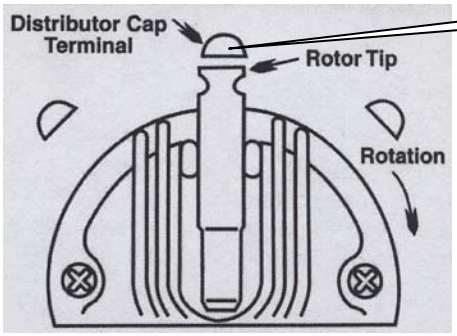


Illustration shows rotor in-phase with cap terminal

To check rotor phasing dynamically, the distributor cap will need to be modified so that the position of the rotor tip to the cap terminal can be observed when the engine is running. To do this, a large hole must be made in the distributor cap, near a terminal that can be easily observed. To help see the rotor tip, mark the top of it with white correction fluid. Install the modified distributor cap. Connect the timing light inductive lead on the plug wire going to the terminal with the hole near it. Start the engine and run it at a 3,000 RPM. Make sure the "Dash" timing value reads the desired timing for maximum power. You may have to set the values in the timing map to correspond to this. In our boosted timing example, make the all the values 20^o. Shine the timing light into the hole in the cap. The light from the timing light should show the rotor tip in-phase with the cap terminal at the timing for peak power (20^o in our boosted example above). See the illustration above. Most timing lights have somewhere around a degree of propagation delay so keep that in mind when looking at the tip

Type 3 - IPU Cam Sync Signal Distributor with a Crank Trigger Setup

Description of Events - Cam and Crank Input Signals

The Cam Sync signal, references the start of an injection or ignition firing sequence, and needs to occur 10^{o} - 20^{o} before the crank trigger signal.

The cam sync informs the ECU of the position of the number 1 cylinder and provides a signal to the ECU once per 360° of cam rotation. After the cam sync signal, the next input received by the ECU is the crank signal from the crank trigger.

Delay-Back vs. Feed-Forward Ignition Strategies

BigStuff3's GEN3 ECU uses a **"delay-back"** ignition control strategy.

Many competitive systems use a "feed-forward" strategy, where the ECU has to forecast, or predict, the next timing event, 90^{o} before it will occur. The ECU predicts the next timing event based on a constant engine speed assumption. If the there is a transient event, and the engine accelerates or decelerates the ECU's timing forecast or prediction becomes inaccurate, resulting in retarded or advanced timing.

BS3 employs a "**delay-back**" strategy, where the ignition timing forecast or prediction occurs within several degrees of the actual "Crank Reference" signal, thus significantly reducing timing fluctuations during transient events. The difference may not seem significant, but it can result in timing inaccuracies during conditions when accurate timing is critical!

The Crank Trigger setup will be described before explaining how to modify (if need be) the IPU Cam Sync Signal Distributor. An understanding of the "Crank Reference" (angle) is needed when considering the cam sync position.

Crank Trigger (wheel, and sensor assembly) Considerations

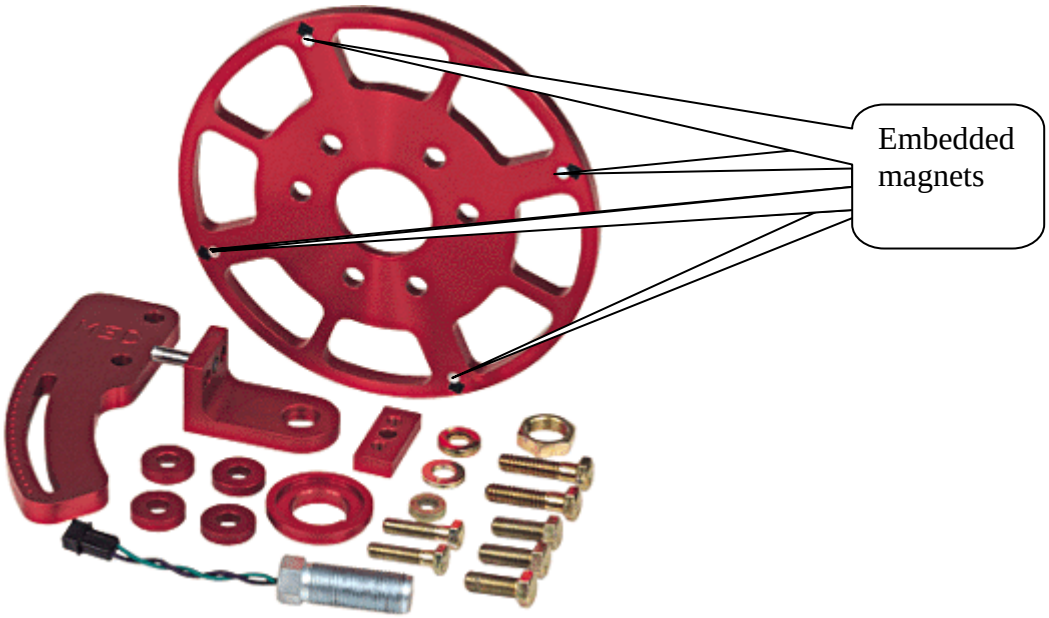
The number of magnets (or raised metal studs) the crank wheel should have is based on the number cylinders the engine has as shown below:

