INTRODUCTION

The Alarm Output Module (AOM) can be incorporated in any GroWeather or EnviroMonitor weather station. It monitors the status of the alarms in the Console and of bits sent by the user from the Computer and makes any four of these available as contact closures which may be used to control external systems, indicators, or equipment.

> **NOTE**: the Alarm Output Module is not suitable for any use in which the health or safety of any person or the value or protection of valuable property is dependent on the operation of the AOM.

OPERATION of the AOM

As shown in the block diagram, Figure 1, serial data are fed to the AOM's Input Registers from the Console via the Sensor Interface Module (SIM) or the Interface Cable Adapter (ICAM). As an error check, the data stream contains two copies of the alarm data, one in true form and one inverted. A user-set POLARITY switch determines whether the outputs will be open or closed when their respective alarms are active:

N/O = contact open when alarm is inactive, closed when active. Open when AOM power is off.
N/C = contact closed when alarm is inactive, open when active. Open when AOM power is off.

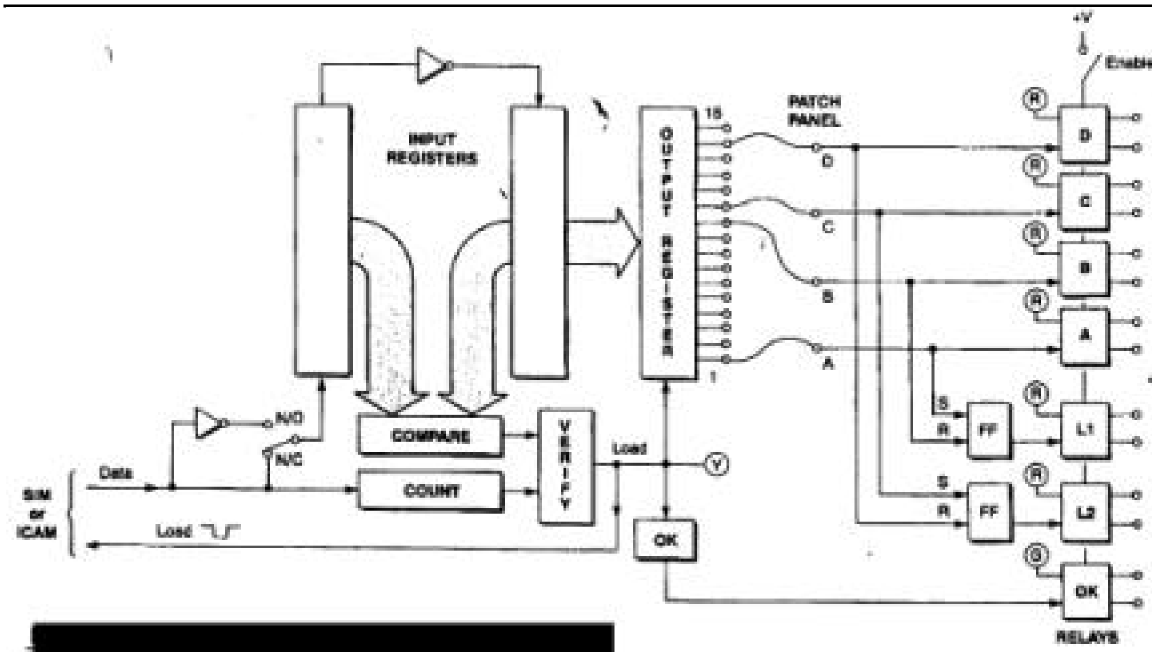

Figure 1. Block diagram of the Alarm Output Module

When the Verify circuit confirms that the correct number of bits has been sent and that the two copies of the data compare correctly, it generates a LOAD pulse to transfer the data into the Output Register. A yellow indicator flashes to show that a good data transfer has occurred. Each bit of the Output Register now contains an alarm status or user-set bit as shown in Table 1.

The TIME alarm is active for one minute after initiation. The DAILY ET alarm is active for eight to 24 seconds. All other outputs remain active as long as their corresponding alarm conditions are true or user-input commands are set. The RADIO POWER contact may be used to control power to the radio for power-conserving wireless Link operation.

