



## Features

ToughRelay is an electromechanical relay with integrated smart features:

- A rugged AC or DC rated SPDT power relay with large contacts, 12A fuse and software circuit breaker. Takes the place of a delay relay, breaker and voltage/current monitor.
- DC powered, 5-24VDC, about 1W. Switches 240VAC 10A, 48VDC 10A or 72VDC 10A
- Built-in AC ammeter with power integration for energy monitoring.
- Monitored ADC inputs can triggering the relay or measure and log external DC voltages.
- A real-time clock and battery for scheduling.
- RS-232 / TTL serial I/O control with easy connection to a host microcontroller.
- Use default settings or custom configure the relay using the USB port.
- Long life non-volatile FRAM memory to store logs.

## Initial Setup

ToughRelay can be used in default mode, or configured through a serial USB interface. Power is provided by USB during configuration. After configuration, power can be provided by an external DC supply of 5-24VDC via terminals DC IN (positive) and GND (negative.)

To get started, first attach a USB<->serial cable to a host PC. In most cases, the CH340 driver will automatically install. If not, you can manually install the driver for your OS:

<https://www.digital-loggers.com/CH340Windows.exe>

<https://www.digital-loggers.com/CH340Linux.zip>

<https://www.digital-loggers.com/CH340Mac.pkg>

Once the serial driver is installed, you may use any terminal emulator program such as Putty, TeraTerm, Hyperterminal, etc. to communicate with the USB<->serial configuration port at 9600/8-N-1.

to request attention once connected, enter:

**report**

or simply press <Return>. The relay replies:

```
2021/2/6 13:24:01
Relay ToughRelay OFF
S/N: XXXXXXXXXXXXXXXXXXXXX
0.0A 120V 4.8V 29C 0.0kWh 0.0usd
Power-up time: 2023/2/6 13:20:51
Relay ON time: ---
ADC: 0.0V
ADC2: 7.0V
TRIG: ALL - PWR | HIGH | CYCLE OFF
```

To set the clock/calendar, use “**setrtc**”, ie: (Please note that the century is omitted.)

**setrtc YYMMDDhhmmss**

To reset the relay to default settings:

**default**

The relay will close, connecting any attached loads to power. Wait for a few seconds and type:

**report**

The report indicates current flowing through the contacts on the 4th line.

## Relay Configuration

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### Name

Each ToughRelay has a name (up to 15 characters). This name is displayed in the periodic reports.

**name <name>**

### ID

You can assign an ID to a relay. This is particularly useful if you daisy-chain multiple relays over a single serial link. If your relay has an ID, you must prepend all the following commands with it, otherwise the command will be ignored by the relay:

**id <id> (The <id> is 1-F)**

**id off**

### Example

Set your ToughRelay's ID to 3:

**id 3**

Then request a report from your relay with id #3:

**3report**

As you can see, the report command is prepended by 3 (the current ID). Next, let's remove the ID (note the 3 prefix at the beginning):

**3id off**

**report**

## Manual Control

You can control the state manually using the commands:

**turn on**

**turn off**

These commands switch trigger to com automatically when used.

## Circuit Breaker

ToughRelay implements a software circuit breaker. It triggers if the load current, supply voltage or internal temperature are too high. To reset the breaker after it was triggered, type

**breaker reset**

To disable this feature completely:

**breaker disable**

And to adjust its parameters:

**breaker <amperes> <interval>**

If the load current stays higher than <current> amperes for more than <interval> seconds, the breaker trips. The relay is rated at 10A, fused at 12A, so 12A is a good default trip current.

## Wear level

To show wear level, i.e. to estimate relay contact lifetime, use the following command:

**wearlvl**

## Cycle

In cycle mode, relay turns on the load for a specified amount of time, and then disables it until the next trigger.

**cycle on**  
**cycle off**  
**cycle <seconds>**

To switch a load for 5 seconds each time ADC voltage exceeds 5.0V, type:

**adcv 5.5 4.5**  
**cycle 5**  
**trig all adc**

## Delays

You can specify a period the relay must wait after receiving a trigger signal before actually enable the load (and before disabling it after the trigger is off).

**delay on <seconds>**  
**delay off <seconds>**

To set a 10 seconds delay before enabling the load, type

**delay on 10**

To set a 5 second delay before disabling the load, type

**delay off 5**

## Reports

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The relay periodically sends the summary of its operation (“periodic reports”). You can set the period using the following command:

**report rate <seconds>**

The contents of the reports can also be customized:

**report contents [serial] [current] [dcin] [relay] [kwh]**

The report will contain only the data specified in the command: “serial” is ToughRelay’s serial number, “current” is the load current in amperes, “dcin” is supply voltage, “relay” is relay wear level, “kwh” is the load’s energy consumption. For example, after the following command:

**report contents serial current**

The periodic reports will contain the device serial number and load current.