4-Cylinder Engine Example

The typical firing order for a 4 cylinder, 4 stroke engine is 1-3-4-2. To complete a 4-stroke cycle, the crankshaft rotates 720 degrees, or two turns. The cam shaft (ignition distributor), rotates at half-speed or 1 turn for every 360° of crank rotation. A four cylinder has 720/4=180 degrees between ignition firings.

Engine Cylinders	Number of Magnets in Crank Wheel	Magnet Spacing on Crank Wheel
8	4	90°
6	3	120°
4	2	180°

Some crank trigger assemblies use a crank wheel, with steel studs protruding from the wheel. As the crankshaft turns the steel studs pass by a stationary **magnetic** pickup, creating a sinusoidal wave, which is used to trigger the ignition. The potential exists for the magnetic pickup to false trigger. Other steel objects like bolts, debris and even vibrations can cause magnetic pickups to false trigger. False triggers can cause a loss of power and potentially damage the engine.
In order to avoid this problem BigStuff3 recommends using a system that has four magnets (for a V8) embedded in the trigger wheel. As the magnets pass by a stationary **non-magnetic** pickup a sine wave is created, which is used to trigger the ignition. The magnet-in-the-wheel design produces a more accurate trigger signal and will not create a false trigger, like magnetic pickups have to potential to do. MSD's "Flying Magnet Crank Trigger" system is an example of a magnet-in-wheel design, preferred by BS3.



The MSD Flying Magnet wheel and sensor assembly has a two-piece mounting bracket, used to secure the non-magnetic pickup that in most cases will work on either the passenger side or driver's side of the engine. The aluminum bracket is slotted to provide a wide range of timing adjustability to ensure the assembly can be set at between 45° – 50° BTDC.

Note: It is important that the pickup being used is compatible with crank wheel. If the crank wheel has non-magnetic studs, a magnetic pickup needs to be used. If the crank wheel has magnets, a non-magnetic pickup needs to be used. Do not use a magnetic sensor with a crank wheel that has magnets! Also, do not use a non-magnetic pickup with a crank wheel that has steel (ferrous metal) studs!

Crank Trigger Set-up

The easiest way to mount the bracket and non-magnetic pick-up assembly is to rotate the crankshaft clockwise until Top Dead Center (TDC) number 1 cylinder compression is determined. Next, rotate the engine back the number of degrees (BTDC) equal to the maximum timing advance the engine will run at, plus 5^o. For example, rotate the engine back 45^o (max timing advance of engine), plus 5^o or 50^o Before Top Dead Center (BTDC), number 1 cylinder compression. Next, mount the wheel, bracket and sensor assembly so that the crank wheel magnet and sensor are aligned or in phase. The air gap between the sensor tip and face of the crank wheel should be between .050" - .075". The crank trigger 2 wire connector must be changed to the 2 way black male Metripack connector (included in IPU kits). Crimp the seals and female terminals on with the correct crimping tool. Use Packard crimper, PN 12014254 or MSD's Pro-Crimp Tool, PN 35051, with Weathertight Dies, PN 3509. Install the crank trigger pickup green wire into cavity "A" of the black Metripack connector and plug it into the 2 wire black connector labeled "Crank" on the BS3 harness.

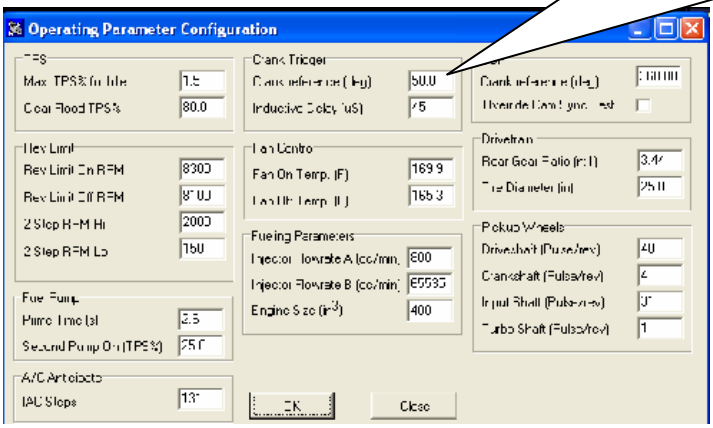
This crankshaft position (BTDC) is known as the "**Crank Reference" (angle)**. The "Crank Reference" (angle) is defined as the distance, in crankshaft degrees, between the crank wheel reference magnet, when it is aligned with the crankshaft position sensor, and Top Dead Center compression, number 1 cylinder.

