Digital House Specifications Sample Family Minimal Interaction

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Digital House Specification
Sample Family: Minimal Interaction

Section 1. Introduction

The purpose of this document is to clarify the application concept of digital (Smart) house technology to a family dwelling currently in the planning stages. This specification is based on a real application custom designed to meet the specific needs of a specific family building a ~600m house in central Israel. No two families are alike, not all applications in this specification are necessary for all families, and many applications that are applicable to a specific family are not mentioned here. The basic premise of a digital house is ease of customization.

The digital house is known to be an application for controlling the functionality of lights, blinds and home comfort equipment (HVAC system) integrated with high end audio-visual equipment. It is considered a hallmark for high end residential dwellings and is often applied solely for this reason. In many cases the functionality is never maximized.

The ability of the digital house to affect architectural effects with added audio-visual functionality is a function of the imagination and desire of the home owner to spend the time both initially and in the future to change these effects. It is understood that these aspects of the digital house are of limited interest to some families. I have undertaken the design of the smart house to be utilitarian in nature. Any positive architectural ramifications of the design are to be suggested by the interior decorator.

The technological design is typically that of separating the user interface from the electrical power system. In a conventional system, a light is switched with a switch that is hard wired into the lighting circuit. The operation of a switch is decided at the time of construction and not changed unless physical rewiring is undertaken. In the digital house system, the lights, and any other entity that is to be controlled, are switched from actuators in the panel. The switches, and any other controlling entity, are programmable. The communication between all the elements is by a simple two wire BUS.

Every actuator output has an address and every controlling entity has an address. The programming process performed by the contractor assigns the controlling entities to the controlled entities, while defining the method. For example, a switch can operate one light by a 1 second touch, and a different light by a 5 second touch. As such, dimming, and other controls are implemented.

Digital inputs include weather stations that input outside temperature, wind speed, precipitation, humidity etc., motion sensors, light level sensors, as well as discrete inputs and logic units that allow system optimization.

There are two types of digital house systems worth discussing. The European Installation Bus (EIB) is an international protocol with hundreds of equipment manufacturers across Europe. All hardware from every supplier is interchangeable. The second system is an American proprietary system. This system uses their proprietary protocol. Where as this company is a very large and successful company that is not likely to go bankrupt tomorrow, only their equipment can be used when replacing or adding equipment to the system.

Section 2. Energy Profile

The house under construction is close to 700 square meters. Part of the house is relegated for housing elderly parents. The house is equipped with an indoor therapeutic constant current swimming pool and an outdoor recreational swimming pool. Concerns over the availability of constant hot water have been voiced. The house is equipped with three food preparation areas. The climate control is to be of VRV inverter type. The bathing and sleeping areas are augmented with under floor heating.

The architectural electric design translates to the following installed power requirements:

- Installed lighting~22 kw
- Installed HVAC~ 27 kw + 12 kw indoor
- Installed power appliances (approximated) ~ 17 kw

Based on my load calculations I have ordered 3 x 200A service for the house.

For the purpose of cost analysis, we will assume that for half a day the HVAC is running at half it's capacity and half the lighting is operating, making for ~31kw running. That translates to about 16 NS an hour. If we turn off all the lights and leave half the HVAC for the other half of the day, we have ~20 kw running at 10 NS an hour. For half a day the electricity will be 192NS. For the other half about 122NS. Total daily bill will be about 314NS. This amounts to ~10000 NS a month based on the current tariff rate of 50.8 ag. (incl.VAT) a kwH for household users.

This estimation does not take into account ANY use of refrigerators, ovens, pools, water heaters etc. the assumption of half the lights operating for half a day and the HVAC running all day at half capacity can be pondered along with the following hourly values:

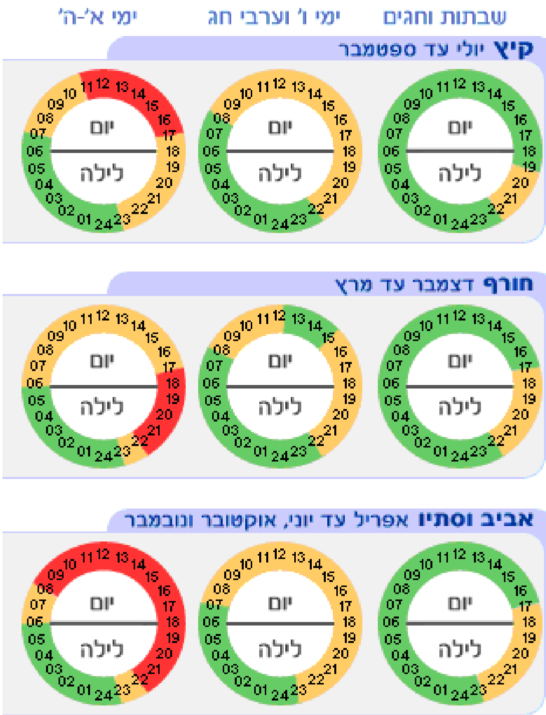
- Computer: 0.375 NS/ hour
- Oven: 1.5 NS/ hour
- Swimming pool pump: 0.56 NS/ hour
- Wave machine: 1.5 NS/ hour
- Typical water heater 1 NS/ hour

