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Overview

The All-in-one remote has been designed as a versatile, portable photographic accessory that you can tuck in your camera bag. It combines a number of useful features that you will provide capabilities that you’ll find both useful and fun during your field, home, or perhaps even studio photography.

In one box, you’ll find a wired remote, a wireless remote, a power supply for your camera, a versatile intervalometer, and an interface to devices such as pressure-sensitive pads, trip wires, etc, that can take a picture when your subject trips the trigger device.

The unit can be set for a normal exposure, bulb exposure, or programmable time exposure from 1/10 second to almost 1000 hours.

You can program the intervalometer to pause between pictures anywhere between 0 seconds and almost 1000 hours. It will stop taking pictures after the number of shots you specify so you won’t overfill your digicam’s memory card capacity.

In addition, you can configure the intervalometer to stop taking pictures after a specified run time.

You can also program the intervalometer for scheduled operation, automatically starting and stopping at specified times on specified days. Let’s say you’ve been hired to document the history and progress of a construction project. You’d like to lock a camera in place, then take a picture of the construction site every 30 minutes between 7 AM and 4:30 pm, on Mondays through Fridays. The AI-1 is just what you need for this job, or any other long-term photography task.
The remote can even function as a travel alarm clock, complete with snooze alarm.

The unit is powered by a self-contained 9 volt battery, or can be powered by an external 12 volt “wall wart” power supply or even a 12-volt sealed lead-acid battery pack.

The remote is easy to build, using inexpensive, commonly-available through-hole parts.
Features and Functions

Mechanical:

Self-contained box containing buttons, switch, jacks, and a 16 x 2 character LCD

Accompanied by a keychain-sized four-button transmitter

Power:

Internal 9 volt battery or external 12-volt DC "wall wart" pack equipped with a 2.1 x 5.5 mm center-positive coaxial power plug

Clock:

When the unit is idle, it displays the current time in a 12-hour format.

When the unit is powered down, the clock will keep time for approximately one week.

Alarm:

The unit can function as a handy travel alarm. It even provides a 10 minute snooze feature.

While the alarm is sounding, a press of the Select, Up, or Down buttons will set the alarm for a 10 minute snooze. The Menu button will turn the alarm off.
If you don’t press any button, the alarm will stop sounding after 15 minutes.

When the alarm is set, a little bell icon is displayed in the lower right-hand corner of the display. While snoozing, the bell icon flashes.

The alarm will even work when the intervalometer is running. You can have the unit drive your camera while you sleep, gaining you brownie points when you tell your boss that you worked all night, taking pictures. <g>

**Wired remote**

You can program the unit for either Normal, Bulb, or Time exposure modes.

For all exposure modes, the remote sends the focus output to the camera for the focus time, followed by the shoot output for the shoot time. At the end of the shoot time, both the focus and shoot outputs open.

If the intervalometer isn’t running when you take a picture, the shot counter will be displayed on the second display line:

```
11:24:32 AM
0024
```
Normal Exposure:

Takes a picture using the Focus and Shoot times as described above. Triggered by the Shoot button, RF transmitter button, or the External Trigger input.

Bulb mode:

The exposure lasts as long as the Shoot button, the RF transmitter button, or the External Trigger signals are active. Upon release of the button or signal, the exposure ends.

Time Exposure:

When activated by the Shoot button, RF transmitter button, or the External Trigger signal, the remote holds the shutter open for the user-programmed time exposure interval (from 0.1 seconds to nearly 1,000 hours in 1/10 sec steps).

When the intervalometer is running, only Normal or Time exposures will be taken. If set for Bulb mode when the intervalometer is started, the unit returns an error message.

Manual Exposure During Intervalometer Run:

The Shoot button, the RF transmitter button, or the External Trigger signal will take an exposure while the intervalometer is running. Manual exposures will increment the “Shots Taken” counter.

Wireless remote:

A keychain-sized four-button transmitter can trigger the camera exposure functions described above. The top button on the transmitter takes the picture.
There are three other transmitter buttons which serve no purpose in this design, but are available for you to add special features to the unit you construct. (They are terminals 12, 11, and 10 on the receiver. They output a low on idle, +V when active.)

**Intervalometer:**

The intervalometer can be started or stopped from the menu.

For more information on the intervalometer, its modes, and its capabilities, refer to the "Intervalometer Overview" section later in this document.