Table 1. Alarm, Radio Power, and User's Bits in the AOM

SYSTEM:	GroWeather	Energy	Health
BIT			
16	Time	Time	Temperature, High
15	Daily ET	Temp-Hum Index	Temperature, Low
14	Dew Point	Dew Point	Inside Temp, Low
13	Radio Power	Radio Power	Inside Temp, High
12	Humidity, Low	Temperature, Low	Humidity, Low
11	Humidity, High	Temperature, High	Humidity, High
10	Temperature, Low	Humidity, Low	Inside Humidity, Low
9	Temperature, High	Humidity, High	Inside Humidity, High
8	Soil Temp, Low	Wind Chill	UV Dose
7	Soil Temp, High	Wind Speed	Temp-Hum Index
6	User's 1	User's 1	Wind Speed
5	Temp-Hum Index	Daily Rainfall	Temp-Hum-Sun-Wind Index
4	Wind Chill	***not used***	Daily Rainfall
3	Wind Speed	***not used***	Inside Temp-Hum Index
2	User's 2	User's 2	Wind Chill
1	Daily Rainfall	Barometer	UV Index

NOTES: "Temperature" and " Humidity" refer to outside air unless otherwise stated.

At a small user-set patch panel four of the Output Register bits are selected for input to relay-drivers and four photo-isolated solid-state relays: A, B, C, and D.

In addition to the direct outputs, the module has two latched outputs: signals A and B are wired as SET and RESET inputs to an R-S flip-flop which drives relay L1; signals C and D similarly drive relay L2. The SET input causes the latch relay contact to close, the RESET input opens it. . The POLARITY switch must be set to **normally-open** for correct operation of L1 and L2.

Each of the six relays has an associated red LED which is lighted when the relay contact is closed.
The ENABLE switch controls power to the relays. When it is set to OFF the output contacts are unconditionally open. The LEDs continue to display the status of the signals to the relays. This permits the user to "disconnect" all outputs while continuing to monitor the performance of the AOM.

For possible use as a safety interlock, the OK output indicates that the other contact outputs may be considered valid. The green LED is lighted and the OK contact is closed when all the following conditions are true:

- a valid data transfer has occurred within the prior 10 seconds
- the ENABLE switch is on
- AOM power is present.

The polarity of this output is not affected by the setting of the POLARITY switch.

LOAD pulses are sent back to the Console, where the success-rate of data transfers is monitored and sent to the Link software in the PC for reporting to the user.

When power is first applied to the AOM all output contacts are kept OPEN until the first valid LOAD is performed.

CONNECTION ALTERNATIVES

The AOM communicates with the Console via the SIM-Console bus. It may be connected at the SIM, or, if it is desired to locate the AOM farther from the SIM, it may be connected at the ICAM, which may be placed at any point on the SIM-Console cable. The connection cable to either SIM or ICAM may be a maximum of 40 feet (12 m) in length (Davis cable #7878-040); a two-foot (0,6m) cable is provided with the AOM. Figure 2 shows alternative placements of the ICAM in one system configuration.

The AOM requires its own source of +12VDC power. This may be provided by either a separate power adapter or by a short "Y" cable, which wires power from a single adapter to both the Console and the AOM; both are provided.