These assumptions are using the current tariff rate for household users. However, it is highly likely that the electric company will insist on charging according to TOU (Time Of Use) or "taoz" in Hebrew. This assumption is due to the fact that all commercial customers from 3x100A have TOU meters installed, and are charged TOU when they use 100,000 kWH a year (constant 12 kW). Residential customers are "invited" to order TOU under the assumption that it works out cheaper for the residential customer. Studies I have conducted in the past prove this assumption to be false. The current (October 2006) rates for TOU including VAT are as follows:

<u>בעד כל קוט״ש</u>:

בקיץ:	בשעות הפסגה	92.98	אגורות
	בשעות הגבע	57.05	"
	בשעות השפל	21.12	"
בחורף:	בשעות הפסגה	85.93	אגורות
	בשעות הגבע	48.63	"
	בשעות השפל	19.88	"
באביב או בסתיו:	בשעות הפסגה	66.75	אגורות
	בשעות הגבע	42.02	"
	בשעות השפל	20.21	"

The TOU definitions are as follows:



It is readily apparent that a lot is to be gained by doing as much electrical work as possible outside of Peak hours. The digital house is the platform for this type of energy saving.

Section 3. Application Characteristics

The design is based on the following premises:

- The family will not interact willfully with programming the system
- The digital or "smart" house is to perform it's duties with out the intervention of the family
- Any interaction that will take place must be via an easily accessed and super user friendly interface
- The functionality is primarily for the purpose of energy management, safety and security.

The functionality is to be dealt with on two levels.

1. Programmed architectural functionality by the Digital House (DH) contractor
2. Preprogrammed functionality by the DH contractor for future configuration by the family

The programmed architectural functionality includes:

√ the assignation of the lights to the switches that operate them

√ the initial dimming percentages (dimming from an energy management point of view)

√ initial scenes, such as "arrive home to empty house", "last person to retire", "possible prowler", "leaving the house", "pool party", "home alone" etc.

The preprogrammed functionality will include the following types of interfacing through IP connectivity and applicable GUI:

√ Time clocks

√ Appliance activation or enabling

- √ Energy management parameters including:
  - √ Load shedding order of preferences
  - √ Temperature control for vacant rooms
  - √ Logic for turning off unused lights
  - √ Enabling and disabling all of the above

3.1 Application Elements

The Smart house is to offer functionality in three fields, Safety, Security and Energy Management.

3.1.1 Safety

The house is to be equipped with three food preparation areas, two pools areas, laundry room, a gas furnace and possibly other areas of potential interest to this application. One of the food preparation areas is in an area designated for the independent use of elderly parents, and another is in a recreational area that may be used by younger members of the family. The electrical outlets for use by heating elements such as cook tops and ovens are enabled by an actuator just as are all the lighting circuits. It will be possible to enable the use of these sockets by push button on the wall (one of the "light switches") for a set period of time, thereby preventing damage due to the heating element being forgotten in the "on" position. Similarly, it will be possible to totally disable the sockets from the system IP GUI.

The laundry room is assumed to be the realm of the cleaning crew, and as such cleaning solvents and rags are to be stored there. This room has no windows. This room requires ventilation. The ventilating fan will automatically switch on for a few minutes every hour, as well as being operated manually from the room.

Though not safety related, it is relevant to point out at this point that the ventilation for the western bathrooms on all floors will be centrally located by a single fan on the roof. This fan will be operated by a switch by each of the bathrooms immediately and for 3 minutes after the last of any of the bathroom lights are switched off.

Location of the gas furnace is yet to be decided; it is probable that a gas sensor will be installed allowing alarming to the system on gas leaks. Similar exhaust fan arrangement to that mentioned above may be implemented.

Water sensors and gas sensors may be employed where ever water system integrity is lowest, and gas or other caustic material may cause damage.

The system will control the operation of the circulation pumps and the solar/electric water heater. The system will also control the valves on the gas furnace. This will allow for using the solar/electric heater to heat only the areas required, such as bathrooms, while excluding one or both pools when the gas furnace fails.

Failure of circulation pumps will trigger an alarm to the system, immediately commencing operation of the electric water heater.