## Triggers

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The state of ToughRelay is controlled by one or more “triggers”:

**com** -- A manual trigger. It is set manually using “turn on” and “turn off” commands.

**rtc** -- A scheduled trigger. It is activated according to the schedule (see below).

**adc** -- A trigger that is controlled by ADC levels.

**pwr** -- An always-on trigger To set the ADC trigger values, use the following command:

**adcv <enable\_threshold> <disable\_threshold>**

The thresholds are in volts. Example:

**adcv 7.5 5.0**

The ADC trigger is set on at 7.5 volts, and is disabled at 5.0 volts.

## Selecting triggers

You can specify which triggers to use (up to two) using the **trig** command:

```
trig any rtc adc  
trig all rtc adc  
trig {com | rtc | adc | pwr}  
trig {high | low}
```

The first form (“any”) activates the relay if rtc OR adc trigger is active.

The second form (“all”) activates the relay only if both rtc AND adc triggers are simultaneously active.

The third form simply selects one of the all four triggers, e.g.

```
trig adc
```

The fourth form (“high/low”) sets the polarity:

```
trig low  
trig high
```

In “trig low” mode, the relay is activated when the trigger (or the combination) is inactive.

Let's enable the relay for 10 seconds every 10 minutes, but only when the voltage on ADC pin is above 5V:

```
adcv 5.0 4.8  
period 1 10 001000  
trig all adc rtc
```

If you want to activate your relay by schedule, or when ADC voltage exceeds 5V, type:

```
adcv 5.0 4.8  
period 1 10 001000  
trig any adc rtc
```

Let's turn the load off when ADC voltage is above 9V:

```
adcv 9.0 8.8  
trig low  
trig adc
```

## Schedules

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The rtc trigger is activated by the built-in customizable schedule, it has 30 slots. Each slot describes daily, weekly, monthly, or periodic activation of the trigger for a specified amount of time.

### daily

To set up a daily slot, use the following command:

```
daily <slot> <duration> <hhmmss>
```

“slot” is the index of schedule slot you want to set (1-30). “duration” is in seconds. “hhmmss” parameter describes the required time of the day. For example,

```
daily 1 60 103000
```

activates the relay every day at 10:30:00 for 60 seconds (schedule entry #1).

### weekly

To set up a weekly slot, use the following command:

```
weekly <slot> <duration> <weekday> <hhmmss>
```

“weekday” specifies a weekday number (1 is Monday, 7 is Sunday). The command

**weekly 2 60 1 112035**

activates the relay every Monday at 11:20:35 for 60 seconds.

## monthly

To set up a monthly slot, use the following command:

**monthly <slot> <duration> <day> <hhmmss>** “day” is day of month (1-31). For example,  
**monthly 3 120 10 120000**

activates the relay every 10th day of month at 12:00:00 for 120 seconds.

## periodic

To set up a periodic slot, use the following command:

**period <slot> <duration> <hhmmss>**

“hh” part of “hhmmss” can exceed 23. For example,

**period 4 120 302000**

activates the relay every 30 hours 20 minutes for 120 seconds.

Also, you can set the built-in RTC using: **setrtc YYMMDDhhmmss**

le: **setrtc 230401101234**

sets the clock to 04/01/2023 10:12:34.

To enable or disable a schedule slot, type

**schen <index>**  
**schdis <index>**

To completely remove the entry:

**schrm <index>**

To show current schedule:

**Sch**

## Energy Log

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ToughRelay can integrate and log the load’s power consumption over time. Type

**energy**

to view the log. To clear the log, type

**energy reset**

And to set up energy log interval, use the following command:

**energy <interval>**

where interval parameter is in seconds. For example,

**energy 120**

will store the entry into the energy log every 120 seconds.

You may want to attach a known AC load to COM and NC/NO to aid in configuring the ammeter. To view the configuration, type

## **config**

To reset all the settings to their default values:

**default**

To set the AC voltage for energy measurement calculations:

**acvolts <volts>**  
**acvolts 120**

To set energy cost, type:

**kwhcost <cost> <unit>**  
**kwhcost 0.10 usd**

To set the load power factor:

**pf <value>**  
**pf 1.0**

Value is 0.01-1.00.

To set the power-on default state of the relay eg: after a power failure select one:

**pwr on**  
**pwr off**  
**pwr last**

In the third case, the device will recover its previous state (on or off) at boot-up.

To reboot the relay:

**Reboot**

Help

The relay itself contains a simple help system. To view the list of available help topics, type

**help**

To view a particular topic, type

**help <topic name>**

For example,

**help id**

For wiring examples, see [www.digital-loggers.com/TRexamples.pdf](http://www.digital-loggers.com/TRexamples.pdf)

Questions and suggestions are welcome: [engineering@digital-loggers.com](mailto:engineering@digital-loggers.com)