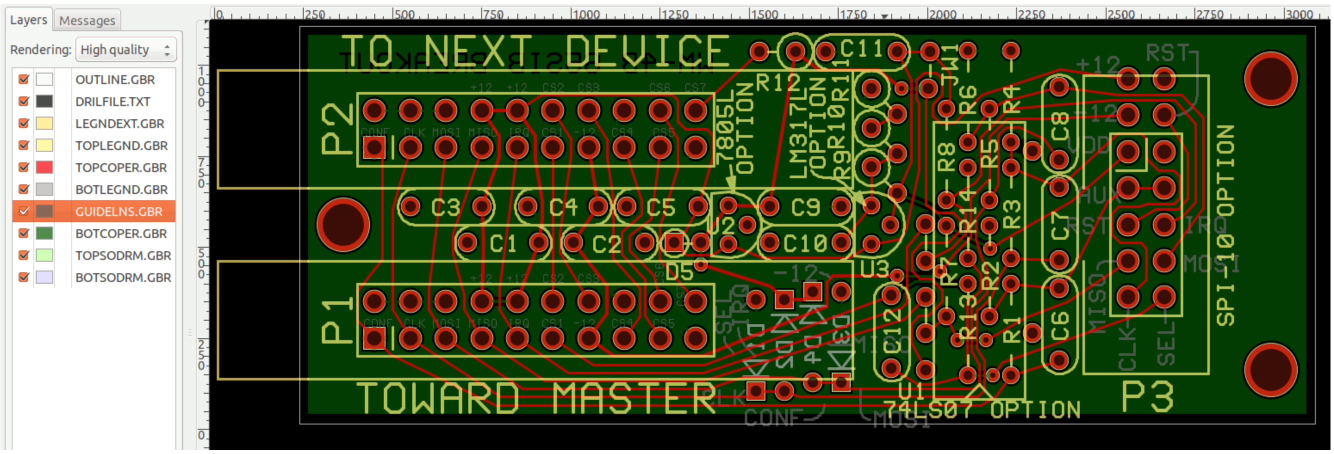
WM-4b 65SIB breakout board

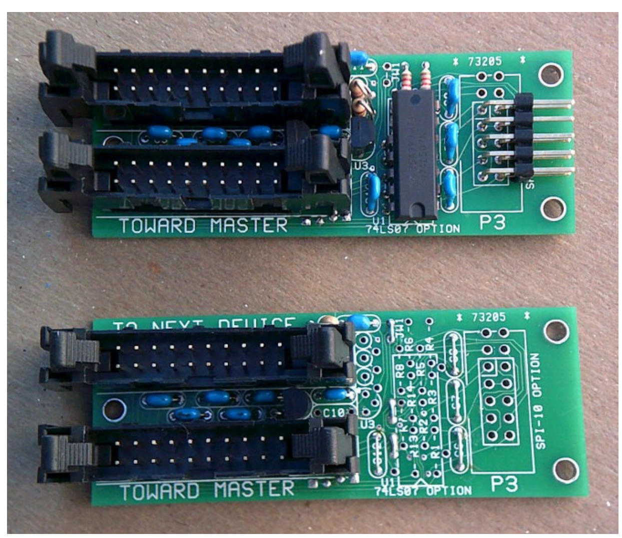
description, reasons, assembly, stuffing options, other considerations

65SIB (from "6502.org serial interface bus") is a very flexible, full-duplex, daisychainable external bus similar in function to IEEE-488 (same as HP-IB or GPIB). It accommodates SPI, Microwire, dumb shift registers such as the 74xx165, 74xx595, 4094, and 4021, and similar synchronous-serial devices.

The reason for the 65SIB breakout board is that after we developed 65SIB on the 6502.org forum, I made a peripheral with the small graphic LCD and an SPI flash, and found it was a lot of work to wire up the connectors, regulator, and voltage translation for 3.3V. This breakout board takes care of all that, plus termination diodes for the MOSI and clock lines. Most of the parts on it can be omitted if you're just interfacing to 5V parts; but it does give the *option* to interface to the lower voltages too.



