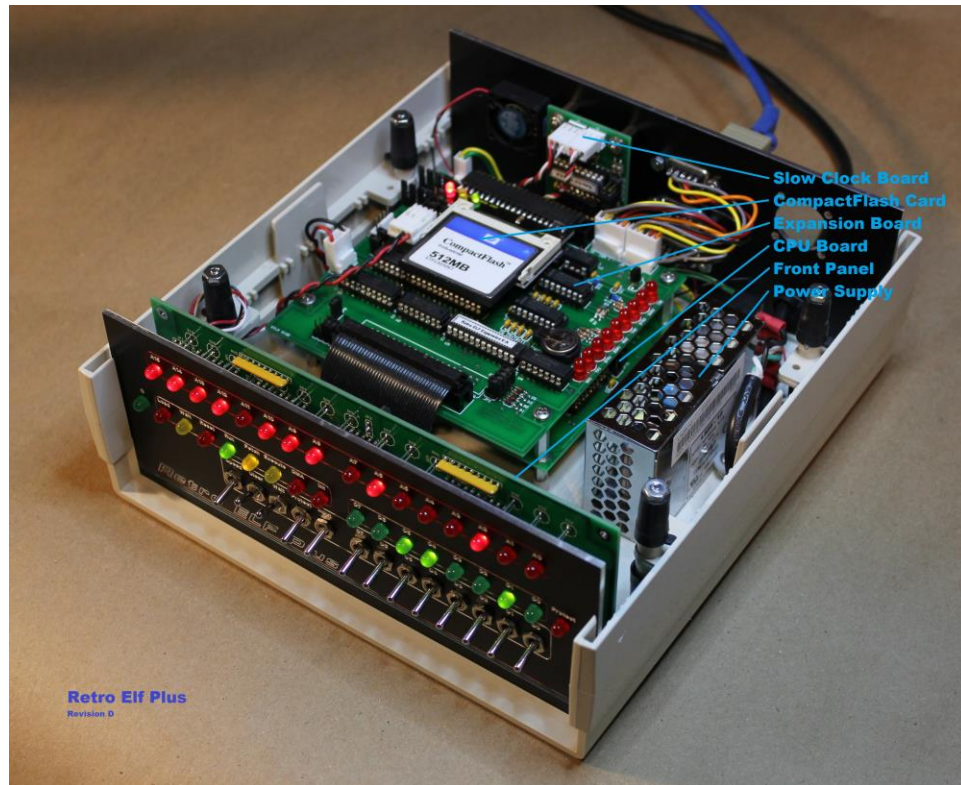


Retro Elf Plus



The Retro Elf Plus System

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Website at www.astrorat.com

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1 – About the Retro Elf System

A complete Retro ELF System is constructed from four building blocks. The CPU board, a user Front Panel, an Expansion board and finally a Slow Clock board. Each of these boards build on the others to create a complete Retro Elf System.

CPU Board

The heart of the Retro Elf System is the CPU board. The CPU board is not depended on any other boards in the Retro Elf System allowing it's use in standalone applications. Here is located the CDP1802 microprocessor and its supporting electronics.

The designs used within the Retro Elf use low power CMOS components to help keep the power needs to a minimum. An on board 5-volt DC voltage regulator is implemented to power both the CPU, and if used, the front panel. This regulator can supply 5-volts up to half an amp from an 8-12 volts DC input to the CPU board. A protection diode is used to help protect against accidental reversal of input power.

The system clock is provided by an on-board oscillator module. The labeled oscillator module frequency is divided by two before entering the 1802. So, if the oscillator is rated 6MHz the 1802 would see 3MHz. One interesting feature of the 1802's CMOS architecture is the capability to operate at any frequency from DC up to the processor's rated frequency. You can even vary the frequency at any time. The Slow Clock board will take advantage of this feature. You can adjust the processor frequency during operation allowing you to see each fetch and execute cycle operation of running code via the front panel.

All 64K bytes of supported memory has been split in to two 32K chunks and have been addressed in to two chip sockets. On-board jumpers provided configuration for each of the two sockets as needed. The most common default setup has a static RAM in the first socket addressed from 0000H to 7FFFH and EEPROM/EPROM used the second socket addressed from 8000H to FFFFH.

An on board "boot-strap" circuit is provided. When enabled, the 1802 is tricked in to start running code from 8000H after a clear (reset). A jumper selectable boot-strap clear signal can come from either a high on the 1802's Q line or any I/O operation.

An optional on-board battery backup circuit is also implemented to provide 3V DC to SRAM when normal power is lost. The use of a low power CMOS SRAM should be used to allow for a normal standby battery life.