**External trigger:**

A switch closure or CMOS/TTL low-going signal will take a picture. Suitable inputs might be derived from a pressure-sensitive pad, a tripwire, an object breaking an infrared beam (using external hardware), an audio signal (again using external hardware), etc.

**Camera power:**

When the unit is powered by an external wall wart power pack, it can supply 8 volts DC at up to one ampere to the camera.

**Programmable shoot and focus times:**

The time the shoot command is sent to the camera can be programmed from 0.1 to 9.9 seconds. The time the focus command is sent to the camera is programmable from 0 to 9 seconds.
During exposure, the focus command is sent for the focus time, then the shoot command begins for the specified period. The focus command remains active during the shoot period.

The unit can be adapted to almost any camera that has a wired remote jack by means of an internal "personality plug" constructed on a 14-pin dip header. Personality plug layouts are provided for Panasonic FZ-series cameras and Canon prosumer DSLRs.

(If you have the wired-remote specifications for another brand or series of camera, please let me know. I'll be happy to design the appropriate personality plug, if I'm able.)
Parameter Volatility:

The value of all parameters except time is stored in non-volatile memory, and will maintain their settings indefinitely.

The clock will keep time for approximately one week after the unit is powered down.

However, if the intervalometer was running when you turned off the power, it will not automatically resume when the unit is next powered up. (In timed mode, however, the intervalometer maintains its schedule, and will start again at its next programmed start time/day.)
Battery Monitor and Backlight Control:

The unit continuously measures the battery voltage. If the battery is low, a low battery icon will be displayed in the top-right corner of the display, and the backlight will not illuminate. (I have the low battery threshold set to switch on at 6.5 volts. The low dropout regulator will drop out at 5.6 volts or so. You have almost 1 volt of headroom when the low battery icon shows up.)

Backlight operation is automatic. When running on external power, the backlight is on continuously. On battery, the backlight illuminates with each key press, then turns off after several seconds. When the battery is low, the backlight does not illuminate at all.

The backlight remains on continuously while you are in setup mode. To prevent excessive battery drain, the unit will time out and return to idle mode, turning off the backlight, if you don’t press any of the Menu, Select, Up, or Down buttons for two minutes.

You can measure the battery or external power pack’s voltage from the setup menu.
Controls and Indicators

Buttons

Menu button scrolls through the menu, turns the intervalometer on and off, locks in parameter selections

Select button selects the digit(s) to be updated

Up button increments the digit or field selected by the Select button

Down button decrements the digit or field selected by the Select button

Shoot button fires the camera manually. If the time exposure time is set, pushing the Shoot button will send the shoot condition to the camera for the specified interval.

In setup mode, the Shoot button functions as an escape key. Pressing the Shoot button won’t take a picture. Instead, it will immediately close the setup and exit to idle ("time display") mode.

Wireless Shoot functions identically to the manual Shoot button

Note that the Up and Down buttons will autorepeat if held down.
**Menu Button Operation**

The Menu button is the key to the unit’s operation. You will use it to scroll through the menu to review or change the unit’s settings, to turn the alarm on and off, and to start and stop the intervalometer.

Just passing over a parameter with the Menu button won’t change that parameter’s value. If you adjust a value, though, your change will be locked in at the next Menu button press.

**LED Indicators**

- **Shoot**: Illuminates when the remote is sending your camera the shoot signal
- **RF**: Illuminates when the receiver detects a valid signal from any of the four buttons on the keychain-sized transmitter
- **Ext**: Illuminates when the remote receives a signal from the device wired to the External Trigger jack
Rear-panel Jacks

**Camera**
3.5 mm stereo jack to connect to the camera's wired remote jack

**Camera Power**
2.5 mm x 5.5 mm coaxial power jack. Supplies 8 VDC to the camera when the remote is running from an external power pack.

When you build your unit, I recommend that you use the specified 2.5 mm x 5.5 mm jack, rather than the more common 2.1 mm x 5.5 mm jack. If you do, you'll never accidentally insert your wall wart power cord into the camera power jack. (Doing so would probably fry the LM7808 regulator.)

**External Power**
2.1 mm x 5.5 mm coaxial power jack for external 12 VDC power from a "wall wart," cigarette-lighter power adapter cord, sealed lead acid battery, etc. Center-positive, shell ground.

This jack is protected by a reverse-biased diode. If using anything other than a wall wart power pack, make sure that the power lead contains an inline fuse.