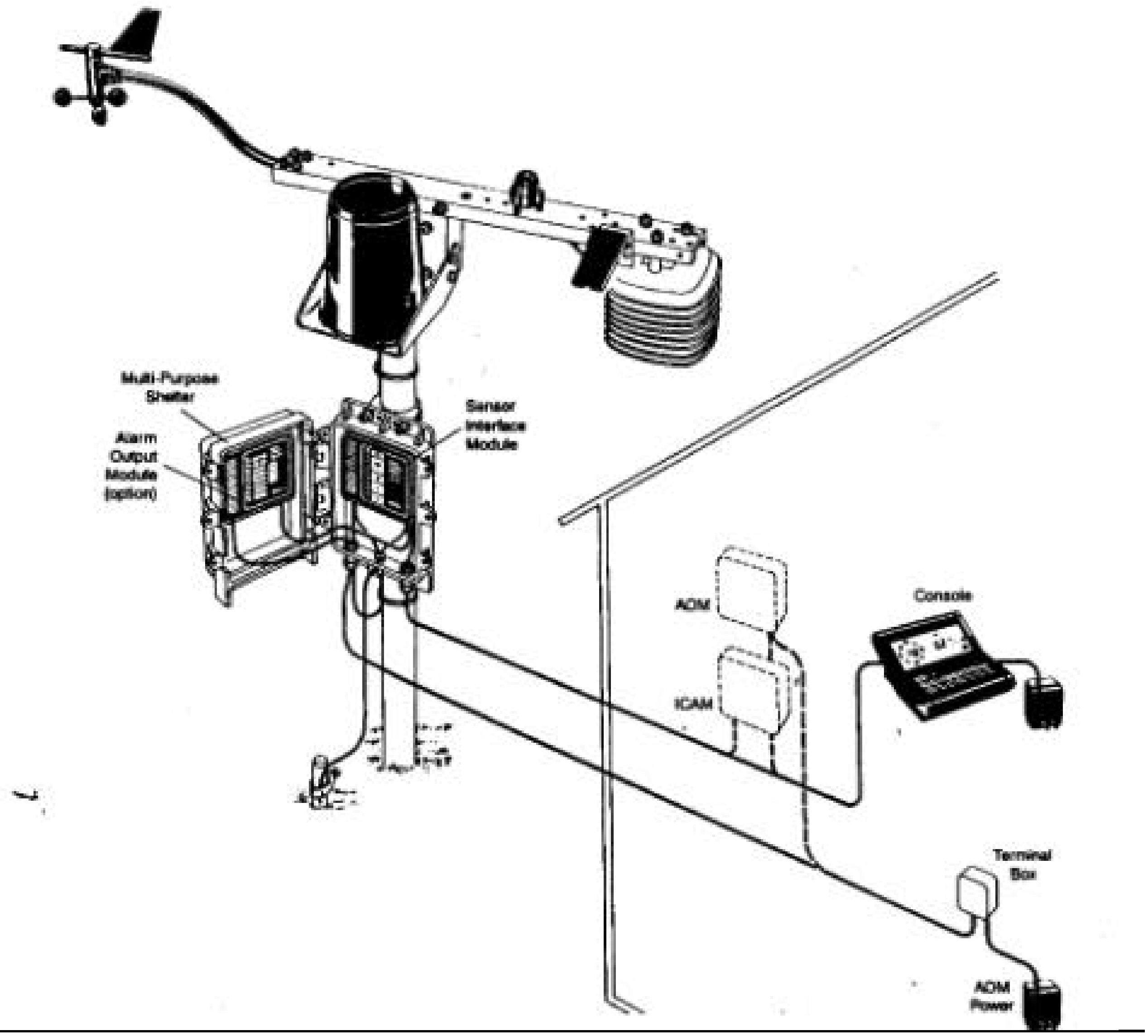

Figure 2. Field Interface System, Showing Alternative Locations of the AOM

CONTACT SPECIFICATIONS

Each of the seven output contacts is rated as follows:

Type:	Photo-coupled MOS FET
Load Voltage:	28VAC or 48VDC
Peak Voltage:	± 100 V, max.
DC Load Current:	300 mA, maximum, at +77ºF (25ºC), derated to 150 mA at 176ºF (80ºC).
AC Load Current	200 mA rms, max. at +77ºF (25ºC), derated to 100 mA at 176ºF (80ºC).
Peak Load Current:	900 mA, 100 msec., max.
ON Resistance:	4 Ohms, max.
OFF Leakage:	1 uA, max.
Power Dissipation:	450 mW, max.

The contacts are suitable for direct connection to low-voltage systems with contact-closure inputs, such as thermostats, security systems, and irrigation controllers. They are also suitable for switching power to low-power loads such as buzzers, doorbells, light-duty relays and solenoids, small lamps, etc. If heavier loads are to be controlled, or if special timing or logical requirements must be met, intermediate devices must be used, as discussed below.

DRIVING LOADS

The paragraphs below discuss in general terms some of the possibilities for controlling higher-power circuits from the AOM. This is intended to be only an introduction to the issues. It does not give sufficient information to enable one to design or install a specific circuit.

Unless you are qualified to do so, do not attempt to wire electrical circuits. Wiring should be done only by a qualified professional. FIRE and ELECTROCUTION are hazards of improper wiring.

HIGHER VOLTAGE and CURRENT

When the load voltage or current exceeds the ratings of the AOM output contacts, you'll need a relay (or maybe two) between the AOM and the circuit to be controlled. Relays come in all shapes, sizes, and flavors; the categories include mechanical, reed, and solid state relays.

