DIGWDF 675 Plus Controller – Construction/Operation Manual

Self-standing light controller with 4-channel A/C SSR

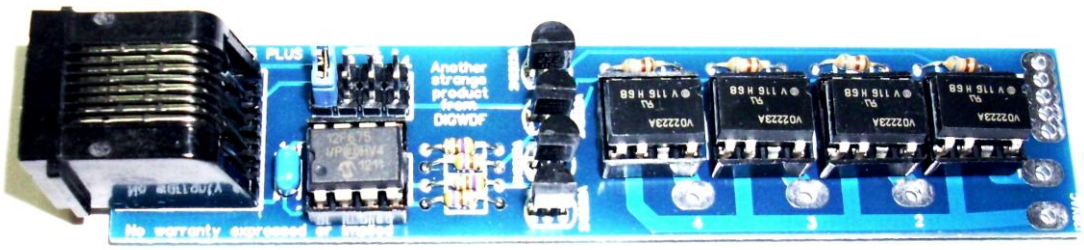
Overview

The 675 Plus is a small, 4-channel self-standing light controller that includes four SSRs to control lights. Because of its small size and inexpensive components, it can be built into the display piece itself or optionally, installed centrally. It is normally connected via common cat5 cable using the normal DIYC cabling method. The device itself is partially powered via the input cat5 control cable where 5vdc and ground are provided in the normal DIYC pin out design with pin 1 at +5vdc and pins 2-4-6-8 ground. The 675 plus requires approximately 160ma current at 5vdc when all four channels are on simultaneously. The A/C SSR portion of the 675 Plus uses the VO2223A Phototriac which can accommodate up to 1A current per chip at up to 240 volts. It is also possible to use the 675 Plus as a simple DirkCheapSSR and information about doing that is also included in this manual.

BOM – Bill of Materials

The 675 Plus shares many common parts with other popular DIYC controllers/SSRs:

Qty	Mouser Part#	Item Description
4	299-470-RC	Resistors, 470 ohm, 1/8 watt (1/4 is okay)
1	80-C322C104K5R	.1uf 50v non-polarized capacitors
1	579-PIC12F675-I/P	PIC12F675 microprocessor (or PIC12F629/PIC12F683)
4	863-P2N2222AG	2N2222A transistor (or equivalent)
5	571-1-390261-2	8-pin DIP sockets (optional)
1	538-95503-2881	RJ45 jack, vertical PCB mount
		Note: You may want a side-entry jack instead
1	538-42375-1863	10-pin breakaway single row header
1	151-8000-E	Shunt jumper
4	299-680-RC	Resistors, 680 ohm, 1/8 watt (1//4 is okay)
4	782-VO2223A	Phototriac



Note: eBay can be an excellent source for inexpensive electronic components in bulk, such as 5mm terminal blocks, breakaway header pins, DIP sockets, resistors and capacitors, fuses, voltage regulators, triacs and LEDs. Buying common parts in bulk (even from Mouser) can require a slightly greater investment up-front, but you'll save tens and even hundreds of dollars later in terms of convenience and eliminating expensive shipping fees for small orders. At the end of this document is a listing of parts common to a lot of DIY electronic gear.

Step-by-Step Construction

Read this complete manual first. The information at the end of the manual can be very helpful, too!

General concepts: It is usually advisable to assemble a circuit board by the height of the parts themselves, starting with the smallest/thinnest parts that are mounted so they lie low right on the board and graduating to the taller and finally the tallest parts such as large capacitors and transformers. In this fashion, you can usually insert several common-height parts into their respective mounting holes, flip the board over and solder them as a group which is more convenient because the parts stay in the holes instead of falling out. In these general construction tips, some items may not be applicable if the board does not require those parts; just skip to the next item on the list. The word "install" implies both mounting and soldering the part to the board and clipping off any extra leads after soldering. Note that many parts are polarized and require that they be installed in a specific orientation on the board. Also, most electrical parts are pretty robust and can withstand some heat, but in general, over-soldering by using too much solder and/or too much heat can create problems and damage either the part or the board itself.

