

# Flyin' Miata

tech line: 970 464 5600

## 1.6 to 1.8 Swap Hints

People have been installing 1.8 engines in Miatas that originally came with 1.6es since the 1.8 engine was available. It's a pretty straightforward swap, but there are a few important things to know. Be sure to read this entire document before purchasing parts or starting the swap. No, really, read it all.

### Preliminary information

As with any unknown car / engine, we strongly suggest doing some preventative maintenance. Unless we have maintenance records (that we trust), we always do a full timing belt kit and a water pump. We also change all of the fluids. You guessed it - we do sell all of those parts. Also, unless you have a standalone ECU or are a gifted fabricator with lots of time, you'd be well-served to pick up our conversion kit. It turns the job into a pretty straightforward bolt-in affair, as opposed to something requiring a fair amount of fabrication. If you need some of our parts but not all, no problem - we sell everything individually, as well as in kit form.

### Electronics

The general rule is that if it's a mechanical part, it follows the engine (i.e., 1.8), and if it's an electronic part, it follows the chassis (i.e., 1.6). This means that you'll use a 1.8 engine (duh!), 1.8 intake and exhaust manifolds, and 1.8 fuel injectors (granted, that one could be considered electronic). You'll need to retain the 1.6 throttle body (because of the throttle position sensor) and the 1.6 ignition coils - hence the reason we sell a throttle body adapter and coil bracket as part of our conversion kit. But wait! You have a complete donor car, so you can just use the 1.8 ECU and wiring, right? Nope. Sure, it's possible, but it's going to make your life dramatically more complicated for little, if any, benefit. This is especially true with the NB (1999 - 2005) cars (01 - 05 cars have immobilizers which make it almost impossible), but it's still true with the 1.8 NA (1994 - 1997) cars. If you call us to ask if it's really that bad, we'll tell you it is. No, really. Unless you're bored, want a project, and have the skills, you really shouldn't use the donor car's electronics. All of this having been said, if you're using our Hydra, you can run whatever sensors you want - in other words, you can use your 1.6 wiring harness and the 1.8 TPS / coils / whatever, if you're willing to do some simple reprogramming and wiring. Email us at [tuning@flyinmiata.com](mailto:tuning@flyinmiata.com) if you're interested in doing this. Most - but not all - of the electronics section won't apply to you.

**Fan wiring** (If you have a non-stock intake, this section probably won't apply to you.)

The sensor in the thermostat neck is what turns your primary engine fan on with the engine temperature. When you use the 1.8 thermostat neck, you lose the place to install the sensor. (Read the intake section to find out why you need to use the 1.8 thermostat neck.) This sensor is pretty basic - it grounds out when the temperature is high enough to warrant turning the fan on. You have a few different options for how to address this:

**Option 1:** If you have a standalone ECU (if you don't know what this is, you don't have one), you can use the wire at 1R (at the ECU) to turn the fan on - that would be your best option, if it's available. You may have already done this, in which case the sensor would be missing or unplugged.

**Option 2:** You can run the wire straight to ground by cutting it, putting on a ring terminal, and putting it under a bolt. This is good because it's easy, but it's bad because it means that the fan will be running whenever the ignition is on. This will shorten the fan's life (although they're pretty resilient) and could cause the engine to take a longer time to warm up. If you live in Alaska, this could be pretty bad, if you live in Arizona it's almost irrelevant.

**Option 3:** You can run the wire through a switch, then run it to ground. This is good because it will eliminate the problems above, but it's bad because your engine will overheat if you forget to turn the fan on. This makes us nervous, so we never recommend it.

**Option 4:** You can find a way to mount the sensor:

**Option 1:** The easiest but most expensive method is to purchase our 1990 - 1993 / 1.6 coolant reroute kit. You should purchase the 1.6 version, even though it's going on a 1.8 engine. This will give you a mounting position for the sensor that shouldn't interfere with the intake.

**Option 2:** You can have a bung welded onto the thermostat housing or neck. Be sure that the sensor won't interfere with anything inside or outside of the housing / neck.