Mechanical Relays contain a coil and moving arm with electrical contacts. When current passes through the coil, a magnetic field is generated; this moves the arm and thus closes the contacts, completing the circuit between the higher-power equipment and its power source. Figure 3a illustrates the idea. The "Power Source" in the figure might be a 12- or 24-Volt wall power adapter or a 24-Volt doorbell transformer.

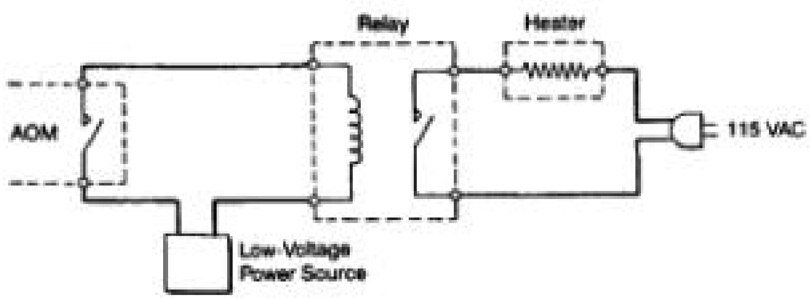

Figure 3a. Use of a Relay to Switch a Heater. (Simplified circuit.)

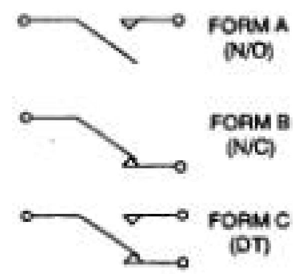

Figure 3b. Contact Forms

Mechanical relays are usually specified in terms of their coil voltage and resistance (or current) and their contact ratings. The coil specifications must match the ratings of the AOM contacts and the low-voltage power source, and the relay's contact ratings must match the characteristics of the driven load and its power source. Low-voltage relays often have coil voltage specs of 6, 12, or 24 Volts DC and 24 Volts AC. Any of these is suited for the AOM contacts. The coil resistance must be high enough that the current rating of the AOM's contact is not exceeded over the temperature range. Surge protection, as discussed below, must be added to this simplified circuit to protect the AOM from the relay coil's inductive surge.

A good choice might be a 24-Volt coil with resistance of 160 Ohms or greater or a 12-Volt coil with resistance of 80 Ohms or greater. The current should be 150 mA or less. One possible choice:
Relay #275-218 from Radio Shack has a 75-mA, 12V coil and contacts rated for 15A at 125VAC.

Mechanical relays often have multiple poles (or sets of contacts). These can be used for switching multiple circuits or multi-phase voltages, or they can provide provide auxiliary outputs for driving indicators or relay logic. The relay's contacts may be one of three types: Form A, normally-open; Form B, normally-closed; Form C, double-throw. Figure 3b shows the contacts in their inactive state.

A Reed Relay is a form of mechanical relay in which the coil is wound around a reed switch. This relay tends to be more sensitive; coil current requirements are often in the range of 10 to 20 mA. Because the reed contacts are not as husky as those of a typical mechanical switch, their contact ratings are lower, but some heavy-duty versions have ratings of 0.7Amps at 150 VAC.

Solid State Power relays are usually intended for AC loads. They use semiconductor devices (SCRs or triacs) rather than mechanical contacts to switch the power. Their advantages include high sensitivity, no contact bounce or arcing, and no mechanical wear or degradation. A typical input requirement is 3 to 30 Volts AC or DC with only a few mA of current; such a unit may switch 50 mA to 50 Amps at 48 to 280 VAC. The circuit would be very much like that in figure 3. Digi-Key Corporation offers a "Solid State Relay Design Guide," part number 92138-ND, for about $20.

The solid state relay (SSR) does have limitations. These include --

- Voltage Transient Sensitivity. Noise spikes from inductive loads, lightning, and other sources can damage the semiconductor components. Snubber circuits (see below), MOVs, or other surge suppressers may be needed to protect the relay. With protection the SSR is extremely reliable.
- Voltage Drop. The relay causes a drop of about 1 Volt, creating a power dissipation of 1 Watt per Amp of load current. This heat must be pulled out in order to keep the relay's temperature below 125ºC.
- Leakage Current. When open, a mechanical relay breaks its circuit completely. A solid-state relay will allow a leakage current of one to 10 mA to pass.

