The Unofficial SmartCarb® Tuning Guide

Version 3.00

By

Barry Jackson

I've taken my own SmartCarb® experiences and tuning efforts and combined them with others that have been noted on various forums, and compiled them into a single one-stop guide for those who want to get the best out of their SmartCarb®.

This is Version 3.00. In it I have added a "So, How Does It Actually Work" section and a "Frequently Asked Questions (FAQs)" section.

The main emphasis is on "Basic setup", and I've tried to boil it all down into one prioritized list of suggestions to help you get your SmartCarb® running the way you want, even if it's in extreme cold. The Design, Troubleshooting, and FAQ sections are all works-in-progress and will be enhanced as I gain experience or learn more on my own or through others. And yes, I did run it by Technology Elevated for their suggestions and clarification, but it's not their guide, its mine. You'll have to ask them whether they endorse it.

Now on to the good stuff…

Basic Setup

Remember that your SmartCarb® is a precision instrument with high resolution adjustment, compared to the stock carbs. A few thousandths or millimeters in the setup can make all the difference in how your engine performs while starting, or idling, or riding at speed. Make changes in SMALL increments and you'll find the sweet spot more quickly and with less frustration than if you make large changes. ***I can't over-emphasize this.***

Clicker adjusting hint for KTM 2 Strokes: try adjusting the SmartCarb® clicker from the right side of the bike (i.e., the throttle side). It's way easier to reach and feel the clicker action. If the pipe is hot, lay a glove over it while you are making an adjustment. Crank the handlebar around and work the throttle with your left hand and the clicker with your right hand.

1. If you are dealing with a new, out of the box SmartCarb® and have made no changes, the basic setup should be very close to right on. If you are like me, you might have fiddled too much with those settings on initial startup and inadvertently moved too far away from the sweet spot. In any event, Technology Elevated keeps a master list of all carbs with the original settings and application and can be called for reference. Try to avoid making any changes (even if it's a high idle) beyond any tiny ones necessary to get a persistent idle so you can get in a bit of riding.

a. If you or your buddies couldn't resist taking the slide and clicker apart, you may need to put everything back to where it was when delivered. In particular, the throttle return spring that pushes the slide down is a less obvious, but critically important part that you need to assure has not been bent or distorted.

   If you damage that spring it could change the way the throttle feels when it's all put back together. Worst case, a bent or kinked spring could cause a sticking throttle and that could be bad in the worst kind of way. DON'T DO ANYTHING THAT MIGHT COMPROMISE THE SPRING'S INTEGRITY.

2. Make sure your throttle cable slack is capable of allowing the slide to completely bottom out. Then take up enough of that slack to avoid any possibility that the cable end could escape it's holding slot when the slide is ultimately set to your preferred (and presumably the correct) running position.
   a. Since the 36mm and 38mm SmartCarbs® have slightly taller venturi's than a stock carb, your throttle cable might be too short to allow bottoming of the slide unless you remove some of the adjuster locking nuts from the cable ends. This is rarely a good idea.
   b. If your cable won't adjust enough to allow the slide to bottom and still retain the adjuster locking nuts, bite the bullet and get a Motion-Pro 10-3000 cable (that's the number that works for KTM 300s; I don't know if other bikes would use a different Motion-Pro cable). It's 4 inches longer than stock and has plenty of adjustment to allow the slide to bottom and still retain the adjuster lock nuts.
   c. If you use the Motion Pro 10-3000 cable, be sure to remove the OEM cable fitting in the SmartCarb® slide cap; screw the new cable all the way into the cap and use the lock nut to secure it. There will still be enough adjustment at the throttle to allow any slack adjustments that are needed. If you don't remove the OEM fitting, you may not have enough slack to make the proper slide height adjustments.
   d. On some of the earliest (Revisions C,D,E. As in 3838AC_000) SmartCarbs® if you back the idle screw out too far you will need to lift the slide high enough for the idle screw to find the slide resting point when re-setting the idle screw back to its previous setting. If you don't do this and inadvertently turn the idle screw in on the resting point without raising the slide slightly you can force the idle set screw into the side of the slide and lock up the slide and /or distort it enough to disable it. The later revisions of the SmartCarb® don't present this concern.

3. If you've already made adjustments to the idle screw but don't know where you started, here are a couple of measurements to get you back in the ballpark. You'll need a dial caliper to set these dimensions. If you don't have one, get one; they are fairly cheap and are a useful tool for many things. The positioning of the idle screw discussed below is intended to produce a slide height setting of 2mm, which is the target height to begin any carb setup efforts for the 36mm and 38mm SmartCarbs®.

a. First a word about the idle screw dimension vs. slide height. The idle screw dimension is given as a way of getting close to the correct slide height without having to take anything apart. There are many things that could make the "proper" idle screw dimension vary from what I've given below: manufacturing tolerances, design changes from version to version of the SmartCarb®, wearing-in of parts (slide groove and idle screw point), inconsistent measuring of the idle screw dimension when trying to set it, and so forth.

   For these reasons it's important to be aware that the slide height dimension trumps the idle screw dimension. If the idle screw dimension is not working for you (too low or no idle, etc.) stop using it and set the slide height as detailed in steps 3.e or 3.f below. When you are through setting the slide height, make note of the then-existing idle screw dimension so you'll have an easy way to get back to a starting slide height dimension that works for your SmartCarb®.

b. Billet 36mm & 38mm – the basic Idle screw dimension is .730 inches from the top of the Idle screw to the body of the carb. This dimension should be close enough on the 40mm too, but see 3.d or 3.e below if you want to verify by setting the slide height directly.

