

Gadget Freak Case #170

Smoking Permitted, But Bring a Roast

Anyone can drop a roast or spare ribs into a commercial meat smoker, but Peter Rauch decided to create an electronically controlled smoker that uses a programmable controller, touch-screen human-machine interface, and a network connection. Not only will this high-tech smoker control its temperature, it also monitors meat temperature and can hold it at that temperature until you're ready for a feast. The design includes a Web server for remote control and text-message alarms. As they say in German, "Rauchen erlaubt."

Overview

Peter Rauch used a proportional-integral-differential (PID) controller that modulates electrical power to a heating element to create a home-built electronic meat smoker. A touch-screen display let him manage the controller set point and control-loop parameters. A J-type thermocouple in the top of the smoker provides a voltage signal so the feedback loop can control the smoker's temperature. A second sensor, which reads meat temperature, is used only for monitoring and alarms. A user can enter a desired meat temperature, and receive an alert via a text message when the temperature reaches a preset value. Additionally, when the temperature reaches this setpoint, the controller can 'hold' the meat at a preset temperature to avoid overcooking it until you can remove it.

Editor's Note: Because this meat-smoker uses line-voltage power, follow safe power-circuit rules and regulations. Consider connections as electrically "hot" and capable of a shock hazard that could cause injury or death. Always use grounded receptacle and a 3-wire earth-ground connection to line power! Neither Rauch nor Design News accepts any responsibility for your safety or the safety of others who build or use this or a similar circuit. We cannot be responsible for how you build, fabricate, use, or package circuits. Work on a nonconductive surface. Keep the components, circuits, and power sources away from children and others. During testing, connect test instruments or probes to the UNPOWERED circuit and then with one hand in your pocket, plug in, or turn on, the circuit and read your measurements. Ensure that you have carefully grounded any metal chassis, cases, and racks to the ground terminal (green wire) on your line-power plug.

For more photographs and the wiring diagrams for the controller, HMI, heater, and sensors, go to: <http://www.gfreak.com/GF170/GF170.zip>.

The Temperature Controller

You could use almost any electronic temperature controller in a meat smoker, but Peter had control equipment used for other development work. So, think of this Gadget Freak design as a proof of concept project rather than a design to follow exactly.

This smoker used a 4-loop Gefran GFX4 (www.gefran.com) temperature controller, that came with integrated solid-state relays (SSRs), current transformers (CTs), and semiconductor fuses. The GFX4 can implement PID Heat/Cool controls in many configurations. In this application, it switches both legs of a 110V AC single phase load--a heating element from a hot-plate. The unused feedback input for the second switched leg connects to the meat-temperature sensor.

The controller itself has no integrated display, so Peter used the Modbus remote terminal (RTU) interface on the GFX4 to connect it with a TS8010 HMI Touchscreen from SSD Drives (www.ssddrives.com). Each temperature-control loop has a unique Modbus address--address 10 for the smoker-temperature control zone and address 11 for the meat-temperature probe. (Zones 3 and 4 at Modbus addresses 12 and 13 were not used.)

The Operator Interface

Peter coded custom screens on the TS8010 touchscreen interface to simplify setting the smoker temperature, as well as enabling or disabling alarms and transmission of short text message based on events that occur in the temperature controller. A user can set up the temperature controller via the touchscreen for sensor type (and associated scale limits), high and low temperature alarms, and operator temperature set-point limits. You don't want someone to enter 1200 degrees by mistake! The temperature controller or the TS8010 touchscreen interface saved this information.

The touchscreen interface also was configured to perform an unattended start-up of the smoker. An operator can enter a desired start date and time, and then the heat will turn on. At any time the operator can turn heat on or off manually, and change the control mode from automatic (PID output) to manual (0 to 100 percent power). Every five seconds the TS8010 touchscreen interface logs smoker temperature, meat temperature, and controller output (on or off), and it stores this data on an internal compact flash card. You can download the data via the web server built into the TS8010 and import it into a spreadsheet for 'analysis.' Peter prefers to use his taste buds, though.