The 74LS07, if used, goes over the top of the 1/8W resistors that are lying down, on the same side of the board. Several pins of the '07 are unused and have no hole in the board, so they get cut off at the body of the IC. (Pin 2 is unused also but is left for mechanical stability.) Unused 74LS inputs pull themselves up, so there's no need to connect them to something external like CMOS needs. The mounting holes and right-end header pins are on a .100" grid, for mounting on standard project perfboard. The screw holes on the breakout board are .115" (2.9mm) diameter. With small screw heads, 4-40 screws will fit. Otherwise use 2-56 screws. Either way, the intention is that there will be nylon standoffs between the boards, with a length that produces your desired board spacing.



The picture at right shows a board assembled for 3.3V SPI-10 with a 90° pin header, and below it, a board assembled for 5V, intended to go over a board with your 65SIB project, connecting through the 14 holes in two rows at the right end.

There's room for these larger shrouded 20-pin headers with ejector hooks; but if you do use them (as opposed to bare pin headers), the left end will hang off the end of the board. Everything is crammed in there (including resistors underneath the 14-pin DIP, and the four termination diodes on the back) to minimize the board size, not just so it doesn't take so much room on a 65SIB device, but also so I could get as many boards as possible for the minimum price at the board house. The picture at the right shows shrouded headers with ejector hooks. Ejector hooks help unplug the IDC without bending the pins.

The breakout board might seldom get used to host an SPI-10 module (as shown in the picture at the bottom of page 1), but the option is there. Otherwise the 10 holes for SPI-10, plus four more at one end, 14 total, go to your project board below this breakout board, with all the necessary connections plus at least a couple that you may or may not need.

There's enough room around the SPI-10 holes for even a shrouded pin header, if you choose to use one; but note that the shrouds are made for IDCs, and board-mounted sockets like the tiny WM-2 SPI-10 flash module leave a lot of room around them. They don't fit snugly in the shroud; so you might want to forgo the shroud, assuming you don't intend to use an IDC on a ribbon cable.

If you put a pin header on the bottom (non-component side) instead, to connect to a board below, remember that the pinout will, in effect, have the two rows reversed, in terms of pin numbering. If you put a socket underneath instead and put the header on your other board, there's no reversing necessary to keep in mind. You can of course solder wires into the holes instead, if you prefer. The holes are .040" (1.0mm) diameter to accommodate the .025" square posts of standard pin headers, including the typical ±0.003" hole-size tolerance. (.025" square is .035" diagonally across the corners.)