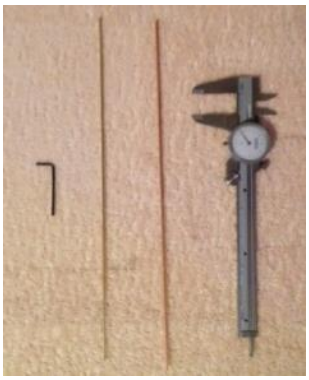
c. Cast 38mm – the basic dimension is .955 inches from the top of the idle screw to the body of the carb. On the 38mm Cast SmartCarb® there is a boss that the Idle screw spring rests in. This boss is not used as the measurement point to set the .955 inch dimension. The measurement is taken at the body of the carb.

   This dimension should be about the same for other versions of the Cast carb, but again, you can verify by directly setting the slide height according to 3.e or 3.f below. See the picture above for an example, on a 36 mm Billet, of the measurement points from the top of the idle screw to the body of the carb.

d. The target slide height dimensions discussed below are just that - targets. But make no mistake about it: if you don't get the slide height very, very near these targets you are likely to find yourself chasing lean or rich running symptoms, and may not experience optimal

power, fuel economy, and throttle responsiveness. The slide height is the vital setting; the idle screw dimension is a convenient setting to allow you to quickly arrive at the proper beginning slide height for setting up your carb. Remember the Mantra… "precision instrument".

e. Verifying the correct idle screw setting takes more work if your carb is already installed. You need to remove the air filter and get into the air intake enough to measure the height from the top of the slide's air cutaway to the bottom of the carb's throat. It should be set to 2mm (about .078 inches) for the 36mm and 38mm SmartCarbs®.
    i. An easy gauge to make the 2mm measurement is a 2mm Allen wrench. You may need to tape the Allen wrench to a screw driver to reach the slide on some KTM models. Be sure to measure with the Allen wrench positioned on its flats, not its points.
    ii. Another easy gauge is found at your local hobby shop. If the hobby shop supports RC cars and aircraft, they are very likely to carry a selection of small metal tubing and metal rods that will work as gauges. I found 2mm brass rods that are plenty long enough to use as gauges for about $2.75.
f. The 40mm has a little taller throat, and needs a little taller gap between the slide's air cutaway and the throat bottom, so it should be set to 2.3mm (about .090 inches).
    i. For the 2.3mm measurement (.090 inches) on the 40mm SmartCarb®, I'd go looking at your local hobby store for some 3/32 round copper tubing (this tubing is 2.38mm or about .0925 inches in diameter). These tubes are close enough in diameter and long enough to use as gauges from inside the carb's air boot.
g. Here's a picture of some possible tools to use as the gauge for measuring the slide height. Left to right:
    i. 2mm Allen Wrench alternative for setting slide height on 36mm and 38mm carbs
    ii. 2mm Brass Rod alternative for setting slide height on 36mm and 38mm carbs
    iii. 3/32 (2.38mm) Copper Tube for setting slide height on 40mm carbs
    iv. Dial Caliper set to .730 inches for measuring distance from top of the Idle screw to the body of 36 and 38 billet carbs. For Cast 38mm carbs the distance is .955 inches.



4. If you have your slide height in the correct range, or if your idle screw and clicker settings are the same as from new, try to avoid changing them, if you can, for the first couple of hours of riding. The

metering rod and nozzle (remember – precision instrument) need to lap into each other to arrive at what will be their "normal" relationship to each other.

a. This takes anywhere from a few minutes to a couple of hours of riding.
b. When the carb is brand new, the idle might be set a little high, in order to allow a persistent idle while the lapping process is underway, and it may go higher as the lapping takes place. In those cases, you might want to progressively reduce the idle speed with the idle screw. Again this will most likely only require tiny adjustments to keep the idle in a usable range. While making these idle adjustments on a new carb, resist the temptation to fiddle with the clicker until the lapping process settles down.
c. When the SmartCarb® components settle in and stop needing further adjustment, you are ready for your final setup. On my 2008 KTM 300 XCW this took about a half hour to an hour of riding.

5. When the initial lapping in process is done, double check and if necessary reset the slide height to the recommended dimension. Either measure the slide height directly, or use the Idle screw dimensions mentioned above to set it. When using the idle screw dimension, if the engine won't idle at that slide height, before changing the idle screw setting, verify that the clicker setting is at or near the sweet spot.

    a. Probably the easiest method to get in the ballpark for finding the sweet spot on your carb is the "whack throttle/lean-bog" test. Once you have the slide height set in the correct range (see 3.e and 3.f above) and the engine is warmed up, whack the throttle wide open as quickly as you can and return it to closed. I emphasize that this must be done as quickly as you can manage. If you don't do it quickly enough you won't recognize the lean-bog even when the clicker is set lean enough.

        When I say "the engine is warmed up" I mean ridden until the engine is at its normal operating temperature if at all possible.

        When whacking the throttle open, if you don't notice a lean-bog then keep leaning it one click at a time until you do get an obvious lean-bog. Once you get the bog, start richening the clicker one click at a time and whack the throttle again, repeating until the lean-bog no longer occurs. When the lean-bog disappears completely you should have a really crisp throttle response, and perhaps a high idle.

        At this point you should be very near the sweet spot. Keep richening the clicker one click at a time until you have a responsive throttle and a strong idle (the idle will probably be lower than when you first eliminated the lean-bog). My experience has been that I usually obtained a strong idle and a responsive throttle within 5 clicks to the rich side after initially eliminating the lean-bog.

