

Energy Saving on Street Lightings

DIGITEK TECHNOLOGY

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1. Introduction

Street lightings not only provide traffic safety but also general public safety at night. It is a symbol of progress of a city. Therefore, every city worldwide pays important attention on street lightings. Improvement of street lightings inevitably makes the utility cost a heavy burden to the city.

Voltage instability to some extent is inevitable in a power supply network. The instability can be as much as 15% higher or lower. Design of street lighting system should have enough luminosity for the street when the voltage is low. On the other hand, late at night when the factories and offices are closed and home lightings are turned off, the voltage can be largely increased.

Increase on voltage can result in two serious consequences:

- a. Increase consumption on electricity: Lighting facilities consume more energy at higher voltage. For a 40 W fluorescent light with rated voltage of 110 V the energy consumptions at different voltages are as follows:

Voltage (V)	Watt (W)	Amperage (AMP)
105	35.5	0.626
110	40.8	0.728
115	45.3	0.801
120	50.2	0.895

From the above table, we see that an increase of 15V can increase energy consumption as much as 41%. Therefore lowering the voltage can effectively save energy.

- b. Shorten the lifespan of the lighting devices: Every increase of 1V will increase temperature of the ballast 0.6 °C, and increase of 10 °C can shorten the lifespan of the ballast to half. Of course increase on the voltage also shortens the lifespan of the bulbs. Increase of temperature shortens lifespan of lighting device, as a result the bulbs and ballast have to be replaced more often and the maintenance cost is largely increased.

It is therefore clear that installation of energy saving device can save electricity bill and maintenance cost. The power supply facility can also be reduced.

2. Energy savers currently available in the market

1) Transformer Type Energy Saver:

The simplest and oldest way is to make use of a transformer to lower the voltage. This kind of energy savers was originated from traditional voltage regulator with a small modification for voltage control on lighting system. It has the following shortcomings:

a. Large volume:

This kind of energy savers is nothing but a transformer with a simple electronic control device to have proper voltage output. The transformer itself has a very large volume. As a result the size of this kind of energy savers is very large and requires a large indoor space for installation. The requirement of additional large indoor space becomes a big problem in practice.

b. Ineffective in responding to the voltage change:

Although the transformer can adjust the output voltage with electronic device, it still can not adjust the output voltage effectively. Sometime the output voltage can be somewhat too high or somewhat too low. More seriously it breaks down easily.

c. High cost:

Although the design of a transformer type energy saver is simple, but the transformer itself is expensive and is not suitable for small current application. Its application is therefore largely limited.

d. Not suitable for small current applications:

For a street light close to the power supply the voltage can be very high and lowering the voltage can save a lot of energy. On the other hand, at the point far from the power supply, the line voltage drop can be that much that the voltage should not be further lowered in order to maintain proper function of

the light. If we install a transformer type energy saver at the point close to the power supply, it can lower the voltage near the energy saver to the allowed proper voltage. However, the voltage far from the energy saver might be too low and the lightings there do not operate properly.

e. Energy saver itself consumes too much energy:

It is well known that a transformer consumes a lot of energy.

2) Electronic Energy Saver:

If one can design an electronic device with thyrister to control the output voltage, one can have an energy saver for lighting system with low cost and high efficiency. It is an idea energy saver for lighting system.

It is well known that when the voltage is higher the luminosity is higher but the lifespan of the lighting device is shorter. For fluorescent light and HID light the lifespan of the ballasts and bulbs is shorter when the voltage is higher. In general the design of a lighting system allows the voltage to be higher or lower than the rated voltage 5% to 10 % while the luminosity still meets the requirement. If we can maintain the voltage to the lighting system at the lower limit of the allowed voltage we can save energy and extend lifespan of the lighting system tremendously.

More importantly, we can install one DIGITEK energy saver on each streetlight without large installation room requirement.

Feature	Transformer Type Energy Saver	DIGITEK Electronic Energy Saver
Size	Larger than (80x40x50cm ³)	Small (14x5x8cm ³)
Weight	Heavier than (Over 30 Kgs)	Light (Only 0.68 Kg)
Price	Expensive	Inexpensive (about 1/10)
Response to Input Voltage	Not sensitive enough, not accurate enough	Sensitive and accurate
Individual street light control	No	Yes
Not enough voltage at the distance street light due to voltage drop	It might happen and cause serious problem	This problem will not happen

3. DIGITEK Technology

DIGITEK has developed an electronic energy saver for fluorescent light and HID light with the following features:

Save what should be saved - Energy:

It can save more than 15% energy with power supply voltage higher than rated voltage.

Maintain what should be maintained - Luminosity:

It maintains the luminosity required by the design.

Expand what should be expand - lifespan:

DIGITEK-ILT lowers the voltage to the light and expands the lifespan of the ballasts and bulbs.

