DESIGN AND IMPLEMENTATION OF INTELLIGENT BUILDING /SMART BUILDING

by

Dipak Patel

Bachelor of Engineering, Gujarat University, 1998

A project

presented to Ryerson University

in partial fulfillment of the

requirements for the degree of

Master of Engineering

in the program of

Electrical and Computer Engineering

Toronto, Ontario, Canada, 2017

Author's declaration

I hereby declare that I am the sole author of this project.

I authorize Ryerson University to lend this project report to other institutions or individuals for the purpose of Scholarly research.

I further authorize Ryerson University to reproduce this project report by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

I understand that my project report may be made electronically available to the public.

DESIGN AND IMPLEMENTATION OF INTELLIGENT BUILDING /SMART BUILDING

Master of Engineering, 2017

Dipak Patel

Electrical and Computer Engineering

Ryerson University

Abstract

The intelligent building is supposed to provide the environment and means for an optimal utilization of the building, according to its designation. This extended function of a building can be achieved only by means of an extensive use of building service systems, such as HVAC, electric power, communication, safety and security, transportation, sanitation, etc. Building intelligence is not related to the sophistication of service systems in a building, but rather to the integration among the various service systems, and between the systems and the building structure. Systems' integration can be accomplished through teamwork planning of the building, starting at the initial design stages of the building. This paper examines some existing buildings claimed to be “intelligent”, according to their level of systems' integration. Intelligent buildings respond to the needs of occupants and society, promoting the well-being of those living and working in them and providing value through increasing staff productivity and reducing operational costs. Intelligent Buildings considers cultural changes affecting the way people live and work, the importance of an integrated approach to design and management and the benefits technological developments can bring in developing sustainable buildings that meet users' needs.

Acknowledgements

This project could not have been completed without the help of many extraordinary individuals and organizations.

I want to express my gratitude to Dr. Vadim L. Guerkov, my graduate supervisor and mentor, for your dedicated support and guidance throughout my academic career at Ryerson thus far, and for giving me the opportunity to work on a topic so close to my heart.

Table of Contents

List of Figures

Figure Page

Introduction

Intelligent buildings apply technologies to improve the building environment and functionality for occupants/tenants while controlling costs, improving security, comfort and accessibility.

Intelligent buildings respond to the needs of occupants and society, promoting the well-being of those living and working in them and providing value through increasing staff productivity and reducing operational costs. Written by authors from practice and academia, Intelligent Buildings considers cultural changes affecting the way people live and work, the importance of an integrated approach to design and management and the benefits technological developments can bring in developing sustainable buildings that meet users' needs.(17)

As building owners, facility managers and tenants fully understand the impact modern technology will have on their business operations now and into the future, they will also realize the benefits of network integration of these various systems, devices and applications within their buildings or campuses. Through this network approach, they are able to share the value generated by the knowledge worker to be more efficient and productive, and also information generated by existing and future 'Intelligent Building' systems, devices and applications to contain operational costs and maximize ROI(Return on Investment) .(5) Rapid advances in technology and the emergence of enterprise distributed computing platforms created the need to integrate IT systems. This integration of applications required a single, low voltage cable distribution infrastructure. The rapid deployment of integrated voice and data systems based on digital transmission and IP based protocols, set the stage for the next step in the technology evolution process. The advent of integrated voice and data digital transmission techniques, coupled with ever increasing data transmission speeds and customer demand for additional information, led to the proliferation of the Local Area Network (LAN) industry. LAN systems and networked devices provided an economical method to connect and distribute information within organizational work groups. The evolution of the integrated IT systems and markets has dramatically effected and guided the development of structured cabling systems. A "total end-to-end connectivity solution" offers customers low voltage connectivity that is critically important as the bandwidth, data transfer speeds and mission critical information from various devices attached to the network is transmitted within a building or campus. Information technology in buildings does not refer only to PCs and telephones, but also Building Automation Systems (BAS), such as security (surveillance and access control), Heating Ventilation Air Conditioning (HVAC), and Fire/Life/Safety (FLS) as they transition from electro/ mechanical and pneumatic technology to microprocessor based software driven systems. Leading building automation providers already have state of the art computer based software controlled systems for building management. Most manufacturers of major building automation systems offer computer based, software driven systems, based on distributed processing architectures. These systems are required to interface with other building automation systems and devices, and also to interface with voice, data, LAN and video systems located within a building or campus.(14).(16)

Here, based on requirement I contribute my skills to design the building automation project. This consist hardware design, hardware selection, program controller with designed sequence of operation, commissioning controllers for its proper operation and create graphics for end user operation. Details are described in later part of the project.