For example, if the reference magnet is aligned with the crankshaft sensor when the crankshaft is 50^o BTDC compression number 1 cylinder, the crankshaft position value entered into the Crank Reference window must be 50^o. The "Crank Reference" (angle), needs to be inputted into the BigComm software Operating Parameters Configuration window, explained below.

"Crank Reference" Input

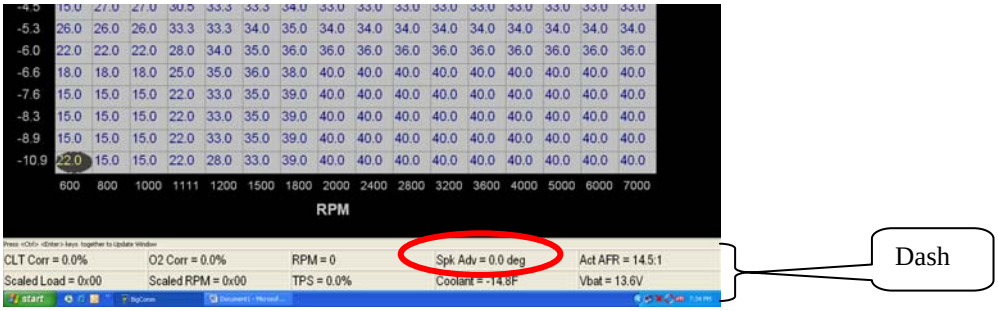
The "**Crank Reference**" input is perhaps the most important timing value entered into the BigComm software (see Operating Parameter Configuration screen print below). The crank signal tells the ECU where the engine is in relation to TDC compression, cylinder number 1.

"**Crank Reference**" window in the BigComm "Operating Parameter Configuration" Window.

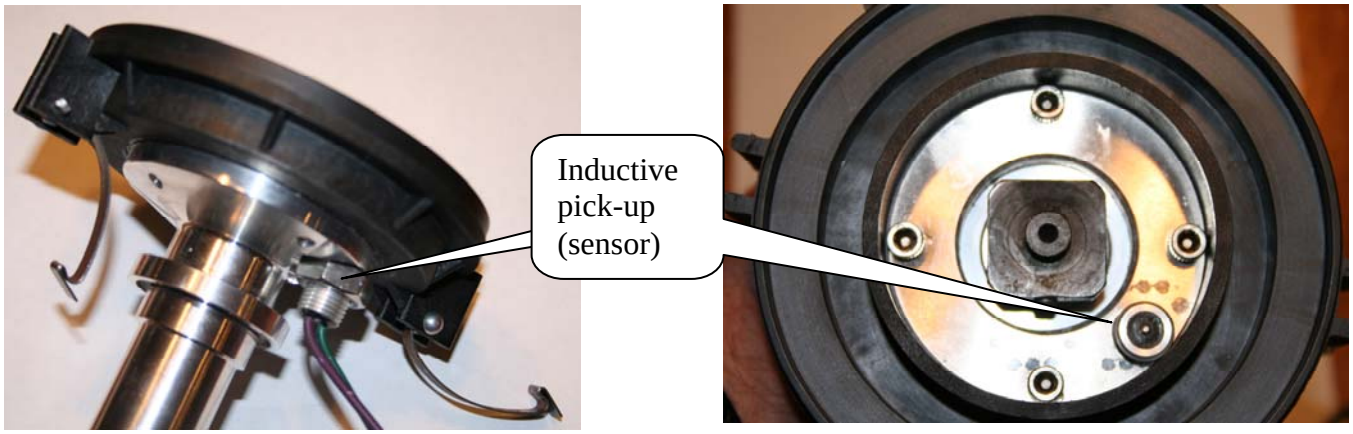


Once the crank trigger is installed and the engine is running, you must use a timing light to check the "**Crank Reference**" value entered into the BigComm software. The spark advance value displayed in the "Dash" window (see below) should match the value shown on the crank dampener. If they do not match, change the value in the " Crank Reference" window until the value in the "Dash" window matches the crank dampener value exactly. Set the Inductive Delay to 13 uS for 2 wire pickups.

"Dash" Window

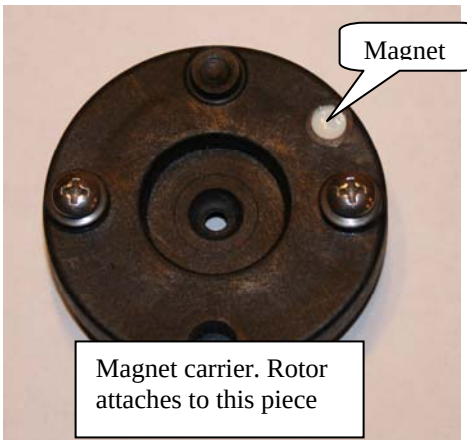


IPU Cam Sync Distributor
Shown below is MSD's cam sync distributor, part number 2340.



