Theory of Operation

CPU

OpenEVSE is based on the ATMEL AVR:
- 8-bit microprocessor
- 16mhz
- Compatible with Arduino IDE

Pilot circuit

The +/- 12v square wave is created by supplying an operational amplifier with a +/- 12v power supply created by the DC/DC converter module from the 12 volt supply. The output of the op-amp is buffered by R1 (https://code.google.com/p/open-evse/source/detail?r=1) (which allows the EV to drag the voltage down without unduly straining the output stage of the amp) and fed to the vehicle. The pilot pin is also fed back to ADC1 of the CPU, which allows the CPU to sense the voltage. The CPU will detect the negative portion of the signal not being all the way at -12v as a missing diode condition and will use the measured voltage level (and therefore, the resistance being offered by the EV on the pilot) to select states A through D (EVSE Ready - Not Connected, EVSE Ready - Vehicle Connected, Vehicle requests charging, vehicle requests vent+charge). In stage A, the CPU will set a solid +12v output, and in the other states except state E and F (Error stated output steady -12v).
Pilot Duty Cycle

The pilot will output a square wave whose duty cycle represents the current availability setting made in the UI for the current charging mode (L1 or L2). It does this by oscillating PB2 under software control.

J1772 Duty Cycle

The J1772 Pilot is a 1khz +12V to -12V square wave, the Duty cycle (ratio high state to low state) determined the maximum available current. The EVSE sets the duty cycle the EV must comply to original setting or changes to the duty cycle.

<table>
<thead>
<tr>
<th>Amp</th>
<th>Duty Cycle</th>
<th>Amp</th>
<th>Duty Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>6A</td>
<td>10%</td>
<td>40A</td>
<td>66%</td>
</tr>
<tr>
<td>12A</td>
<td>20%</td>
<td>48A</td>
<td>80%</td>
</tr>
<tr>
<td>18A</td>
<td>30%</td>
<td>65A</td>
<td>90%</td>
</tr>
<tr>
<td>24A</td>
<td>40%</td>
<td>75A</td>
<td>94%</td>
</tr>
<tr>
<td>30A</td>
<td>50%</td>
<td>80A</td>
<td>96%</td>
</tr>
</tbody>
</table>

6A - 51A
Amps = Duty cycle x 0.6
Duty cycle = Amps / 0.6

51A - 80A
Amps = (Duty Cycle - 64) * 2.5
Duty cycle = (Amps / 2.5) + 64
GFCI

The current transformer coil detects any unbalanced current flowing through conductors passing through it. By passing both of the J1772 power cables through it, any current leaked to ground in the EV will result in a differential current within the CT. This will result in a voltage appearing at the input of the OP amp (diode D1 protects against excessive voltage in a run-away leakage event, such as a conductor short to ground). The second OP amp acts as a comparator and will "switch" from a low output to a high output when a threshold is exceeded. This output is fed as a fault indication into the CPU, which will register a ground fault and open the relay.

GFCI measures the difference of current going in vs. current going out. The circuit “trips” if an imbalance of > 20ma. The trip point can be adjusted by modifying the burden resistor R17 or the ratio of R14 – R15. The output of the fault line is monitored by the microprocessor as an interrupt.

AC Test

The two AC line monitor chips act as opto-isloators. The presence of an AC voltage potential relative to ground on either L1 or L2 will result in a state change from High to Low appearing on PD3 and PD4 of the CPU. Since the test pins are downstream of the relay, there should be no voltage present (pin state HIGH) the relay is open. This is how the stuck-relay test is accomplished. Automatic selection between L1 and L2 is accomplished by observing the state while the relay is closed. L1 will have a LOW state on only one line, L2 will have LOW state on both. A lack of voltage present on both while the relay is closed is a ground test failure.
Relay control

The transistor and resistor on PB0 and PD7 are straightforward open-collector switching circuits. The reverse bias diodes across the relay coil protect the transistors from coil collapse voltages when the transistors are turned off.
The relay circuit uses 2 2222 NPN transistors to switch 12V to the relay(s). Beginning in 2.0B2 OpenEVSE supports both 1 DPST or 2 SPST. Using 2 relays allows the self tests to be run one leg at a time avoiding powering the J1772 handle during the test. Also power can be removed from 1 leg if there is a stuck relay condition.

Power on Self test