Motivation

A big Hindu Temple is built in 2007 called BAPS. This temple add the community hall and residence for priests in 2012. They have 2 floors concrete structure with various mechanical equipment and under floor heating system implemented for heating and cooling purpose. It was a big challenge to bring all equipment under one umbrella and control using centralized control system. To operate this different equipment locally, there must be an operator work 24/7. Also, these equipment needs to have alarm system to notify the operator in case of failure of any mechanical equipment. Also, there is no system which can analyze the performance of the system and give suggestion to improve the system. Also, there is no graphics interface to view the detail performance of the system. So, in nutshell, there are quite a few challenges to control these mechanical equipment.

Challenges :

- Control multiple mechanical equipment using centralized control.
- Required alarm system to notify the fault in the system.
- Required performance analysis using trends to improve the system.
- Required graphics interface to watch the system with real time data and control over it
- Required design and implementation of automation system to perform the system automatically.

Objectives and Contribution

These challenges brought to my attention. To overcome all challenges, the only solution can implemented would be centralized building automation system or intelligent building automation system.

The new add on building has 7 Rooftop units, 8 manifolds to control the under floor heating system. These building needs control system design which includes detail study of mechanical equipment and needs layout to control it. First of all, I design a sequence of operation for each mechanical equipment. Based upon that, next step is to choose controller and peripheral devices to accommodate the sequence of operation. Once hardware is selected, need wiring diagram to do wiring between controller and equipment. This results in detail wiring diagram for each equipment. To perform centralized control system, there is a need for network between controllers and communicate them to one another over common protocol language.

Once the hardware design is completed, there is a need to run wires for peripheral devices like space sensors, duct sensors, relay wiring to control the equipment and under floor sensors, control valves etc. All field wires comes back to controller which controls the equipment using control algorithm.

Contribution :

- Design and implementation of building automation system
- Hardware selection based upon the application of the unit
- Design the sequence of operation, control algorithm, control drawing- wiring diagram
- Hardware installation, programming controller and commissioning
- Verify sequence of operation and functional test of the system
- Graphics design and implementation to monitor and control the system locally and remotely

Below are the details about control drawing which explains the entire control system design.

1. History and Technological Evolution of Intelligent Building

As the Figure-1 below, Buildings uses 39% of the total energy consumption as highest of all energy consumption. This building portion is total of residential and commercial building consumption. So, there is huge opportunities of making this building intelligent to control it better and interact it with end users.(1).(3)

