

## **EMCP 4.2 Simulator Manual**

**Author: Lucas Tolbert  
CIC Engineering  
345 Center Street  
East Peoria, IL**

**Date of Origin: 11/30/2010**

## Overview

This document will detail the features and operation of the EMCP 4.2 simulator. The EMCP 4.2 simulator was designed to provide a way to demonstrate some of the capabilities of Caterpillar's EMCP 4.2 control.

Each simulator comes with a set of prints that details the wiring and circuitry inside the simulator. The simulator manual document will describe the functionality of the simulator and will reference the internal wiring. This document is not intended to convey complete details regarding the internal wiring of the simulator. Complete details are shown in the electrical schematics.

The simulator can be configured via the UP/DOWN and ENTER/ESC toggle switches and the simulator's LCD display.

The simulator produces a 3-phase waveform to simulate the generator's output voltage. These waveforms are connected to the EMCP's generator voltage input pins. A separate set of 3-phase waveforms are generated to simulate the current phases.

The simulator generates an engine speed sensor. The simulator will begin ramping the engine speed when a start initiate command is issued. The RPM will ramp until 1800 RPM is reached. An idle request will ramp the RPM to 1200 RPM.

The simulator has switches to allow the user to control some of the EMCP digital inputs. The simulator has LEDs used to indicate the state of some of the EMCP relay outputs.

The simulator has connectors for the user to connect devices to the CAN1, CAN2, RS485 MODBUS, and the RS485 annunciator ports of the EMCP.

## **Simulator Power**

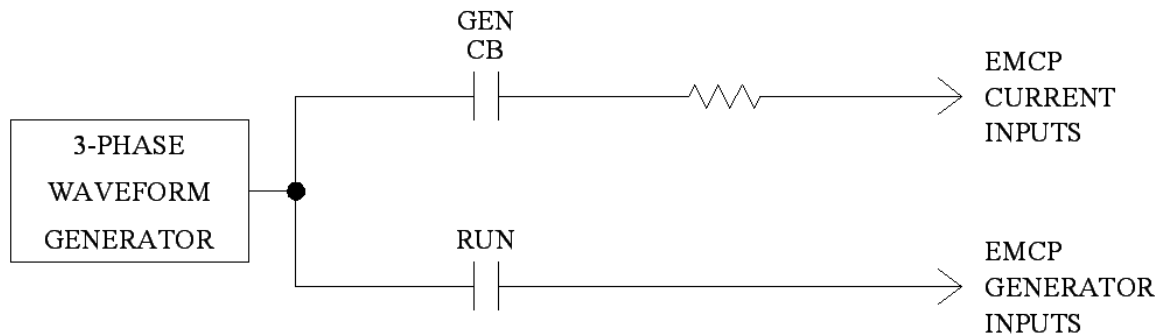
The simulator's incoming power can range from 120VAC to 240VAC at 50 or 60Hz. Power is connected through an AC inlet located on the top right of the simulator front panel. Power can be switched on and off using the toggle switch located to the left of the AC inlet. The incoming power has a 6A breaker in series with the power switch.

A 24VDC power supply is used to provide power for the simulator I/O and the EMCP control. This power supply also powers any devices attached to the communication ports. The 24VDC power supply has a 6A breaker in series with the output.

There is a 9VDC power supply that is used to power the internal electronics of the simulator.

There is a +5VDC and -5VDC power supply used to provide power for the 3-phase current and voltage waveforms.

## 3-Phase Voltage



**Figure 1**

Figure 1 shows a simplified schematic of the 3-phase wiring. The RUN contact and GEN CB contact are relays. The 3-phase waveform generator is the large PCB in the simulator.

The simulator PCB generates a set of 3-phase voltage waveforms. These waveforms are approximately 70 volts RMS. The amplitude for each phase can be digitally controlled using the simulator LCD interface. See the simulator configuration section later in the manual for details on how to use the setup interface.

The RUN relay contact will close when the engine speed sensor is above 400 RPM. The GEN CB relay contact will close when the simulator receives a START INITIATE request. A LED is provided on the front panel that illuminates when the GEN CB is closed. The GEN CB relay contact will open when the simulator loses the START INITIATE request.

## 3-Phase Current

The simulator PCB generates a second set of 3-phase waveforms. These waveforms are approximately 3.5 volts peak. These waveforms are connected to a 2-ohm resistor and return to common through the EMCP current inputs. Current does not flow until the GEN CB relay closes. See the Figure 1 for additional details.