Web Server

When turned on, the web server within the TS8010 touchscreen interface lets you control the meat smoker via any web browser that can access the IP address of the TS8010. By using simple port forwarding or port mapping through various routers in a home, for example, you could control the meat smoker from anywhere with Internet access. For now, though, Peter will keep control within his private LAN.

Wireless LAN Access

Wireless LAN access is achieved by using a Linksys Wireless-G Bridge on a rack that also holds the temperature controller. The bridge connects a 5-port Ethernet switch on the rack to a specific WiFi service-set identifier, or SSID--Peter's wireless router elsewhere in his home. Any networked device plugged into the switch can access the LAN (the TS8010) via the bridge.

Text Messaging Alarms

You can create short message service (SMS) text messages by sending an alarm email from the TS8010 touchscreen interface. The messages go to an email-to-text-gateway that many wireless-service providers seem to have. The following figures show screen images for the configurations.

The screenshot displays the configuration interface for SMTP. On the left, a vertical sidebar contains tabs for 'General', 'SMTP', 'SMS', and 'Addresses', with 'SMTP' currently selected. The main area is divided into two sections: 'SMTP Transport' and 'SMTP Authentication'.
SMTP Transport Section:
- Transport Mode: Enabled (dropdown)
- Server Selection: Manual Configuration (dropdown)
- Server IP Address: Fixed (dropdown) with input field '162 . 39 . 147 . 58'
- Server Port Number: Fixed (dropdown) with input field '25'
- Domain Name: Fixed (dropdown) with input field 'grill@driveway.com'
- Reverse Path: Input field 'G3 Panel' with an 'Edit...' button
- Initial Timeout: Input field '30' with 'secs' label
- Record Log File: Disabled (dropdown)
SMTP Authentication Section:
- Method: Login (dropdown)
- Username: Fixed (dropdown) with input field ending in '@windstream.net'
- Password: Fixed (dropdown) with input field containing '*****'

Figure 1. The screen image above shows the controller's server-configuration information for the simple mail transfer protocol (SMTP).