**Option 3:** You can make or purchase (if it's available) a hose splice that has a bung in it for the temp sensor.

## Coolant temp sensors

There are two coolant temp sensors in the back of the 1.6 head, one with a single spade connector, and one with two terminals in a plastic housing. The two-wire sensor feeds the ECU and the one-wire sensor feeds the temp gauge on the dash. On 94 - 97 engines, you'll need to swap over your two-wire sensor, but you can use the 1.6 or 1.8 one-wire sensor. On 99 - 05 engines, you'll need to remove the single three-wire sensor, as it's not compatible with the 1.6 wiring. You can thread the 1.6 two-wire sensor into the three-wire sensor's hole, then remove a plug to install the single-wire sensor.

## Alternator

1.6 cars use a V-belt for the alternator and water pump, whereas 1.8 cars use a four-rib belt. If your car came with a big-nose crank (mid-91-93, look for eight slots on the face of the crank pulley), you can bolt your 1.6 alternator, water pump pulley, and crank pulley onto your 1.8 engine. If your car had a small-nose crank (90 - mid 91, look for four slots on the face of the crank pulley), you'll need to use the 1.8 crank pulley, water pump pulley, and 94 - 97 alternator. The wiring between 1.6 and 94 - 97 alternators is a direct swap, except that you'll need to enlarge the ring terminal (to 8mm / 5/16"), as the stud on the 1.8 alternator is larger than that on the 1.6 alternator. It's critical that you do NOT use a 99 - 05 alternator. The ECU controls the output of the alternator in the 99 - 05 cars, whereas the alternator itself controls its own output on 90 - 97 cars. In other words, a 99 - 05 alternator in your 1.6 chassis with stock wiring will output way too much voltage (when the engine is spinning fast enough) and will fry your electronics.

## Oil pressure sender

1.6 cars have true oil pressure senders, but all 1.8s - aside from 94s - have idiot lights turned into gauges. Hence, you'll want to install your original oil pressure sender in place of the 1.8's oil pressure sender. Your original sender is pretty big, whereas the sender on the new (post-94) engine is pretty small, but they both use the same spade connector and thread into the same place in the same manner.

## Cam angle sensor (CAS) wiring

On 94 - 97 engines, you can use either the 1.6 CAS or the 1.8 CAS - the 1.6 CAS is technically different than the 1.8 CAS, but they're interchangeable and output the same signal. 99 - 05 engines use a totally different setup, but you can install your CAS in the new head and ignore the sensors that came on the engine. There will be one at the crank (that's present on the 96 - 97 engines as well) and one on the intake cam - either on the front of the valve cover (99 - 00) or the top rear of the valve cover (intake side, 01 - 05). With our Hydra (and some rewiring and reprogramming), you can use the original sensors if you'd like - with the stock trigger wheel or our high-resolution 36-2 trigger wheel. Since the CAS will be farther away (the CAS is on the intake side with a 1.6 and the exhaust side with a 1.8), you'll need to extend its wiring - our conversion kit includes butt connectors and color-coded wires for that purpose. If you're using the 99 - 05 sensors and our Hydra, you can skip the CAS altogether.

## Throttle body

The 1.8 throttle position sensor (TPS) won't talk to the 1.6 ECU, so you must retain the 1.6 TPS (if you retain the stock ECU). The 1.6 TPS won't bolt up to the 1.8 throttle body, so you'll need to reuse the complete 1.6 throttle body (and the idle air control valve (IAC) that's bolted to the bottom of the throttle body). The 1.6 throttle body uses a different bolt pattern than the 1.8, so you'll need an adapter - hence the reason we sell one.