Now would be a good time to take a plug reading in the 1500 to 3500 RPM range to verify that your setting is nearing (or on) the sweet spot. If you go too far to the rich side you may get a noticeable rich burbling sound when opening the throttle.

b. This difference between bogging and burbling can be subtle regardless of what kind of carb you're using, so I use the die-off test to confirm that the metering rod setting is near the sweet spot. Obviously, for the die-off test to work you will have to set the idle at least high enough to keep running until the test is completed. However, I caution you to be sure your slide height is in the 2mm or lower range. Too high a slide height setting may not yield a useful result in the die-off test.
c. The die-off test: with the engine warmed up, turn off the fuel at the petcock. Let the engine idle until it dies. What you are listening for is a change in the RPM of the idling motor in the final seconds, as the last of the fuel is sucked from the float bowl. Sometimes this RPM change can last as long as 30-45 seconds, other times lasting only 5 or 10 seconds; still other times it can sound like a recurring pattern of slight but prolonged surging as it dies-off.
    i. You are looking for a very slight rise in RPM at die-off (25-50 RPM). That result will put you very near the sweet spot. Here's a link to a video demonstrating what the sweet spot die-off sounds like.
    ii. If the RPM just dies off with no elevation, the metering rod setting is on the lean side. Here's a link to a video demonstrating what the lean die-off sounds like.
    iii. If the RPM obviously elevated at die off, sort like a hanging idle for a couple of seconds, the metering rod is set on the rich side. Here's a link to a video demonstrating what a slightly rich die-off sounds like.

6. When the metering rod is near the sweet spot, making tiny changes in the Idle speed setting can get you to a solid idle without significantly compromising the slide height. When the slide height is at or very close to the 2mm setting and you have a persistent idle, you may have to make a 1 or 2 click adjustment to the metering rod to attain the throttle crispness you desire.

7. You should be able to attain a solid idle in the range of 1100-1500 RPM (or possibly lower). This setting of the slide height and adjustment of the idle speed is a round-robin kind of thing. I call it "the dance". Repeat it until you have the lowest slide height that will support a persistent idle and crisp throttle response. The slide height should be very near to or lower than the 2mm dimension. When you're there, you're done. The SmartCarb® will take care of the mid and upper RPM fuel mixtures automatically.

   If for any reason you have the slide height and idle speed working right and you are getting anything other than good clean running at mid and upper RPM ranges (i.e. detonation, pinging, lean overrun, loading up, etc.) don't be silly and run it into the ground anyway. These are signs that something else is wrong and it needs to be attended to.

a. Here's a "Top Ten" list of some likely possibilities:
    i. You installed a spark plug that's way out of the proper heat range for your stock or modified engine, or the spark plug is worn out, or its gapped way wrong
    ii. Your air filter is seriously blocked with dirt or mud or caked with dust, or your muffler is blocked or in need of a re-pack.
    iii. Your gas tank air vent or check valve isn't working properly
    iv. You have a fuel filter that's partially blocked
    v. You are using really crummy fuel, or the wrong fuel combo (i.e. pump + race gas) for your kind of riding or engine mods
    vi. You are overheating; check the radiator, thermostat, and hoses for proper operation
    vii. You are underheating; check the thermostat (if there is one) for proper operation
    viii. You have some kind of air leak in the intake tract, or the reed valves are not functioning properly
    ix. You significantly modified your engine in some way that wasn't made known to Technology Elevated when you ordered your SmartCarb®, or you modified it after you got your SmartCarb®
    x. Your engine is seriously worn out and needs mechanical maintenance

8. If, after getting these suggested carb setup settings working on your bike, you are still having trouble starting it, there is one more set of suggestions I have to offer. They may sound stupid, but they are not. Take a deep breath, un-grit your teeth, and focus. I'll tell you why these techniques are important if you are using a SmartCarb®.

    a. When starting, whether you are using the choke (cold start) or not, DON'T TOUCH THE THROTTLE. This applies to e-starting and kick starting equally. After 50+ years of riding 2 strokes, this was the hardest habit to break. It's built into my DNA to give a little touch of throttle as I turn the motor over. It is so ingrained I had to train myself not to get close to the throttle when starting, so now I just grab the handlebar elsewhere.
        i. Why is this so important? Because the SmartCarb® relies on getting a good signal from the airflow that passes thru the slide cutaway, and the airflow passing thru the choke circuit if you are using the choke.

            If you roll the throttle open at the exact moment that the airflow signal is drawing fuel out of the float bowl, you will stop the fuel from being pulled out. Now the slide is open too much for the fuel to flow out of the nozzle, AND open far enough that the choke circuit is also unable to draw fuel (because the choke circuit only works most effectively when the metering rod/nozzle circuit is working effectively). **Blipping the throttle effectively kills the fuel draw you need to start the motor**.
        ii. Once I understood this my starts became instantaneous pretty much all the time, if I just left my hand off the throttle.

Now, just 'cause I can, every once in a while when I'm walking by my bike in the garage I'll hit the starter, no choke, no turning the gas on, no throttle, and it starts instantaneously and idles strongly. Here's a link to a video demonstrating a walk-by cold start. The video is amateurish, I know, but the walk-by cold start, now that's cool.

b. Long-time two stroke riders know this next suggestion regardless of whether they have ever used a SmartCarb®, but those coming from a 4 stroke background may not have made it part of their style yet. If you are using a kick starter, you have to kick it through sharply. Hammer it through like you are trying to ring the carnival side-show bell and your girlfriend is watching. You need either a strong battery, or a strong leg, or both when starting any 2 stroke.
    i. Again, why does this matter? A two- stroke relies on sucking air-fuel mixture into the crankcase during the piston's upward stroke. The more vigorous that upward stroke is, the higher the suction and the more likely it is that the air-fuel mixture is going to be at a combustible ratio.