3.1.2 Security

The alarm system has been designed only to the level of conduit and pulling cord. A contractor is to be chosen by the family independent of the building process, since it is understood that the relationship between the alarm contractor and the family is to continue after the installation process as the family is living in the house. Whereas most possibilities have been planned into the building process, it is in the interest of the family to choose a contractor as soon as possible in order to remove unnecessary points, install points that may be more efficient and to facilitate an optimal interface between the digital house and the security system.

The security system door and window magnets can be used by the digital house for enabling a/c operation, if the family usage of the window and the system allow this.

The digital house can augment the security system using the following features:

- Panic button for exterior flood lighting
- Activation of the alarm system as part of a scene
- Dual usage of digital house elements for the alarm system
- Digital house IP connection may be used by the security system for alarm and tracking

3.1.3 Energy Management

The main application for the digital house is energy management. The major energy users are the HVAC and the lighting. Motion sensors designed for energy management are to be positioned in all rooms to register the existence of people, awake or asleep. When no one is in the room for more than a configurable time, the thermostat will raise two degrees (configurable). When more time elapses, the thermostat will raise another two degrees, or turn off.

Temperature sensors will be installed in the hot water lines. Both the gas furnace and the electrical heater will be operated by accurate real time temperatures and not the analogue, cheap, safety thermostat supplied with the heater.

The plumbing will be directed by valves. It will be possible to send heated water to different zones. If heating one pool or a whole floor is not necessary, it will be able to cut these floors from the hot water supply. This is particularly important for the backup electric water heater. If the gas furnace fails, it will be possible to automatically fall back on the electric water heater, this will be configurable to automatically cut out hot water to specific areas such as one or both pools. This is considered important since the heating capacity of the stock water heater is much lower than that of the gas system.

Since both the price of gas and electricity are prone to fluctuate independently of each other, it is conceivable that the cost of heating water during certain periods of the day will be cheaper by electricity than by gas, particularly at night, when the price of electricity is lowest. At this time of day, it is likely that the pools do not require heating. The system can be programmed to heat with electricity during these times.

Lights will be initially set to a dimmed level acceptable to the users of the room. When more light is necessary, it is possible to raise the level, however, the initial level of 100% usage is probably not necessary in most cases. When the room is unoccupied for a configurable time, the lights will switch off. Lights can be configured to turn on automatically on entering and off when exiting.

A photocell is to be installed, either separately or as part of a weather station. This photocell will enable outdoor lighting only when it is dark. Unlimited software time clocks will also be available to ensure that outdoor lighting is used only when necessary.

Load shedding for the purpose of over current protection and for the purpose of energy management will be possible. Loads will be classified according to importance, and will be shed in that order. A sample scenario is when a phase current flows above 200A. The system will shed loads in order of importance; first shedding under floor heating, then cycling the a/c units.

It is suggested that under floor heating be used during the cheapest tariff, since the heaters heat a stone floor, and the stone holds heat, the system can be configured to shut of all under floor heaters when the TOU moves to the next tariff.

It is strongly suggested that the walls and ceilings be constructed of wallboard with proper insulation with a vapor barrier installed.

Section 4. Applied Functions

The following functions are available for application in a digital house above and beyond the architectural functions. All the functions are configurable through an internet browser from anywhere in the house or outside of it:

1. Control of Ceiling fans with a dimmer. This allows for accurate control of fan speed

2. Lights are switched off by presence detectors; switched on from the switch or by presence detector
3. Room temperature control by presence detector. If no one is in the room for 10 minutes, the thermostat is raised 2 degrees, after 30 minutes, the temperature is raised another 2 degrees
4. Room temperature is automatically controlled after a configurable time. Upon entering a room, some guests may set the thermostat at 15 degrees, after a time the system will knock it up to a realistic and acceptable level
5. A/C is closed when a window is opened (configurable per window and with override)
6. Cost of electricity awareness. System always knows how much a kwh costs (TOU)
7. Running electricity bill, allows accurate utility bill verification
8. Decision making regarding heating water by diesel or electricity
9. Load shedding- never a main service black out due to over current
10. Load shedding during peak TOU
11. Cyclic shedding of A/C units in the house during peak hours (TOU)
12. Water heating according to temperature at the lowest point in the house- accurate temperature control of heated water
13. Control of under floor heating and effective integration with a/c during TOU
14. Optional closing and opening of blinds in relation to sun, season, time of day
15. Control of wall outlets for configured periods of time by pushing a button
16. Fault indication- pumps, spds, etc
17. Electric water heater tester, checks if water heater is working every day- warns if burnt out
18. Water sensors under plumbing junctions to indicate breakage of pipes
19. Custom user friendly GUI to control all the above