**External Trigger**
3.5 mm mono jack. The tip is the trigger input, the sleeve is ground.

A contact closure or CMOS/TTL low-going logic signal will trigger a normal exposure or time exposure.
Serial TTL

3.5 mm stereo jack used for re-programming the Arduino processor.

The tip is the data coming from the processor, the ring is the data going toward the processor, and the sleeve is ground.

The signal applied to this jack must be positive-true TTL or CMOS logic level. When you build your unit, one of your decisions will be whether to place your RS232-to-TTL converter onboard, using up some board space, or make arrangements to convert the levels externally.
Power-up

The Arduino has a 10 second delay, after power is switched on, before it begins running the program. When you switch on the power, the Shoot LED will flash briefly, then the unit will appear to be dead. This is normal. You’ll see the signon screen in about 10 seconds. Be patient.

Signon screen:

```
AI-1 Remote
Version 1.00
```

This screen is displayed for two seconds, then the unit drops to Idle mode, displaying just the time.

Idle mode screen:

```
11:24:32 AM
```
Menu Structure

The unit is configured and operated by scrolling through the menu using the Menu button.

Note that many of the screens are popups that show up only when needed. For instance, if you don’t set the intervalometer for Timed operation, you won’t see the Start Time, End Time, and Run Days programming screens.

Idle Mode

Start/Stop Auto (Intervalometer)
   [No - Yes]

Clock Set

Day/Date Set

Alarm ->
   [Off - On]
   |  
   Alarm Time Set

Focus Time Set

Shoot Time Set

Exposure Mode ->
   [Normal - Bulb - Time]
   |  
   Set Time Exposure Time
Clear Intervalometer Settings

Set Intervalometer Interval

Set Max Shots Limit

Clear Shots Taken counter
   [No - Yes]

Intervalometer Mode
[ShotLimited - TimeLimited - Timed Start/Stop]
   |   |   |
   |   |   |
   | Start Time -> End Time -> Run Days
   |
Set Run Time

Display Power Bus Voltage

Set Backlight Brightness

Idle mode
Setting Parameters:

When you select a parameter set operation with the Menu button, the cursor will appear under the digit to be changed, for numeric fields, or the selection will be displayed in the second display line for alpha fields.

For numeric fields, select the digit with the Select button, then change its value with the Up and Down buttons.

For alpha fields, the Select key has no function (except on the Day of the Week selection screen.) You’ll make all your selections by scrolling through the choices using the Up and Down buttons.

After you’ve changed a value with Up and/or Down, the Menu button will lock in the value of that parameter at the next Menu button press.

Pressing the Shoot button any time that the unit is in setup mode will immediately exit to idle ("time display") mode. When exiting the menu, make sure that you’ve locked in any changes by first pressing the Menu button.
Intervalometer

Intervalometer Overview:

The intervalometer (nicknamed "Auto" in the system, since messages such as "Start Intervalometer" are too long to display on a 16-character screen) is the heart of the system’s operation, and probably the reason you built this unit in the first place.


In Shot-Limited mode, the intervalometer runs until it reaches the programmed number of exposures. In Time-Limited mode, it runs for the programmed run time or until it reaches the programmed shot limit. Both of these modes are started and stopped manually, and automatically set the Shots Taken counter to zero when you start a run.

A third mode, Timed, will automatically start and stop the intervalometer at programmed times on selected days. Since a timed run spans a number of sessions, Timed mode doesn’t clear the Shots Taken counter each time an intervalometer run begins.

Timed scheduling begins when you select Timed mode with the intervalometer mode setting screen. You can end timed scheduling by setting the intervalometer to either the Shot-Limited or Time-Limited mode.

All modes use the Interval and Max Shots settings.
The Interval is the amount of time the intervalometer waits between exposures. It can be set from 1 second to nearly 1,000 hours, in 1 second increments.

The Max Shots limit will normally be the number of exposures you can store on your camera’s memory card at the selected resolution. Max Shots is a hard limit in all three intervalometer modes.

When the intervalometer is running, any shots taken with the Shoot button, the RF transmitter’s Shoot button, or by the External Trigger input will be added to the Shots Taken counter so even manual exposures won’t overfill your camera’s memory card.

When Timed scheduling is enabled but the intervalometer isn’t running, you’ll see an hourglass icon displayed in the lower-left corner of the LCD.

When the intervalometer is running, you’ll see a countdown field, displaying seconds until the next exposure, and the number of shots taken during that intervalometer run.
Starting and Stopping the Intervalometer:

Start and Stop the intervalometer using the Menu button from idle mode, or from the intervalometer's run time screen.