Construction of the 675 plus will be covered in two parts; the first part pertains to the LEFT half of the board, which is the "computer" part:

1. Install resistors first in the four locations marked "470". Resistors do not have a polarity, but it's the best technique to install them all the same way, reading the colored stripe values from left-to-right.
2. Install the DIP socket (if used) for the PIC12F675 chip. Take care to orient the notch on the socket with the markings on the board. Note: DIP sockets are optional but highly suggested; some users solder the chips directly to the board, which is fine. If you do, solder them in place of the DIP sockets and understand that IC chips are usually quite heat-sensitive.
3. Install the .1uf decoupling capacitor. This is a non-polarized part.
4. Install the four 2N2222A transistors, making sure to orient them in the holes according to the outlines on the circuit board. Transistors are heat-sensitive; don't over solder and take care not to bridge solder across the solder pads as they are rather close together.
5. Install two rows of header pins at the 1-2-3-4 channel areas. The breakaway header pins are handy to use (and less expensive overall) because you can cut off the number you need.
6. Place a shunt-jumper across the two pins beneath the channel 1 marking. The shunt jumper selects which control channel will be used to power the 675.
7. Install the RJ45 jack. You may wish to use side-entry jacks in place of vertical mount jacks depending on the enclosure into which you mount the controller. Before soldering, press-fit the jacks and test for a fit in the enclosure you've selected.
8. Check both the top and bottom of the board for any bits of wire or solder which may be leftover from construction, and check the bottom of the board to ensure that no solder points have been missed, which is a rather common assembly mistake.
9. At this point and for the purpose of these instructions, it is assumed that the PIC12F675 processor chip has been properly flashed with the appropriate firmware. This is a separate

topic that is quite adequately addressed elsewhere. If the PIC12F675 is not configured properly, the controller's function will be unpredictable at best.

10. Prior to inserting the PIC12F675 chip into the socket, you may wish to review the Making connections and Pre-Testing sections (below). Otherwise, be sure to orient the chip properly with the notch on the sockets, which should also match the notch marked on the board. Some chips may not have a notch but use a dot or other mark adjacent to what is "pin #1" on the chip. You may have to gently bend the legs on the chips so they fit easily into the socket. When done, double-check each socket to make sure there are no bent pins and that the chips are securely mounted.

This completes the "computer" (left) side of the controller. The next section pertains to the RIGHT half of the 675 Plus: the SSR portion of the controller.

1. **DANGER - USE CAUTION. This circuit board connects directly to high voltage electrical current, which can be dangerous or even lethal. If you are not comfortable working with 120vac, consider asking for assistance in assembling and testing this half of the board.**

2. Install the four 680 ohm resistors in the places marked "680", just above the locations of the VO2223A chips. There is no special orientation to the resistors but they should lie flat against the circuit board. Solder them into position and clip off the extra leads. NOTE: Resistors with values between 120 and 1000 ohms will work. The resistor lowers the trigger current for the LED in the VO2223A chip. Either 1/8 or 1/4 watt resistors will work fine although one end of the quarter watt resistors may have to be elevated a bit to fit between the mounting holes.

3. Install four DIP sockets (if used) for the VO2223A chips. Take care to orient the notch on the socket with the markings on the board; note that the orientation is OPPOSITE that of the PIC12F675 chip on the left side of the board. DIP sockets are optional but highly suggested as they make it easier to replace a VO2223A chip, should that become necessary later on. Do NOT install the VO2223A chips in the sockets yet!

4. Clip off the power plugs from the 4 strings of lights this SSR is to control. You may wish to leave enough wire on one of the plugs to it can be used later.