The front panel of the simulator has a LOAD CURRENT ADJUST potentiometer that is used to vary the amount of current being generated by varying the amplitude of the waveforms. The waveforms have been adjusted such that the waveforms are sinusoidal until the LOAD CURRENT ADJUST is set too high.

Once the potentiometer is adjusted high enough; the current waveforms will begin to clip. This was done to allow for higher current readings while reducing the total amount of heat generated. Once the current waveforms begin clipping the power factor displayed by the EMCP control will no longer match the setting of the simulator.

## **Engine Speed Sensor**

The engine speed sensor is simulated by generating a square wave and then passing it through an isolation transformer. The engine speed begins ramping from 0 to 1800 RPM at the rate configured in the simulator configuration. The rate is specified in the number of seconds it should take the simulator to ramp from 0 to 1800 RPM.

The engine speed sensor begins ramping up when RELAY OUT 5 turns on. The engine speed sensor begins ramping down when RELAY OUT 5 turns off.

RELAY OUT 6 is used to command the simulator to go to the idle RPM

The current engine speed sensor rate is used to drive the RUN relay. The RUN relay connects the generator output voltage to the EMCP generator voltage input pins. The RUN relay turns on when the engine speed sensor reaches 400 RPM as the sensor ramps up. The RUN relay turns off when the engine speed sensor falls below 400 RPM.

## **EMCP Digital Inputs**

There are 4 switches wired to the EMCP digital inputs. These switches are wired to be active low and are active when switched up (towards the descriptive text).

The E-STOP switch is connected to the E-STOP input on the EMCP. The REMOTE INITIATE switch is connected to the REMOTE START input on the EMCP.

The DIGITAL INPUT 1 switch is connected to the DIGITAL INPUT 1 input.

The DIGITAL INPUT 2 switch is connected to the DIGITAL INPUT 2 and the DIGITAL INPUT 5 input. DIGITAL INPUT 5 is used on the EMCP control in order to allow the EMCP simulator to detect an idle request. The EMCP DIGITAL INPUT 5 input can be configured to turn on the RELAY OUT 6 output. The simulator will detect the change of state in RELAY OUT 6 and ramp the engine speed sensor to the idle RPM.

## **EMCP Digital Outputs**

There are 4 LEDs wired to the EMCP's RELAY OUTPUTS. These LED's are wired to output 1 through 4.

RELAY OUTPUT 5 is used by the simulator's internal logic to begin simulating the start of a generator by ramping the engine speed sensor.

RELAY OUTPUT 6 is used by the simulator's internal logic to simulate an idle request.

## **EMCP Analog Inputs**

The EMCP ANALOG INPUT 2 is wired to simulate the jacket water temperature sensor. This input is tied to a 47-ohm resistor.

The EMCP ANALOG INPUT 1 is wired to simulate the engine oil pressure sensor. This input is tied to a 10-ohm resistor when the engine is not running and a 100-ohm resistor when the engine is running.

The EMCP ANALOG INPUT 3 is wired to a potentiometer on the front panel. The potentiometer has 2 possible modes: ACTIVE and PASSIVE. When in ACTIVE mode, one end of the potentiometer is connected to the EMCP control's 5V sensor supply. When in PASSIVE mode, the 5V sensor supply is removed. A tip jack is provided on the front panel to allow for easy voltage measurements of the analog signal.

## **EMCP Communication**

There are several connectors in the lower left of the front panel that allows access to the various communication ports supported by the EMCP.

The CAN 1 CONNECTOR allows access to the CAN 1 communication port of the EMCP. The connector is wired to match the standard service port wiring. +24VDC power is supplied through pins A and B. An internal 120-ohm termination resistor is installed inside the simulator.

There are 2 connectors provided for access to the CAN2 communication port. These connectors are wired in parallel. The 2 connectors have been provided so that auxiliary devices such as a DIO module can be connected to the simulator using one of the connectors and a computer can be connected to the other connector. The connectors are wired to match the standard service port wiring. +24VDC power is supplied through pins A and B. An internal 120-ohm termination resistor is installed inside the simulator.

An 8-pin connector has been provided to allow for connection of a RS-485 annunciator. An extension cable has been provided to allow the annunciator to be connected to the simulator.

A spring cage terminal strip has been provided for connection to the RS-485 MODBUS communication port.

