

Car PC's: something profound goes here...

Article by "Java"

A bit of my history

A while back while attending ITT in 2002 something hit me: Why can't I shove a full computer into a car? It wasn't totally practical. To some it was against the grain. How else can you get MP3's in your car besides MP3 CD's and having to have special head units to play them? I got the "Why don't you just get a laptop?" A lot. It just wasn't satisfying to me to drop a laptop on the front seat with an audio cable to the auxiliary port on a head unit or even a, *gasp*, cassette tape adapter. Of course, a laptop has all the things you need. There's a screen, keyboard, touchpad, battery for power, audio out, etc. Some back in the day had wireless built in. It was all too easy though. For me, it had to be difficult.

One of my first implementations of a "Car PC", before all the fun, made for Car PC stuff, was a 2003 Toyota Corolla and a Shuttle XP mini PC. It sat on the floorboard behind the front passenger seat. It had a DC to AC power inverter connected to the battery for power. So inefficient... The screen was a 5.3" LCD coming from the RCA video out of the PC integrated into the driver side sun visor. The text was blurry and so small I had to use Windows Magnifier to see anything I typed! For audio I had to use an FM Modulator because of the stock head unit. Although the implementation seems like a bad experiment, this was my favorite due to an internal PCI wireless card and external high gain antenna. Yes, the good old WARDRIVING days! Seeking unsecure access points and having a bit o' fun...

The next major build was in a 2005 Scion tC. This was the time for unconventional thinking. A lot of "made for Car PC" parts were in the market now. We'll cover most of those parts later. The unconventional part of this build was when I asked myself, "Do I really need to have a PC case?" I already by this point had a case less PC in my desk and a PC all laid out flat in a shadow box on the wall. So, into the glove box it went. It was showy with LED lighting. It had that kind of WOW factor when you opened the glove box lid. This build was also the start of me using the double DIN size touch screen and even a USB HDTV adapter.



2005 Scion tC with a Car PC in the glove box

This leads me to now and my 2008 WRX. I'm older so now I really needed the "clean" look. OEM looking double DIN screen in place of the stock radio, hidden PC under the seat, the actual use of the glove box, etc. I'm running a Tatrix OBD2 to USB adapter, with the use of the Romraider software, to run up to 12 gauges at once from sensors from the ECU. Since the head unit was completely replaced, a four-channel amp is in use. As I go through the different parts in this article, I'll explain what I'm using and why.

Just like any hobby, my Car PC will *never* be finished. As hardware evolves, upgrades will always be needed or wanted. As I write this, the latest would be the use of a solid-state drive and a new motherboard. There will also be things I want to try including the integration of a backup camera and regaining the use of my steering wheel controls as keyboard type inputs. I'll cover some of these items in the Advance Parts and Peripherals section.



2008 WRX with an EBY-701 7" touchscreen in a double DIN housing

So WHY Car PC???

There are tons of options on the market. Things like double DIN Android units and factory or aftermarket video displays. You might be saying to yourself that you have a phone / tablet/ laptop that do all of that. You may also already have a touch screen entertainment system either aftermarket or from the car manufacturer. My quick answer is "Because it's possible and I'm addicted to building PC's!" Many have actual utilitarian ideas in mind. So, here is the short list: music, navigation, productivity and vehicle monitoring. This is true but then again, the Car PC started before smart phones, tablets and video head units were mainstream. It has turned in to a sort of geek hobby, oh, and see my quick answer above. Let's move on to all the wonderful pieces that can make a Car PC.



Car PC pre-installation staging

BASIC PARTS

To build a Car PC you'll need some basic parts: motherboard (we'll include processor, memory, video, audio, etc. with this), power supply, display, input device(s), storage devices and operating system. Sounds like a regular desktop computer, right? Close, but let's try to get a bit specific...

Enclosures

Case or no case? Do you want to have the components exposed, integrated into the spaces of the vehicle or secured in a hard case? This is one of the most customizable options and your imagination can run wild.

I've done all the above but for the current setup, I have gone with the Mobile Computing Solutions "Black Box" case. I'm able to disconnect the case for easy upgrading, I can run the PC with external power for loading OS or troubleshooting without draining the battery, it has a built-in monitor power output and plenty of ventilation.