Built-in timer:

Lat at night, some of the lightings can be switched off automatically.

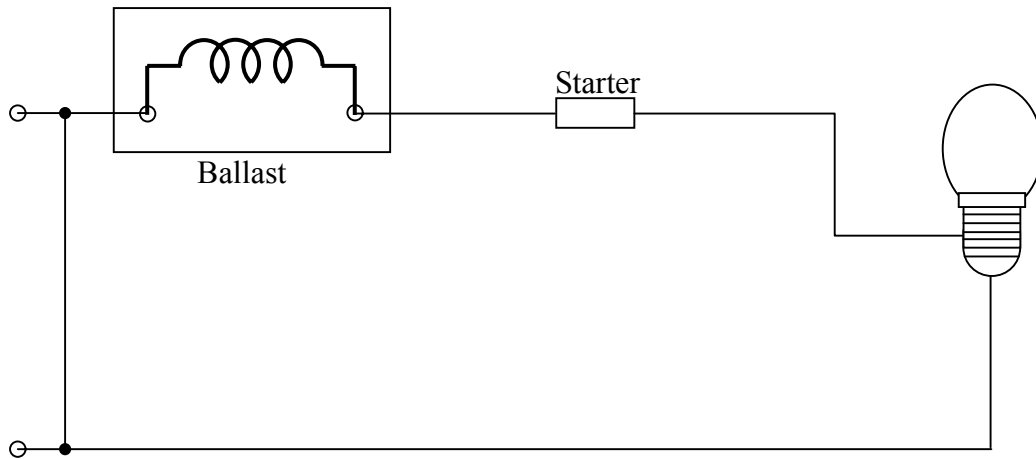
Work on magnetic ballast without capacitor or with separable capacitor:

This energy saver can be used for fluorescent light and HID light with magnetic ballast without capacitor or with separable capacitor. Lowering voltage on a magnetic ballast with capacitor which is not separable will not result in energy saving.

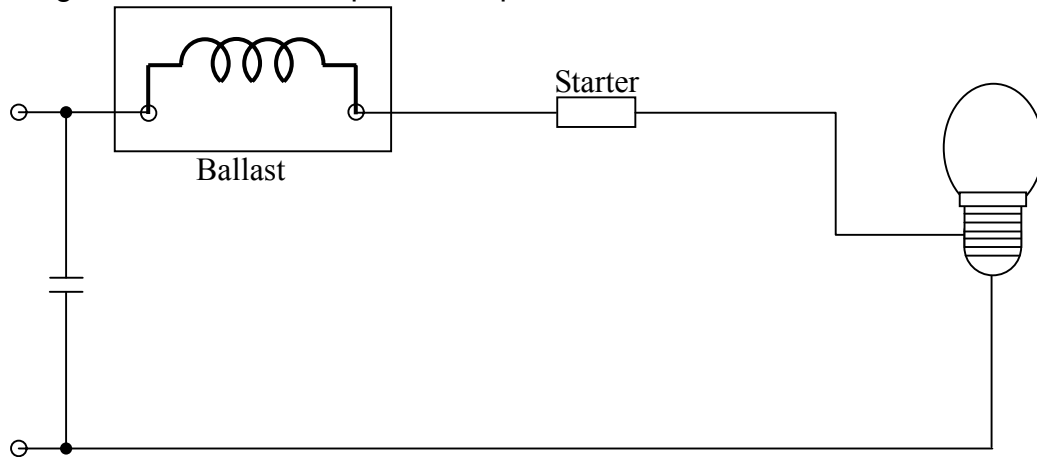
Do not work on electronic ballast:

This energy saver can't be used on electronic ballast for energy saving purpose.

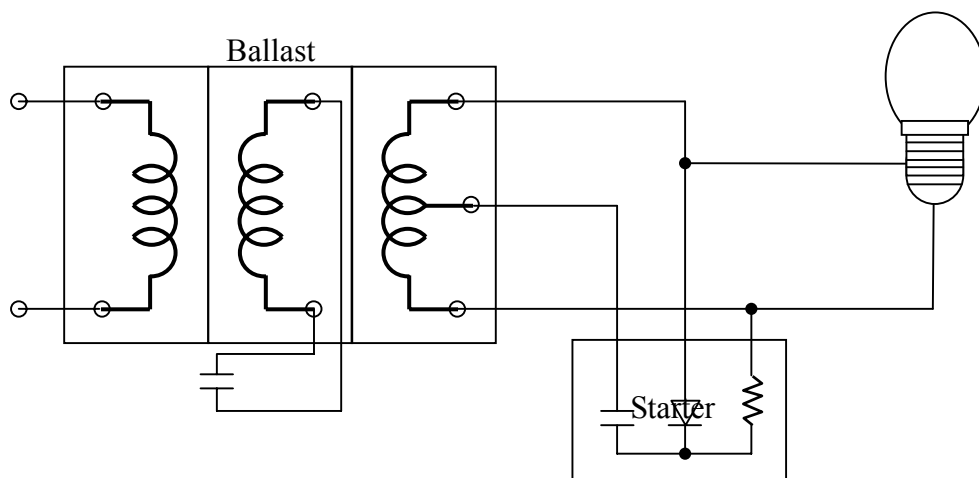
Magnetic ballast without capacitor:



