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What "maker board" for a controller with these components?

From scratch (self.PeripheralDesign)
submitted 1 month ago by HotSeatGamer

So I've really become accustomed to the SteamDeck. It's an amazing little machine and its controller layout is the unsung hero that really enables its functionality as a handheld PC.

I'd like to replicate its functionality in a custom controller, or at least entertain the possibility here.

Is there a board that could support all of these components? Two small trackpads, two thumbsticks, two analog triggers, a motion gyro, and I don't know yet but I'm thinking about having even more buttons than the SteamDeck since the custom controller wouldn't have a screen, there should be room for more buttons within easy reach, even while being smaller than the SteamDeck. Oh and in a perfect world, it should be wireless.

From what I've seen, the common maker boards don't directly provide for that amount of component inputs. Two analog inputs seems to be the high end of what's available. I'm aware of ADC boards such as the ADS1015, but not sure if there is a practical limit to how many I can add.

Hit me with some knowledge, and don't be afraid to knocking me out! ;) I'd really appreciate it.

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[−] **henrebotha** 2 points 1 month ago

The current state of the art firmware for game controllers is GP2040-CE, which runs on RP2040 chips such as those found on the Raspberry Pi Pico. Unfortunately, it doesn't yet support half the things you want. Still, it might offer a starting point.

It only has 4 ADCs, so you will definitely need additional ADCs. Look at Cirque for trackpads; QMK and other keyboard projects have implemented support for those, which you can refer to.

Wireless is a whole thing.

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> [−] **HotSeatGamer** [S] 1 point 1 month ago
>
> I got some time looking over the firmware. I was aware of the fighting game button pads, but not of what hardware and firmware they used.
>
> It does look great at what it's designed for, but you're right that it falls a little short for my needs. If I understand it correctly, it only supports the buttons of a standard controller layout. If there is a way to expand that functionality, I don't see it, and I don't expect it considering that it's meant to be compatible with game consoles and Xinput.
>
> Still, thanks for sharing. I love things like that and it's one more potential resource at my disposal.
>
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>
> [−] **xan326** 1 point 1 month ago
>
> Hey Henre, could you assist in a portion of research into this project?
>
> The Steam Controller, and I assume the Deck's controller halves as well, are raw HID devices, i.e. generic. This has me curious if any raw HID device of the correct variety, i.e. gamepad, trackpad, etc., would show up in Steam Input Configurator, or if SIC only allows the SC's/SD's feature set via device IDs. Digging around in Steamworks documentation, there's zero relevant information, everything is gamedev integration and user control, no hardware, no pre-SI side of integration, though there is one or two mentions of DirectInput and RawInput being compatible input devices but no information on limitations or what actually shows up in SIC with a Dinput/Rinput device is within the documentation.
>
> So if you have some hardware on hand, or know someone who does, as I know you're active in many of the adjacent communities, could you (or they) test raw HID devices (say, gamepad, trackpad, a combination of the two, things relevant to the SC/SD)? It'd be very helpful to seeing how this project can theoretically develop, and it would feed into the future of SC alternatives as it's a legacy peripheral, or just custom peripherals in SI in general. Knowing how SI behaves with raw HID devices is a key factor in this, otherwise the next step would be finding out the fuller extent of Dinput/Rinput integration as that's not documented very well. A potential alternative would be spoofing IDs on a custom

peripheral, as the SC already reports as a composite of a mouse + keyboard + four vendor-defined devices under HID, and they're all generic devices at that; I wouldn't think spoofing these IDs and tacking on an additional raw HID gamepad within the software-composite device on a custom controller would be too difficult, if the solution has to resort to this to force proper compatibility with SI.

The next steps beyond this would of course be the hardware and firmware. As we now know driver is generic and the SC as a whole is generic outside of device IDs, and now the SI integration of generic devices is in question. Once Steam Input's behavior is understood within the relevant topic, discussion moves to the next step of how to approach the project, just one of many puzzle pieces to figure out. Hopefully the answer to this is the simpler of the solutions, though I have my doubts.

Also would you happen to know if there's any Valve devs who lurk on the various subs, or are publicly active on other platforms? Just on the off-chance they could bless the community with how to actually integrate a custom controller into Steam Input, given Steamworks documentation has zero information on this, especially in the context of a custom Steam Controller successor.