Simple software (bit-banging) serial can be provided using the 1802's Q output line and one of the four jumper selectable EF input lines. Both the serial input and output can be setup as normal or inverted using on board jumpers. A MAX232A integrated circuit is used to create standard RS232 signal level on the serial lines. This allows for easy connection to most terminals or computer serial ports supporting RS232 signaling.

The 40-pin expansion header brings out most of the 1802's signal lines as well as a 5-volt DC power source. It is via this header that the front panel will be connected in addition to any other future expansion boards that may come.

Two groups of status LEDs have been provided to indicate operational status of the CPU board. The group of four LEDs provide status on the boot-strap circuit, the +5VDC power, serial RXD and serial TXD

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(aka 1802's Q LED). The group of three LEDs provide processor status; RUN, WAIT and RESET. If all three LEDs are off the microprocessor is in a LOAD mode not normally seen while in standalone operation.

Front panel

The next level to the Retro Elf system is the addition of a user front panel. The front panel is connected to the CPU board via a 40-pin flat cable connected to the CPU's bus.

The front panel gives the user a window in to the operations going on within the 1802. Key information is provided via LEDs that monitor the memory address, processor state (fetch, execute, DMA or Interrupt) and process mode (load, wait, reset and run). An additional eight LEDs are used as an output port.

13 toggle switches are used for system control and data input. Four switches handle Clear, Wait, Memory Protect and Input. The remaining eight switches are used for user data port input OR data to be written to the current memory location while in processor load mode. The Input toggle switch is a spring return type returning to the down position for each operational cycle for the switch. The final switch controls the Slow Clock board's speed to be used by the Retro Elf CPU.

Expansion board

When the expansion board is installed in to the Retro Elf system, it being a rich set of extra features like dual high-speed serial ports, a real-time-clock option and a simple interface for external CompactFlash cards.

The Expansion board is plugged in to the CPU board via a 40-pin header socket placed on the bottom side of the board. This creates a board stack between the CPU and the expansion board. The front panel is then plugged in to the expansion board using the 40-pin CPU board pass-through connector.

The expansion board increase the number of features available to the Retro Elf Plus system. An additional simple on board 5-volt DC voltage regulator is implemented to power the expansion board and peripheral connect to it. This regulator can supply 5-volts at up to half an amp when an 8-12 volts DC input is supplied to the board. A protection diode is used to help protect against accidental reversal of input power. Four jumpers are provided to select how the Retro Elf system will be powered. The complete system (CPU, front panel, slow clock board and expansion board) can be powered by either the CPU's or expansion board's on-board regulators. In some cases, you may need to power the CPU, front panel and slow clock board separately from the expansion board. These four jumpers allow the flexibility to setup the power needs for each application.

Two COM ports using 16550, high speed, serial UART chips are implemented. Each COM port is interfaced using a MAX232A integrated circuit to create standard RS232 signal level on the serial lines. This allows for easy connection to most terminals or computer serial ports supporting RS232 signaling. Both COM ports support hardware handshaking to allow for the fast as possible transfer of serial data. Two jumpers for each of the COM port channels are used to select if DTR/DSR or RTS/CTS pairs signaling will be used to support handshaking. Four diagnostics LEDs are provided for each COM port channel that show the status of TX, RX and both handshake lines.

A 40-pin header is supplied that conforms to most of the standard ATA-3 specifications and supports pretty much any ATA device that conform to:

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- Support for 8-bit transfer mode.
- Support for logical block addressing (LBA) mode. This connector can be used to attach an external device like disk drives or many versions of Compact Flash cards that meet the above requirements.

A four-pin header is also supplied that allows the addition on streaming external interfaces that support the use of an audio tape recorder or streaming floppy to save programs.

Real-Time-Clock support is provided using an Epson RTC72421 module. This RTC module provides highly accurate time-keeping and supports time and date for hours, minutes, seconds, month, day, year and day-of-week. An on-board backup battery provides continues operation of the RTC even when no power is being supplied to the Elf. The RTC can also be programmed to supply fixed-period interrupts to the Elf system.

Slow clock board

As mentioned earlier, one of the interesting features of the Retro Elf's CMOS construction is the ability to adjust the clock speed at any time to any rate. The slow clock board takes advantage of this by providing a three-level system clock speed control.

The slow clock is NOT a single step operation, where the 1802 clocks a full speed through fetch and execute and then waits at the end of the cycle for you to say another step please.

The slow clock feature is a nice way to both debugging hardware and software issues. It also allows you to see how the 1802 processing code. You will discover that the address LEDs no only display the address of the next memory operation but also the 16-bit data being moved from internal registers. So, a decrement of an internal register will show up on the address LEDs during the execute phase and then return to the next memory location on the next fetch.