5. Solder one wire from each of the light strings to one of the "Neutral" holes at the far right side of the board. Then solder the OTHER wire from each of the strings to the desired channel hole, marked 1-2-3-4 on the board. Note the order of the channels has channel 1 as the far right hole. **Important:** It is highly suggested that the A/C wires to the channel holes be soldered before the VO2223A chips are mounted into place. This is to prevent accidental overheating of the VO2223A chips because the solder pads for the A/C channel wires are very close to the VO chip's pins.

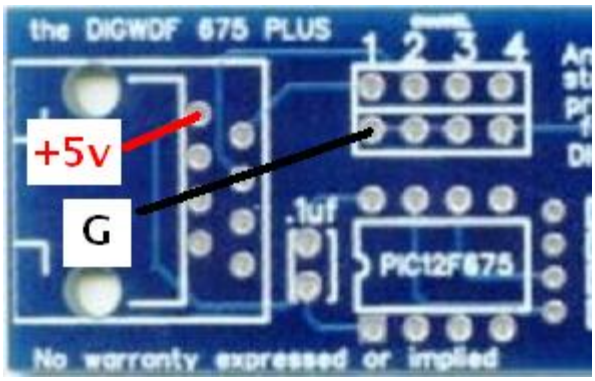
6. At this point, there should be two open holes on the far right side of the board: the hole marked 120VAC and one of the Neutral holes. Solder the power plug (from step 4 above) to these last two open holes. If the plug is polarized (one blade wider than the other), install the corresponding wire from the WIDER blade into the hole marked NEUTRAL. Use your DVM/VOM to test which wire is connected to which blade. Using the power plug from a string of lights is preferred as it normally has a 3A fuse built into the plug. This fused plug then provides additional protection.

7. Mount the four VO2223A chips into place, following the orientation of the dot/notch on the chip; the square pin is for pin #1 of the VO2223A chip. Note that the orientation of the VO2223A chips is OPPOSITE to that of the PIC12F675 chip. Also note that the VO2223A chip has only 7 pins. The side of the chip with only 3 leads should be on the same side as the channel hole marked 1-2-3-4. This completes the assembly of the 675 Plus controller.

Powering the DIG675 Plus Independently with a Wall Wart

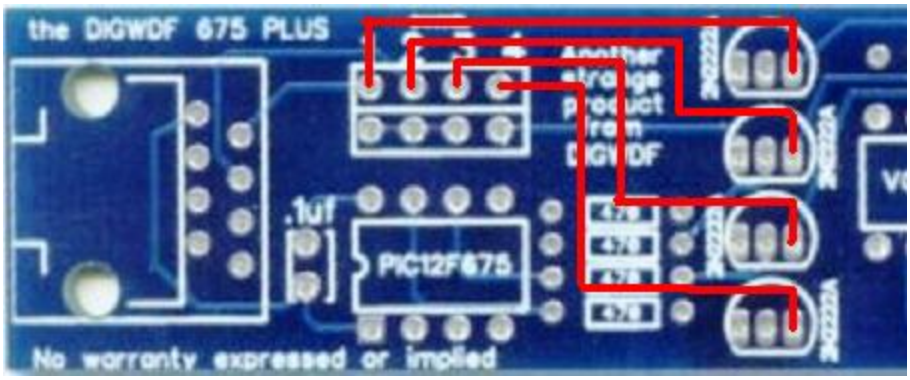
If you wish to use the 675 Plus as a self-standing, automatic running controller for a small display, you can power the board with a 5vdc wall wart. The 675 Plus will then run continuously until the wall wart is unplugged from a socket.

- Test the wall wart's voltage before using it. Absolute maximum voltage: 6vdc.
- Connect +5vdc to pin 1 of the RJ45 jack
- Connect the Ground lead to any of the lower holes of the 2-row header marked 1-2-3-4.
- Alternately, you could build the 675 as you normally would and connect the wall wart's +5vdc lead to the ORANGE/WHITE wire of the cat5 cable and the Ground lead to the SOLID ORANGE wire. Then put the shunt jumper on position #1 of the 1-2-3-4 header.