Installing the Cam Sync Distributor

The cam sync (signal) needs to occur 10^{o} – 20^{o} before the "Crank Reference" angle (see Crank_Reference described above). For example, if the "Crank Reference" angle is set to 45^{o} BTDC (number 1 cylinder, compression stroke), the cam sync should be installed between 55^{o} and 65^{o}'s BTDC.



Start by rotating the engine to the desired cam sync position (55 – 65^{o} BTDC #1 Comp). Next remove the distributor cap and rotor. While aligning the magnet with the Inductive Pick-Up (IPU) sensor, drop it into the engine. Note: Install the IPU Cam Sync Distributor making sure that it is installed in the engine in an orientation that allows the plug wires to be easily routed to their respective cylinders and that the leads (wires from the pickup) can be easily connected to the main wire harness. Make sure the distributor is seated fully. "Bump", the engine if need be, to engage the oil pump drive. Once fully seated, rotate the engine back to the desired cam sync position (55 – 65^{o} BTDC), then realign the magnet with the Inductive Pick-Up (IPU) sensor and tighten the base down.

Next you'll need to check/verify your rotor phase. Rotate the engine now to the timing desired for max power (20^o in our boosted example above) note where the rotor is in relation to the distributor cap terminal. It should be directly across. If not, and space allows, use a MSD "Cap-a-Dapt" to correct the rotor phase. If space does not allow for a "Cap-a-Dapt" then you'll need to reposition the magnet in the magnet carrier.

Repositioning the Magnet

You may have to reposition the magnet in the magnet carrier, if the rotor phase is unacceptable for the desired timing at peak power. Next, rotate the engine back to the 10-20^o before the "Crank Reference" (55 – 65^o BTDC). Once there, remove the magnet carrier and note the position of the Inductive Pick-Up (IPU) sensor and mark the magnet carrier where the IPU aligns. Remove the magnet carrier by loosening the center flush mount cap screw. Next drill and re-epoxy the magnet into the carrier at the new/marked location. Important: Make sure the magnet is reinstalled in the same direction! Note: the Inductive Pick-Up (IPU) sensor may have to be moved instead of the magnet, if there is not enough material to encapsulate the magnet in the new position.

Note: The cam sync signal must never occur at the same time as the crank trigger signal. If this occurs, (due to belt stretch) the ECU will set the Cam_Sync error flag. You can record this in the Replay datalog. Once the Cam_Sync error is set, the individual cylinder timing corrections could jump to the wrong cylinder causing engine misfire.

The MSD IPU Cam Sync Distributor distributor 2 wire connector must be changed to the 2 way grey male Metripack connector (included in IPU kits). Crimp the seals and female terminals on with the correct crimping tool. Use Packard crimper, PN 12014254 or MSD's Pro-Crimp Tool, PN 35051, with Weathertight Dies, PN 3509. Install the MSD IPU Cam Sync Distributor green wire into cavity "A" of the grey Metripack connector and plug it into the 2 wire grey connector labeled "Cam" on the BS3 harness.