Any assistance would be appreciated. Especially as I don't have hardware on hand, and I'm not active enough these days to just know who to be asking for quick hardware-software testing for a hypothetical concept.

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[−] **xan326**   1 point 1 month ago

TLDR: Trackpads are going to be problematic on the PC side if you're wanting features that Steam Input provides, otherwise you have two mouse pointers, or you have to do a ton of work just to recreate trackpad configuration options. Salvaging hardware also isn't a realistic option, as you're getting close to OLED prices from a reliable source due to scalp economy. Or find a Valve dev that can help with this. Deck's controllers should've been detachable and there's zero reason as to why they're not. At the end of the day, it's the Deck itself, a different gamepad solution, or ditching the trackpads as configurable inputs and having them as essentially mouse-only devices.

Also two comments, due to character limitations, gotta love limited platforms.

Trackpads, I'd recommend Cirque's circlepads which is what the Steam Controller used, work over I2C or SPI. I'd also recommend a discrete ADC for the RP2040, get one with six channels, this'll cover the two triggers and four analog axes, a variety of these chips will also work via I2C. Also get an I/O expander for the button sets, this'll also commonly work over I2C. Then get a wireless module, an IMU, and some battery management circuitry. You can use basically any microcontroller via this method, since everything is an I2C device you don't need to reroute a ton of pins if you change the MCU, just two data lines as VCC and ground are otherwise common to the board as a whole.

You're also just so entirely incorrect on your statement about 'maker boards' not providing enough analog inputs, what chips are you even looking at? Teensy provides more than enough analog lines, Arduinos provide at least enough for a controller's six analog inputs, same goes for STM, NXP, Renesas, etc. chips; really only the RP2040 is lackluster at four analog inputs but its internal ADC is such low-quality you'll want a discrete ADC anyways. If you really want more analog inputs than you'll ever use, which I'm not sure why you want this, look at something

like the STM32G474, which provides up to 42 analog channels; even if you did Sony's analog button thing from the PS2 and PS3 era, I can link a video as to why it doesn't make sense in practical use, you'd only need 16 channels on a standard controller, 20 with four rear buttons also being analog-capable, 22 if you also include the Deck's pressure sensitivity under the trackpads, which can also be accomplished via an ADC or two, or via a variety of microcontrollers. For reverence the Controller uses an NXP LPC11U3x and the Deck uses a Renesas RA4E1-Group r7fa4e10b2cfm per side (yes, it's two controllers instead of one), in this context there's nothing special about either MCU.

The only caveat is that the trackpads may be a pain in the ass if you want features from Steam Input, such as what you'll find in the controller configurator. As far as I know, nobody has fully replicated what Steam Input does, neither via development or borrowing from Valve's programming; I'd love to be wrong about this, but at the same time nobody is using trackpads for gamepad inputs in this way outside of Valve.

If things like polling rate matter to you, you need to look at the specs of the MCU. If you're expecting a certain performance with the wireless implementation, then you need to check datasheets. If gyro accuracy matter to you, you again need to look at the datasheet; though IMUs are a bit more complicated, you need to look at axes, a typical six axis IMU will have a 3dof accelerometer and a 3dof gyroscope, some IMUs are only four axes, 2dof+2dof, some IMUs also go up to nine axes with a 3dof magnetometer (compass). You just need to spec your components according to your expectations. This is just part of research and development.

You'll also be designing everything from scratch. The Deck itself isn't very ergonomic in its entire layout, having pad-sticks on a vertical and sticks-buttons on a horizontal with the two sets being perpendicular to each other is not a good design, rather you'll want a consistent arc between the three to where the radius of the stick and pad are comfortably reachable from one hand position; this would entail fairly large design changes, and a unique shell considering no other device puts three control sets per side on the face of a controller. Stemming from this, you also need to get the ergonomics of the shoulder buttons and rear buttons correct for a comfortable controller. Beyond this, you also need to figure out what you're doing for the face buttons themselves, you could probably borrow a membrane and button set from a different controller, but keep in mind that buttons are keyed to the shell and the membranes are keyed to either the shell or the PCB; otherwise there's a variety of switch types to choose from. You'll also be making a PCB to fit the shell and component layout. Then you'll be programming it.