Magnetic ballast with separable capacitor:



Magnetic ballast with non-separable capacitor:



4. Energy Saving Tests

4.1 Fluorescent Light

Rated voltage: 220V

Lighting device: Fluorescent light 18W X 24

Dip switch setting: 1. OFF 2. ON

4.1.1 Data

Table 4.1.1a: Without DIGITEK

V (IN)	200	202	204	206	208	210	212	214	216	218	220	222	224	226	228	230	232	234	236	238	240
AMP	3.08	3.15	3.27	3.41	3.50	3.63	3.69	3.79	3.88	4.06	4.17	4.19	4.37	4.43	4.55	4.66	4.78	4.81	5.00	5.06	5.21
KW	0.45	0.46	0.47	0.49	0.50	0.51	0.52	0.54	0.55	0.56	0.57	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.65	0.67	0.68

Table 4.1.1b: With DIGITEK

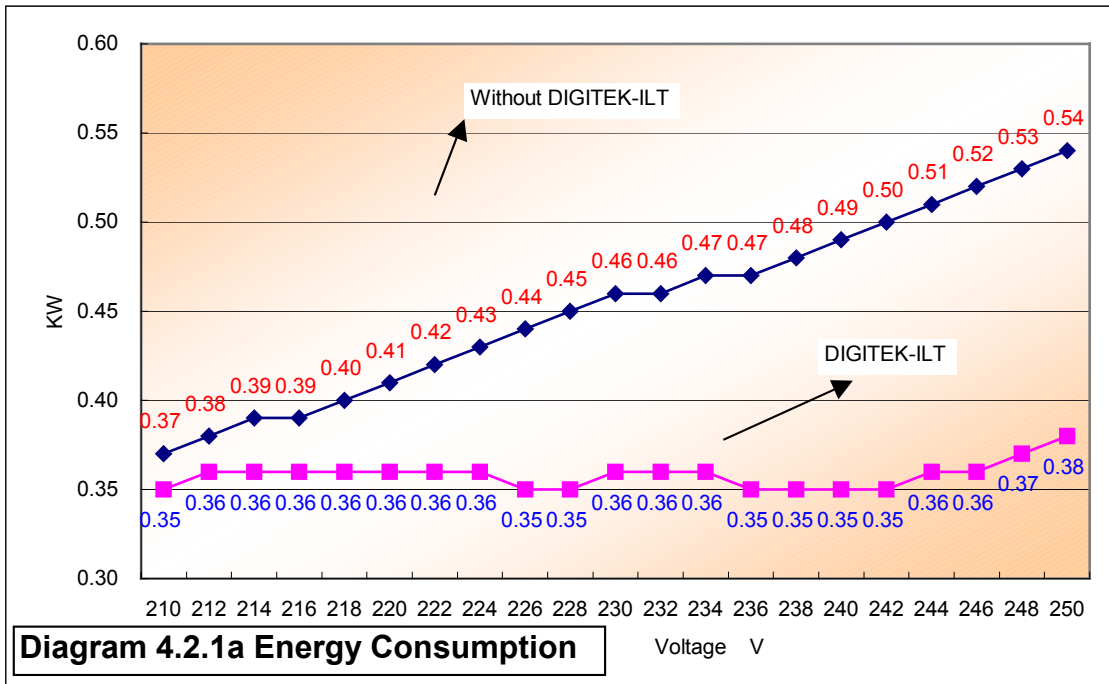
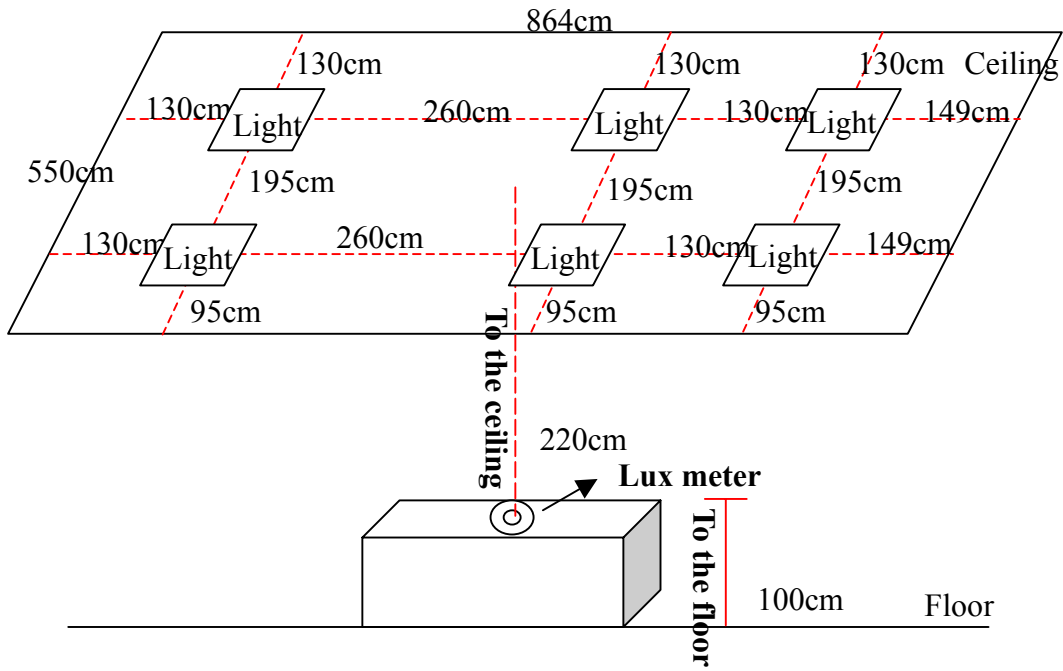
V (IN)	200	202	204	206	208	210	212	214	216	218	220	222	224	226	228	230	232	234	236	238	240
V (OUT)	199	201	203	203	204	204	204	204	204	204	204	204	204	204	204	204	206	208	210	212	214
AMP	3.03	3.14	3.25	3.38	3.39	3.41	3.43	3.44	3.47	3.49	3.50	3.52	3.52	3.52	3.57	3.57	3.59	3.65	3.72	3.79	3.89
KW	0.43	0.44	0.45	0.46	0.46	0.46	0.46	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.48	0.49	0.49	0.51	0.53