    Both stock carbs and SmartCarbs® rely on a good vacuum signal from the piston to draw the right amount of air and fuel into the crankcase. A lazy kick or a weak battery might not get the job done. An "all-in" kick is especially needed on the older big boomer 2 strokes (400cc to 500cc + motors) that never had e-start. So, kick hard.

    ii. Old-timey 2-stroke riders will remember from the days before e-start that our engines got harder and harder to start as we got weaker from overcoming the trail obstacles (muck-holes were always my nemesis). The less energy we could put into kicking the engine thru the more kicks it took to get it going again. Kicking hard does matter.

Additional hints and setup for starting in extreme cold:

1. Do the basic stuff above first.
2. The first hint is to rotate the throttle wide open 4-5 times with the gas on and the choke on (dead engine). This helps draw some added fuel up the nozzle to participate in the enriched cold-start mixture. Try to start with the choke on. Don't touch the throttle until after the engine fires.
3. Try the "Rocking" technique. This technique only works on a 2 stroke motor (because of the design of the engine's fuel draw cycle). This technique often works outright without resort to any of the other techniques that follow below. Even if it doesn't work as the sole solution to a cold start effort, it will enhance the other techniques listed below. It is equally useful in cold starting even if you are still using the stock carb.

Here's the "Rocking" technique:

a. Turn on the gas, and pull the choke open.
b. Put the bike in 2nd or 3rd gear. With it in gear, rock the bike back and forth enough for the piston to bump up on compression in both the forward and backward directions. Each bump up on compression, forward or backward counts as a "rock".
c. Sometimes it will only require 4 or 5 "rocks". Other times, usually as the air temperature gets colder, it can take 20 or 30 "rocks". When you've completed the rocking, put the transmission in neutral and hit the starter or give it a good kick (or several). When performing the rocking technique on a SmartCarb®-equipped bike, **do not touch the throttle until the engine fires off**.
    i. In my experience, if you have rocked the bike enough times, it will start within one or two kicks (or a couple of short bursts on the e-start).
    ii. Don't bother to kick beyond 20 kicks or so. If it's going to work without resort to any of the other suggestions below, it'll work within 20 kicks.
    iii. If you are using electric start, stop before you wear out the battery, so you still have some power left when you try the other suggestions below.
d. If you have a Rekluse auto clutch this technique will still work, as there is enough clutch drag when the engine is not running to bump the piston back and forth.
e. If the "Rocking" technique doesn't work, or you just don't want to try it, move on to the next technique, below.

4. Screw the Idle screw out a half turn or so, to drop the slide all the way down as far as it will go. Adjust the throttle cable slack to allow the slide to bottom out, if you need to. When the engine fires, keep it running by blipping the throttle.
    a. Dropping the slide to its bottoming position gives the metering rod/nozzle a stronger signal and causes more air-fuel draw
    b. It also insures the choke circuit gets the best possible signal and causes more choke air-fuel mixture to be available to enhance and enrich the mixture being drawn in from the metering rod/nozzle
    c. Once the engine is running and warmed a little, turn the Idle screw back in, to its previous position.
    d. On some of the earliest (Revisions C, D, E. As in 3838AC_000) SmartCarbs® if you to back the idle screw out too far you will need to lift the slide high enough for the idle screw to find the slide resting point when re-setting the idle screw back to its previous setting. If you don't do this and inadvertently turn the idle screw in on the resting point without raising the slide slightly you can force the idle set screw into the side of the slide and lock up the slide and /or distort it enough to disable it. The later revisions of the SmartCarb® don't present this concern.
    e. If you loosened it, adjust the throttle cable slack back to its previous position.

5. Reports from those who ride in the extreme cold, including me, say that after the 1st start the engine will start in a normal fashion for the rest of the ride (assuming you don't let it cold-soak again for several hours)

6. If it still fails to start, using starting fluid in the air boot has been reported to work down to at least 0 degrees Fahrenheit

7. If none of this works for your extreme cold starts, it's worth checking the operation of the tip-over valves (often called the floaty balls) if you have an earlier model of the SmartCarb. On some earlier models these valves can become stuck to the valve seats in the shut off position, preventing the float bowl from venting, which prevents the fuel from flowing into the float bowl. This is an unusual condition, and the vast majority of SmartCarbs do not exhibit any sticking of the floaty balls. If this happens, the engine won't start due to lack of fuel flow through the nozzle, or if the engine does start, it quickly stops and won't re-start. Tapping lightly on the float bowl and/or simultaneously blowing in the air scoop will usually unstick the valves. The proper cure is to return the carb to Technology Elevated and have revised tip-over valves utilizing the latest seats installed.

If these hints and suggestions don't get you into the neighborhood of the sweet spot, there is likely something else contributing to your difficulty.

Virtually all carbs are sensitive to air leaks anywhere in the engine. When a carb is properly set up and fails to perform as expected, often the carb is really unmasking some other problem, such as air leaks. When I say "air leaks anywhere in the engine" I include things like cracked intake boots, cracked or leaking reed cages and reeds, leaking base gaskets on the cylinder, leaking head gaskets/o-rings, really worn out rings and/or piston, leaking exhaust o-rings/gaskets, gaskets on the carburetor itself, case gaskets, crank seals, and on and on. These possibilities need to be considered in any troubleshooting regimen and addressed if found.

However, lest you think you need to rebuild your engine before you will be satisfied with your SmartCarb®, I want to point out that my bike, the one used in the demo videos for this guide, is a 2008 KTM 300 XCW. It's now 7 years old and has never had any mechanical work done to the engine. No new piston, no new rings, no new gaskets, no new seals, no nothing. I typically put on about 1000 trail miles in a season.