Dynamically Checking Rotor Phasing

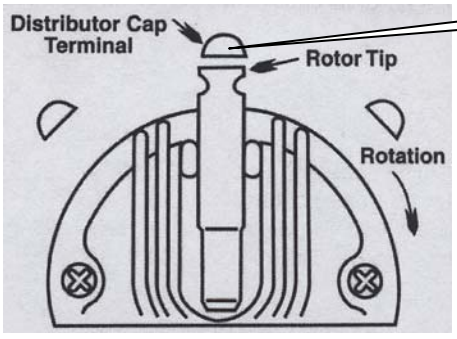


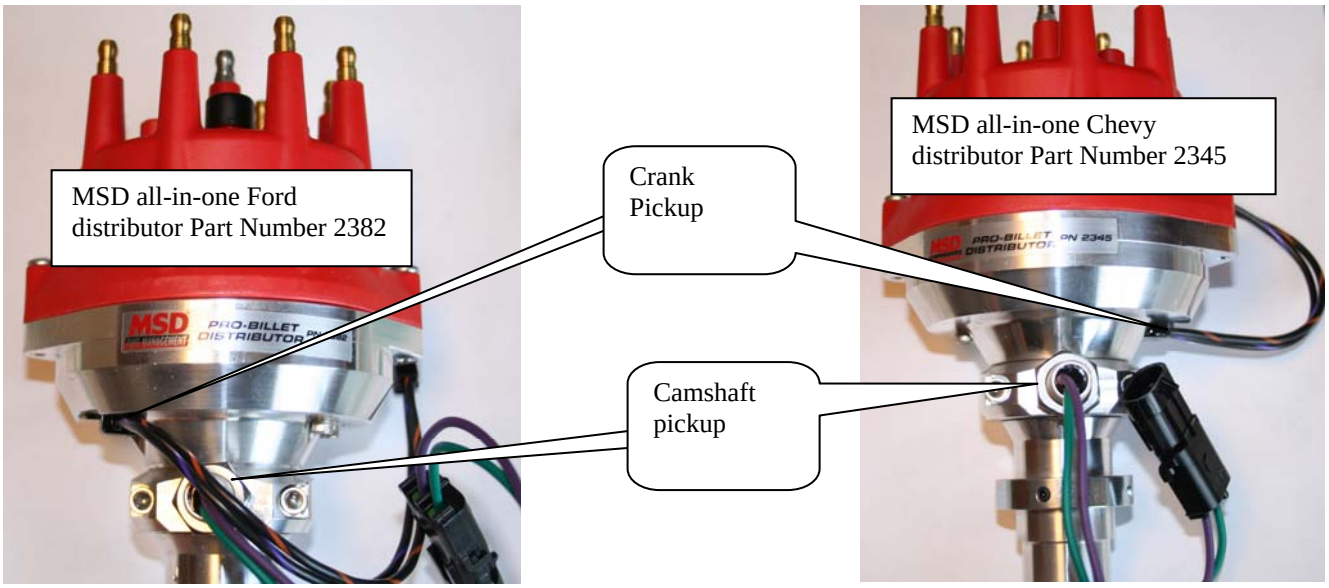
Illustration shows rotor in-phase with cap terminal

To check rotor phasing dynamically, the distributor cap will need to be modified so that the position of the rotor tip to the cap terminal can be observed when the engine is running. To do this, a large hole must be made in the distributor cap, near a terminal that can be easily observed. To help see the rotor tip, mark the top of it with white correction fluid. Install the modified distributor cap. Connect the timing light inductive lead on the plug wire going to the terminal with the hole near it. Start the engine and run it at a 3,000 RPM. Make sure the "Dash" timing value reads the desired timing for maximum power. You may have to set the values in the timing map to correspond to this. In our boosted timing example, make the all the values 20^o.

Shine the timing light into the hole in the cap. The light from the timing light should show the rotor tip in-phase with the cap terminal at the timing for peak power (20^o in our boosted example above). See the illustration above. Most timing lights have somewhere around a degree of propagation delay so keep that in mind when looking at the tip.

Type 4 - All-in-One, Crank and Cam Sync Distributor

Currently MSD makes two all-in-one cam and crank distributors (see below).

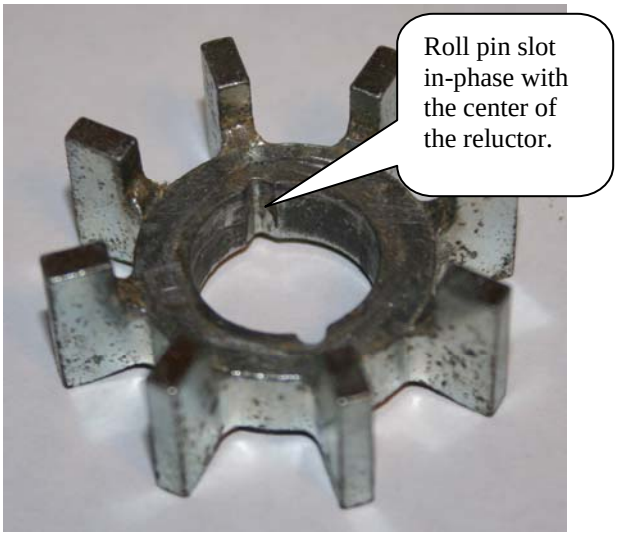


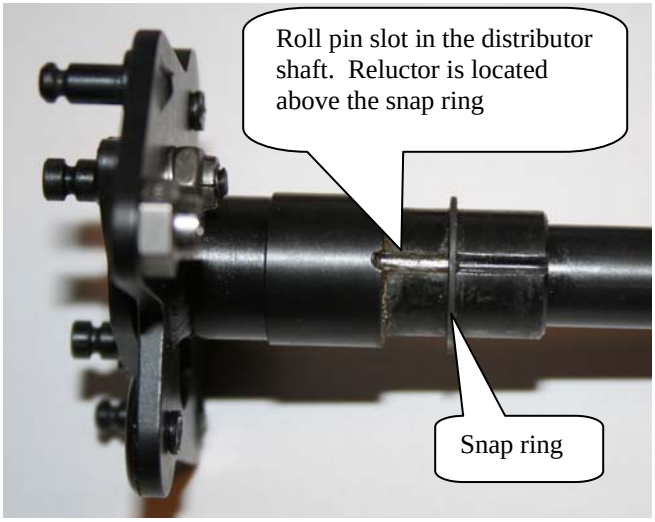
The All-In-One IPU distributor has both a cam and crank sensor built into a single unit.