I have used the above prototype clocking systems in classes to show students the inner workings of their code. It is exciting to see the lights go on in a student's mind as the LED lights reveal what going on inside the Elf as it steps through their simple test code.

The resulting design uses a three-position toggle switch with the same look a feel as the toggle switches already in place on the front panel of the Retro Elf. In the up position, you get full clock speed normally 3Mhz. In the middle position, the system clock is divided down to ~183Hz. With the toggle set in the down position you get the lowest speed of ~3Hz.

Testing showed that the middle speed was just fast enough to push through code but still get some useful indications from the status LEDs. The slowest speed gave you the time to really watch each clock cycle happen.

In reality you can use jumpers to select one of four frequencies for both the middle and down positions. If you wish, you can reverse the order so that the middle position is very slow and the bottom is the faster speed. It is even possible to make both middle and bottom the same clock speed!

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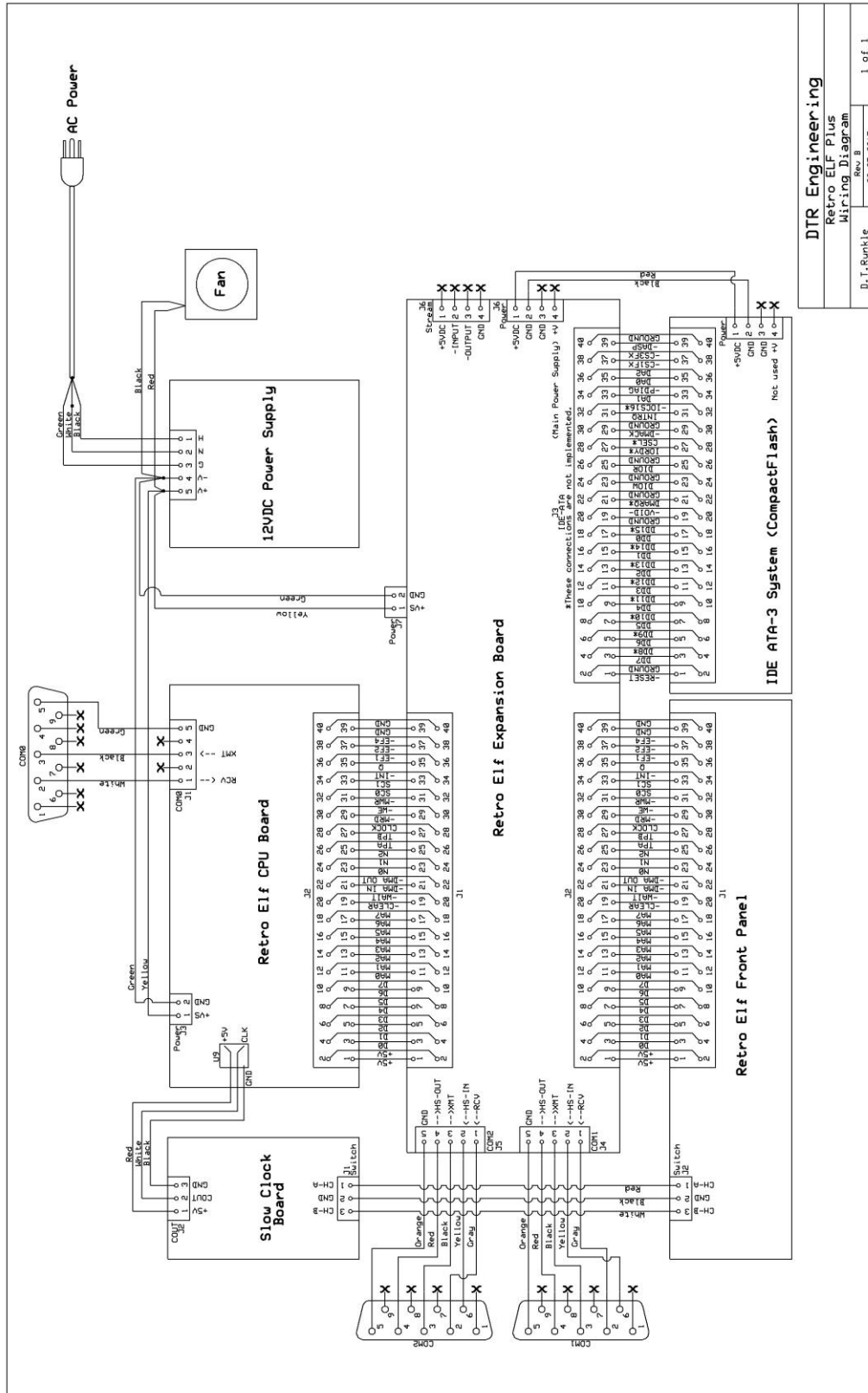
Power supply

Power needs for the Retro Elf unit can be easily supplied by a small enclosed 12-volt switching power supply. The power supply selected for all the development units are rated at 25 watts and can be plugged in to most mains power from 88 to 264 VAC at 50/60Hz.