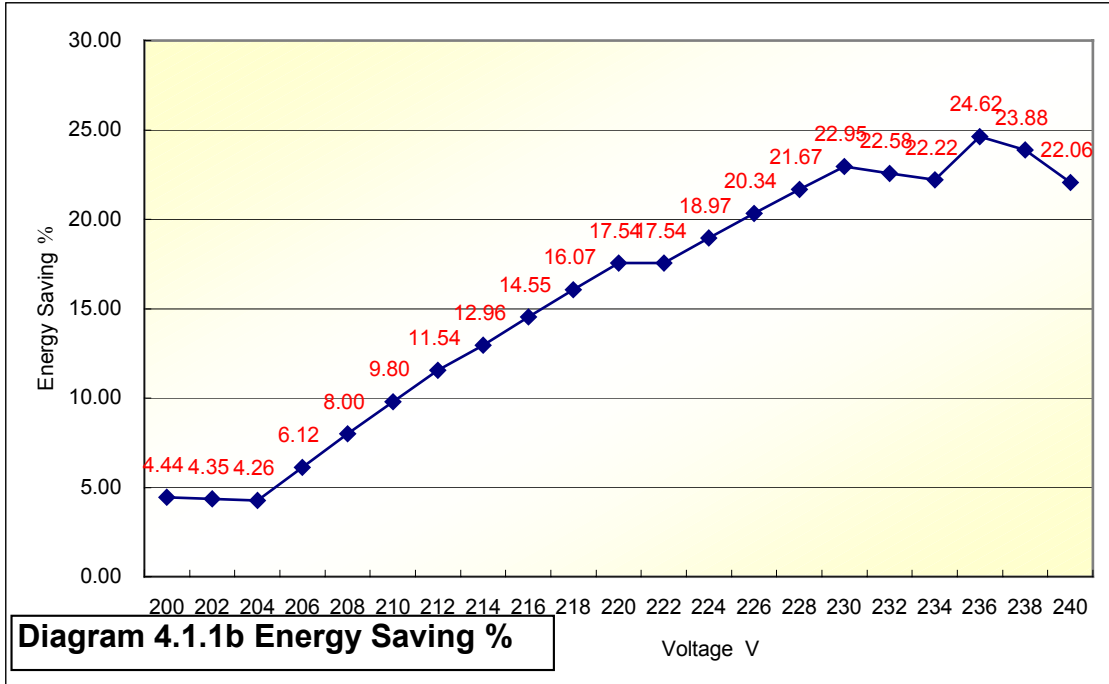
Table 4.1.1c: Energy Saving

V (IN)	200	202	204	206	208	210	212	214	216	218	220	222	224	226	228	230	232	234	236	238	240
Without DIGITEK KW	0.45	0.46	0.47	0.49	0.50	0.51	0.52	0.54	0.55	0.56	0.57	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.65	0.67	0.68
With DIGITEK KW	0.43	0.44	0.45	0.46	0.46	0.46	0.46	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.48	0.49	0.49	0.51	0.53
Energy Saving %	4.44	4.35	4.26	6.12	8.00	9.80	11.54	12.96	14.55	16.07	17.54	17.54	18.97	20.34	21.67	22.95	22.58	22.22	24.62	23.88	22.06