Also keep in mind that the Controller put switches at the end of the travel of the triggers and under the trackpads. The Deck does not have trigger switches and opted for an FSR under the pads. Both solutions don't use rumble, but instead haptics under the trackpads, I'm not sure what the Deck uses but I know Cirque recommends ALPS' Haptic Reactor, the AFT14. Though typical rumble could also be integrated.

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> [−] **xan326** 1 point 1 month ago
>
> Though I do have some questions before getting into the hard reality of this controller being either a pain in the ass or a pipe dream. How much relevant experience do you have with this, sourcing parts, designing a PCB, modeling a shell, getting these things manufactured, programming ARM microcontrollers, etc.? Even with an abundance of experience, this will be a fairly daunting project considering it's a controller with atypical features that only one company has properly fully developed an implementation for with proprietary software. And how do you actually use the features of the Deck, do you use the trackpads during gaming

or do you only use them as a pointer within the desktop? Because there's a monumental difference between typical gamepad plus desktop trackpads and having a complete system that functions as the original hardware does. Frankly, I'm not sure if there's any way to integrate trackpads into Steam Input if it's not a Valve device, if you're not using identical microcontrollers with dumped programming from the originals with identical components otherwise, or hacking your way through the unofficial global variant of SI-API to get what you want for the trackpads and forking your own software for the custom controller.

With how the Deck is designed, it's insane that the controllers aren't detachable. The only other component in the two side portions are the speakers, otherwise the Deck is built like a tablet. And given how everything is based on daughterboards via ribbon cables, these could have easily become detachable controllers anyways. Missed opportunity, but potential Nintendo lawsuits, I guess, and this is after the Steam Controller was killed by Scuf's frivolous lawsuit over 'paddles' (now owned by Corsair, actions still have not been walked back, screw this company and its subsidiary, for this reason and multiple others), where Valve was also later sued by a patent troll over the Deck's haptic implementation but surprisingly the Controller was not. I've also done some looking, you'd be close to the price of an OLED deep in replacement board costs, due to everything being scalped, because 'iFixIt will sell nearly every part of the Steam Deck' never happened, the controller boards alone are $136 each on eBay, or there's another source, KasynParts which I have no idea if they're actually legitimate or not, has the pair for $86, but you also have the trackpads, trackpad FSR boards, the ABXY/Dpad board-membrane-button set, the shoulder assemblies, the stick modules, the Steam/View buttons, all of the ribbon cables, and while you're at it you might as well get the front and rear shells with the rear buttons just to make things easy for yourself given how complicated the screw arrangement is and the alignment of the rear buttons, oh and hardware is an additional cost because replacement boards hardly come with replacement screws; then you have to figure out how to make a singular controller for it, genuinely you might be better off developing a chassis mod that integrates a rail system for detachable controllers, you'd just need to figure out how to make them wireless, which is a separate rabbit hole to go down.

Otherwise it's learning to live with the full Deck itself, getting a secondhand Controller, dealing with separate devices such as a gamepad and an alternative to trackpads for desktop use, or finding a gamepad that is sufficient enough for your needs. Honestly the closest thing might be a DualShock4 or a DualSense, and learning to live with the pad they provide. Either that or look into VR controllers and hoping there's a way to integrate them into non-VR use. I know Valve's hardware devs have said they wanted to do a Steam Controller 2, but Index's successor and Deck 2 are the prioritized projects, likely with Deck 2 up first. This is the problem when Valve is the only company to fully develop a dual-trackpad gaming solution via their proprietary software that is Steam Input. The alternative is having the pads as mouse-only, or deep diving into figuring out how to make them behave like joysticks, and other features on top of that, but then that gets into experimental companion software just to configure it; again, the 'hacking your way through the unofficial global variant of SI-API' issue, you either make the feature set from scratch or you dig around enough to borrow from what's already developed- this is such a specific project that you might as well befriend a Valve dev that has relevancy to the hardware, firmware, and software, just to create a subvariant of what they produced. Though this is only relevant if you actually use the pads in game and with various configurations, if they're glorified pointer inputs then the project becomes far simpler, and honestly it's down to the programming of the pads themselves, everything else on the list is entirely feasible as everything is modernly standard.