The cam sync signal (every 360^o of cam rotation) allows the user to take advantage of cylinder "fuel-phasing" (controlling the point, BTDC, when the fuel is injected into the cylinder) and individual cylinder "timing control". With both of the All-In-One IPU distributors (PNs 2345 & 2382) you will need to change the reluctors to get good rotor phase for most applications.

Reluctor Re-positioning Procedure

Start by removing the cam gear at the bottom of the distributor shaft by removing the roll pin with a 1/8" punch. Pull the distributor shaft out of the distributor housing. Remove the snap ring just below the reluctor. Using a hammer and non destructive punch, strike the reluctor circumferentially until it slides down the shaft, fully exposing the roll pin used to hold it in place (see the photos below).





BigStuff3 offers a reluctor with two (2) additional roll pin slots (**BigStuff3 Part Number JMI-007-012)** See photo below. The slots are shifted approximately 10^{o} from the center of the reluctor tabs. One slot is 10^{o} (camshaft degrees) clockwise (CW) while the other is 10^{o} (camshaft degrees) counter clockwise (CCW).

Reinstall the reluctor on the distributor shaft, using the correct slot (one of two the 10^{o} offset slots) for the engine rotation you have. Remember you want to ADVANCE the reluctor/pole piece while retarding the rotor.

Reassemble the distributor and install it in the engine.

Installing the All-In-One Distributor

Start by rotating the engine so that the number 1 cylinder is Top Dead Center (TDC) (compression stroke). Rotate the engine back or **B**efore TDC (**B**TDC) the number of crankshaft degrees equal to the maximum timing advance the engine will run at, plus 5^o. Keep the example from above, assume the maximum advance you plan to run is 45^o (high speed/light load), add 5^o to this number. Drop the distributor into the engine, then "bump" the starter until it engages the oil pump drive while applying a light downward pressure. Once the oil pump drive is engaged, rotate the engine back to 50^o BTDC #1 compression. Turn the base of the distributor so that the center of the reluctor aligns with the pole piece. Once aligned, tighten down the distributor, reinstall the cap and wires.

The MSD All-In-One Distributor 2 wire connector (wires from the blue pole piece) must be changed to the 2 way black male Metripack connector (included in IPU kits). Crimp the seals and female terminals on with the correct crimping tool. Use Packard crimper, PN 12014254 or MSD's Pro-Crimp Tool, PN 35051, with Weathertight Dies, PN 3509. Install the All-In-One Distributor violet/black wire into cavity "A" of the black Metripack connector and plug it into the 2 wire black connector labeled "Crank" on the BS3 harness.

The MSD All-In-One Distributor 2 wire connector (green and purple wires) must be changed to the 2 way grey male Metripack connector (included in IPU kits). Crimp the seals and female terminals on with the correct crimping tool. Install the MSD All-In-One Distributor green wire into cavity "A" of the grey Metripack connector and plug it into the 2 wire grey connector labeled "Cam" on the BS3 harness.

Dynamically Checking Rotor Phasing

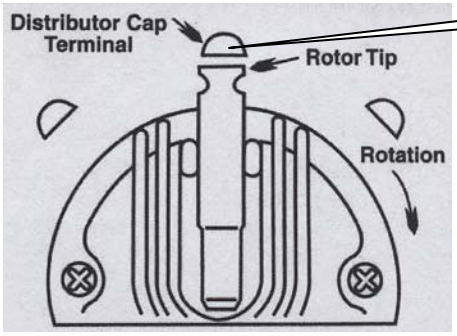
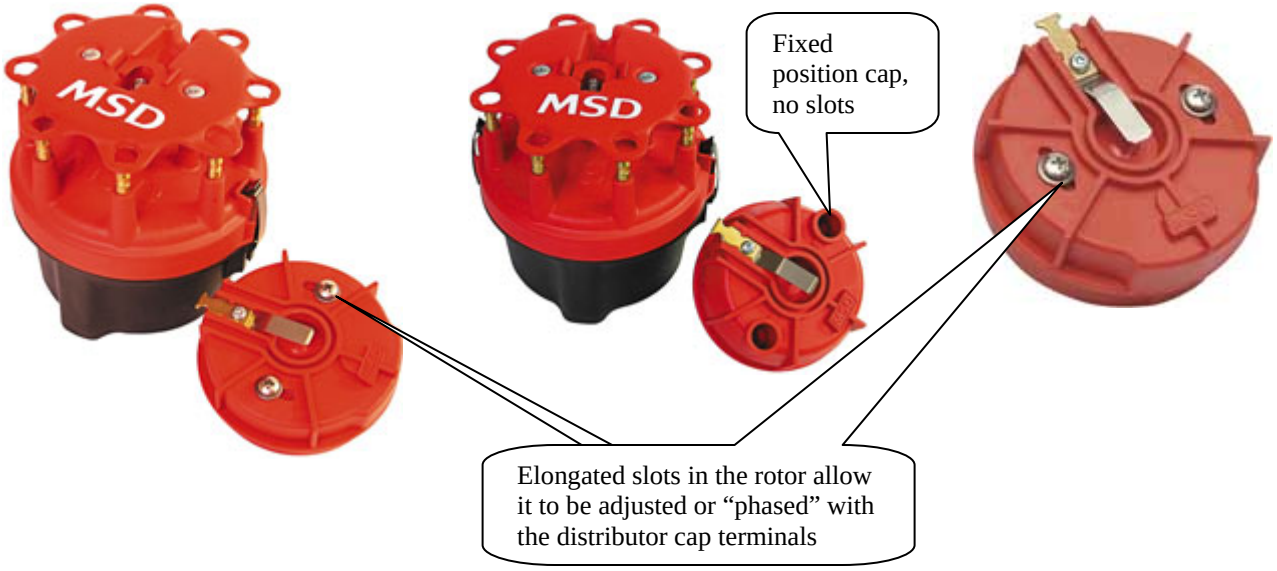