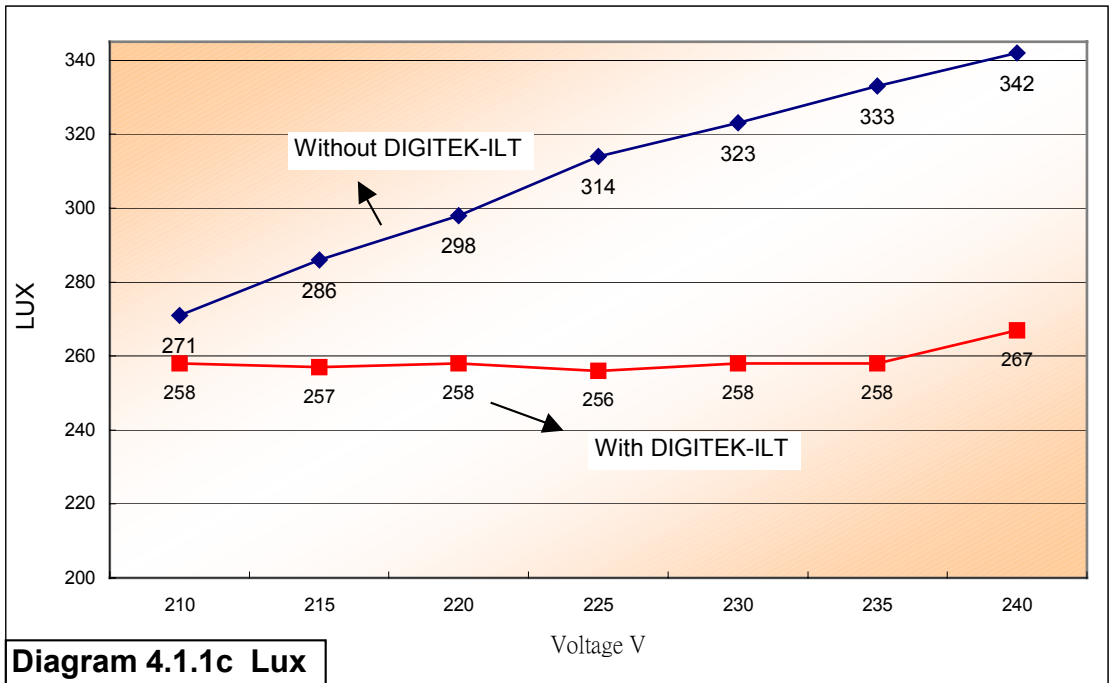
Table 4.1.1d: Luminosity

IN VAC	210	215	220	225	230	235	240
Without DIGITEK LUX	271	286	298	314	323	333	342
With DIGITEK LUX	258	257	258	256	258	258	267





At rated voltage the energy saving is 17.5%.