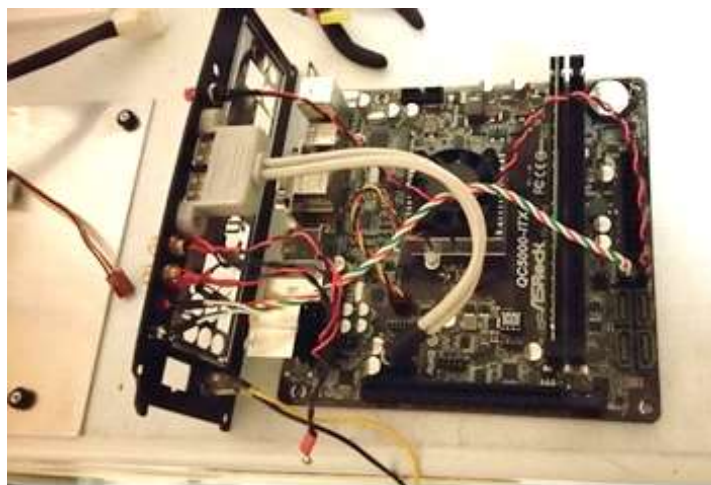


MCS Black Box Case pulled out from under the passengers seat

Motherboard

We'll keep with the mITX standard for right now. It has a small footprint; a lot have the processor already "built in" and power requirements are low. Most also come with video and audio on board also. There are many other form factors one would consider but, in the end, it's up to you. The mITX form factor will usually require desktop or laptop style RAM. Some examples would be the Intel Atom series, the AMD FT3 series and the Via Nano series. Depending on your build, most of your peripherals are going to be USB. One of the key things to look for are the amount of rear USB ports and USB headers on the board itself, unless you plan on running a *powered* USB hub. You'll have to research to see what's best for you as I could go on forever about all the specifics of all the different boards, their features, processors, the chipsets, memory busses, BIOS, etc...

The board I'm currently running is the ASRock AMD FT3 mITX. (Upgraded from an Intel Atom series board.) Plenty of USB, uses DDR 3 1600 RAM, quad core, has spike and surge protection and fits in the case I currently have. This is just a few reasons for going with this board.



ASRock Mini-ITX motherboard and MCS Black Box backplate

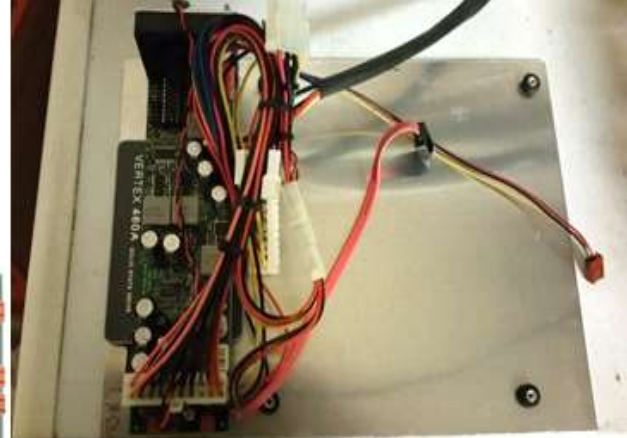
Power

The most inefficient thing you could do? A desktop power supply ran from a power inverter. This is why there are DC to DC power supplies! These power supplies allow for a broad range of DC voltage input and allow for you to start the car without killing your PC, down to 6v. There are generally two types of these power supplies, the M series (M2-ATX, M3-ATX, and M4-ATX) and the PicoPSU series. Both are efficient and, because both are DC to DC, do not require a case around them with a fan like conventional AC to DC desktop power supplies. Here are the comparisons:

M series: "Intelligent" type DC to DC power supplies, like the M series, have a controller that can send a virtual power button push to the motherboard, via a cable from the power supply to the motherboard's POWER header, depending on the 12v accessory status. Read: if the car is turned on or not. The M series comes with jumpers that allow you to customize the way the PC will startup, shutdown or even kill power completely after a period to save the car's battery. Another feature that the M2-ATX and M4-ATX have is an "anti-thump" 12v remote turn on for audio amplifiers. Both the M series and the Pico series has inputs for 12v power and ground, but the M series has an additional input for the vehicles 12v accessory that controls this "intelligent" function. The M series will also kill power to the PC if the voltage from the car battery gets too low.



M2-ATX 160W DC to DC Power Supply Unit



MCS Black Box bottom plate with an M2-ATX PSU and OCZ SSD

PicoPSU series: This power supply is all about the small size with all the electronics directly on the ATX connection that plugs in to the motherboard. This allows for custom enclosures where space is a premium. Although with the PicoPSU you would need a remote power switch, you do have the option of adding a very small, separate startup / shutdown controller board which will give it the same "intelligent" functions of the M series.