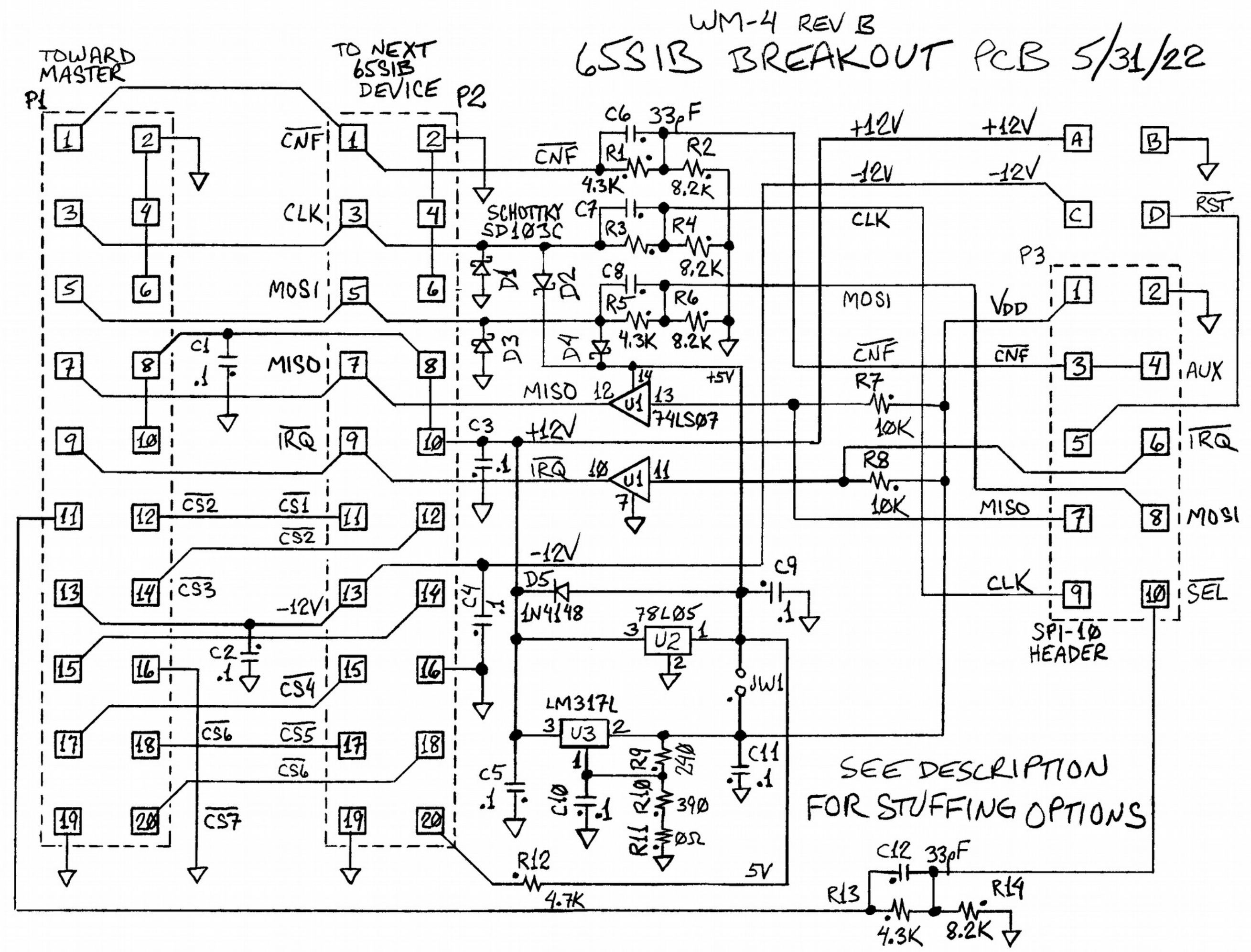
A 65SIB peripheral device can occupy more than one 65SIB address; but the need for that will probably be uncommon, and this board does not accommodate that (unless you put more than one of these breakout boards on a device and link them with a short ribbon cable, or substitute soldered wires).

Most of the components can be omitted if you're just interfacing to 5V parts, since 65SIB uses 5V logic; but the board does give the *option* to interface to the lower 3**.**3V and 2**.**5V logic voltages too. On the inputs from the bus, you can see the voltage-divider resistors for use at these lower voltages, with the 33pF capacitors across the input resistors, for the four signal input lines. The capacitors prevent the slowing of the edge rates that would otherwise come from the time constant of the resistance multiplied by the load capacitance. The exact capacitor value is not critical; but don't go above 47pF.

If you build it up for 5V with the 78L05 regulator, all you need is: C1, C2, C3, C4, C5, C9, R12; all five diodes; U2; install jumpers in place of C6, C7, C8, and C12; add JW1 (an easy mistake is to put one end of it in the R6 hole); and add the connectors. Since you don't need U1 (the 74LS07), jumper its pin 10 to 11, and 12 to 13 (which is barely visible in the photo on page 1), and don't use R7 or R8.

If you build it up for 5V with the LM317L instead of the 78L05, you need: C1, C2, C3, C4, C5, C10, C11, R9, R10 (680Ω), R11 (33Ω); all five diodes; U3; install jumpers in place of C6, C7, C8, and C12; add JW1 (an easy mistake is to put one end of it in the R6 hole); and add the connectors. Since you won't need U1 (the 74LS07), then jumper its pin 10 to 11, and 12 to 13, and don't use R7 or R8.

Here's the schematic:



The dots beside each resistor or capacitor indicate the end that's toward the left or top edge of the PCB. Parts and values are shown for interfacing to 3.3V logic on your 65SIB device, translating from the 5V logic of 65SIB.