4.2 Mercury Light

Rated Voltage: 230V

Lighting device: Mercury light 200W X 2

Dip switch setting: 1. OFF 2. ON

4.2.1 Energy Saving Testing

Table 4.2.1a: Without DIGITEK

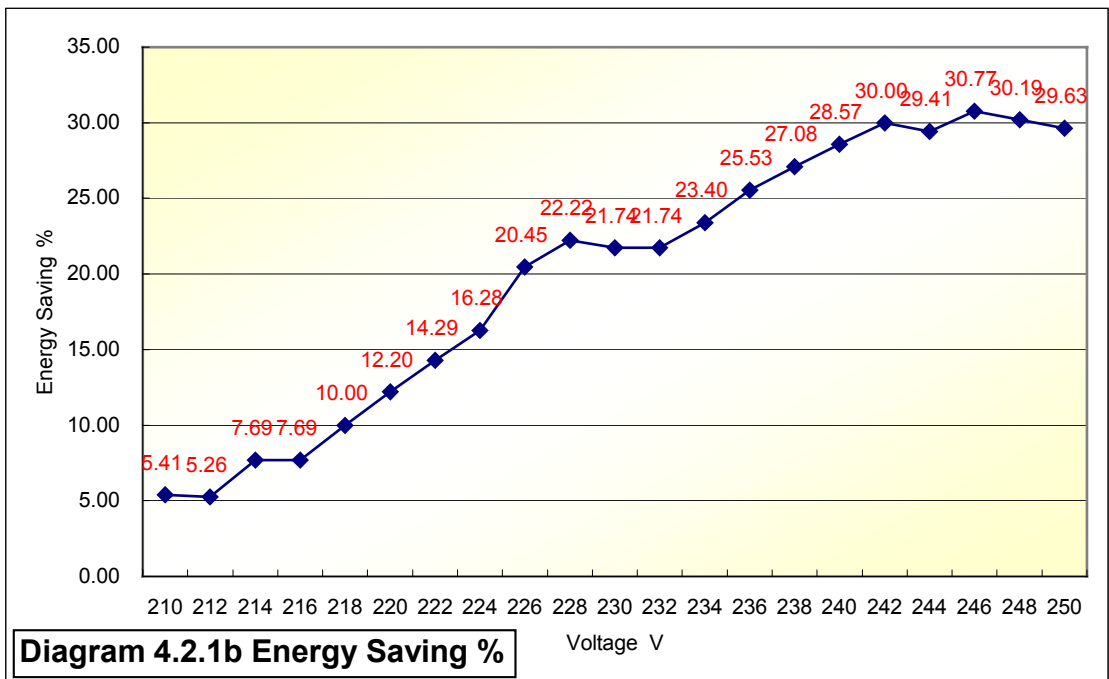
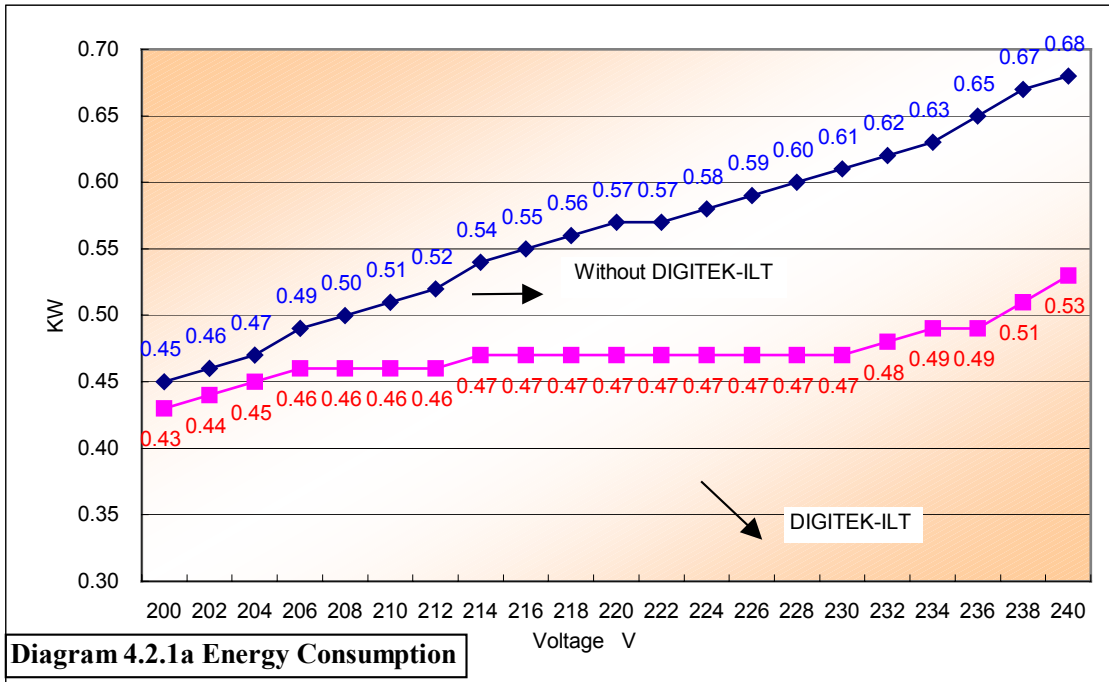
V (IN)	210	212	214	216	218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250
AMP	1.78	1.81	1.84	1.87	1.89	1.92	1.97	2.00	2.01	2.04	2.08	2.10	2.13	2.17	2.20	2.23	2.25	2.27	2.33	2.35	2.38
KW	0.37	0.38	0.39	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46	0.46	0.47	0.47	0.48	0.49	0.50	0.51	0.52	0.53	0.54

Table 4.2.1b: With DIGITEK

V (IN)	210	212	214	216	218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250
V (OUT)	209	211	212	213	213	214	214	214	214	213	213	213	213	213	213	213	215	217	219	221	223
AMP	1.76	1.78	1.80	1.79	1.77	1.75	1.73	1.71	1.69	1.67	1.66	1.64	1.62	1.61	1.59	1.58	1.60	1.62	1.64	1.64	1.68
KW	0.35	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.35	0.35	0.36	0.36	0.36	0.35	0.35	0.35	0.35	0.36	0.36	0.37	0.38