With the SmartCarb® my bike runs better than it ever has: no spooge, noticeably more power, dramatically better gas mileage, instant starting, wonderful throttle response, and to top it off once I hit the sweet spot I haven't had to make any further adjustments to compensate for the varying altitudes I occasionally ride at. My last top speed run with the SmartCarb® indicated 94 MPH and was still accelerating when I ran out of room.

If you think that sounds a lot like the benefits you'd expect from Direct Fuel Injection (DFI) on a two stroke, then we think a lot alike. The difference is that the SmartCarb® is here now, and can be

retrofitted to most any 2 stroke, and compared to the price you would pay in money and complication for Factory FI (if it ever gets here for our 2 stroke dirt bikes) the SmartCarb® is likely to be radically less expensive and less complicated. I bought my SmartCarb® on the chance that it would live up to just one of those claimed benefits (altitude compensation), but it's turned out to be good enough for me to stop waiting for a fuel injected 2 stroke. So, I bought another SmartCarb® and a 2015 KTM 300 XCW 6 Days to go with it.

If you are having continuing setup or tuning issues with your SmartCarb®, get in touch with Technology Elevated and follow their advice. As mentioned earlier, Technology Elevated keeps a master list of all carbs with the original settings and application and can be called for reference.

Design

This is a discussion of the SmartCarb's® design from a layman's perspective (mine) and in my own, perhaps inadequate, words. I offer my apologies in advance if I offend any engineers out there with my potentially lame explanations. Here goes…

To promote the most appropriate air/fuel ratios to obtain the greatest power, fuel efficiency, and low emissions, the SmartCarb® uses several design elements that are a result of new innovations and the extension of previous single-circuit carburetor developments. Some of these are discussed briefly below.

The Four A's

Airflow

Venturi shape:
You'll notice the rather complex shape of the venturi on the intake side of the SmartCarb®. This shape is meticulously designed to focus the highest airflow toward the region of the nozzle where it comes through the floor of the venturi. This focus promotes airflow and dispersal of the fuel into the most turbulent portion of the high speed airstream and helps keep the fuel suspended in the airflow, yielding a very high level of fuel atomization (even better than fuel injectors).

Without an effective and efficient dispersal of the fuel into the high speed air flow, the fuel charge would unnecessarily wet down the walls of the intake, reducing the effective atomization, and wasting a portion of the fuel by removing it from suspension in the air flow. These things, atomization and efficient suspension of the fuel charge, contribute to an increase in power and fuel economy and are promoted by the venturi shape. Simply put the SmartCarb® moves the air and fuel to the engine more effectively and efficiently than any other carburetor.

Slide design:
In looking at the slide shape, there is a nose on the front. Together with the shape of the slide

cutaway, this nose also helps to shape airflow and form a compression zone leading into the area under the slide. This compression zone contributes to flow acceleration and signal amplification to further promote a higher degree of atomization of the fuel droplets.

Turbulence in the high speed airflow:
One of the keys to the effectiveness of the SmartCarb® is its creation of a highly turbulent and cohesive air flow that maintains the efficient suspension of the fuel charge while also enhancing the level of atomization. More air/fuel charge yields more power, while at the same time a higher degree of atomization of that fuel charge yields greater fuel economy. More power and better economy are two things you don't usually see side-by-side.

Atomization

Fuel droplet size:
More surface area on more and finer droplets allows more work (controlled heat and pressure) to be generated from less fuel. The fuel droplets are small enough that the fuel is burned more completely instead of being wasted; it's closer to a vapor than is allowed in normal carbs. It's even a finer level of atomization than provided by typical high-pressure fuel injectors.

Nozzle:
The altitude compensation channel (above the intake venturi) allows the float bowl pressure to always be equivalent to the air pressure in the SmartCarb's venturi, causing the nozzle to deliver fuel in proportion to air altitude-density, even when the metering rod position and air slide opening are changing, automatically adjusting available fuel for a given throttle opening. Altitude-density is defined by air density (the number of oxygen molecules available to support combustion) and temperature (fewer oxygen molecules at high temps, more at lower temps) in a given quantity of air at a given altitude (more oxygen molecules at sea level, fewer at the edge of space).

Metering rod:
The rod controls fuel allowed to escape the nozzle and assists with enhanced atomization. Its precision shape is based on the engine's expected airflow and fuel flow requirements. The metering rod is unusual in that it is designed to rock back and forth in the airstream. Its shape and rocking action releases fuel into highest speed/most turbulent portion of airflow column. The rocking promotes greater atomization.

How? Think of a wet dog just stepping out of a pond or stream. As the dog steps out water is literally flowing off in one or more streams. There's not much atomization of the water at that point. But, when the dog shakes the water off by rotating its coat, the water is immediately atomized and flings off as a fine mist of droplets. The Metering Rod promotes greater atomization by rocking back and forth, much like the dog does when it shakes.

In addition, the Metering Rod has a rotation limiter that promotes the rocking action, but also keeps the highly atomized droplets focused into the high speed portion of the air flow column.

This assists in managing the droplets so they stay suspended in the high speed portion of the air flow column and do not wastefully wet down the wall of the intake. This keeps the highest proportion of the fuel in suspension and ready to make its way to the combustion chamber, enhancing fuel economy.

Altitude compensation (automatic)

Why no vent lines:
SmartCarb® uses air channels into the float bowl to provide instantaneous ambient air pressure and temperature corrections to the air/fuel ratio along with continuous fluid communication to equalize float bowl pressure with the pressures forming in the venturi. The system is designed to be sealed against leaks except when controlled by nozzle and metering rod, so, no vent lines.