Enclosure

The complete Retro Elf development systems where housed in an off-the-self PacTec C-350 series enclosure. A small 12volt DC fan is also installed on the back panel cover for the case. This fan helps provide air flow through the case to keep everything cool while the Retro Elf is in operation. Bench tests seem to indicate that given the low power needs for the CMOS electronics, the fan may not be needed. But having one give peace of mind.

Appendix A – Retro Elf System Wiring



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Wiring Diagram

Rev. B

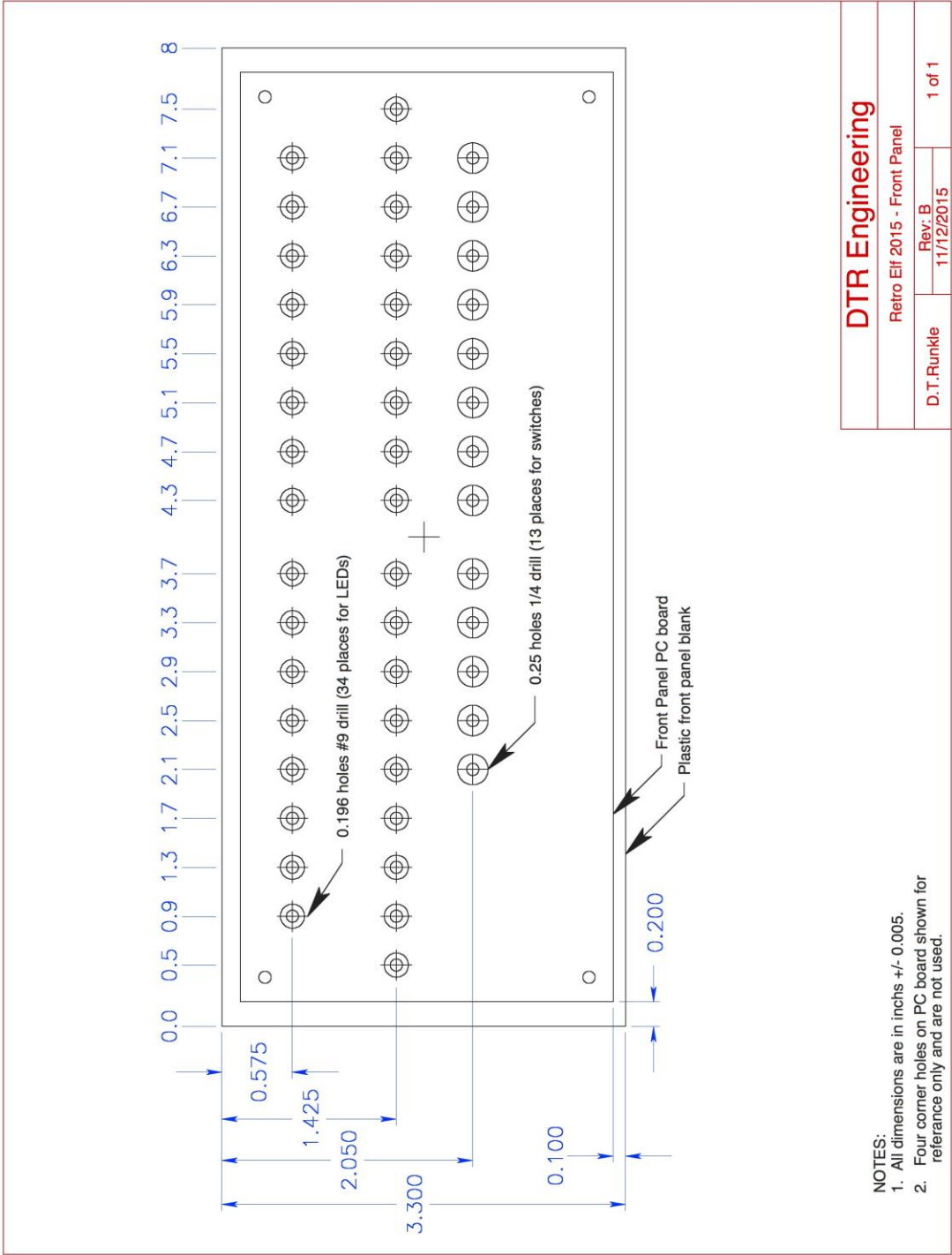
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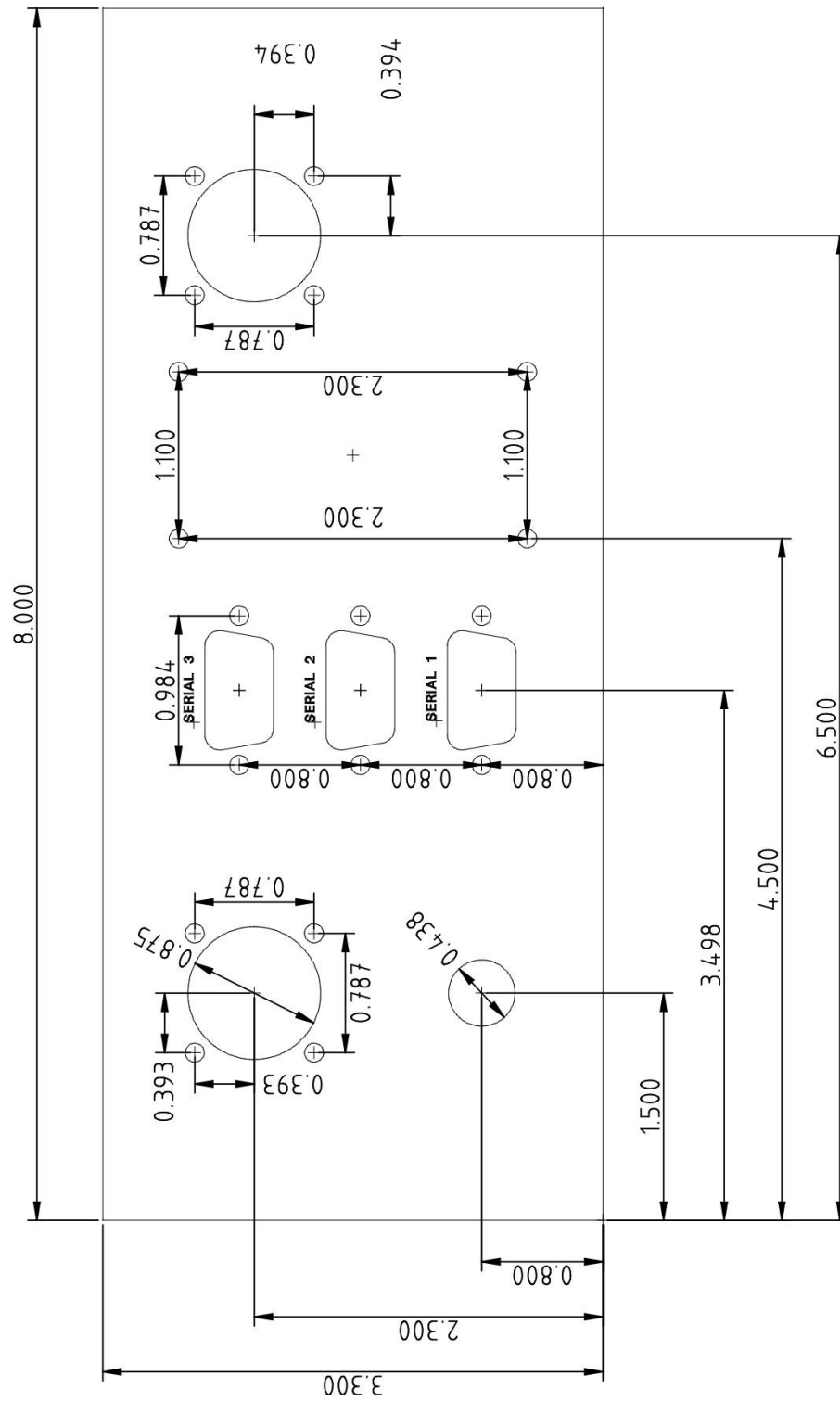
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Appendix B – Case and wiring