Table 4.2.1c : Energy Saving

V (IN)	210	212	214	216	218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250
Without DIGITEK KW	0.37	0.38	0.39	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.46	0.46	0.47	0.47	0.48	0.49	0.50	0.51	0.52	0.53	0.54
With DIGITEK KW	0.35	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.35	0.35	0.36	0.36	0.36	0.35	0.35	0.35	0.35	0.36	0.36	0.37	0.38
Energy Saving %	5.41	5.26	7.69	7.69	10.00	12.20	14.29	16.28	20.45	22.22	21.74	21.74	23.40	25.53	27.08	28.57	30.00	29.41	30.77	30.19	29.63



For power supply voltage equal to rated voltage the energy saving is 21.7%.

4.3 Sodium HID Light

Rated voltage: 230V

Lighting device: Sodium HIV 250W X 2

Dip switch setting: 1. OFF 2. ON

4.3.1 Energy Saving Test

Table 4.3.1a : Without DIGITEK

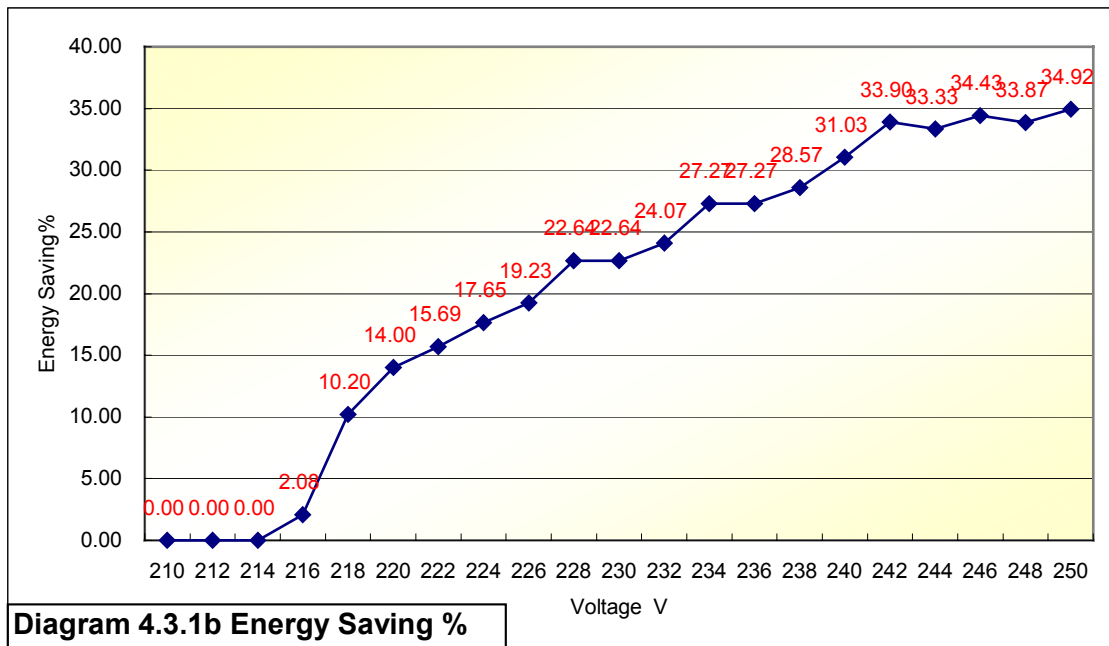
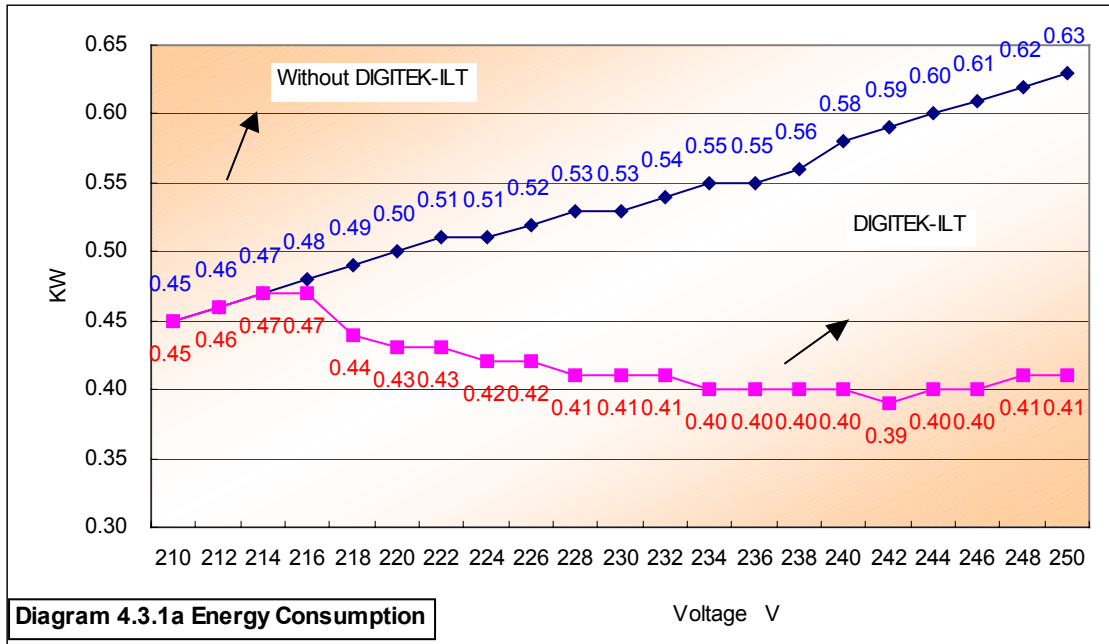
V (IN)	210	212	214	216	218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250
AMP	2.47	2.50	2.52	2.53	2.56	2.60	2.63	2.65	2.66	2.70	2.72	2.75	2.77	2.79	2.82	2.85	2.87	2.89	2.92	2.95	2.97
KW	0.45	0.46	0.47	0.48	0.49	0.50	0.51	0.51	0.52	0.53	0.53	0.54	0.55	0.55	0.56	0.58	0.59	0.60	0.61	0.62	0.63