Using the DIG675 Plus board as a DirkCheapSSR only

- Do not install the PIC12F675 chip, the .1uf capacitor, dual row of jumper headers, the 470 ohm resistors or the transistors.
- Connect a small wire from hole #1 (of the top row of header pins marked 1-2-3-4) to the far right hole of the top transistor.



- Connect a small wire from hole #2 to the far right hole of the second transistor.
- Connect a small wire from hole #3 to the far right hole of the third transistor.
- Connect a small wire from hole #4 to the far right hole of the bottom transistor.
- Install the RJ45 jack, 680 ohm resistors, VO2223A chips and wires to lights as normal.

IMPORTANT: WHEN PLUGGED INTO 120VAC POWER, VARIOUS PARTS OF THE 675 PLUS ARE CARRYING DANGEROUS ELECTRICAL CURRENT. DO NOT PICK UP OR HANDLE THE BOARD IN ANY WAY WHEN IT IS PLUGGED INTO 120VAC POWER!

Making Connections

The 675 Plus controller's computer is powered by another controller or other 5v power source. The input pin connections are as follows, and match the basic DIYC standard for cat5 cabling:

- Pin 1 +5vdc
- Pin 2 channel 1 (ground)
- Pin 4 channel 2 (ground)
- Pin 6 channel 3 (ground)
- Pin 8 channel 4 (ground)
- All other pins: no contact

Note: in the list above the channel number is relative to the cable and not to the overall sequence itself; channel 1 means the first channel of the 4 channels being sent through the cat5 cable. The header pins marked 1-2-3-4 are used to select which of the four possible channels the 675 will use as its power supply. Since the power is coming from the output of another controller, and because the total draw on the supply can be upwards of 160ma, be sure that the outputs from the source controller can manage at least that amount. For example, connecting the 675 Plus directly to the output of a PIC16F688 will exceed the 16F688 chip's capability. However, connecting the 675 Plus to the outputs from a MiniRen8XBLSD or Ren48LSD is acceptable since those outputs are rated at up to 400ma of output current.

Pre-Testing

Using a standard, straight-through cat5 cable, connect the 675 Plus to the output controller of your choice. Use the channel test feature of your sequencing software to turn on all four channels that are now connected to the 675. (Note: You may wish to remove the PIC12F675 chip during pre-testing.)

1. Using a DVM, measure the voltage between the 1-2-3-4 channel pins – the top pin should be ground and the bottom row of pins +5v. All four channels should measure +5vdc.
2. Set your sequencing software to turn on only the first channel that is connected to the 675. Using a DVM, +5v should be on the 675's channel 1 but none of the other channels.
3. Repeat test #2 on each of the other three channels to ensure that the channel signals are unique and of the proper voltage when they are on, and also to become familiar with the 675 Plus' powering concept.

Troubleshooting

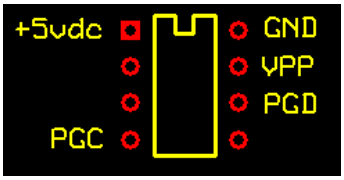
As long as the board has been assembled carefully and properly, there is very little that can go physically wrong with a 675 Plus controller, and any problems likely lie in one of the following areas:

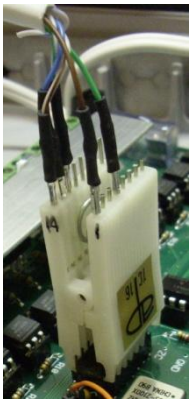
- The chosen channel that's used to power the 675 is not "on" in the sequence.
- A bad connection cable between either the power supply controller and the 675 or the 675 and the SSR.
- The 675's shunt jumper is either not on or is on the wrong pair of channel headers.
- The 675 firmware is not configured properly. The default ASM firmware provided by DIGWDF turns on the channels in 1-2-3-4 order and keeps them on until power is removed from the 675.
- The lights are not plugged into the SSR, or the SSR is not powered with 120vac.
- It's possible that a pin inside one of the 675's RJ45 jacks could move and short with another pin. While this is very rare, it's always worth checking.