The 74LS07 is an open-collector hex buffer. Its pull-up resistors, typically of 3.3K, are on the 65SIB master. The IRQ\ line needed to be wire-OR'able and an interrupt should be able to get through even when the device is not selected; and with the potentially long ribbon cables, the 'LS07 was reasonable for signal integrity for MISO (master-in, slave-out) as well. Another IC in the running was the 74HC125, which nearly won out, with a slightly different circuit configuration.

You'll need the 74LS07 if you're interfacing to lower-voltage parts. Depending on the line length used and the number of 65SIB devices, you might need to experiment with allowable data rates on MISO (master-in, slave-out). For example, 100pF (a hypothetical total of several devices and perhaps five feet of ribbon cable) and 3.3K make for a time constant of 330ns (for rising edge only. The falling edge will be faster, since the ‘07 can pull down much harder). If the master sees 2.0V and up as a logic '1', it will take half that time, ie, 165ns, to go from a logic '0' to a logic '1' under these conditions. For CMOS levels (instead of TTL levels), figure on approximately the time constant, 330ns in this example. For users bit-banging with a 65c02 and 65c22, the edge slowing caused by the parasitic capacitance and the 3.3K resistor usually won't be a bottleneck. This will not affect the speed of other devices on the bus that don't need the voltage translation.

For 5V logic, omit C6, 7, 8, and 12, and also R1, 2, 3, 4, 5, 6, 13, and 14, and solder a jumper wire across each of C6, 7, 8, and 12. Omit the 74LS07. You will still need a 5V regulator, but not two regulators, so you can omit either U2 (the 78L05) or U3 (the LM317L). Put a jumper wire in the JW1 spot. (An easy mistake is to put one end of it in the R6 hole.) You can use either the 78L05 or the LM317L, depending on what you have in inventory. If you use the LM317L, make R9=240Ω, R10=680Ω, and R11=33Ω. Again, this is for if you run 5V only. If you use the 78L05 instead, omit the LM317L, C10, R9, R10, and R11.

For 3.3V logic, use the 78L05 to supply 5V to the 74LS07, and leave the jumper at JW1 out. The LM317L will be used to power your 3.3V circuit. Make R9=240Ω, R10=390Ω, and R11=0Ω (ie, just a jumper wire). Do not omit the resistors and capacitors mentioned in the last paragraph above.

For 2.5V logic (which might be rare), a departure from the last paragraph above is that R10 becomes 240Ω instead of 390. Another difference will be in the voltage dividers. Instead of the 4.3K and 8.2K that are on the schematic, use 6.8K for R1, 2, 3, 4, 5, 6, 13, and 14. The value is not very critical; so if you don't have 6.8K but you have 5.6K or 6.2K or 7.5K or 8.2K, those will be fine, as long as the two resistors for each divider match. Again, this is for 2.5V logic. The capacitors remain the same.

Most SPI devices won't have a RST\ ("reset-not," an active-low reset line; I can't seem to get the overline here) input, and 65SIB doesn't provide a RST\ signal; but there is a pin on the SPI-10 header for RST\. Most SPI-10 devices won't need it; but if you want to implement it, the signal will need to be generated on a board of your creation, below the breakout board, and connected by way of hole D.

65SIB has has a CNF\ (configure-not) line which most devices won't use. If the device doesn't implement the autoconfigure function, you can use that line for something else. My graphic LCD for example has a register-select pin. I don't know why they didn't just make the register-select part of the instruction information that's fed into it by SPI. The CNF\ 65SIB line feeds the AUX pin of the SPI-10 connector (through the voltage divider if necessary). If you do use the SPI-10 connector, remember that you must remove whichever AUX pin will become the keyway for the intended voltage, whether 3.3V or 5V. For a 3.3V SPI-10 port, you'll remove pin 4. For 5V, remove pin 3. The SPI-10 module that plugs in there will have the matching hole blocked. This is so you don't connect a 3.3V SPI-10 module to a 5V port and cause damage. (On the other hand, connecting a 5V device to a 3.3V port probably won't do physical damage, but might cause unpredictable behavior.)