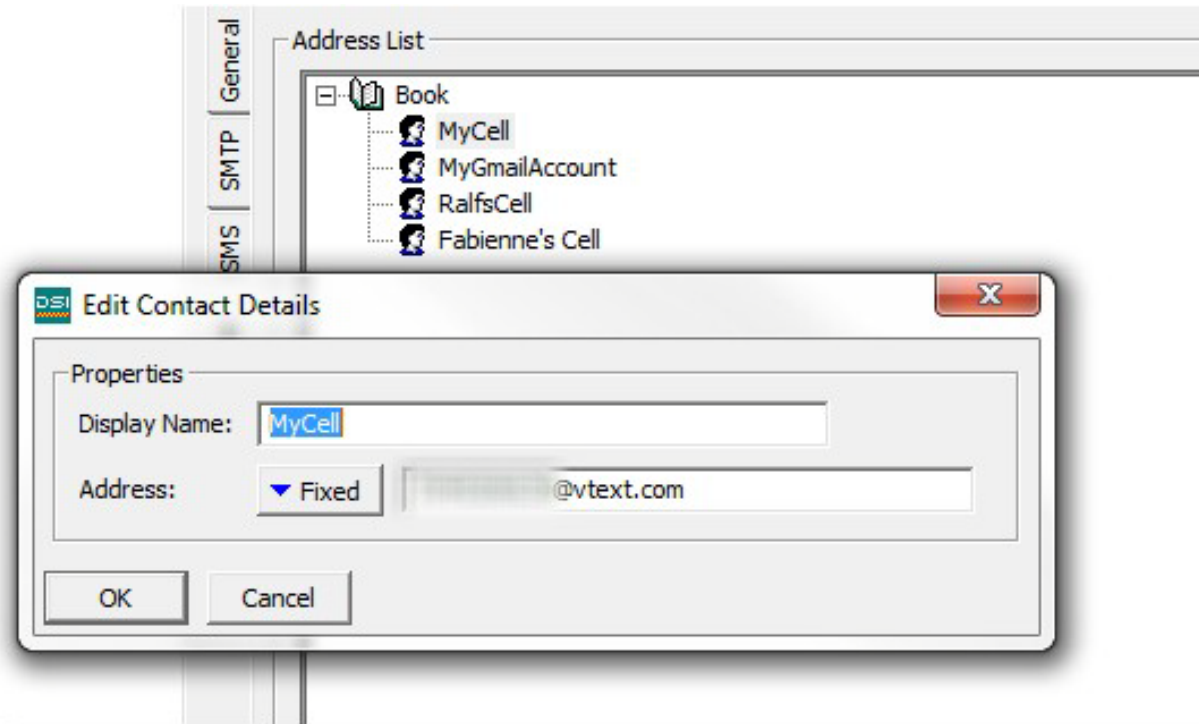


Figure 2. The Contact Details portion of the controller's configuration settings let Peter specify an email address for smoker-alert messages.

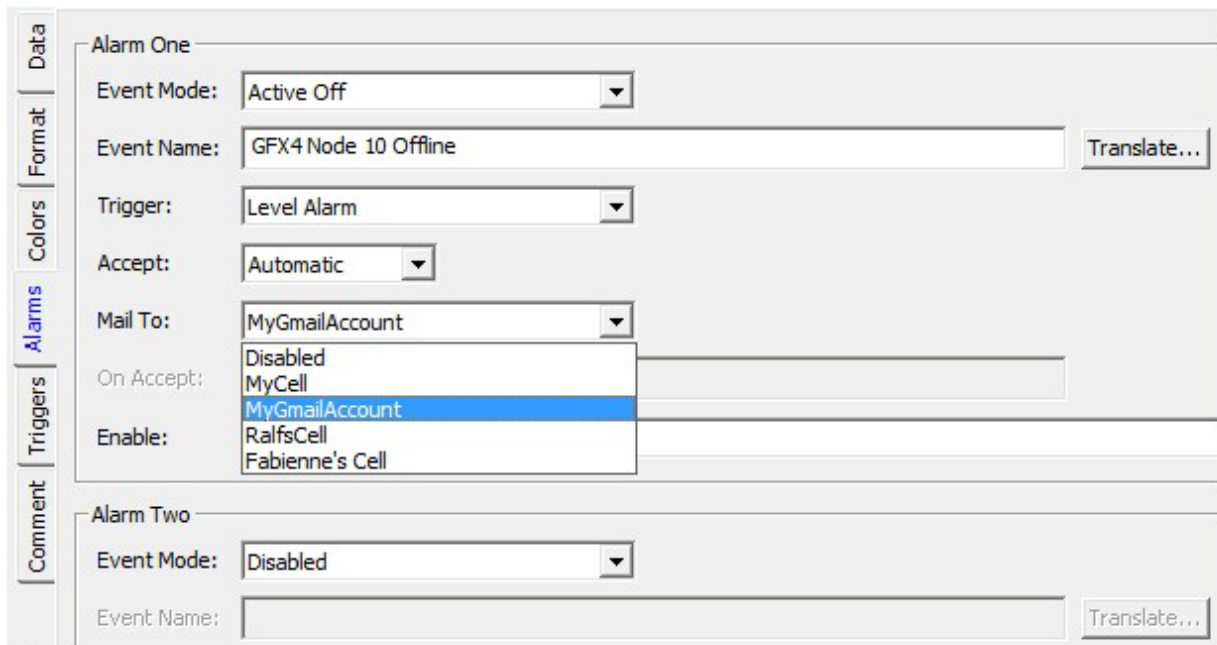


Figure 3. The alarm-setting window establishes the events that cause the controller to send an email message to a chosen recipient.

The Smoker

Peter assembled his smoker from two common terra cotta flower pots obtained at a local garden "super center."



Figure 4. Peter with the completed meat smoker in operation.

A standard 16-inch (41-cm) pot served as the main pot, and what people refer to as an Azalea Bowl formed the lid. Peter noted Azalea Bowls can prove hard to find, but he found one on his first outing. If you can't find an appropriate Azalea Bowl, you can probably find something similar.