Front panel drill detail

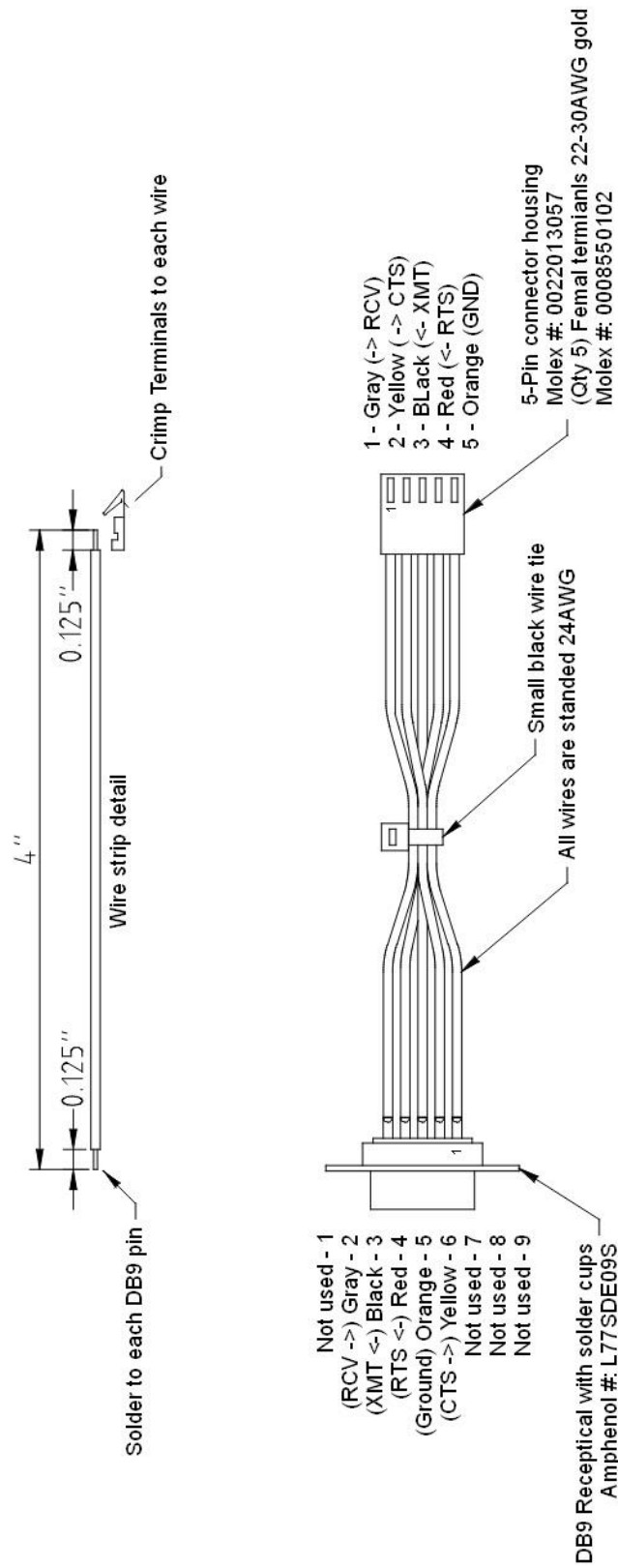


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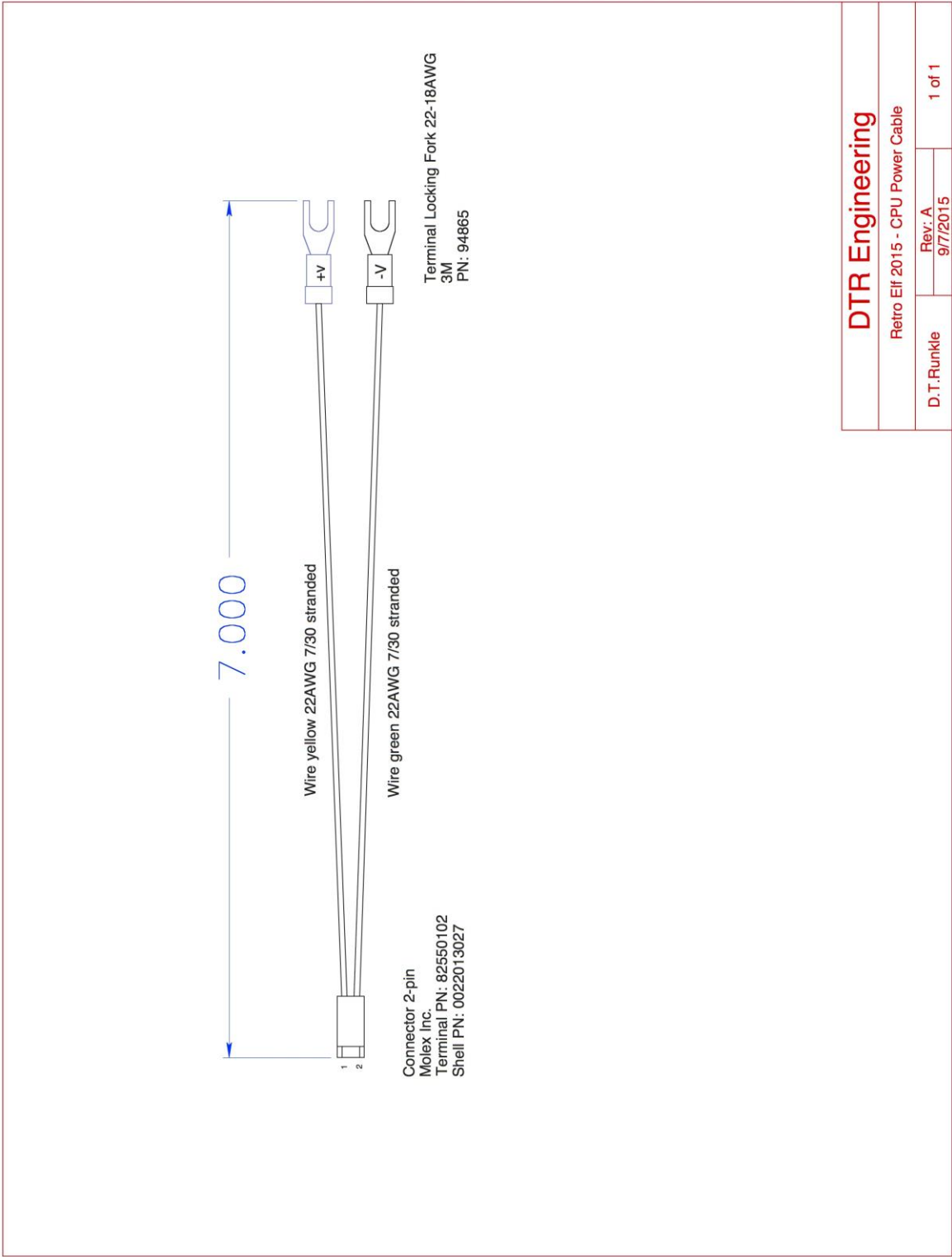


