



Features

ToughRelay is a smart electromechanical relay with several 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, circuit breaker and voltage/current monitor.
- Universal power, 5-24VDC, about 1W.
- Built-in AC ammeter with power integration for energy monitoring.
- Monitored ADC inputs used for triggering the relay or measuring external DC voltages.
- A real-time clock and battery for scheduling.
- An RS-232 / TTL serial output for streaming histograms, status reports, etc. to a host processor.
- 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 an USB cable to a host PC. In most cases, the CH340 driver should automatically install. If not, you'll need to manually install the USB-Serial driver for your OS:

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

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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

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

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

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

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

Schedules

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:

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Energy Log

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,

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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>
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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
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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

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

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

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

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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,

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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

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Features

ToughRelay is a smart electromechanical relay with several 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, circuit breaker and voltage/current monitor.
- Universal power, 5-24VDC, about 1W.
- Built-in AC ammeter with power integration for energy monitoring.
- Monitored ADC inputs used for triggering the relay or measuring external DC voltages.
- A real-time clock and battery for scheduling.
- An RS-232 / TTL serial output for streaming histograms, status reports, etc. to a host processor.
- 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 an USB cable to a host PC. In most cases, the CH340 driver should automatically install. If not, you'll need to manually install the USB-Serial 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

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

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

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

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

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

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default

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To set energy cost, type:

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