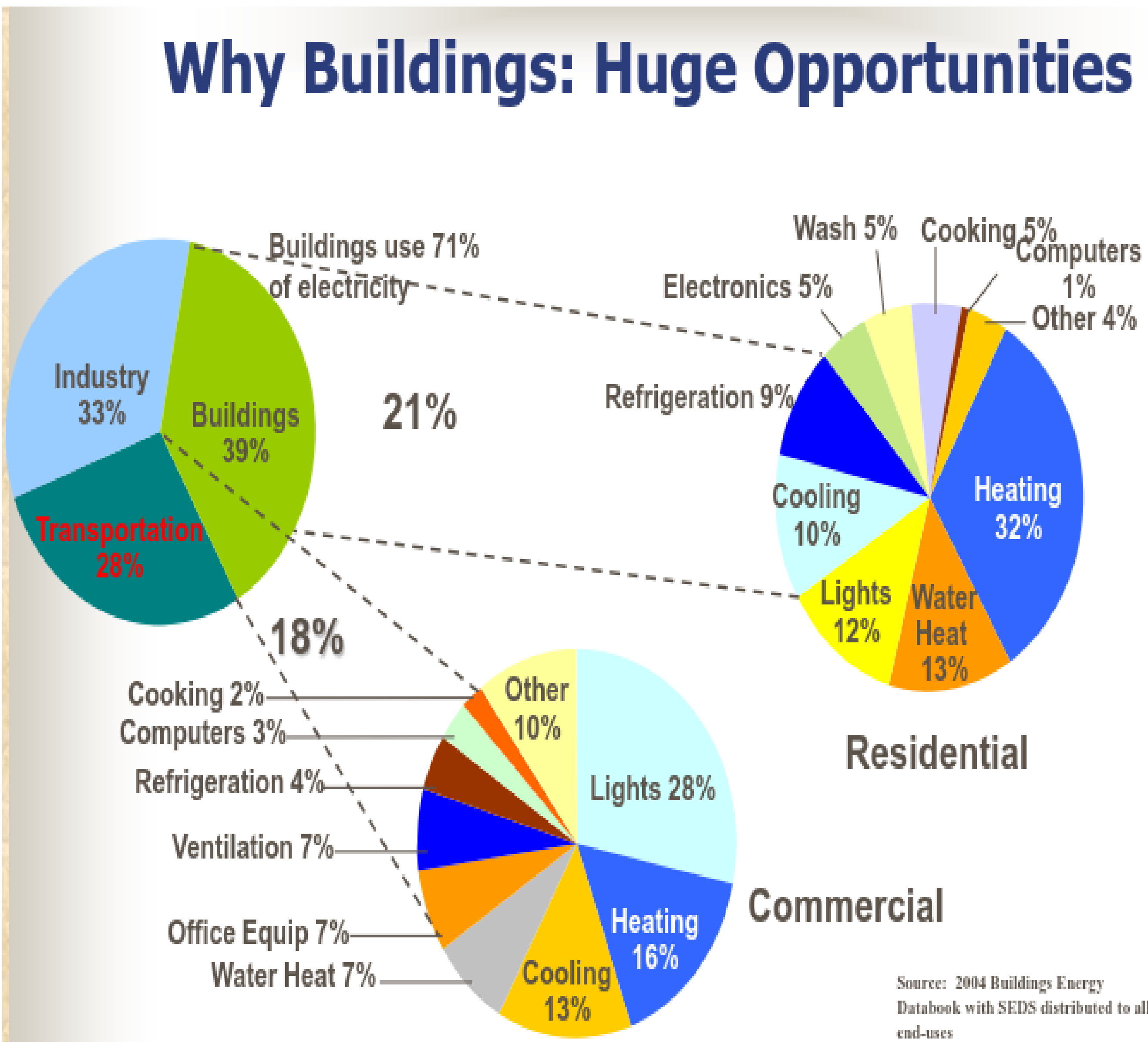


Figure -1. Summary of Energy Consumption

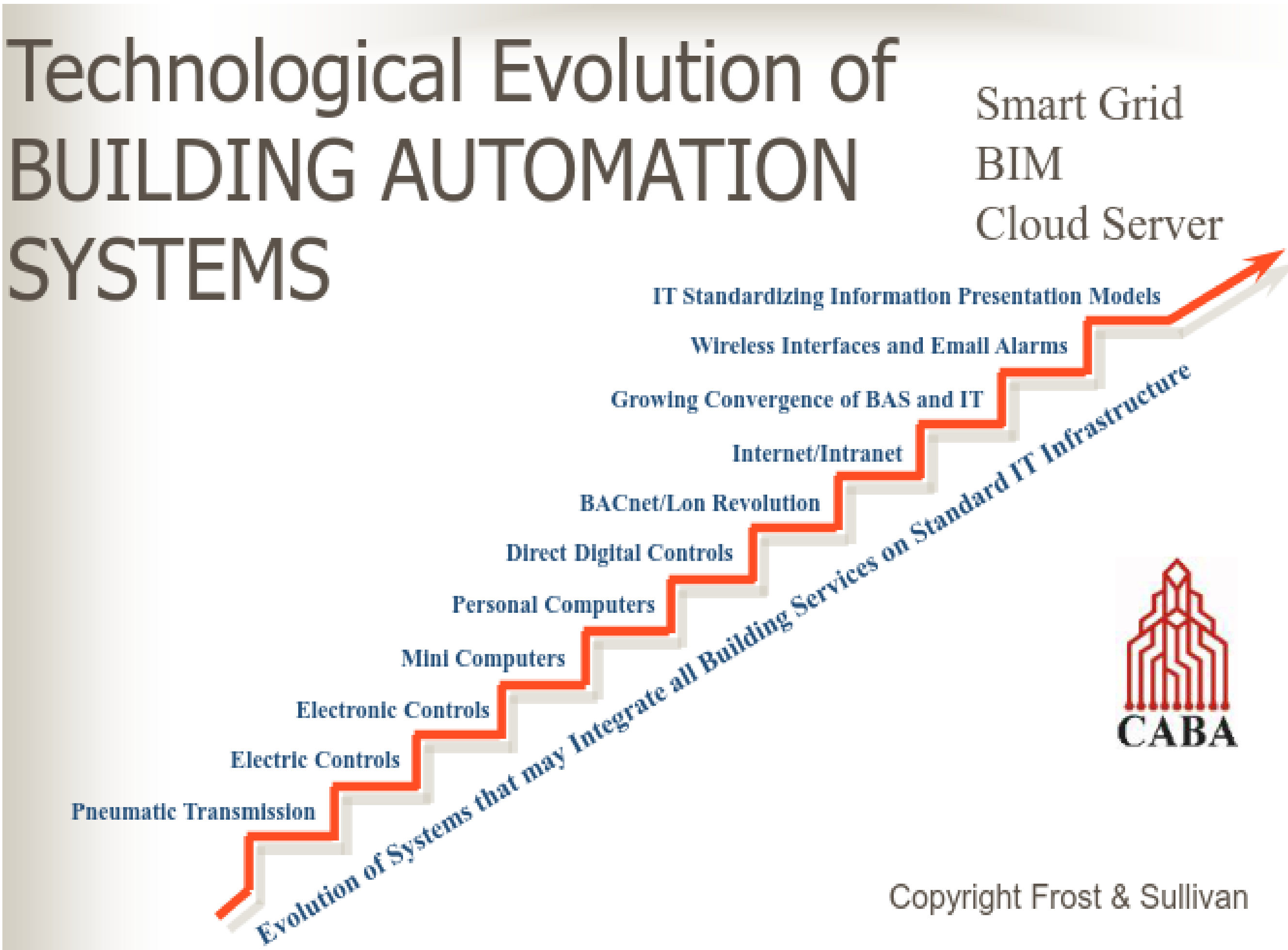


Figure - 2 Technological Evolution of Building Automation Systems

In early 60s', the Pneumatic Controls control the major HVAC system in the buildings. It uses large air compressors to compress the air to control the major component of the HVAC systems. It was expensive and local control over the equipment. Later on, Electrical controls took place to control the HVAC system. In 70s', the Electronics controls change the electrical controls into Electronics. In 80s', BACnet and LON protocol made big revolution in the industry. This protocol unified the platform to bring different devices together first time. Later on, internet with IT concepts made the building automation control remote and wireless. Now, IT becomes the standard for building automation with industry standard protocols.(3)(7).

1.1. Typical building Vs Integrated Buildings

As we seen in the Figure -3, typical building with no integration has five different segments to control the entire building. All five segments which is Fire Management System, Door Access and Intrusion Detection, Lighting Control System, HVAC Control System and Main Electrical/Power distribution system are controlled individually. In this system, there is no link between two systems. The building control locally using computer as an interface. There is no interaction with Humans as system operates individually and locally. In case of emergency, one system can't pass the signal to the other system to react. No integration is involved to interact the system to one another.