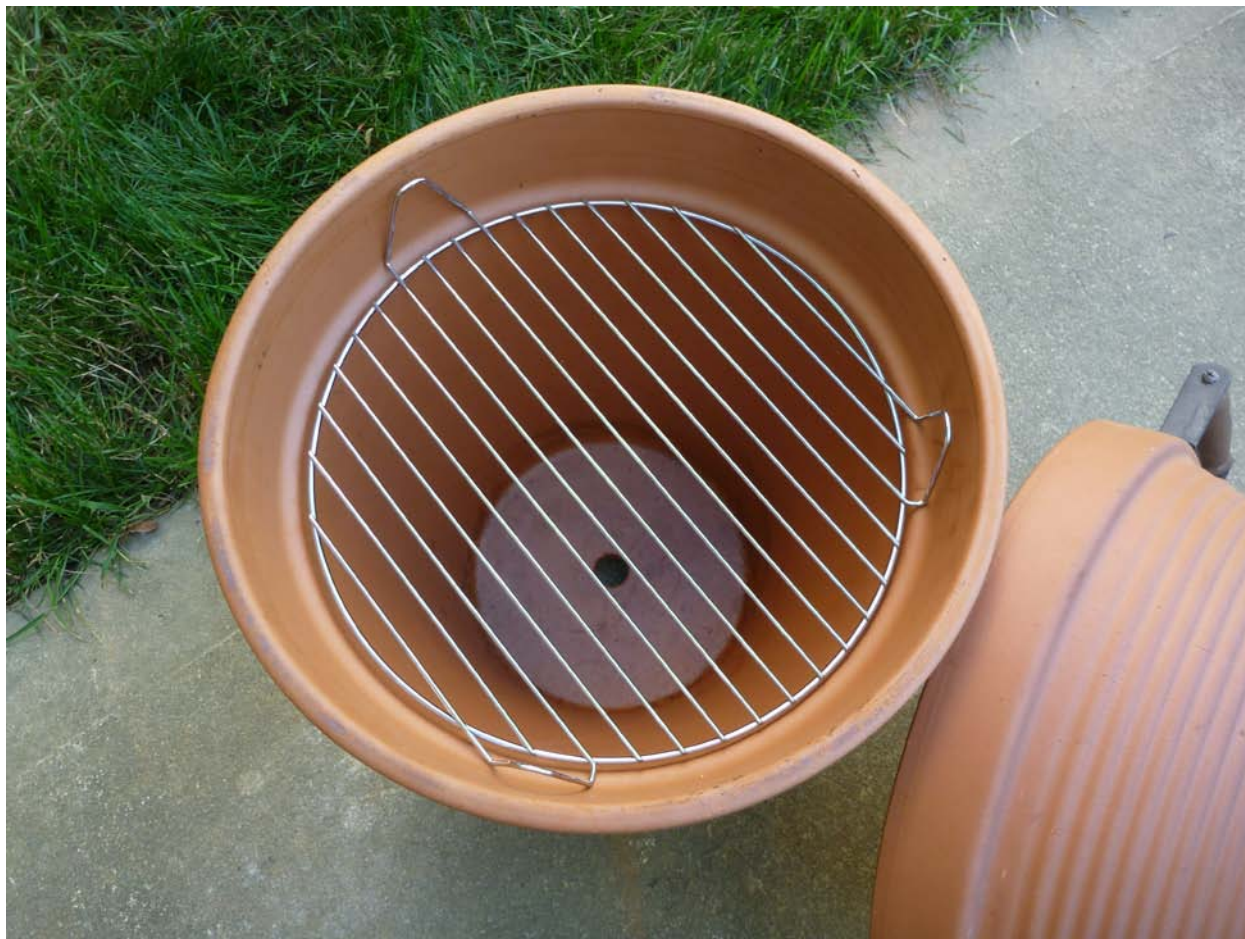


Figure 5. The terra-cotta smoker "body" with top (right side).

Three terra cotta feet complete the body of the meat smoker. The feet let the high-temperature wire from the heater element exit the pot via the normal water-drain hole in the base. The heating element came from a twin-element hot plate obtained at a local Walgreens (a US drug-store chain). Peter salvaged the meat rack, or circular grate, from a convection oven/microwave, and he salvaged two handles from an old non-electronic metal smoker. (Be sure to use thermally insulated handles!)