Float bowl equalization with venturi airflow signal:
The equalization of the internal float bowl altitude-density with the venturi's altitude-density signal allows the SmartCarb® to auto-compensate for altitude-density changes. Once set, the SmartCarb® automatically delivers the optimum air/fuel ratios for the altitude where you ride regardless of how much variation in altitude, temperature, and pressure you encounter.

Tip-over valves (floaty balls):
These check valves close off the air channels in the event of a tip over to prevent venting that could allow fuel leakage. This sealing of a potential pathway for fuel to enter the mouth of the venturi is designed to prevent the carb from flooding the engine. The tip-over valves also aid in compliance with Federal and State emission standards related to incidental fuel loss.

Adjustability

Simplicity:
Set the idle and low RPM mixture and the metering rod automatically maintains the correct mixture throughout the RPM range from top to bottom. There's nothing else to adjust.

External adjustment on the fly:
If you can reach the top of the carb, you can readily make mixture adjustments while on the trail, without tools. At least on KTM 2-strokes, the clicker is easily accessible from the throttle side of the bike. Just swing the kick starter out and reach in with your right hand while using your left hand to roll the throttle to full open in order to engage the clicker. This technique allows good feel of the clicker engagement so you can count the clicks. If the pipe is hot, just lay a glove or shirt sleeve over it.

High precision adjustment:
Small changes yield big results. The precision of this carb is not what we are used to for the most part. A difference of only a few clicks, even as few as 5, can take you to a whole other world of throttle response, power, and fuel economy if you are setup as described in the earlier portions of this Guide. A single click moves the Metering Rod approximately .001", and a couple of clicks

can make a very noticeable difference. Yes, it's that sensitive. Making big clicker count changes is usually not going to yield results that meet your expectations.

Idle Screw precision adjustment of air/fuel ratios:
The idle screw is useful in arriving at and fine tuning the recommended slide height range. In making small idle screw changes, you are also making very subtle mixture changes. It's useful to take care to balance idle screw changes with clicker adjustments to insure a strong and persistent idle in the desired RPM range. I call this balancing process "the dance".

Other features

One circuit (after choke is off):
It's hard to get used to the idea that there's only one circuit, and once its setup, no other adjustments need to be made. It challenges my learned habits of decades and my inherent need to fiddle with the carb. The simplicity of setup is hard to get used to. As the old Peggy Lee (I'm dating myself here, I know) song said "Is that all there is"? The upside is more riding, better performance, and confidence that I'm not inadvertently harming my motor every time I go on a long run in the mountains.

In addition, the single circuit allows reliable plug readings at any loaded RPM – there's no masking caused by overlapping circuits. Plug readings at low RPM (just off idle, 1500-3500 RPM) are reliable for full RPM range and altitude-density range. But if I want a WFO plug reading, I can do that too and expect the same results. SmartCarb® is the only carb that can say that.

Float bowl drain screw & nipple:
SmartCarb® has an easy to drain float bowl if a drown-out allows water into the bowl. On one of my trail rides last year I completely submerged my bike and myself under water. I mean really submerged; the engine was still running for a couple of seconds while the bike was fully under water. When we were done with the de-watering drill, I elected to try to start it without draining the float bowl. Surprise! It started with the first push of the starter button and I rode back to camp. When I got home I removed the float bowl and was surprised to find that there was no water, none, zero.

The sealed system actually worked. That's when I became a believer. It's no fun being towed 30 miles back to camp, and until the SmartCarb® a drown-out always carried a high risk of a long day at the wrong end of a tow rope.

The float bowl's drain screw and nipple also allows you to check the float bowl level without removing the SmartCarb® from the bike. By attaching a clear length of tubing to the nipple and opening the drain screw, you can position the clear line so it reveals the fuel level in the float bowl. Just loop it so the fuel that flows into the line is kept from escaping by holding the line above the level of the float bowl.

The fuel level in the line should (taking the tilt of the carb into account) rise to the level of the carb-to-float-bowl mating surface at the back of the carb. This measurement will vary depending on the way your carb is installed, so it might be useful to make note of the fuel position using the clear line when you first install the carb on your bike (with the float bowl fuel level set correctly). Then you will know what the correct fuel level looks like if you ever have to check it on the trail.

Choke circuit:
This circuit is often not needed at all for starting when the carb is properly setup and near the sweet spot. In order for the choke circuit to work effectively it requires the slide height to be within the recommended range (see the setup instructions above). The higher the slide height the less effective the choke circuit will be. Lowering the slide height (even temporarily, as in cold weather starting) allows the choke circuit to add more fuel to the mixture.

So, How Does It All Actually Work?

Conventional Carb:

Fundamentally, a conventional 2-stroke carburetor relies almost completely on the degree of vacuum created by the engine at changing RPM levels. Higher RPM levels result in increasing vacuum characteristics that can be put to use drawing air from the atmosphere through the carb's venturi. That vacuum-caused passage of air through the venturi is managed by the degree of throttle slide opening.

The fuel is managed by the degree of vacuum-caused airflow over or through the various jet orifices (pilot jet, needle jet, needle, and main jet) located in or near the venturi. The carb's operation is based on the amount of airflow the engine is producing during its vacuum cycle.

In other words, the conventional 2-stroke carb is based on how much air, and subsequently fuel, the engine can suck. The only signal source is the vacuum coming from the engine (the suck).

SmartCarb®:

The SmartCarb® adds another dimension to this fluid-control mechanism (air behaves as a fluid, as does fuel) by also causing the fuel to come under pressure, courtesy of the air scoop at the top of the SmartCarb's intake. At a point in the throttle opening (RPM) range the SmartCarb® will actually begin injecting fuel into the SmartCarb's throat, due to the pressure in the float bowl. In the throat the fuel is highly atomized (even better than a fuel injector) and mixed with the highly turbulent and focused incoming air.