## Ignition coils

You must reuse your 1.6 coils, as the 1.8 coils aren't compatible with the 1.6 electronics. The easiest method is to simply bolt your 1.6 coils into our coil bracket, which will allow you to bolt them to the 1.8 valve cover. Most plug wires won't fit with the coils in their original orientation, though - from left to right, the 1.6 plug wire order is 2-3-4-1 and the 1.8 order is 1-4-2-3 (1 being the front spark plug). By swapping the signal wire between the two coils, you'll match your 1.6 coils to the 1.8 plug wire order and your plug wires will work (all 90 - 00 plug wires are the same). There are two wires (underneath a plastic cover) on the bottom of each coil. The power wire is red, and you can easily tell that the wire goes to both coils. The other wire is the signal wire. Swap those signal wires and use the correct (1.8) plug wire order.

## Intake

The 1.8 engine is physically longer than the 1.6, and with how the engine is mounted, that length is all on the front - this means that it's tough to fit the 1.6 intake in with the new engine. The throttle body adapter that's necessary for most installations just exacerbates this. If you have a non-stock intake (such as one of our turbo kits), these notes probably won't apply to you.

Using the stock 1.6 crossover pipe (the plastic pipe that runs from the airbox / air filter / AFM to the throttle body) will allow you to retain the 1.6 thermostat neck and the sensor that threads into it. However, it no longer physically fits. You can trim the fan shroud and remove the resonator box (big plastic box attached to the crossover pipe, just in front of the throttle body), but you'll still have a hard time fitting it. We don't recommend this option.

Aside from one of our turbo kits (just think of all the horsepower!), the 94 - 97 crossover pipe is the best option. This will match up to the 1.6 throttle body (on your shiny new 1.8 engine) and the 1.6 AFM / airbox. It will also fit much better than the 1.6 crossover pipe. However, this will require that you use the 1.8 thermostat neck, as was mentioned in the electronics section. **Installing the 1.8 thermostat neck requires that you remove the timing belt**, so plan ahead. The 99 - 05 crossover pipes will fit as well, but they don't have a provision for an inlet for the IAC valve (the small valve underneath the throttle body that has a hose running to the crossover pipe). This is a solvable problem, but it's far easier to use a 94 - 97 crossover pipe.

With other intakes, you may or may not have interferences to figure out. For example, with our turbo kit, you won't need to change the fan wiring, but you'll have to play with the intake to get it to best fit, as it will be fairly tight.

The 1.6 throttle cable is the wrong length for the 1.8 engine, so you'll need to either swap in the 1.8 cable or use our throttle cable bracket. The latter is far easier, so it's included in our conversion kit.

## Exhaust

As mentioned previously, you must use a 1.8 header / exhaust manifold. You have a few options on the specifics, though.

**Easy but expensive:** purchase a 94 - 97 aftermarket header and a 94 - 97 catalytic converter. The aftermarket header will be a single piece, whereas the stock setup consists of a header and a downpipe. The 94 - 97 cat will bolt up to your existing post-cat exhaust, assuming it was originally connected to a 90 - 93 cat.

**Cheap but more effort:** Use a 94 - 97 stock header, and connect it to your 90 - 93 downpipe. This setup leaves you without a bung for your oxygen sensor, so you'll need to get one welded in. 99 - 05 headers (stock or aftermarket) won't work without replacing or fabricating more pieces than is logical. Stick with 94 - 97 exhaust parts.

**In the middle:** Use a 94 - 97 stock header, 94 - 97 downpipe, and 94 - 97 catalytic converter. No fabrication is necessary, and the 94 - 97 cat will bolt up to your stock 90 - 93 post-cat exhaust.

**EGR:** The 1.6 doesn't use EGR (exhaust gas recirculation), but all of the (US) 1.8s have EGR. You'll need to block off the EGR ports in both the exhaust and intake manifolds. Our kits include a block-off plate for the EGR valve, which you'll remove. You could also leave the EGR valve in place but unplugged, as it defaults to closed, but it's an ugly piece that serves no purpose. With the ports for the EGR valve sealed by the plate (or closed valve), you can leave the EGR port (for the EGR pipe) on the intake manifold open, as it's just a passage to the port at the EGR valve. For the exhaust manifold, you'll need a cap (which we sell) for the 94 - 97 manifolds, which is the only manifold that will work easily. You could use the EGR pipe, but it's a pain to deal with and also serves no purpose. If you're using a turbo kit, or you're determined to make an NB exhaust fit, you may need a different plug - contact us and we'll try to help.