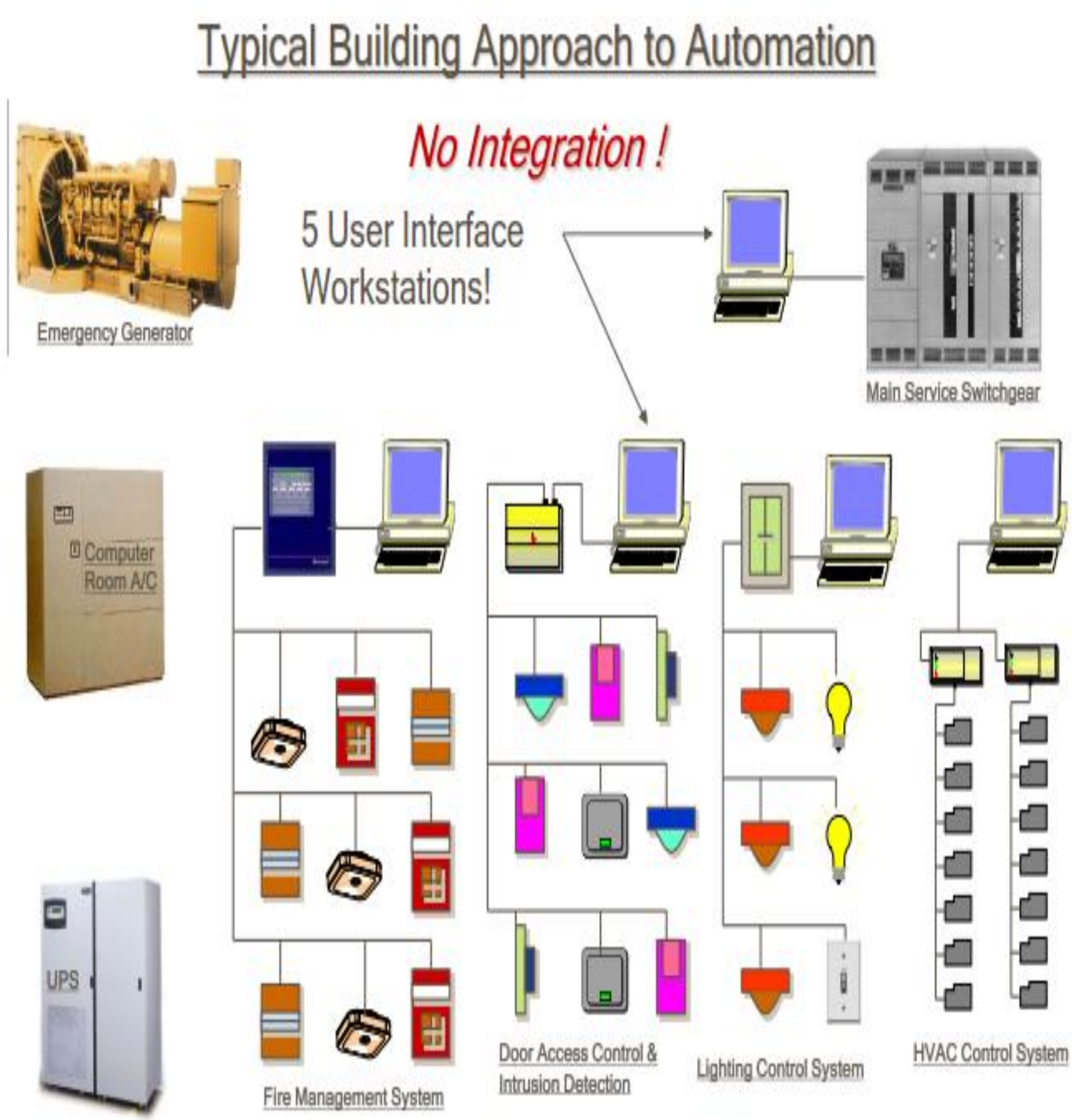


Figure-3. Typical Building with No integration

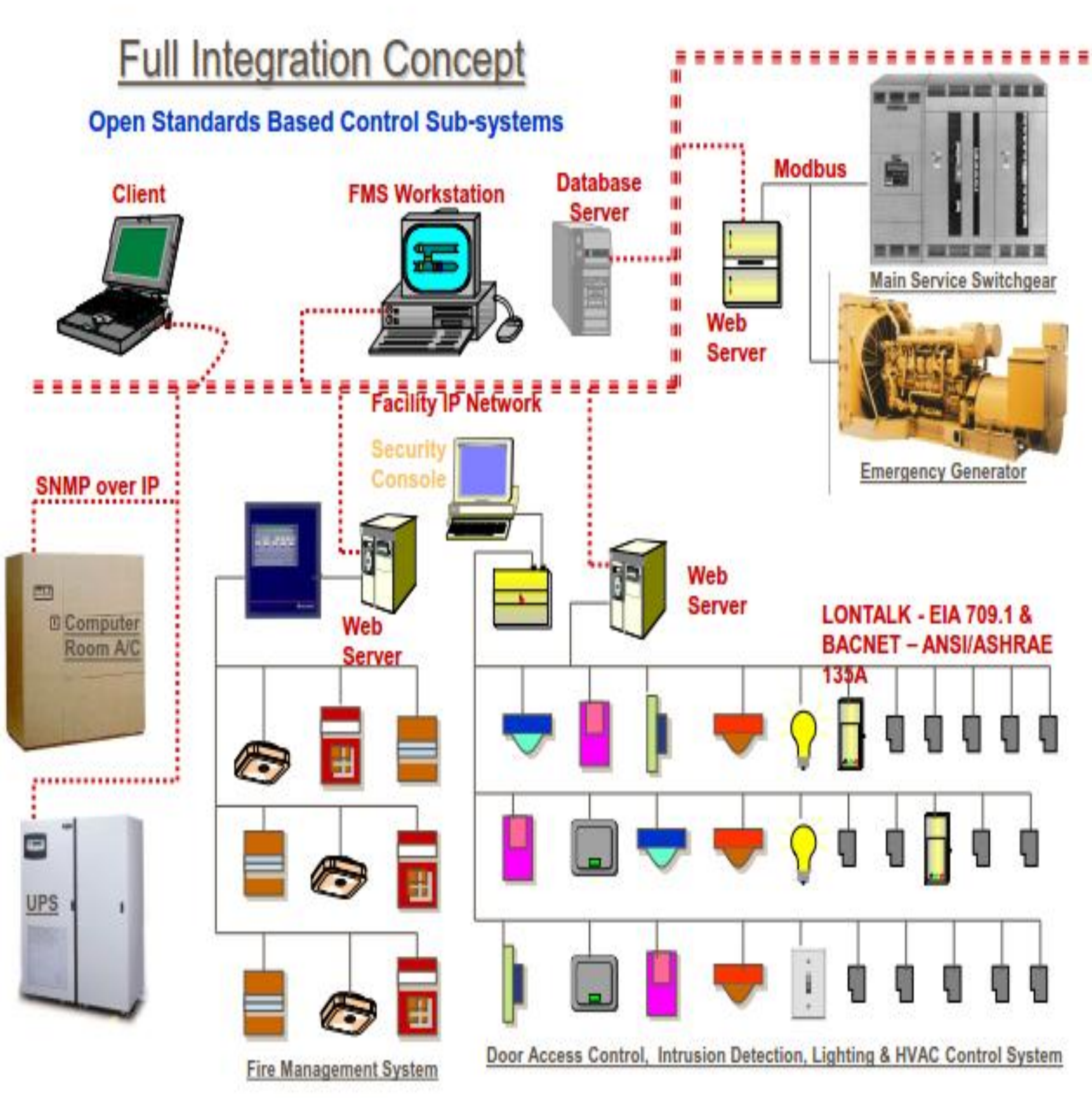


Figure -4 . fully integrated Building

As shown in figure-4, all systems are connected on a common platform to interact with each other. Finally, entire system has one interface to control, monitor and feedback. The end user whether occupant or operator can interact with the system. End user interact with the system and the system respond to the end user's request.(9).(10).(11)

1.2. Characteristic Intelligent Building

- Designed around Users : Intelligent buildings are designed keeping end user in mind. The end user is play an important role in operating the building. The Occupant of the building input the value to get comfort in the building. Human interaction is needed to control the building.

- Improves Security : Secure access and CCTV camera are the main component of the intelligent building for security. The occupant enters the building through secure designated access. The building track the occupant and provide security through its various systems.(15).

- Enhances Comfort : One of the best feature of intelligent building is to provide comfort to the end user. The end user has capability to change the comfort level by changing the set point. This set point is taken by building automation control system to adjust heating/cooling to provide comfort.(17)

- Provides Energy Savings : This another important feature of the intelligent building to save energy. Building receives data from its sensors all the time. This data get processed by system all the time and take decision to save energy without compromising the comfort of the occupant.(21)

- Enterprise-wide Energy Monitoring : Intelligent building has capability to integrate all the system of the building and bring it to common work station. This work station can access locally as well as remotely. It also has access to all data remotely and monitor in real time. (19).