INDUCTIVE LOADS

Inductive loads, such as motors, solenoids, mechanical relays, and even long wires, can cause voltage surges when they are switched off. When current flows the inductor stores energy in its magnetic field; when the circuit is opened, the field returns this energy, forcing the current to continue to flow. The result is a voltage "spike." This spike can cause arcing of mechanical relay contacts and breakdown of solid-state relays. SSRs are susceptible, not only to the magnitude of the spike, but to its rate of rise (dV/dt).

In the case of DC-driven inductive loads, such as mechanical relays, solenoids, and DC motors, a diode placed across the inductor will shunt this current and reduce the spike (the upper circuit in Figure 4a). A resistor in series with the diode will dissipate the current surge faster and cause the relay to drop sooner, but this may be of little value in a slow-acting AOM circuit. A 1N4001 diode is a good choice for protecting the AOM.

In AC circuits the answer is resistor-capacitor "snubber" circuits, which may be built-in to some SSRs or added to the circuit (the lower circuit in Figure 4a). The selection of optimum resistor and capacitor values is often a matter of trial and error, but the values shown in Table 2 are good as a starting point.

Figure 4b shows an example of small-motor switching by the AOM. The diode protects the AOM from the inductive surge of the mechanical relay; the snubber prevents arcing and burning of the relay contacts. When switching power to large motors, one must be aware that they can act as generators when still turning.

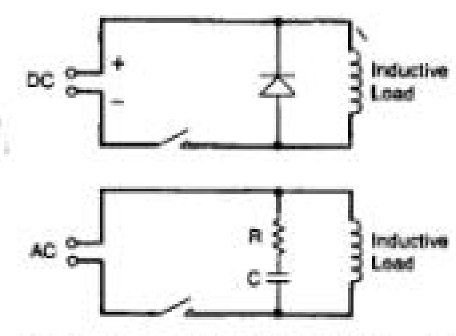

Figure 4a. DC Circuit With Diode Clamp. AC Circuit With Snubber.

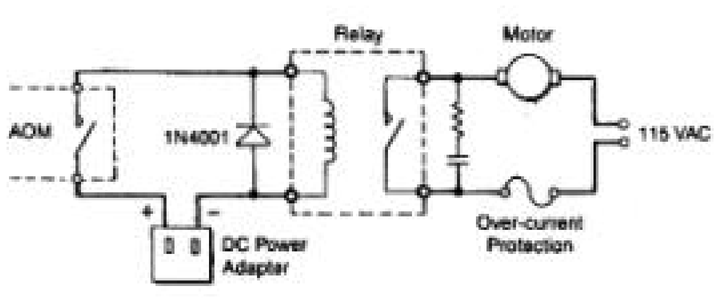

Figure 4b. AOM Motor-control Circuit.

Table 2. Typical Snubber Circuit Values

Load Current Amps rms	Resistance Ohms	Capacitance uF
5	47	0.047
10	33	0.1
25	10	0.22
40	22	0.47

Source: Motorola Thyristor Device Data

MECHANICAL MOTION

To convert an electrical signal to a simple push-pull mechanical force or short movement, a solenoid is the usual component of choice. A solenoid is much like a relay: its coil generates a magnetic field which moves an armature. In the case of the relay, the moving armature makes and breaks an electrical contact. The solenoid makes the armature motion available; one use might be the opening or closing of a slide lock.

Solenoids are specified in terms the following characteristics:

- AC or DC
- Push or Pull
- Coil Voltage and Resistance
- Length of armature movement
- Force exerted by the armature.

The design considerations for switching power to drive the coil of a solenoid are essentially the same as those for driving the coil of a relay.

POWER SOURCES

If the circuit to be controlled must be driven by a voltage or current (as opposed to a contact closure) and if low-voltage power is not available from the circuit being controlled, a separate low-voltage power source is required. As mentioned above, this might include any of the following alternatives, among others --

DC Power: 5 to 48-Volt power supply or plug-in AC/DC power adapter.

AC Power: 5 to 28-Volt plug-in AC/AC adapter or a transformer.

TIMING and LOGIC

If the output of the AOM does not have the right timing characteristics, or if AOM outputs need to be logically combined with each other or with other outputs, the use of some simple circuits may be the answer. Note that any of the following techniques may be used in combination with each other and with the load-driving techniques discussed above.