If the intervalometer isn't running, this screen will appear:

Start Auto Run
No

If the intervalometer is running, this screen will appear:

Stop Auto Run
No

If you select Yes with the Up or Down buttons, pressing the Menu button will either start or stop the intervalometer. If you have selected No, either the intervalometer will continue running, or the unit will return to idle ("time display") mode.

This is the intervalometer's run time screen:

11:24:32 AM
0000106  0041

The top line displays the clock time. The bottom line displays, on the left, the countdown (in seconds) until the next exposure. On the right, it displays the number of shots taken during the current intervalometer run.
When the intervalometer reaches either its shot limit or the run time limit, you will see the Done screen:

![Done Screen](image)

Press one of the Menu, Select, Up, or Down buttons to clear this message and return to idle mode.
Intervalometer Error Messages:

When you start the intervalometer, the unit checks your parameter setup. If all is well, the intervalometer starts.

If there is a problem, the unit will beep, and you will see one of the error messages shown below. Press any of the Menu, Select, Up, or Down buttons to clear the error message, correct the indicated error condition, then start the intervalometer once again.

- You can’t use Bulb in Auto

Set the exposure mode to Normal or Time Exposure.

- Max Shots must be > 0

Set the Max Shots to something other than zero.

- Run Time is set to zero

You’ll see this error message if you’ve selected the Time-Limited intervalometer mode with the run time set for zero. Set the run time to something other than zero.

- Shots Taken > Max Shots

You’ll see this error message when you’ve selected the Timed intervalometer mode, and the Shots Taken count is greater than the Max Shots limit. Clear the Shots Taken counter and restart.
Parameter Setup and Review Screens

Clock set:

Set Time
11:24:32 AM

Time display, entered with cursor under selected digit. Menu locks in setting, Set scrolls to next digit, Up increments selected digit or toggles AM/PM display, down decrements selected digit or toggles AM/PM display.

If the time has not been changed, pressing the Menu switch will not update the time.

If the time has been changed, pressing the Menu switch will set the hours and minutes as shown in the display, and zero the seconds, the instant the Menu key is pressed. Sync the remote’s time to an accurate external time source by pressing the Menu key the instant the external source hits zero seconds.
Day/Date set:

Set Date
Wed Jul 26, 07

Date display, entered with cursor under the day of the week. Menu locks in setting, Select scrolls to next field, Up and Down change the settings.

Alarm On/Off:

Alarm Off
07:30 AM

Displays Alarm On or Alarm Off. (When the alarm is on, a small "bell" icon will be displayed in the lower-right corner of the display.)

The Up and Down buttons will toggle the alarm setting on and off.

If the alarm is on when you press the Menu key, you will enter the alarm set routine, below.

If the alarm has been turned on, the beeper will begin sounding at the alarm time. Pressing the Menu button will turn the alarm off. Pressing any of the Select, Up, or Down buttons will set the alarm for a 10-minute snooze.

While snoozing, the bell icon will flash.

You can set snooze periods indefinitely. If the beeper isn't acknowledged in 15 minutes, the beeper will shut itself off.
**Alarm Time Set:**

If you turn the alarm on, you will next see the Alarm Time Set screen.

The Select button scrolls through the fields, the Up and Down buttons change the values, and the Menu button locks in your choice.

**Focus Time Set:**

This sets the duration of the focus signal sent to the camera while taking a picture. Range is 0.0 to 9.9 seconds, in 1/10 second steps.

The Up and Down buttons increase and decrease the time. Menu locks in the displayed value.

**Shoot Time Set:**

This sets the duration of the shoot signal sent to the camera while taking a picture. Range is 0.1 to 9.9 seconds, in 1/10 second steps.

The Up and Down buttons increase and decrease the time. Menu locks in the displayed value.
Exposure Modes: Normal, Bulb, and Time

Select the exposure mode using the Up and Down buttons. Lock in your choice with the Menu button.

![Set Exp Mode]

If you selected Time Exposure, you will next see the Time Exposure Time Set screen:

![Time Exp Set]

Select the digit using the Select button, adjust the value of the selected digit with the Up and Down buttons, lock in your time with the Menu button.

You can set the time exposure time to anything between 0.0 seconds and nearly 1,000 hours, in 1/10 second increments.
Clear Intervalometer Settings:

The Up and Down buttons toggle Yes or No.