Sorry to crush your dreams of de-tablet-ifying the Deck's control scheme. If it wasn't so utterly proprietary, or if Valve was willing to put documentation out there for trackpad input integration into Steam Input as a third party device, things would be far simpler. I'm a bit surprised they haven't released documentation on this anyways, Steam Controller died for such a stupid reason and the only alternative is the Deck itself, they could've at least given people a way to make a Controller alternative considering how available parts are and how they had otherwise been friendly with repairability and letting people DIY stuff. Maybe someone has connections and could pull some strings to get a dev to dump some documentation, or to get Steam Input to open up to peripherals that otherwise aren't supported. Hopefully I'm just ignorant and a solution does already exist, though I have yet to find it, I'd love to be incorrect on this because I'd absolutely build my own Steam Controller if I could.

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[−] **HotSeatGamer** [S] 1 point 1 month ago

Wow! I asked for knowledge and I sure got it! This is amazingly helpful and I will be back later today to make make a response that tries to cover each point.

I'm not ready to give up the dream just yet though!

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[−] **HotSeatGamer** [S] 1 point 1 month ago*

Just to get this out of the way: I was very clearly wrong about the maker boards not having enough analog pins. I gathered this conclusion based on what I thought I found out some time ago when I was looking at all the options. I really should have looked again before making that claim. I definitely confused myself somehow.

Well, that puts me off balance from the start, but don't loose hope in my efforts yet.

You made it clear to me that trying to incorporate trackpads as customizable inputs is not really something that anyone has made much headway on, and it's definitely outside my abilities. That really leaves me two options. I could tear down a SteamDeck, or a Steam controller. Both are immediately available options for me. I have an "old" LED SteamDeck that hasn't seen much use since I got my OLED SD. I still would rather part out a Steam controller, as it hasn't been used for years, but it only has one joystick instead of two, and it is also lacking the amount of buttons that the SD has.

I actually don't care if what I end up with has two separate boards incorporated into one controller, especially if they both use a wireless connection. If I have to connect a Steam Controller and a maker board as two separate wireless devices, it is a small annoyance that shouldn't interfere with a playable experience.

I have noticed the poor ergonomics of the SteamDeck, although I've just decided to deal with it. I hope to have better ergonomics in my controller design, and I'm not attached to the SD layout at all. I just love the level of functionality.

As for my level of ability, well, I definitely have not attacked such a project myself before. I have been playing in Fusion360 for a few years now, and working with solids is comfortable for me, working with forms is not exactly easy yet, and working in the Electronics design space is pretty new to me. I do well enough to design parts for 3D printing. I solder small components and can investigate to figure out how things should be wired together. I've made some very early prints to figure out how I should arrange

components while keeping them within easy reach, and maintaining an ergonomic hand and wrist position.

Initially, I'd be happy to just have all the components figured out, have them fit and positioned well inside a comfortable controller body, have it all wired up correctly with the hardware "ready-to-go", and then from there I wouldn't be afraid to jump into how to program and write the code necessary to make it function. I also wouldn't mind having someone else take up the task at this point because I'm sure it would get done much faster, and to a higher standard than what I might generate, lol.

It's seeming to me like the easiest, most direct path, would be to use a Steam Controller and a maker board running ZMK. They'd run separately with two bluetooth connections, but it shouldn't really matter?

The Steam Controller would handle all of it's own inputs, obviously. Left and right trackpads, left thumbstick, two back buttons, A, B, X, Y, L1, L2, L3, R1, R2, R3, Start, Select, and the Steam button.

The ZMK board could cover what's missing, although it would be seen as a keyboard, so I would still be missing the gamepad inputs: D-Up, D-Down, D-Left, D-Right, and the right thumbstick. Beyond that I have every keyboard key at my disposal and I can potentially regain said inputs, and more.