PicoPSU DC to DC power supply

M3-ATX: This is the same shape and size of the PicoPSU but also has the startup / shutdown controller on board!

The one I am using is a M2-ATX at 160 watts. Unless you are going for a full gaming system in your car, 160 watts SHOULD BE PLENTY for any simple Car PC. Do your research though on your power requirement needs as the M4-ATX comes in at 250 watts if you need that! The Black Box case I'm using has a special internal mounting point for the M2-ATX power supply. I have the jumpers set to start the PC after 5 seconds of turning the car on, shutting down the PC after 5 seconds of turning the car off and killing power completely after 45 seconds, just in case. Let's say, if the computer hangs. I've also included a separate 12v accessory power "switch". If in the OFF position, it keeps the PC from turning on. This is useful if you want to keep mechanics or valets from playing with your PC or keep the PC from starting if you are just backing out the car from the garage. It also allows me to kill the power and turn the PC back on while on the road, without using the vehicles key, if the PC freezes or something like that.

Display

Or, the monitor. There are many different shapes and sizes in this area. Screens can be 7" all the way to 12". The most common is going to be the 7", due to being able to fit in a double DIN location. All monitors in the Car PC realm will have 12v power requirements and have VGA, DVI and RCA inputs. The newer models will have an HDMI input as well. Let's stick with the latest models.

Form: You can get the monitor either with a stand and a full bezel or with no bezel already mounted in a double DIN casing. While being "double DIN" you will still need the proper Scosche or Metra adapter for your vehicle. I've seen some that used the stand mounted right onto the dashboard allowing the use of the radio head unit and not "replacing" it.

Brightness: The standard brightness is 250 - 300 Nits with the higher brightness models coming in at 450 Nits. There are also sunlight readable models, if your budget allows for one, as they are substantially more expensive.

Resolution: Native resolution will be low (800x480) due to the physical size. 1024x768 will be your best bet as anything larger will be hard to read. Although I have an older Lilliput EBY-701 that does not have HDMI, due to the low resolution I have not had any issues with clarity or any interference by using the non-digital VGA input.

Features: Any "Made For Car PC" monitor should have an Auto-On feature where the monitor turns on as soon as power is applied and auto switch to the "PC" input (VGA, DVI or HDMI) either by the 12v accessory or from a DC to DC Car PC power supply. The latest, most cool feature on a few is that there is a wire is already soldered to the circuit board that you can attach to the reverse light of your car. When you shift to reverse, the power from the reverse light will activate a sort of "relay" that will automatically switch the input of the monitor to the RCA input. This is where a reverse camera would go! After coming out of reverse the monitor will switch back to the PC input. Another option is to add an overlay for screen protection and glare reduction. I use the overlay on my Lilliput and it does work fairly well except in direct sunlight. The sunlight readable units are still too expensive for my taste.



Rear circuit board of an EBY-701 7" touchscreen monitor in a double DIN housing

Storage

So how do you want your Car PC to boot? Where are you going to put your MP3, FLAC, etc. collection? Here we go...

Conventional: This would be your standard 2.5" laptop style hard drive (or 3.5" desktop, if you desire) at SATA or even IDE, if you are old school. "But I'm on lowering springs / sway bars / coilovers / everything on my car has been replaced with urethane, what about bumps or vibration?" Although this is a good concern, my 160GB Western Digital Blue 2.5" 5400 RPM hard drive never had an issue even with me being on coilovers and A LOT of urethane. If you are concerned, read on...

Solid State: This would obviously be the better choice due to speed but also if you are worried about a conventional hard drive and vibration / bumps. To get the most bang-for-the-buck in speed, if you go this route, make sure your motherboard has SATA 3 inputs!

Other honorable mentions: I've seen many other ways to boot. Compact Flash, SD card, USB flash, etc.

I have even booted from a Linux live CD before just for kicks. These options usually are in conjunction with a larger hard drive where one is a boot drive and the other is for storage.

The size of the drive you use is relative to what you are going to run and store on your Car PC.

Audio:

Other than Wardriving, the Car PC was mainly built for MP3's and in my case, not to watch *while driving* but just for showing off, music videos too. The audio portion is also going to be important especially if you replace your head unit. If not replacing your head unit, all you need is a cable from the speaker out on the motherboard to the auxiliary input on the head unit. Done. Oh, and you get to keep the AM/FM function! If your stock head unit does not have an auxiliary input, then an FM modulator would be an option. One option I have considered before is to relocate the stock double DIN head unit (or replace with a single DIN unit) in to, say, the glove box. For people in the car audio scene, I have seen some awesome custom setups!