## **Simulator Configuration**

The simulator has settings that can be configured using the simulator LCD display. There are 2 switches provided that allow for LCD menu navigation. The UP/DOWN switch allows the cursor to be moved or a value to be incremented or decremented. The ENTER/ESC switch has 2 positions. The ENTER switch allows for a menu entry to be selected or a configured value to be saved. The ESC switch allows for a menu or prompt to be exited.

The MAIN MENU is shown at power-up.

One of the methods used to configure the simulator is a series of prompts. This method is used in several places and each of the instances function in a similar manner. The ESC switch will cancel any edits to the current prompt and will return to the previous menu. The ENTER switch will accept any edits to the current prompt and advance to the next prompt. The display will return to the previous menu after the last prompt has been answered.

### **DISPLAY MODE**

This menu entry displays a screen where the current value of the ANALOG INPUT 3 signal is shown. This screen also shows the approximate amount of actual load selected through the LOAD ADJUST CONTROL potentiometer. The screen can be exited using the ESC switch.

### **RPM SETUP/INFO**

This menu entry displays a screen showing details about the engine speed signal generation.

The current engine speed signal ramp time is shown. This number is the amount of time it will take the simulator to ramp from 0 to 1800 RPM.

The ramp rate of the engine speed signal can be configured. Use the UP/DOWN switch to increment and decrement the value.

The screen can be exited using either the ENTER or ESC switch. The ENTER switch will save any changes to the ramp rate. The ESC switch will cancel any changes.

### **LCD SETUP**

This menu entry displays a sequence of prompts that allows the user to configure the LCD contrast and brightness.

### **WAVEFORM FREQUENCY**

This menu entry allows the user to configure the frequency of the 3-phase waveforms.

Use the UP/DOWN switch to increment and decrement the frequency.

The screen can be exited using either the ENTER or ESC switch. The ENTER switch will save any changes to the ramp rate. The ESC switch will cancel any changes.

### **WAVEFORM AMPLITUDE**

This menu entry displays a sequence of prompts that allows the user to configure the amplitude percentage of each phase of the generator voltage signals. The edited value takes effect immediately but edits can still be canceled using the ESC switch. This was done so that phase amplitudes could be tweaked easily.

### **POWER FACTOR**

This menu entry displays a screen that allows the power factor to be configured.

Use the UP/DOWN switch to increment and decrement the power factor percentage.

The screen can be exited using either the ENTER or ESC switch. The ENTER switch will save any changes to the ramp rate. The ESC switch will cancel any changes.

### **ROTATION DIRECTION**

This menu entry displays a screen that allows the rotation direction of the generation 3-phase signals to be selected.

This screen shows the currently selected rotational direction. The UP switch can be used to toggle between the two possibilities: ABC and CBA.

### **DIAGNOSTICS**

This menu entry displays a sub-menu that allows the I/O of the simulator to be viewed.

#### **DIAGNOSTICS->INPUTS**

This menu entry displays a list of the digital inputs for the simulator PCB. The current state of each input is shown. Use the UP/DOWN switch to navigate the list of inputs. Use the ESC switch to return to the previous menu.

#### **DIAGNOSTICS->OUTPUTS**

This menu entry displays a list of the digital outputs for the simulator PCB. The current state of each output is shown. Use the UP/DOWN switch to navigate the list of outputs. Use the ENTER switch to toggle the state of an output. Use the ESC switch to return to the previous menu.

**Note:** while this screen is being shown the automatic processing of the outputs is suspended. When this screen is exited the automatic processing of the outputs will resume.

#### **DIAGNOSTICS->DAC OUTPUTS**

This menu entry displays a list of the analog outputs for the simulator PCB. The 3-phase signals are generated using these analog outputs.



The current raw value of each output is shown. Use the UP/DOWN switch to navigate the list of outputs. Use the ESC switch to return to the previous menu. Use the ENTER switch to begin editing an output.

Once an output is selected for editing the UP/DOWN and ENTER/ESC switches take on a new function. The UP/DOWN switch will increment and decrement the current output's value. The ENTER or ESC switch accept the edit and return to the state where the list can scrolled.

**Note:** while this screen is being shown the automatic processing of the analog outputs is suspended. When this screen is exited the automatic processing of the outputs will resume.

### **DIAGNOSTICS->ANALOG INPUTS**

This menu entry displays a list of the analog inputs for the simulator PCB. The current raw value of each input is shown. Use the UP/DOWN switch to navigate the list of inputs. Use the ESC switch to return to the previous menu.