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> [−] **xan326** 1 point 1 month ago
>
> Multiple comments once again, I really wish character limits didn't exist, they only stifle conversation.
>
> The issue with two separate boards is going to be power draw. I'm not sure what Valve did, but the Controller has a ridiculously long battery life for a controller on AA batteries, you get get around 70 hours with consistent haptics use. But when it comes to Xbox controllers, I can only speak for the One S controller, I only got roughly 20-24 hours of usage on AAs with rumble on. So if you were to combine the two, which this would be experimental and might not even work as intended, you'd have a fairly short lifespan off of the same battery voltage and amperage; you could throw a big battery into it, but you'll have to drop it down to the appropriate voltage. I only mention this specific pairing because they otherwise run off the same voltage, but using a makerboard as the companion half of the overall controller would be much simpler in execution.
>
> The next issue with two controllers is compatibility. I have no idea what game to test this in. But in desktop, on Windows at least, I have both my SC and XB1 pads as SI devices, I'm using the SC's original binding, and I bound all of the XB1's inputs to random keys, and it works. Problem is, I have no idea if games are going to support this at all, again I really have no idea what to test this with, most of my modern library is off-platform and I'm not sure if any of my Steam library fully supports SI. The next issue is that this compatibility may only work under both controllers being SI devices, I remember an old support page where the SC would mimic Xinput inputs when an Xinput pad was on the same Windows machine; I don't know if this was ever fixed, if it's just a Windows issue, etc. But, as far as desktop configuration with both pads as SI devices, I do have full pad functionality, full stick and trigger analog functionality, and all 29 digital switches mapped, so as a proof of concept in this very specific use case it does show promise.

I tried digging around the Steamworks documentation, no luck there. Nothing about the hardware or pre-SI side of things. It was entirely just gamedev integration and the configurator guide for users. There was one or two mentions of DirectInput and RawInput being supported APIs, but no further information of how to integrate them into SI, nor to what extent; i.e. if Dinput is limited to a standard controller, what can otherwise be emulated as an Xinput pad, possibly with addons like gyro and trackpad, but these could also be device-specific features, as in SI recognizing a Switch Pro or DualShock 4/DualSense controller. Any information outside of this would be outside of Steamworks' documentation, though a lot of it doesn't seem up to date and later additions just seem to be thrown into their relevant areas.

With the SC itself, it's reported in Windows Device Manager as 4 USB Input Devices, 4 HID-compliant-vendor-defined Devices, 1 HID-compliant mouse, and 1 HID Keyboard Device. So it looks like any other typical USB-HID device to the system, and it's using the generic drivers provided by the OS; within the input.inf, the matching device ID is HID_DEVICE_UPR:FF00-FFFF, which is a Raw HID device, aka a generic device, where everything is HID_RAW_Inst,, listings. Steam must just be pulling specific vendor and device IDs (HID\VID_28DE&PID_1142&MI_04 - Valve and Wireless Steam Controller), everything else seems identical to any other generic device. So this gives some hope, short of any potential issues with integration into Steam Input, I otherwise don't have other generic HID devices outside of a mouse and keyboard that I can test with Steam Input Configurator.

Though HID on its own is an entire thing. You'll definitely need to look through documentation to set a device up correctly, it's been quite some time since I looked through documentation, though I remember the sheer amount of devices supported HID was absolutely insane. Then it'll be seeing if any generic device shows up properly in SIC. [I'll make a secondary comment tagging Henre, or replying under his comment, to ask about this, if he doesn't have hardware on hand he'll likely know a few people to ask]. Again, there's just zero documentation on the pre-SI side of all of this, so there's no telling how SI will behave with a custom device that's raw HID. If specific IDs are required, then this'll have to be done via spoofing IDs to get Controller's or Deck's configurator to play nice with alternative hardware, then you have a component device where you have a secondary generic gamepad for secondary inputs, akin to the SC+XB1 test I did except it's spoofed SC/SD+raw HID gamepad, both being SI controllers via the configurator, remember how the SC itself reports as six HID devices itself, I'm pretty sure an MCU can spoof what the SC/SD is doing and then some for the additional inputs; this seems like the current worst-case scenario on the software side of things.

The only issue is, I don't have a Deck to check its IDs. I'm not sure if Deck OS has a device manager that'll report this like Windows does, you may need to take your LCD deck and install Windows to check this yourself. From looking at Device Hunt, there's no Deck hardware IDs, unless it's what's labeled as 'wired controller,' or it's just not yet listed considering Windows on Deck was a very niche usage, or the Deck's controllers are just outright raw HID with no relevant IDs; I'm not entirely sure about that situation.