Illustration shows rotor in-phase with cap terminal

To check rotor phasing dynamically, the distributor cap will need to be modified so that the position of the rotor tip to the cap terminal can be observed when the engine is running. To do this, a large hole must be made in the distributor cap, near a terminal that can be easily observed. To help see the rotor tip, mark the top of it with white correction fluid. Install the modified distributor cap. Connect the timing light inductive lead on the plug wire going to the terminal with the hole near it. Start the engine and run it at a 3,000 RPM. Make sure the "Dash" timing value reads the desired timing for maximum power. You may have to set the values in the timing map to correspond to this. In our boosted timing example, make the all the values 20^o. Shine the timing light into the hole in the cap. The light from the timing light should show the rotor tip in-phase with the cap terminal at the timing for peak power (20^o in our boosted example above). See the illustration above. Most timing lights have somewhere around a degree of propagation delay so keep that in mind when looking at the tip.

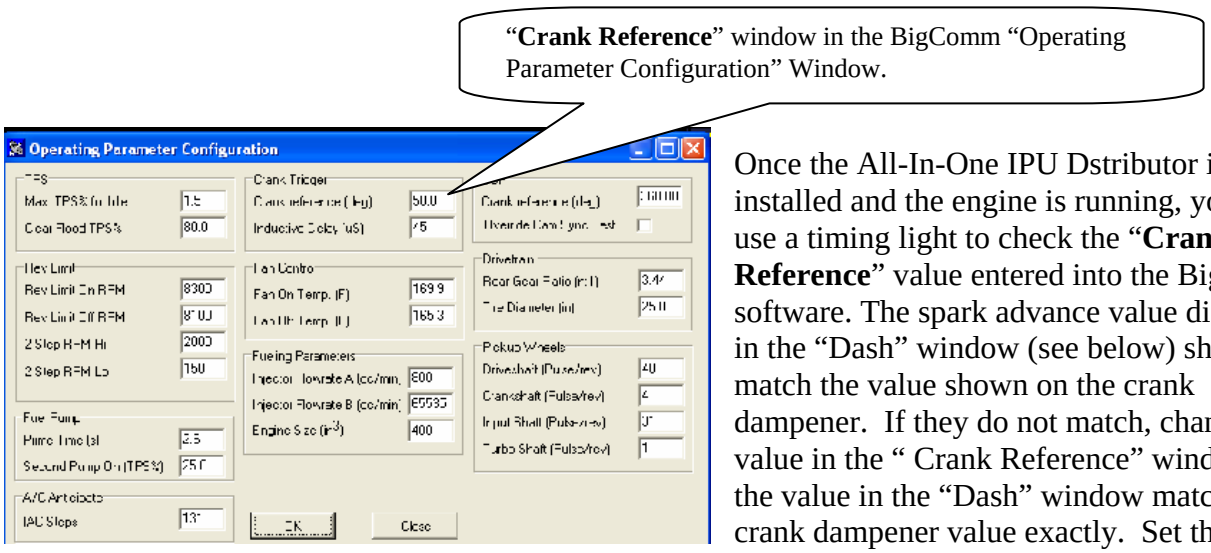
If you need to further tweak your rotor phase, the easiest solution to this problem is to use a cap and adjustable rotor system like MSD's "Cap-a-Dapt". MSD's Cap-a-Dapt kits adapt a large, Ford style cap onto an MSD distributor. The large cap spaces the spark plug terminals farther apart, which prevents the chances of cross-fire and ionization from occurring. The Two Piece Rotor allows the rotor tip to be adjusted so that it can be in alignment or "in-phase" with the cap terminal. The "Cap-A-Dapt"s will install on most MSD Billet and Pro-Billet Distributors (except the Ford FE, PN 8594).