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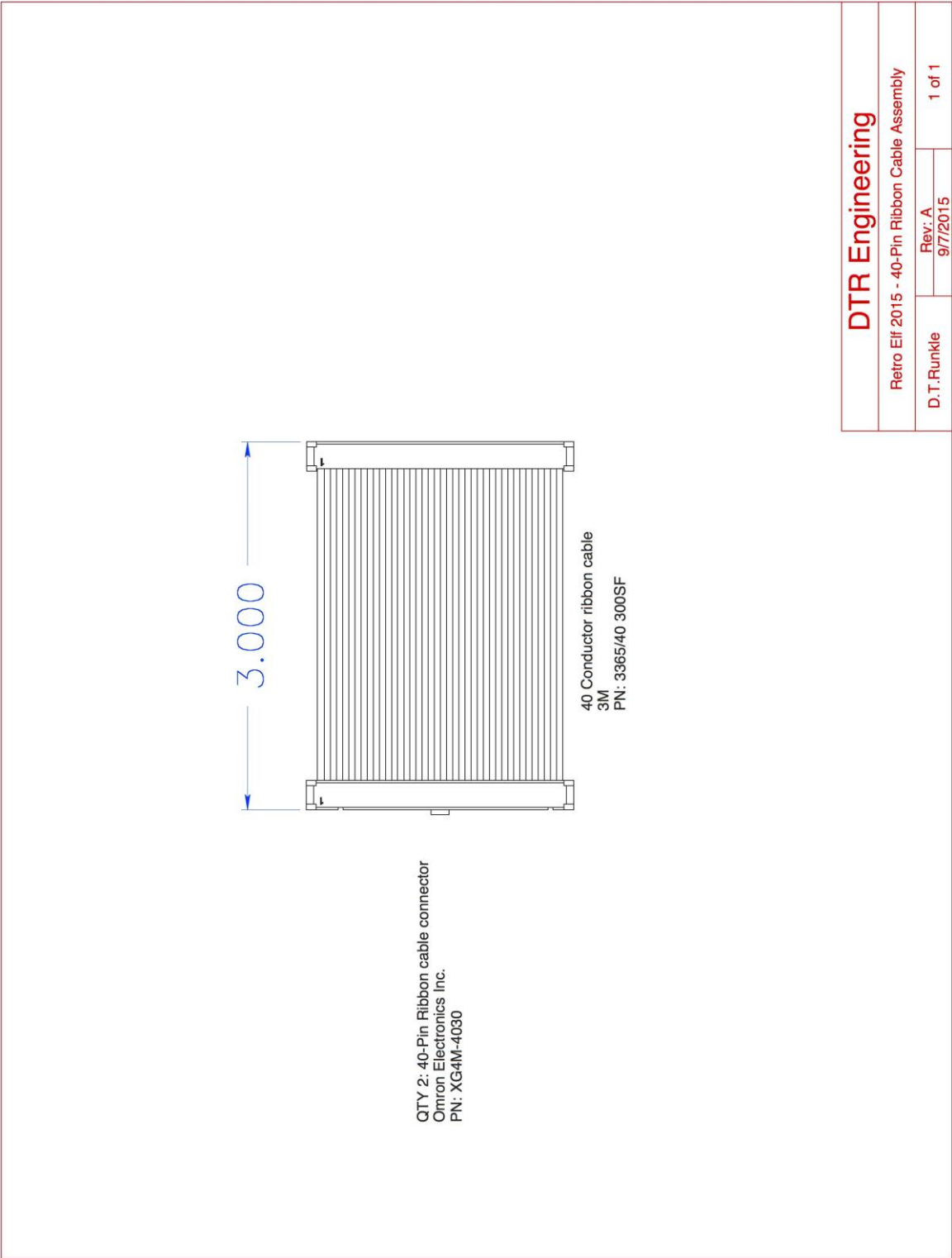
RS232 cable assembly