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    [–] **xan326** 1 point 1 month ago

As for hardware, I'd still try to go for a one-MCU solution, just because then you have one USB-HID device and you're not dealing with composite devices, and everything works over a singular wireless connection, as there's no good way that I know of to do a hardware-composite wireless device such as how USB can do it; though this banks on raw HID showing up correctly within SI, or spoofing a composite device via what I mentioned earlier. If you have to do a dual-MCU solution, then that's fine, it's workable, plus the Deck's controllers are a dual-MCU solution but you'd have to figure out a wireless solution for those. The former will likely be cheaper than using two controllers just to salvage parts from them, plus every component discussed is available from vendors, the only major cost will be PCB manufacturing, though the majority of components should be salvageable or otherwise cost-effective to buy; the only caveat is that Cirque's off-the-shelf circlepads with the dished overlay may not be identical to the SC's overlays, plus lack of Dpad indenting, and personally I know nothing about overlay materials so I can't help there.

If you don't mind modding your LCD Deck, I'd look into just borrowing the hardware from that; you also need to locate where the IMU is, from what information I can source I have zero idea where this is actually located within the Deck. First I'd figure out how they're actually connected to the I/O, I've always just assumed they're USB devices over the mainboard-MCU board ribbon cable, but again short of having one on hand I have no idea and I don't think anyone has actually looked into this; if they are USB devices, I would do an external controller over USB first just to verify they still work as intended. Then I'd probably start out figuring out how to do wireless per side, rather than a conjoined controller at the board, one shell but two internal halves. This would at least provide a proof of concept for doing a Deck with detachable controllers, as it should have originally been, and it leaves breathing room for additional future mods. The only downside is step one doesn't include extra input. Assuming wireless-ifying the Deck controllers doesn't cause any issues. Beyond this, a truly conjoined controller can use one MCU, again assuming SI is cooperative with generic devices, and the potential workarounds for it. Considering that you already have the parts, and if you don't mind turning a Deck into a tablet, this would also be the cheapest solution, given that you'd only be figuring out how to make the two halves wireless. And going further with a conjoined board will only be replacing the MCU boards and not any of the component boards; though short of having these boards in-hand, I'm not sure what these boards have on them other than the MCUs, ribbon connectors, and the system buttons- iFixIt has become absolute dogshit in their documentation of teardowns, instead relying on lackluster videos with rather annoying hosts, so I can't just pull up a high quality image that shows both sides of the boards to know what other relevant components are there.

Though all of these hardware solutions will require a custom shell, so that cost will be roughly equal over the three. In order of very roughly early estimated costs and complexity- 1: Deck controllers, 100% reused boards, conjoined shell, with some kind of wireless solution. 2: Custom controller. 3: SC + makerboard or MCU + PCB + a handful of components. 4: SC + other controller, conjoined in some way, unless you can get away with a dirt-cheap third party controller, mileage may vary.

Unfortunately, I don't do software or firmware that much, just one of those things

that never really clicked with me. Further, as far as I am into ergonomics, sculpting organic shapes is also the bane of my existence when it comes to projects; though, I'd look at PyottDesign on YouTube, their latest vide 'Ultimate FPS Controller Design & Build' has a portion going over a decent modeling methodology and workflow, 3D printing known blanks of components, then sculpting in clay, then 3D scanning (photogrammetry would work as well) the hand-made sculpt and importing it into CAD to clean it up, not only is this a decent process but it also makes the controller fit your hands.

Hopefully early development can get rolling. Hopefully someone can provide some confirmation if a raw HID device does properly show up in SIC; though I'm not sure how many people have trackpads on hand, the only group I know that sparsely does is the ergo keyboard community, as an alternative to trackballs or pointers, though I'm also curious if trackballs and non-joystick pointers would otherwise show up in SIC. Unfortunately this is just part of development, especially when you're working with software that's fairly closed-off (at least from lack of documentation) from the outside unless you're integrating it into a game. It'd also be nice if someone had connections with a Valve dev that'd be kind enough to point any of us in the correct direction.

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[−] **HotSeatGamer** [S] 1 point 1 month ago

Small update: I'm currently testing the functionality and assessing the likeliness of continued support for the Steam Controller.

It seems like the current version of Steam won't update the SC to it's most recent firmware version. Some workarounds and guides exist to get the update, and I'll probably be able to get it done, but the fact that it needs a workaround at all is a bit worrisome.

I have guests in the house for the next week so my progress will be slow.

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