Mind the power dissipation of the regulators. The power dissipated as heat by a linear regulator is $(V_{IN}-V_{OUT})$*total_current. For the total current, don't forget to include the 5mA taken by R9 which the LM317L needs for regulation so the output voltage is not higher than expected. For the 78L05, add the up-to-5mA ground-pin current multiplied by the input voltage to get the total power dissipated. The LM317L and 78L05 are good for about 300mW dissipation at room temperature. They should start shutting themselves down to protect themselves if you get them too hot; but running them near their limit will undoubtedly shorten their life.

You can get better efficiency if you use a switching regulator on your 65SIB device. Even if you don't go for the efficiency and you use a linear regulator instead, if it needs to dissipate more power than the little ones onboard in TO-92 packages can safely do, you'll want to put one with a TO-220 package on your device's board.

The conductors in the ribbon cable are rated for 500mA each; so the -12V can be up to 500mA, and the pair of +12V conductors together can handle one amp. These are totals, for all the connected 65SIB devices combined. The 20 conductors of 65SIB were needed to meet the design goals, and we didn't want to go for even more conductors. The next size of IDC (insulation-displacement connector, which you mash onto the ribbon cable) is 26 conductors. It's easier and cheaper to start with +12 and get +5V than vice-versa if both are needed. If only one of them was put on the bus, it made sense to put the +12V on. Putting a 5V supply line through the daisychain of ribbon cables and connectors might mean the 65SIB device(s) at the end of the line get a "+5V" that's well below 5V. Putting a regulator on each device, to go from the higher voltage down to 5V, solves this problem.

Also, if you need more than 1 amp total, using switching regulators (which are more efficient than linear regulators) will convert excess voltage into current. For example, using one that has 90% efficiency, a 5V device using 150mA would only load a 12V power-supply line by 150mA*5V/12V/90% which is 69mA. It goes even further for 3.3V: 150mA*3.3V/12V/90% which is 46mA (although you'll also need 5V to power up the 74LS07). The benefit will be reduced if the "12V" isn't really 12V but is instead something less. For example, for 9V down to 5V, 150mA*5V/9V/90% is 93mA. For 3.3V, 150mA*3.3V/9V/90% is 61mA. There's no switching regulator on the breakout board, but you can put one on your device's board. A step-down, or buck, switching regulator acts kind of like a continuously variable transmission (CVT), trading excess voltage at the input for higher available current at the output or reduced input current (or any combination needed).

Before inserting D1, 2, 3, & 4 (which go on the back), trim their leads short so they don't interfere with the 20-pin connector's shroud.

The reasons for the higher voltages in the 65SIB specification are given above. The higher voltages do seem to put some potential users off. If the only power supply you have is 5V from USB (which I don't recommend), there are inexpensive 12V wall-wart power supplies ($9-$15 at Jameco) and even inexpensive triple supplies with +5V and ±12V ($24 at Jameco), and remember that even 9V batteries are often adequate for the ±12 lines. In most cases, the voltage for those is very non-critical. However, the + voltage must be at least 7V to get 5V out of either of the onboard regulators, and you'll need at least that much also for any RS-232 line drivers that don't have their own charge pump onboard, or for many op amps to put out 5V on positive peaks. Fewer things need the - voltage than what need the higher + voltage. Some of the nicest-looking supertwist LCDs need a negative backplane voltage, and RS-232 line drivers without their own charge pumps will need the negative supply, and various data converters and op amps will too. Again, even a 9V battery would be enough in most cases. Step-down switching regulators are mentioned in the last previous paragraph above. There are also step-*up* ones, and inverting ones, even integrated with everything in a little module, making it easy to get ±12V from 5V on your controller, to send down the 65SIB ribbon. A supplier we use at work is Pololu.

Mount the capacitors with leads as short as possible, usually meaning the body will go right down to the board, to reduce lead inductance.

I make various modules to break down computer-construction projects into more-manageable chunks, and to make follow-up computers and peripherals easier to construct in the same or different versions, and then provide the modules also to the 6502.org forum members and other enthusiasts, mostly as a service and to promote our interest. It's definitely not a money-maker. I do have a legitimate business, but it's only to make sure I don't break any tax laws. I have a resale license, and I can buy components without paying sales tax, but then I have to charge sales tax to customers in California.

Aug 31, 2022   Garth Wilson wilsonmines@dslextreme.com