MSD's Cap-A-Dapt, Small Diameter Distributors - PN 8441
Cap-A-Dapt, Adjustable Rotor PN 8420



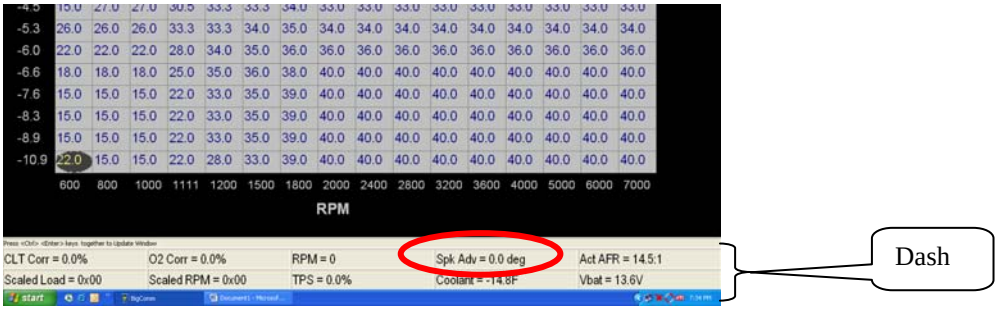
“Crank Reference” Input

The “**Crank Reference**” input is perhaps the most important <u>timing</u> value entered into the BigComm software (see Operating Parameter Configuration screen print below). The crank signal tells the ECU where the engine is in relation to TDC compression, cylinder number 1.



Once the All-In-One IPU Dstributor is installed and the engine is running, you must use a timing light to check the “**Crank Reference**” value entered into the BigComm software. The spark advance value displayed in the “Dash” window (see below) should match the value shown on the crank dampener. If they do not match, change the value in the “ Crank Reference” window until the value in the “Dash” window matches the crank dampener value exactly. Set the Inductive Delay to 13 uS for 2 wire pickups.

“Dash” Window



How to adjust the cam sync signal

In order to adjust the cam sync signal, loosen the 2 screws in the retaining collar. The collar should slide easily if the screws are loose enough. Add to the "Dash", the variable called CamCrkAdv. This variable displays in real time the relationship between the cam sync pulse and the first crank pulse. The reading is in degrees, adjust it to read between 10 – 20^{o} once the engine is running.

Note: In order for the value to move off of 0^{o}, the engine rpm must exceed 2000 rpm. This is the rpm above which the ECU tries to synchronize. If the reading stays at 0 degrees continuously regardless of the rpm, the cam sync pulse is not making it to the ECU. Check the wires for any disconnects/shorts. Because the cam sync window is so wide, it is possible that the synchronization could be occurring on the wrong cylinder. To verify that the synchronization is correct, go to the individual cylinder timing control calibration and retard the timing on Cyl. 1 by 10^{o}, with the timing light verify the timing retards on Cyl.1. If not, slide the cam sensor the other direction until it again reads between 10 – 20^{o}.

Now reverify the individual cylinder retard on Cyl.1. If the timing now retards, the system is synchronized and no Cam_Sync errors should occur. Lastly tighten the 2 screws in the retaining collar.

You can also type the letters " B A L" simultaneously and a real time display of the synchronization status will appear in the upper right toolbar. If the synchronizer is grey and is rotating eccentrically, everything is alright. However, if it's red, problems exist. Note: Remember the engine rpm must exceed 2000 rpm before synchronization is attempted in distributor based ECUs. So the synchronizer will be red initially below 2000 rpm. The individual cylinder timing retard still needs to be verified, even though the synchronizer is grey. This is just a quick test to see if synchronization is taking place. Important: For COP ECUs (LSx and Mod Motor engines), the synchronization status is provided immediately during cranking, so there is no need to rev the engine to 2000 rpm.

Test timing feature

Bigstuff3 has also added a "Test Timing" feature that allows the enduser to enter a value to adjust the "Crank Reference" quickly. It is located in the Operating Configuration next to the "Crank Reference" parameters. By doing this the need to enter a fixed value into the timing map is eliminated. Usually the "Test Timing" calibration value is set to 30^{o}, the enable button must be checked to invoke this feature. Once enabled, the "Crank Reference" is adjusted up or down to get the "Dash" (Spk_Adv value = 30$^{o)}$ to agree with the timing on the dampener. A timing light must be used to verify this. The "Test Timing" value is invalid once the TPS exceeds the Clear Flood TPS for safety reasons (in case someone forgot to disable it), and during cranking. This feature could also be enabled as a quick way to verify the rotor phase at timing for peak horsepower. Just enter the timing for peak horsepower instead of the suggested 30^{o}.

HED Cam Sync Transducer

BigStuff can also supply a hall effect transducer (HED) and magnet for DIY cam sync pulses (**PN JMI-007-013**). See picture below. The HED output is ideal for near zero speed sensing applications. It can be used to provide the cam sync pulse to adapt Coil on Plug ignition systems to virtually any application. It may also be used in place of the 2 wire pickup on MSD All-In-One Distributors (PN 2345 & 2382).