If replacing the head unit with a monitor, it obviously gets more involved. Whether using the stock speakers or replacing them for better ones, you will need some sort of amplifier. I will not claim to be a car audio expert so for this option you will either know what you need or research car audio. I'll explain what I have done and my experience with this subject.

My current setup uses the speaker out on the motherboard. It splits to two outputs, one to a 4-channel amp and one to a powered subwoofer. Before the 4-channel amp, the line splits again with two lines to the right and left front and two lines to the right and left rear. The amp is a cheap 200w four channel going to the stock speakers with a cheap 8" powered sub. Surprisingly, with enough tweaking of the amplifier's gain settings and the settings in Windows, the system sounds surprisingly well.



4 channel amplifier with left and right channels split

For some AM/FM I have tried a USB FM receiver but not with any great luck. The reception was mediocre at best. There are alternatives I'll point out later. I have also tried a USB HDTV receiver but found that while still, TV was great. While moving, the TV output was a choppy pixel mess. For now, I am using my phone with an audio cable going to the audio in on the back panel of the motherboard. This gives me my Pandora, Milk, TuneIn Radio (for local AM/FM), etc.

So, what about alternator whine / feedback? This unfortunately is something I have been battling with from the start of time. Changing ground points around and adding ground loop isolators has helped but did not eliminate the whine completely. After getting the ASRock motherboard, due to its EMI and surge protection, the audio is crystal clear now!

Operating System:

Yep, here's where the big debate starts: Windows vs. Linux. I'm not going to say which one is better than the other. I actually love both flavors believe it or not. On my server, for instance I run 64 Bit virtual machines of Oracle Linux with Apache Web Server, Ubuntu Linux and Linux Mint but the host OS is Windows 10 64 Bit. Yes, Windows. I know Windows well. I ran XP for 3+ years in the Car PC without a hitch before upgrading to

32-bit Windows 7 Pro recently. I like the driver and software support, the power management is good and the fact that I can customize the install completely with RT 7 Lite. To some it seems like the easy way out, yes, but it's stable and I still get to tinker with Linux occasionally. Because I am running Romraider software for logging and gauges 95% of the time, 32 Bit Windows 7 is really my only choice as Linux and 64-Bit Windows are not fully supported yet.



Windows 7 in the process of installing

ADVANCE PARTS, PERIPHERALS AND SOFTWARE

This section is all about the add-on's that will make your build your own. I'm going to generalize here due to there being many different versions of the same type of part. What parts you choose, if any, are up to you and your needs. Research!

OBD2 Adapters

The Tatrix. This is mostly for us Subaru guys and gals as it creates the USB to OBD2 interface needed for Open Source tuning and logging. The Cobb AP is great, but I've started with open source eTuning and never looked back. Having Eric of Torqued Performance as a guide, tuner and generally cool guy has been priceless. Anyway, enough with shout outs. There are other OBD2 adapters with software that will read the ECU, give you gauges and read and reset check engine lights but the Tatrix is specifically for Subaru and Mitsubishi with the correct open source software.



Tatrix Open Port 2.0

Here is the software you'd want and need for the Tatrix:

EcuFlash and the Open Port Drivers: EcuFlash (Now version 1.42) is what I use to transfer maps from the PC to the ECU. Open Port version 2.0 is the driver set for the Tatrix cable to correctly translate from OBD II serial to USB.

Learning View: This is a program that shows a graphical representation of your current fuel trims, pulled timing in an RPM / Engine Load graph and will show CEL codes. Learning View will let you reset the ECU also.

Romraider (RR): Now version 0.5.8 RC 1. RR gives you the dashboard being able to display 12 gauges at once from the ECU to the screen at 1024x768 7" monitor resolution. There is a long list of external sensors (serial or USB to the PC) like AEM, LC-1, etc. Now with this latest version, I can have RR set to open and automatically start the dashboard as there is a shortcut in the startup folder in Windows. For logging a "pull", I have the standard rear defroster button as the start and stop switch for taking the log and then dropping the auto-dated CSV file into a predetermined folder. Other features included are MAF scaling, injector scaling, graphing instead of gauges if you want, read CEL's, reset the ECU and the most fun, a built-in virtual dyno!