If you select Yes, the interval, run time, start time, and stop time will be cleared to minimum values, and the mode will be set to Shot-Limited, when you press the Menu button.

If you select No, the Menu button jumps to the next mode without clearing the settings.

Interval Set:

The amount of time the intervalometer will pause between shots. The range is between 1 second and nearly 1000 hours in 1-second steps. Note that the interval is displayed to the 1/10 second digit, but you can’t scroll beyond the 1-second digit. This isn’t a bug.

The Menu button exits this routine, Select rotates through the digits, Up and Down increment and decrement the value of the selected digit.
Max Shots Set:

The maximum number of shots the remote will take during an intervalometer run. The range is 0 to 9999.

The Menu button exits this routine, Select rotates through the digits, Up and Down increment and decrement the value of the selected digit.

If the maximum number of shots is set to zero, the intervalometer will return an error message when you attempt to start an intervalometer run.

Clear Shots Taken Counter:

This screen displays the number of shots taken and gives you the option of clearing the shots taken counter.

If you would like to clear the counter, select Yes using the Up or Down buttons. If you select Yes, the counter will be cleared when you press the Menu button.
Intervalometer Mode Setup and Operation:

Menu button locks in settings, Up and Down buttons select intervalometer modes of Shot-Limited, Time-Limited, or Timed.

If you select Shot-Limited, the menu jumps directly to the Backlight setting screen when you press the Menu button. You've already set the interval and shot limit, so you're ready to go. When you start the intervalometer, it will run until it reaches the shot limit, or until you shut it off manually.

If you select Time-Limited, you will next see the Set Run Time screen.

On the run time screen, the Select button scrolls the cursor to the active digit, the Up and Down buttons change that digit's value, and the Menu button locks in the setting.

Note that you can't scroll into the tenths digit. This isn't a bug.

After you hit the Menu button, you're ready to go. When you start the intervalometer, it will run until it reaches either the shot limit, until the run time has expired, or until you shut it off manually.

If you select Timed mode, several things will happen.

First, you'll see the Set Start Time and Set Stop Time screens, shown below. You'll next set the days on which you want the timed intervalometer mode to be active. When these parameters have been set, you'll see an hourglass icon in the lower-left of the display. That icon indicated that timed intervalometer mode has been activated.
With timed mode set, you can use all other features of the remote without affecting timed scheduling. You can even run another intervalometer run, started and stopped manually.

To turn off Timed intervalometer scheduling, set the intervalometer mode for either Shot-Limited or Time-Limited.

On these screens, the Select button moves the cursor between the hours, minutes, and the AM/PM fields. The Up and Down buttons adjust the values in each field, and the Menu button locks in your settings, then jumps to the Set Run Days setup screen.

The run days screen works slightly differently than all other screens in the system. The Select button scrolls through the days of the week, while the Up and Down buttons toggle between Yes and No.

If you'd like the timed intervalometer to be active on a given day, choose Yes. Otherwise, choose No.

Once you've set your desired schedule, press the Menu button. The system will check the setup parameters, and issue warning messages to let you know something is incorrect that would prevent the intervalometer from starting its run at the next scheduled start time.
If you receive a warning message, correct the error condition, then set up Timed intervalometer mode again.

The Timed intervalometer will check for setup errors once again at the scheduled start time. If you've changed the setup parameters to an invalid condition, the unit will beep and display the error condition, and the intervalometer will not start. Be careful what you set between intervalometer runs - particularly Bulb exposure mode and the Max Shots setting.

After you've set up the intervalometer, you'll jump to the Bus Voltage screen, below, and see the hourglass icon in the lower-left corner of the display. The intervalometer will start and stop automatically following your selected schedule, stopping only when the shot limit has been reached.

Since a timed intervalometer run spans a number of start-stop sessions, Timed mode doesn't clear the Shots Taken counter as the other intervalometer modes do, keep an eye on the number of shots stored on your memory card. If the intervalometer reaches the Max Shots limit during a run started by Timed mode scheduling, operation will cease when the shot limit is reached.

**Bus Voltage Measurement:**

The unit will display a snapshot measurement of the bus voltage, showing either the battery voltage level or the voltage supplied to the unit's external power jack.

![Bus Voltage measurement](image)

The Menu button takes you to the next screen. The Select, Up, and Down buttons have no function on this screen.
Backlight Brightness Setting:

Sets backlight brightness between 0 (backlight off) and 4.

The Menu button returns to idle, Up and Down increment and decrement the brightness value.