- Everything Communicates : Any intelligent building has HVAC system, Fire system, CCTV system, Energy monitoring system, Security access control system as main components. These all system can interact with each other. Also, they can send and receive command from other systems to re act to the situation. So everything communicates to one another. (17)

- Local Command and Control : All building control systems are connected to common platform and unified the data to a single point control . This single point control is the local work station.(5)

- Remote Command and Control : Building control system is connected to the web server. This web server has capability to access, monitor and control the system remotely.(22)

- The right data to the right people : This system has different layers of access and control capabilities. Different user has different access level to control the system at different level. The system has admin level, programmer level, graphics level, maintenance manger level, engineer level, operator level and guest user level. All this category has different capabilities (22)(16)

1.3. Benefits

- Energy & Operational Savings
- Reduced Equipment Downtime
- Reduced Risks
- Better Customer Experience
- Higher Profits

Benefits of Intelligent Building over Conventional Building

Conventional Building

- Manual control for mechanical equipment
- No fault diagnosis
- Alarm can't send remotely to outside of the building
- No graphics to view the real time system
- No integration of all equipment. Need to control individually
- No trends to view and enhance the performance
- No data storage for performance analysis

Intelligent Building

- Centralized control over mechanical equipment
- Fault diagnosis using real time data and archive data
- Generate and transmit alarm remotely to outside world
- Graphics or HMI to view real time system
- Integration of all equipment to control better.
- Trends to view and enhance the performance

1.4. Example

Manitoba Hydro Place

Figure - 5 Manitoba Hydro Place

- LEED Platinum
- Exceeded the original target of 60% energy savings
- $15 million in annual operating costs savings
- Integrated natural ventilation, shades, blinds, geothermal, atrium water feature

----

2. Practical Design for Building Automation

As we seen so far the theory of Building automation. Now here we introduce the practical design of one of the building. Below are the control drawings of the building to design.(20)

First of all, I need to work out with wiring layout using mechanical drawings. This is also called rough in estimate. This will include field wiring for peripheral devices and network wiring which is link between controllers. In this project, I use BACnet protocol for building automation.(16)

Once wiring lay out is done for field wiring and control wiring, I generate the control drawing showing details about how mechanical equipment is controlled using field controllers. How many inputs and outputs are used to control the mechanical equipment. Each control points needs to be configured in controller with proper range to control the equipment properly.(22)

Next part, I design the sequence of operation based on specs provided by design engineer. Sequence of operation decide how the mechanical equipment needs to be operated. This sequence of operation is needs to be converted into the program to load into the controller for proper operation.(23)

Now, I choose hardware for controller and peripheral devices. Both needs to be chosen based on operation of the unit. Peripheral devices are the sensors giving data from the field and based upon the data, the control sequence work using the residual program.

Once hardware chosen, it needs to be installed with proper installation method. Each controller has its input and output controlling the mechanical equipment. It also need regulated power supply and network connection to communicate with its peer controllers.(20)

After I installed controllers and field devices, program needs to be downloaded into the controller to perform the design sequence of operation. These sequence need to be verified for proper operation of the unit. These commissioning process can be done using graphics or using controllers communicating to the central hub.

I design the Graphics which is the final product of the building automation and face of the entire control system. Graphics represents all control inputs and out-puts with set points,schedules, trends and keep the log of entire system.(19)(22)

Below, I mention the step by step process of designing.