Older version of the RomRaider Dashboard on Windows XP showing real time output from the ECU

Input Devices

Remote controls, keyboards, touch pads, handheld trackball mice, noise cancelling microphones... And most important, the TOUCHSCREEN itself! The touch screen is something that should come standard with any "Car PC" monitor. Windows 7 comes with tablet functions, like swipe, that utilizes the touch screen. Another advance device is a Joycon steering wheel adapter. This will turn your if-you-replaced-your-head-unit-with-a-screen useless steering wheel controls to a simple USB type keyboard with functioning programmable buttons! There are TONS of options here. It's all personal preference. If using a remote or anything wireless, try to use radio based (RF) device. There are infra-red (IR) devices still out there but be prepared to have an IR receiver exposed and must point the device at it. Until I get brave and tear apart my steering wheel for the Joycon, I'm using a RF Firefly PC remote with custom x10 drivers. I've always needed access to keyboard and mouse, so I also use a RF mini keyboard and touchpad combo kept in the glove box.



Firefly remote control and RF keyboard / touchpad device

What about voice command? Sure, give it a shot! If I was going to take that dive, I would first have to have a quieter car and not like to have the windows down as much as possible. I would also have invested in a good, wide array noise cancelling directional microphone. Having a heavy price tag for one of these units has kept me away from this venture.

Radio Adapters

These are going to be anything from HD radio modules to SiriusXM modules, usually a module with an interface cable to the PC. Like I said before, the USB radio adapters I tried had bad reception. The HD radio modules allow you to use your existing car antenna so reception should be better.

GPS Receivers

Before smart phones had GPS, antennas built in, there were GPS receivers. The one I have the most experience with is the Sirf III USB antenna with Microsoft MapPoint. It works well and picks up plenty of satellites quickly. My receiver is still connected and on the dash. Unless you are using a Front-End software, say Centrafuse, your smart phone is going to be the best bet.

Removable Media

This would cover things like CD-ROMs, USB card readers, etc. Not really needed after the PC is staged and installed. I do run a USB slot load DVD burner but just for "coolness" factor. Came in handy for loading Windows 7 after swapping the hard drive. But then again, you can just use a standard DVD drive with a SATA / IDE to USB adapter for those rare times you *need* to. It is a good idea to have a USB port "just in case" that is open, has full power, 500mA, and is readily available. Readily available, like, you don't have to fish for that empty port wherever you installed the PC. Best would be a USB extension cable with the female end built into the center console somewhere or, in my case, in the glove box. This is great as a smart phone charger or if you are able tether your smart phone for internet or even for those times you want to transfer a file or two via thumb drive or portable hard drive. Speaking of internet...

Wireless Adapters

Back in the Wardriving days, we did all kinds of wacky things. We had good compatible cards that worked well with Netstumbler, all kinds of high gain external antennas, etc. Now, you only would need this to connect to your home network for updates, drivers and file transfer. It would also come in to play if you have a smart phone that can be a "hotspot" instead of USB tethering. I would recommend if you are using a Wi-Fi adapter for anything other than connecting to your phone, use something that has good antennas and or the adapter is the open (not buried under the seat, in the dash, etc.) and has the latest "N" or even dual band technologies. The adapter I'm using is the Rosewill RNX-R2X. It was relatively inexpensive, found that it had a good range and best of all, it comes with a laptop screen "clip" that clips well to my passenger side sun visor with a USB cable running down behind the A pillar.



USB Rosewill Wireless N adapter mounted to the sun visor

I still have not found a good reason to have a Bluetooth adapter unless you have some kind of cool app on your smart phone, using an OBD2 adapter that has Bluetooth connectivity, or you are using a Bluetooth keyboard mouse combo.

Front End Software

Front Ends are programs that turn the touch screen into a graphical user interface with button "short cuts" to all the different functions. They will turn the "Windows" part of the PC into an OEM (or Windows 8 start menu) looking infotainment system. These programs will have built in music players, modern GPS functions and voice command to name a few. It will interact with what compatible hardware you have connected and installed on your Car PC. Some that come to mind are Roadrunner and Centrafuse. I do not use these, mostly due to me running Romraider 95% of the time. The Romraider's gauge display has sort of becomes my front end. Other reasons would be that if I play a concert DVD or play MP3's Windows Media Player works just fine (with Codec's, of course) and I am running a remote controller with all the buttons remapped to launch any program and control it.

CONCLUSION

So, Car PC or something like a Pioneer AVIC series head unit?

Hopefully I've shed some light on what a Car PC is, what its entails and what it could do for you. I hope a headache is not one of those things.

If a Car PC sounds awesome to you, you or any of your friends know how to install a head unit or you have even built your own PC, here are a few websites that will definitely get you started on your journey:

mp3car.com

mo-co-so.com

mini-box.com

cartft.com

e3io.com

Hope you enjoyed the article and good luck!

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