This injection is caused by the ram-air pressure of the column of air that began to move in response the engine's repetitive vacuum cycle. That ram-air pressure enters the air scoop and is transmitted directly to the otherwise unvented the float bowl, where it begins to push fuel up the float bowl nozzle. At high throttle openings this ram-air can be moving at hundreds of miles per hour. Under these conditions, it's

as if you were to pressurize the float bowl by aiming a compressor air nozzle at the SmartCarb's air scoop.

As the ram-air flow through the SmartCarb increases it goes from behaving much like a conventional carburetor based primarily on the vacuum signal from the engine, to behaving primarily like a variable volume fuel injector, based on the combination of the engine-generated vacuum AND the ram-air pressure signal in the venturi, AND the ram-air pressure delivered to the float bowl courtesy of the air scoop.

The SmartCarb® is always managing both airflow and fuel pressure, but it's in a continuously varying relationship depending on the engine RPM (throttle opening), the ram-air pressure, and the profile of the metering rod. The metering rod goes from being an enabler of fuel flow, when suction is the primary fuel movement force, to being a restrictor, when there is high ram-air pressure in the float bowl. Of course the metering rod's shape is set through extensive testing so as to manage these two signals to achieve maximum work (HP) and efficiency (mileage) at any given throttle position.

At times you are primarily managing air in the air-fuel ratio (very low throttle positions) and other times you are primarily managing the fuel in the air-fuel ratio (higher throttle positions).

It's the management of these two signal sources that is the main cause of misunderstandings about what to do to properly tune a SmartCarb®. So, if the air scoop is shrouded by your airboot, or there are significant distortions in intake tract ahead of the SmartCarb's mouth that produce turbulence which reduces the ram-air pressure sensed by the air scoop, but not the venturi, the engine will be fed a lean fuel ratio. It will be lean because less fuel will be introduced due to the lower ram-air pressure in the float bowl when compared to the venturi. At a given throttle opening this results in a leaner air-fuel ratio than the metering rod was designed for.

Under these circumstances, the natural action tried by the tuner is to richen the rod via the clicker or go to another, richer, rod. But in this case the problem lies not with the metering rod, but with the airboot's restriction of ram-air pressure to the scoop. You must address the ram-air restriction, not the metering rod, by unshrouding the air scoop or unrestricting the air boot until the ram-air signal at both the air scoop and the nozzle are equal. No amount of tinkering with the metering rod(s) will yield a desirable result until there is an equal ram-air pressure signal at both the air scoop and the venturi.

This specific condition, restricted ram-air flow to the air scoop, is discussed in greater detail in the FAQ section below.

Troubleshooting Tips

If you have a persistent tuning problem that you have not been able to make progress with by ensuring there are no air or fuel leaks related to the engine functions (gaskets, reeds, cracked boots, seals, leaky O-rings and so on), there are a few things related to the SmartCarb® itself (or your use of it) to consider including in your checklist. Here are the most obvious ones.

Air leaks internally

1. Cap gasket: insure there is a clean seal and proper tightening of the screws and that the gasket itself has no nicks or cracks.
2. Float bowl gasket: again, insure there is a clean seal and proper tightening of the screws and that the gasket itself has no nicks or cracks.
3. Choke shutoff valve: take care to insure the shutoff valve is fully bottomed when turning it off. Even a slight failure to close can lead to a hugely rich air/fuel ratio. Be sure to close the choke fully.
4. Choke sealing boot: in some cases the choke boot is dislodged when opening the choke. The failure to properly seat this sealing boot can lead to air leaks even if the choke valve is closed. The air leaks can lead to a lean condition that is hard to diagnose and correct. Make sure the choke valve's sealing boot is properly seated at all times.
5. Throttle cable entry: insure the throttle cable's threaded coupling in the top of the SmartCarb® is tight and adequately locked in place by the locking nut. This will assure there is no air leakage past the throttle coupling. Any air leakage can contribute to a lean running condition that is hard to diagnose.
6. Slide wear: if the slide is unduly worn from either prolonged normal use, or by contamination from dirt, it can allow unwanted air to escape past and lead to a difficult to diagnose lean running condition.
7. Tip-over valve tubing: on billets, insure the external tip-over valve tubing is not compromised. For example insure there is no heat damage from proximity to exhaust. Also insure nothing on the chassis or engine can rub on the tubing and cause an air leak. This is a slightly pressurized area and if its integrity is compromised it could allow a portion of the air signal to be reduced in the float bowl. This unequal signal between the float bowl and the air pressure in the venturi could cause a mismatched altitude compensation. As far as I'm aware, this hasn't been an observed issue, but it's worth keeping an eye on.

Fuel leaks internally

In addition to air leaks, there could be fuel leaks complicating starting, idling, and low throttle responsiveness. Here are a few possibilities.

1. The choke may not be fully closed, allowing extra fuel to compromise the required air/fuel ratios.
2. The choke boot may be unseated, allowing the choke to stick partially open and suck extra air and fuel into the carb.
3. The float level may be too high, causing rich running.
4. The needle and seat may not be functioning properly and can allow leakage of fuel and raising the float bowl level, leading to a hard-to-tune-out rich condition. Worst case, the engine could become flooded with fuel.