Table 4.3.1b: With DIGITEK

V (IN)	210	212	214	216	218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250
V (OUT)	209	211	212	212	211	212	212	212	211	210	209	210	209	210	209	209	210	212	214	217	219
AMP	2.43	2.44	2.44	2.40	2.30	2.21	2.10	2.09	2.03	1.98	1.93	1.88	1.83	1.81	1.75	1.72	1.73	1.73	1.75	1.79	1.81
KW	0.45	0.46	0.47	0.47	0.44	0.43	0.43	0.42	0.42	0.41	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.40	0.40	0.41	0.41

Table 4.3.1c: Energy saving

V (IN)	210	212	214	216	218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250
Without DIGITEK KW	0.45	0.46	0.47	0.48	0.49	0.50	0.51	0.51	0.52	0.53	0.53	0.54	0.55	0.55	0.56	0.58	0.59	0.60	0.61	0.62	0.63
With DIGITEK KW	0.45	0.46	0.47	0.47	0.44	0.43	0.43	0.42	0.42	0.41	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.40	0.40	0.41	0.41
Energy Saving %	0.00	0.00	0.00	2.08	10.20	14.00	15.69	17.65	19.23	22.64	22.64	24.07	27.27	27.27	28.57	31.03	33.90	33.33	34.43	33.87	34.92



For power supply voltage equals to rated voltage, the energy saving is **22.6%**.

5. Economic Benefits

Installation of DIGITEK energy savers on street lightings have at least the following benefits:

- Saving electricity and utility charge
- Lowering maintenance cost
- Reducing power supply facility cost
- High investment return

5.1 Saving electricity and utility charge

Saving on utility charge for sodium HID

In addition to the bulb, the ballast also consumes energy. The energy consumed by ballast is about 25% of the bulb. Therefore for a 500 W bulb the total energy consumption is 625 W and for a 1,000 W bulb the total energy consumption is 1,250 W. Consider 150,000 sets of sodium HID with half in 500 W and half in 1,000 W, then at rated voltage 75,000 sets of 500 W street lightings consume 46,875 KW per hour and 75,000 sets of 1,000W street lightings consume 93,750 KW per hour, totaling 140,625 KW per hour. For 12 hours a day, this lighting system consumes 1,687,500 KWH a day and 615,937,500 KWH a year.

For 20 % energy saving, it saves 123,187,500 KWH per year. For \$0.10 per KWH it can save **\$12,318,750.00 (more than twelve million dollars)** a year.

5.2 Lowering maintenance cost

DIGITEK energy savers extend the lifespan of light bulbs and ballasts, because the voltage is lowered and so the temperature of the bulbs and ballasts is lowered. Increase of 1 V raises 0.6 °C on ballast and increase of 10 °C on ballast reduces the lifespan of the ballast to half. Since the lifespan of the ballasts and bulbs is extended when the voltage is lowered, the maintenance cost is therefore largely reduced.

5.3 Reducing power supply facility cost

Because the power consumption is reduced, the cost on power supply facility can be largely reduced or the saved power can be used for other purposes.

5.4 High investment return

Since the price of DIGITEK energy saver is low, the size is small, the installation is simple, and the pay back time is short, it has very high investment return.

6. Conclusions

DIGITEK electronic energy saver for lightings is a low price, small and light, easy to install device. Its energy saving is certain and the pay back time is short. The investment return is high.