## Fuel

The 94 - 97 engines use the same fuel setup (one line from the tank, another line returning to the tank, i.e. return) as the 1.6, although you will need to use the 94 - 97 fuel rail. The 99 - 05 uses a return-less system (only one line from the tank to the rail). With a stock ECU and a 99 - 05 engine, you'll need a 99 - 00 fuel rail (even for 01 - 05 engines). Bolt your 1.6 fuel pressure regulator (FPR, looks like a miniature top hat with a fuel line and a vacuum line) to the 99 - 00 fuel rail in place of the 99 - 00 damper (looks generally the same, but with no lines). Point the return up, tweak the output slightly, and it should fit well. With a standalone ECU, such as our Hydra, you can change to a return-less system if you'd like. Contact us for more details.

94 - 97 engines have a PRC solenoid in the vacuum line that runs to the FPR. The solenoid is small and black, with two vacuum lines (an in and an out) and a two-wire connector. You won't use this, so remove it and run a vacuum line straight from the intake manifold to the FPR. 99 - 05 engines don't have a PRC solenoid.

One of the most common no-start issues with this swap is when the feed and return fuel lines have been reversed. The feed line, which connects to the fuel rail, is the rear-most hard fuel line on the chassis, next to the frame rail. The return line, off of the FPR, connects to the forward line. It's typically best to label these prior to disassembly, just to be sure.

## Motor mounts

You'll need to use the 1.8 motor mount brackets (stamped or cast steel), which usually come with the salvage motor. Your 1.6 motor mount brackets won't work. All of the motor mounts (the blocks of rubber with studs in opposite sides) are the same between all 90 - 05 Miatas, but they're almost always ripped - hence the reason they're included in our swap kits. You can replace them with OEM mounts (less noise, vibration, harshness, shorter life) or Mazda Comp mounts (more NVH but typically not to an objectionable level, longer life). If you want the smoothest Miata possible, get the OEM mounts. If you drive aggressively, track or autocross the car, or aren't bothered by NVH and want the longest life possible, get the Comp mounts.

## Donor-engine specific information

**1994 - 97:** This is the easiest and cheapest generation to swap in. They're very good motors (all Miata motors are), but they're older and not especially fancy. You must use a 94 - 97 intake manifold, the 99 - 05 manifolds won't work without modification. You don't need to know anything, aside from what's above, to swap in these motors. 9.0:1 compression ratio (the 1.6 is 9.5:1).

**1999 - 05:** These engines have more upright intake ports (which give more power), more aggressive cams, and solid lifters - all good things. The original cam sensor setup is different on these engines, but you can simply bolt in the cam angle sensor (CAS) from your 1.6. With our Hydra ECU, you can retain the original sensors, it just takes a little wiring and programming. There are differences, though:

**1999 - 00:** This is the most sought after engine, and it shows in their prices. This engine has a variable-volume intake manifold (VICS) that will improve the low end power. You must use a 99 - 05 (preferably a 99 - 00) intake manifold. You need an rpm switch (look for MSD part #8950) to control the solenoid for the manifold; be sure to use the 5400 rpm "pill" (MSD part #8745). Or, simply use our Hydra, which can control the VICS and much more. The throttle body sits a little higher with this engine, as a result of the intake manifold, but that doesn't create any tough / unsolvable problems. You'll need to use your original cam angle sensor, unless you're using a standalone ECU. This engine is still a very easy swap, unlike the next one. 9.5:1 compression ratio.