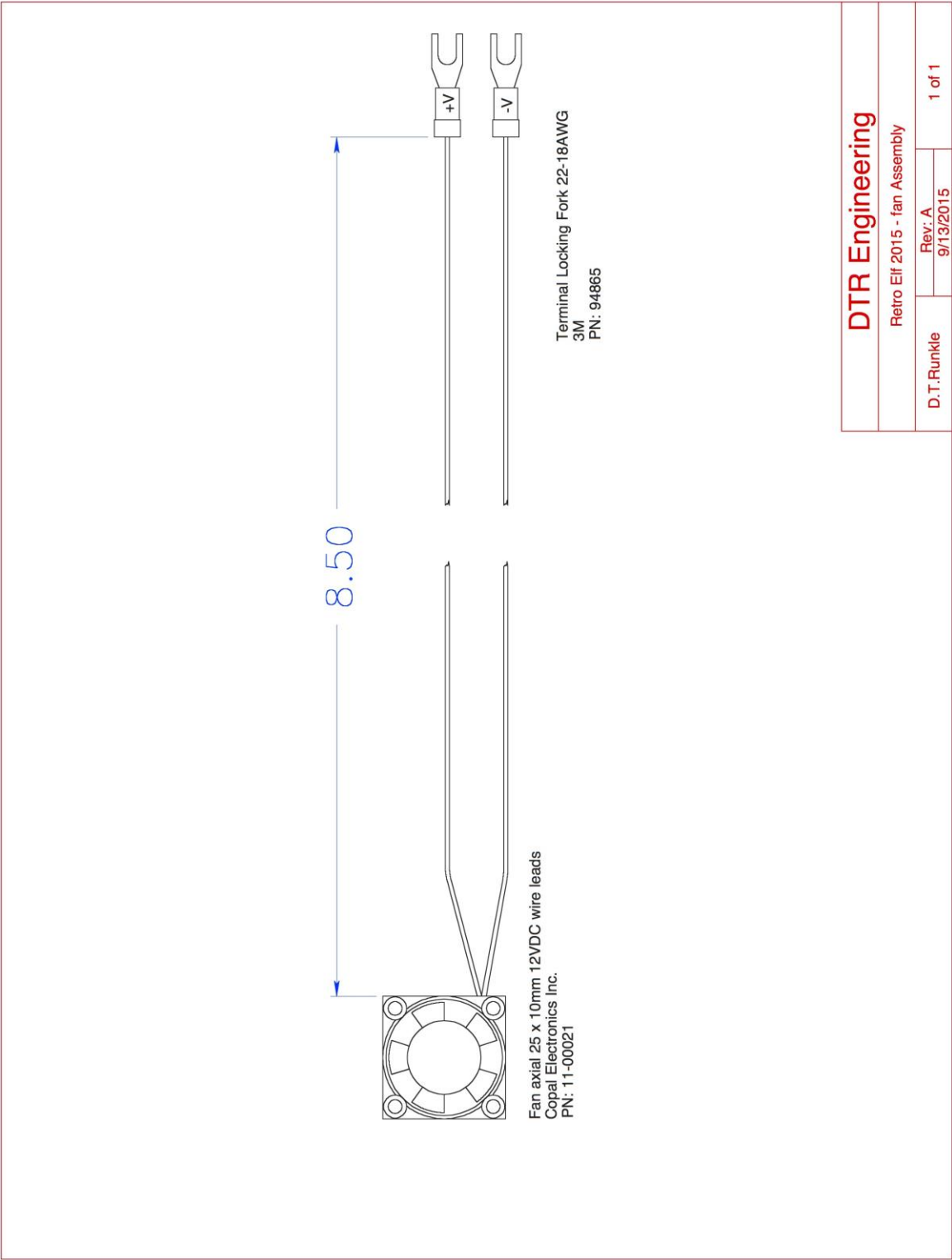
CPU power cable detail



40-Pin ribbon cable detail



Fan wiring detail



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Main AC power cord detail