ICSP Programming of the PIC12F675/PIC12F629 chip

- While a dedicated ICSP header hasn't been provided, the functionality of it can be created by connecting the PIC Programmer to various pins on the PIC12F675 chip:

    - PGD connection PIC pin #6)
    - VPP connection PIC pin #7)
    - PGC connection PIC pin #4)
    - GND: G pin PIC pin #8)
    - VCC connection: PIC pin #1)





- An easier and faster method can be by using a clamp-on test clip that is appropriately connected to your PIC programmer's ICSP port, and simply clamping it directly onto the pins of the 12F675 chip itself. Note that the 12F675 uses the same relative pins as the 16F688 chip, so the same clamp-on test clip can be used with the 12F675 as the 16F688.

Compatibility/Connectivity with other controllers

The 675 Plus is not tied to any specific controller, and in fact, can be powered by a battery pack or wall wart providing the polarity of the connection to the input RJ45 jack of the 675 Plus follows the values outlined earlier (see Making Connections). The 675 Plus will simply run the pre-programmed sequence continuously as long as the 675 Plus is powered on.

Controllers/boards that the 675 Plus is designed to be used with include (but are not limited to):

- MiniRen8XBLSD (may require supplemental 5vdc power)
- MiniRenServoXB (using Regular firmware, not servo firmware; may also require supplemental 5vdc power)
- Ren48LSD (in 5v output mode)
- Ren24LV (may require supplemental 5vdc power)
- Any controller that switches adequate 5vdc power to its outputs.
- Battery power or wall-wart that supplies adequate and continuous 5vdc power.

Controllers/boards that *may* work with the 675 Plus but are untested:

- Olsen 595
- Grinch
- Helix

Controllers/boards that should specifically NOT be used include (but are not limited to):

- Any controller that outputs A/C voltage out its control channels.
- Any controller that outputs more than 5vdc out its control channels.
- Ren64 (any version).
- SimpleRen32 (or any of the SimpleRen controllers)
- Any E1.31 or other Ethernet-based controller

Questions/Answers

- **Is the DIGWDF 675 Plus dimmable?** The original version of the firmware supports only on/off control. A version of the firmware that supports dimming is planned but no work has been made in that direction as yet. For A/C dimming to work a zero-cross signal must be available and there is no facility to provide this to the PIC12F675 chip in the present design.

- **Will the 675 Plus work with A/C and D/C SSRs?** Yes. It should work with any SSR that uses the normal, DIYC pin connection method, whether the SSR controls A/C or D/C electricity.

- **Are there alternatives to the PIC12F675 chip?** Yes. You can substitute a PIC12F629 or PIC12F683. We've tested all three with the HEX code that was compiled for the 675 and found them all to work just fine without recompiling the firmware for each specific chip.

- **Can you get more than 4 channels out of the 675 chip?** Yes, it has six I/O pins that you can use. You can revise the firmware on your own to add the two otherwise unused pins on the 675 chip, but remember, the 675 board has circuitry for only four channels. You'll have to devise your own board to use all six.

- **Does the board support DMX?** The 675 Plus is an on/off device and does not have any capability to gather a serial signal of any kind. If a DMX device has the capability to supply +5v and ground to the 675, there's no reason why it wouldn't work. However, realize that the 675 merely runs its embedded firmware when power is applied, nothing more, so don't expect DMX effects.

- **How much does it cost to build a 675 Plus?** About $15 including the circuit board.

- **I want to etch my own board, is the layout available?** No, neither the source DipTrace file or the Gerber files are available. The DIGWDF store tries to keep a stock of all its products on hand at reasonable prices.