**2001 - 05:** This engine has higher compression and a main bearing support plate, so it should make slightly more power and is a stronger engine (not that the earlier engines are weak). However, it also adds the complexity of VVT (variable valve timing). Your 1.6 ECU cannot operate the VVT, so your powerband will be flat (all of it in a naturally aspirated car, just the bottom end in a forced induction car), and you won't realize most of the benefits of the 1.8 swap. Operating this way won't hurt anything, and is acceptable in the short-term, but it's not a good long-term solution. If you have a way to control the VVT, such as our Hydra ECU, a small amount of wiring and programming can eliminate that issue. We're happy to help you with this if you purchased your Hydra from us (contact [tuning@flyinmiata.com](mailto:tuning@flyinmiata.com)). If you purchased it second-hand, we're still happy to help but there is a fee. If you have questions about other solutions, it's best to call the people that sell those solutions - we don't know what we don't sell. 10:1 compression ratio (except for the MSM).

The oil line for the VVT means that you won't be able to mount the coils to the back of the valve cover as normal. We do have a kit to reroute this oil line (call us), but it does require cutting and tapping of hard metal. Once the line has been rerouted, the coils simply bolt up (with our 1.6 coil bracket).

The intake manifold has Mazda's VTCS system, which consists of four throttle butterflies, one in each intake runner, right where the manifold meets the head. This is for cold-start emissions, and won't work in a 1.6 chassis (without a standalone ECU). This is okay as they default to open, but they will cost you a couple of horsepower, so you can remove them if you feel so inclined. Be sure that you seal any holes to the atmosphere (outside of the manifold) if you remove the butterflies and their rod.

**2004 - 05 Mazdaspeed Miata (MSM):** This is the best engine for turbo applications, but it's priced accordingly. It has lower compression but it still has the main bearing support plate. It also has the VTCS manifold of all 01 - 05 engines. It's possible to use the MSM turbo kit with a non-MSM chassis, but the pipe that runs from the turbo to the intercooler will be impossible to use. If you can make a new pipe, you'll just need to add a Voodoo box or standalone ECU and fabricate an exhaust. 9.5:1 compression ratio.

## Hypothetical plans

**Cost-no-object naturally aspirated build:** Choose an 01 - 05 engine, a 99-00 intake manifold, a Hydra ECU, a 94 - 97 Racing Beat header, and a 94 - 97 catalytic converter.

**Cost-no-object forced induction build:** Choose an MSM engine, a 99 - 00 intake manifold, and add an FMII with a 94 - 97 downpipe (ideally, the 3" exhaust).

**Cost-no-object high power build:** Choose the option above, have us build the motor into a stroker, and add an FMIIIR. This is best for 300 - 500 whp builds.

**Most economical build:** Choose a 94 - 97 engine with a 94 - 97 stock header, weld a bung in, and purchase our conversion kit.

That's about it for most swaps. Please bear in mind that it's impossible for us to cover every possible issue you may encounter, so a swap like this will still need to be performed by someone with problem-solving abilities. Also, we can't support someone else's products and we'd really prefer to not read this information back to you. We're happy to help if you've purchased parts from us. However, in the interest of continuing to be a leading innovator in the Miata world (i.e., having the time to do so), we can't support you (without a fee) if you haven't purchased parts from us. If you're absolutely stuck, feel free to give us a call, and we can try to help out. Do be aware that if you're not a customer, you'll need to purchase our tech support, either \$30 for 90 days or \$110 for a lifetime subscription.

## To summarize:

### What do I need?

- 1.8 engine with intake manifold
- 1.8 exhaust manifold or header
- 1.8 catalytic converter (possibly)
- 1.8 downpipe (possibly)
- 1.8 injectors
- 1.8 motor mount brackets
- 1.8 alternator (possibly)
- The FM 1.8 conversion kit
- 1.8 thermostat housing
- 1.8 crossover pipe

also recommended: new rubber motor mounts, timing belt, new seals.

### What do I reuse?

- 1.6 ECU and wiring harness
- 1.6 coils
- 1.6 throttle body, IAC, and TPS

**Bear in mind that this list can and will vary based on your plans. Don't skip reading the document and use this list, as it might not be right for your purposes. Read the entire document, then add and subtract to / from these lists to suit your particular build.**