Figure 6. Hot-plate element attached to a terra-cotta base ready for insertion into the bottom of the smoker pot.

A cast-iron biscuit plate from 'Lodge Cast Iron Cookware' finishing off the smoker. By cutting of the biscuit-plate handles, Peter could set the iron plate directly on the hot-plate element. Visit: https://secure.lodgemfg.com/storefront/product1_new.asp?menu=prologic&idProduct=3950

The heating-element connects to the GFX4 controller via fast-on style connectors (or quick disconnects) and high-temperature wire. After the high temperature wire exits the base of the pot, Peter connected it to a standard line-cord wire that ends with a male line-power plug. The plug goes into a duplex receptacle on the controller assembly. The duplex receptacle provides switched power from the temperature controller.



Figure 7. Smoker assembly in driveway with controller, HMI, and connections to thermocouples and the heater element.



Figure 8. Get ready for good eating!

Bill of Materials

Amt.	Description	Vendor	Vendor Part #
2	Cat 5E Patch Cord 1 ft. (30 cm)	Allied Electronics	647-0736
1	24" Length High temperature Wire ~16 AWG	Allied Electronics	214-3552
4	Crimp Terminal, Female, Insulated	Allied Electronics	512-5144
1	Duplex Receptacle Face Plate	Allied Electronics	533-0141
1	Duplex Receptacle Box	Allied Electronics	533-0176
1	Power Supply Cord	Allied Electronics	626-3636
1	DIN Rail, Steel	Allied Electronics	809-0110
12 in.	Shielded Cable, Two Conductor (Modbus)	Allied Electronics	216-0998
1	Power Supply 24VDC 60W 120VAC	Allied Electronics	814-0036
1	DC/DC Converter, 24VDC to 5VDC for Bridge	ETA-USA	SVM-SC24
1	30KW 4 Loop Temperature Controller	Gefran	GFX4-30-0-2-F-0
1	Wireless G Bridge	Cisco/Linksys	WBP54G

1	Cable, RJ10, 1-ft. (30 cm)	See Notes.	None
1	J Type Thermocouple Probe, 2-inch Sheath Stainless Exposed Junction (Smoker Temp) with 96-inch Leads	Omega Engineering	JTSS-316E-2/96
1	J Type Thermocouple Probe, 18-inch Sheath Stainless Ungrounded Junction (Meat Temp) with 96-inch Leads	Omega Engineering	JTSS-116U-18/96
1	Touch Screen 10", CABLE KIT, Enet/232/485	Parker SSD	TS8010/00/00
1	5-PORT Ethernet Unmanaged Switch	Wago Corp.	51190894
1	Buffet Hot Plate (Heating Element)	See Notes.	
1	RJ9 (Handset) Breakout DIN Mount	Winford Engineering	BRK4P4C-R-DIN
1	RJ45 Breakout DIN Mount	Winford Engineering	BRK8P8C-S-DIN
1	Terra Cotta Azalea Bowl	See Text.	
3	Terra Cotta Planter Feet	See Text.	
1	Terra Cotta Standard Planter 16"	See Text.	
2	Terra Cotta Saucer (Small)	See Text.	

Notes:

1. Allied Electronics: www.alliedelec.com
2. Cisco/Linksys: cisco.biz/en/US/products/ps10046/index.html
3. ETA-USA: www.eta-usa.com/pdf/files/dcdc/SVM_SC_series.pdf
4. Gefran: www.gefran.com/en/products/product_714.aspx
5. Wago: <http://www.wago.us/downloads/51017274.pdf>
6. Walgreens sells the 2-element Maxi-Matic Electric Double Buffet Burner or the 1-element Kitchen Gourmet Single Buffet Range. www.walgreens.com.
7. Winford Engineering: <http://www.winford.com/products/brk4p4c.php>
8. Winford Engineering: <http://www.winford.com/products/brk8p8c.php>
9. RJ10 cable is a 4-wire phone-extension cable with connectors.

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