5. Stuck tip-over valves. These valves, if stuck closed, can quickly lead to an unwanted flood of fuel into the engine. If you are having persistent fuel flooding issues, be sure to check the tip-over valves for proper operation.
6. The O-rings sealing the fuel nozzle to the carb body may be compromised, allowing extra unmetered fuel to enter the mixture stream. Wetness between the O-rings is a sign of fuel leaking.
7. Metering Rod may be stuck in one position. The metering rod might stick in one position and stop rocking back and forth due to dirt, or due to mechanical interference with the spring that provides tension to the clicker mechanism. This can yield either a lean or rich condition depending on where the metering rod sticks. Try moving the clicker 2 or 3 clicks in one direction and then back to the clicker's original position. This may dislodge any dirt or mechanical interference and restore normal operation.

Frequently Asked Questions (FAQs)

Q. What is the meaning of the metering rod codes, such as Q11, Q09, R09, and V11?

A. Most metering rods are the same overall length @ 2.583 inches. The letter designation refers to the grind length on the metering rod. A Q=2.030 inches in grind length. A V=2.010 inches in grind length. Shorter grind lengths are leaner rods overall, while longer grind lengths are richer rods overall.

The number designation describes the starting metering rod thickness from the upper mid-range to wide open throttle. The numbers vary in increments of two thousandths of an inch. An 11=.080 inches. A 13=.082 inches (leaner than an 11). A 09=.078 inches (richer than an 11).

Q. I have to keep going to richer and richer metering rods to get satisfactory top-end performance, but when I do, the low end performance is adversely affected. What's going on?

A. The symptoms you are experiencing are almost always related to an imbalance in the ram-air pressure being sensed by the air scoop versus the pressure being sensed at the metering rod nozzle in the venturi. Poor or turbulent ram-air pressure at the air scoop can result in lower pressure at the scoop than at the venturi. A blocked or shrouded air scoop can also cause this imbalance as can air boot restrictions, panting (distortion of the airboot when the rubber is warmed up and the engine is at operating temperature and heavy or full throttle is used), kinks in the airboot introduced during SmartCarb® installation and so forth. Less ram-air pressure signal at the air scoop means less pressure forcing the fuel out the nozzle, causing less fuel to flow, leading to an artificially lean condition. This will not be resolved by richer and richer metering rods. It must be addressed by insuring there are no or minimal restrictions to the air flow through the air boot so the best possible ram-air pressure is sensed equally at both the air scoop and the metering rod nozzle.

Q. When I'm fine tuning my idle speed to get a solid and persistent idle, it seems to me that when I lower the idle (slide) a tiny bit, making the metering rod move to a leaner position in the nozzle, I actually have to lean the metering rod even further to get the idle and throttle response I want, which is

the opposite of what I expected. The same kind of thing happens if I raise the idle (slide) a tiny bit (richer metering rod position in the nozzle); in this case, I have to move the metering rod a couple of clicks richer to get the best idle. What's going on?

A. At tiny slide openings the ratio of idle air (slide opening) is not perfectly linear with the fuel mixture because of the changing shape of the venturi opening.

When raising the slide in tiny increments (by the idle screw) proportionally more air is being introduced compared to the fuel, causing a leaner condition that can be corrected by richening the metering rod a couple of clicks.

When lowering the slide in tiny increments proportionally less air is being introduced compared to the fuel, causing a richer condition that can be corrected by leaning the metering rod a couple of clicks.

These are very small changes in the air/fuel ratios, but they can be enough to be noticeable at idle. When dropping the slide to lower the idle speed, expect to lean the clicker a bit; when raising the slide increase the idle speed, expect to richen the clicker a bit.

Q. What is “the Dance” you’re always talking about?

A. “The Dance” is my term for the back and forth adjustment of the idle screw and the clicker at idling speeds in order to achieve an acceptable idle speed that produces a strong and persistent idle. Virtually every time you change the Idle Screw setting, you will also need to make a small clicker adjustment. Lowering the slide will cause the need for some clicker adjustment to the lean side. Raising the slide will cause the need for richer clicker adjustments. Sometimes when I have a rich idle, if the idle speed permits, I will simply lower the slide a tiny bit to lean the mixture instead of changing the clicker.

Q. My bike is stock, but I ride it at high elevations. My buddies all have gone to higher compression heads to help regain some of the lost power at those elevations. I'm going to buy a SmartCarb® and a higher compression head so I can get back my lost power and never have to worry about re-jetting at the changing altitudes I ride at. Any advice?

A. Before you buy the higher compression head, get the recommended SmartCarb® for your bike, tune it in and ride it for a while. It's likely that you will see a noticeable gain in performance compared to the stock equipment. It may be enough to put you on par with or exceed your buddies. Certainly the altitude compensation will be a blessing compared to OEM equipment.

After dialing in the SmartCarb®, if you also choose to add a higher compression head, do so with caution and be prepared to spend some time getting it where you want it. I advise buying a whole new higher compression head and retain your stock OEM head so you can easily get back to the performance you enjoyed with the SmartCarb®-equipped stock engine.

Higher compression heads and SmartCarb® can work well together if the head is well designed and executed and if it's installation on your bike is not problematic. Regardless of what carb you run, this

kind of engine modification can be very time consuming to get set up properly and will always be very dependent on the quality of fuel you use.

Proceed carefully and incrementally and you will be more likely to achieve your desired results. If you need help with your specific setup and gaining the right SmartCarb® settings, please call Technology Elevated's Tech Department.

Conclusion

That's it for this version of The Unofficial SmartCarb® Tuning Guide. I consider this to be a "living guide", to be revised and enhanced as new hints and suggestions are made known. If you like what you have read here, keep checking for new versions. I will update this guide as often as seems appropriate.

I do want to point out that when all is said and done above, what this guide really boils down to is getting into the mindset that the SmartCarb® is a precision instrument that doesn't really require much to get it set up properly, even if you have taken it way far, far away from the sweet spot while you fiddled with it.