USING the LATCH OUTPUTS

The latched outputs (L1 and L2) of the AOM are SET (closed) by one Alarm output and RESET (opened) by another Alarm, as selected at the patch panel. These may be used to generate very simple control functions. For example, if output L1 is being used to control power to a cooling fan in a livestock barn where temperature is being measured, one might use the High Temperature alarm to SET L1 and the Low Temp alarm to RESET it. If the High Temp alarm is set at 90ºF and the Low Temp alarm at 80ºF, the fan will start when the temperature in the barn reaches 90º, and it will continue to run until the temperature drops to 80º.

This will insure that the fan will not start and stop frequently if the temperature hovers around the SET point.

TIMING

Time-delay Relays (also known as Timers) can modify the timing of the AOM outputs in many ways. These incorporate delay times which are adjustable by the user (ranges vary from fractions of a second to hours). The delay can take many forms:

- Delay on operate. After receiving an input signal, the Timer waits a set period before closing its relay.
- Delay on release. The Timer closes its relay as soon as the input is received, then holds it on for the delay period after the input goes off.
- Interval -- ON. The Timer closes its relay when the input us received, then holds it on for the delay period or until the input goes off.
- Single-shot. When input is received, the Timer generates an output for the delay period.
- Cycle. As long as the input is present, the Timer output cycles ON and OFF with a preset period and duty cycle.

Timers are available in both mechanical and solid-state forms, with both analog and digital setting of delay periods. Considerations in driving them are essentially the same as those in driving mechanical or solid state relays.

RELAY LOGIC

Relay contacts are easily connected to generate a wide variety of logical functions, all based on combinations of AND and OR logic circuits and the ability to INVERT a logic signal. The following discussion assumes that a CLOSED contact represents a TRUE condition (the AOM contacts are Normally-Open, closed when active).

OR Function: Figure 5a. shows two contacts, A and B, connected in parallel. The circuit output, C, is TRUE if A ***OR*** B is TRUE. (C is closed if A ***OR*** B is closed.)

AND Function: In Figure 5b, the contacts are connected in series. This provides the AND function: C is TRUE only if A ***AND*** B are TRUE . (C is closed if A ***AND*** B are closed.) An example: if the OK contact is connected in series with the L1 contact in the Latch example above, the fan motor will be on only when the temperature conditions call for it ***and*** the AOM is continuing to receive good data.

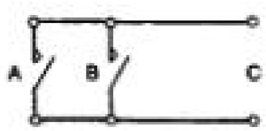

Figure 5a. Contacts In Parallel.
C = A *OR* B

Figure 5b. Contacts In Series.
C = A *AND* B

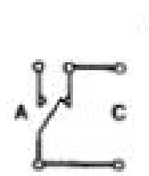

Figure 5c. Inversion.
C = *NOT* A

If the opposite logic polarity is assumed, namely that an OPEN contact represents a TRUE condition (switch is normally-closed, the AND and OR circuits are reversed: 5a is an AND circuit and 5b is an OR (the proof is left to the student).

INVERTING Function: The INVERSE of a relay logic condition is provided by the normally-closed contacts. For example, if relay A in Figure 5c is active when TRUE, its normally-closed contact(s) will be logically TRUE when A is ***NOT TRUE***.

COMPONENT SOURCES

Electrical and electronic components are available from many sources. Following are just a few:

COMPANY	COMPONENTS CARRIED	
· **Radio Shack**	Transformers	Solid-state Relay
Local store	Power adapters	
Catalog: 1-800-THE-SHACK	Mechanical relays	
	Reed relays	Resistors, capacitors, diodes
· **Digi-Key**	Transformers	Solid-state Relays
1-800-344-4539	Power Adapters	
218-681-6674	Mechanical Relays	Timers
fax:: 218-681-3380	Reed Relays	Resistors, capacitors, diodes
http://www.digikey.com	ZNR (MOV) Surge Suppressors	
· **Allied Electronics**	Transformers	Solid state relays
1-800-433-5700	Power adapters	Solenoids
($25 minimum order)	Mechanical relays	Timers
	Reed relays	Resistors, capacitors, diodes
	MOV Surge Suppressors	
· **Mouser**	Transformers	Solid state relays
1-800-346-6873	Power adapters	
http://www.mouser.com	Mechanical relays	
	Reed relays	Resistors, capacitors, diodes
	TVS Surge Suppressors	
· **Securitron Magnalock Corp**		
800-MAGLOCK	Programmable multi-function Timer	

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