2.1 Control Drawing

BAPS Swaminarayan Sanstha

BAPS Swaminarayan Sanstha
Shri Swaminarayan Mandir, Toronto

Community Hall HVAC
+
Floor Heating

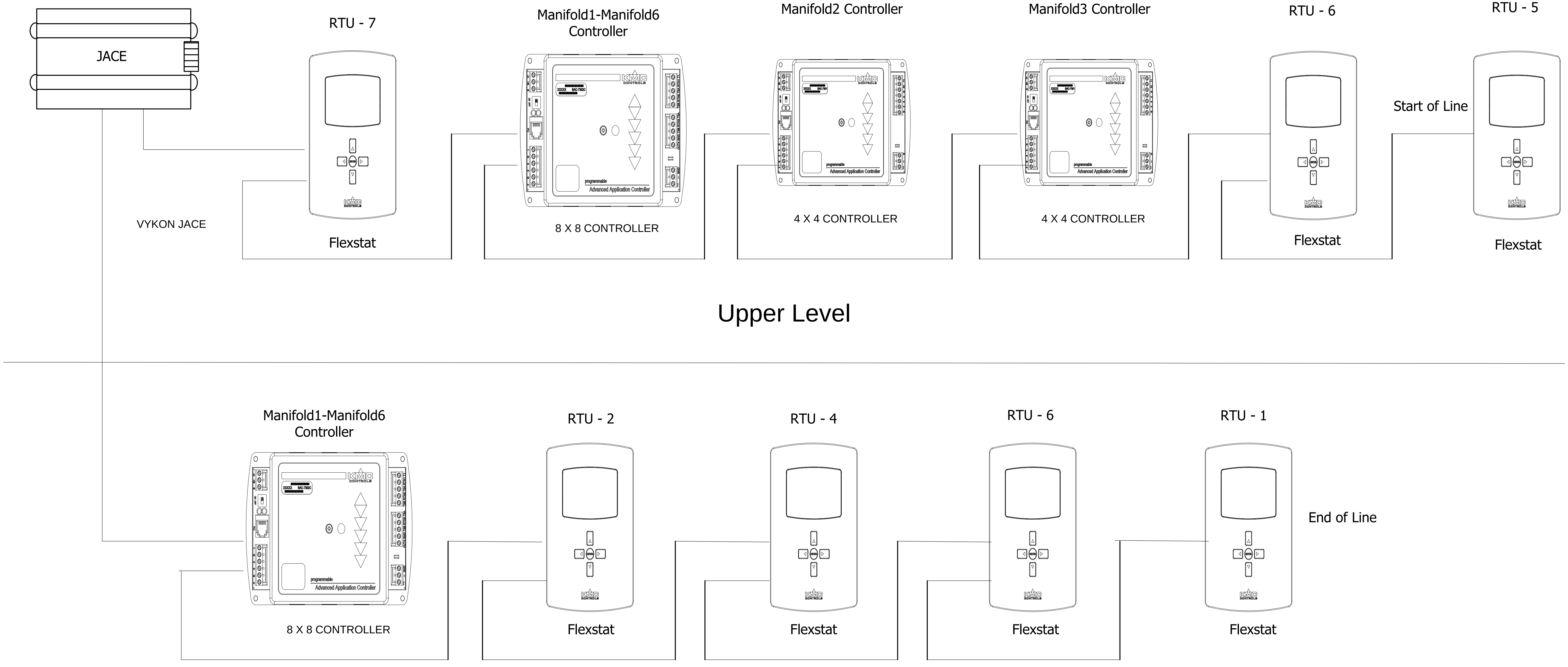
61,Claireville Drive, Toronto, ON,M9W 5Z7, Canada

Econoptimal Automation Inc.

DRAWING INDEX

#	SYSTEM	DESCRIPTION
01	TITLE	Title Page & Drawing Index
02	NETWORK	NETWORK LAYOUT
03	RTU-1	ROOF TOP UNIT 1
03	RTU1-PANEL	RTU1-CONTROLLER LAYOUT
04	RTU-2	ROOF TOP UNIT 2
05	RTU2-PANEL	RTU2-CONTROLLER LAYOUT
06	RTU-3	ROOF TOP UNIT 3
07	RTU3-PANEL	RTU3-CONTROLLER LAYOUT
08	RTU-4	ROOF TOP UNIT 4
09	RTU4-PANEL	RTU4-CONTROLLER LAYOUT
10	RTU-5	ROOF TOP UNIT 5
11	RTU5-PANEL	RTU5-CONTROLLER LAYOUT
12	RTU-6	ROOF TOP UNIT 6
13	RTU6-PANEL	RTU6-CONTROLLER LAYOUT
14	RTU-7	ROOF TOP UNIT 7
15	RTU7-PANEL	RTU7-CONTROLLER LAYOUT
16	M1M6-CONTROL	MANIFOLD1-MANIFOLD6-CONTROLLER LAYOUT
17	M2-CONTROL	MANIFOLD2-CONTROLLER LAYOUT
18	M3-CONTROL	MANIFOLD3-CONTROLLER LAYOUT
19	M4M5M7-CONTROL	MANIFOLD4-MANIFOLD5-MANIFOLD7-CONTROLLER LAYOUT

Network Layout

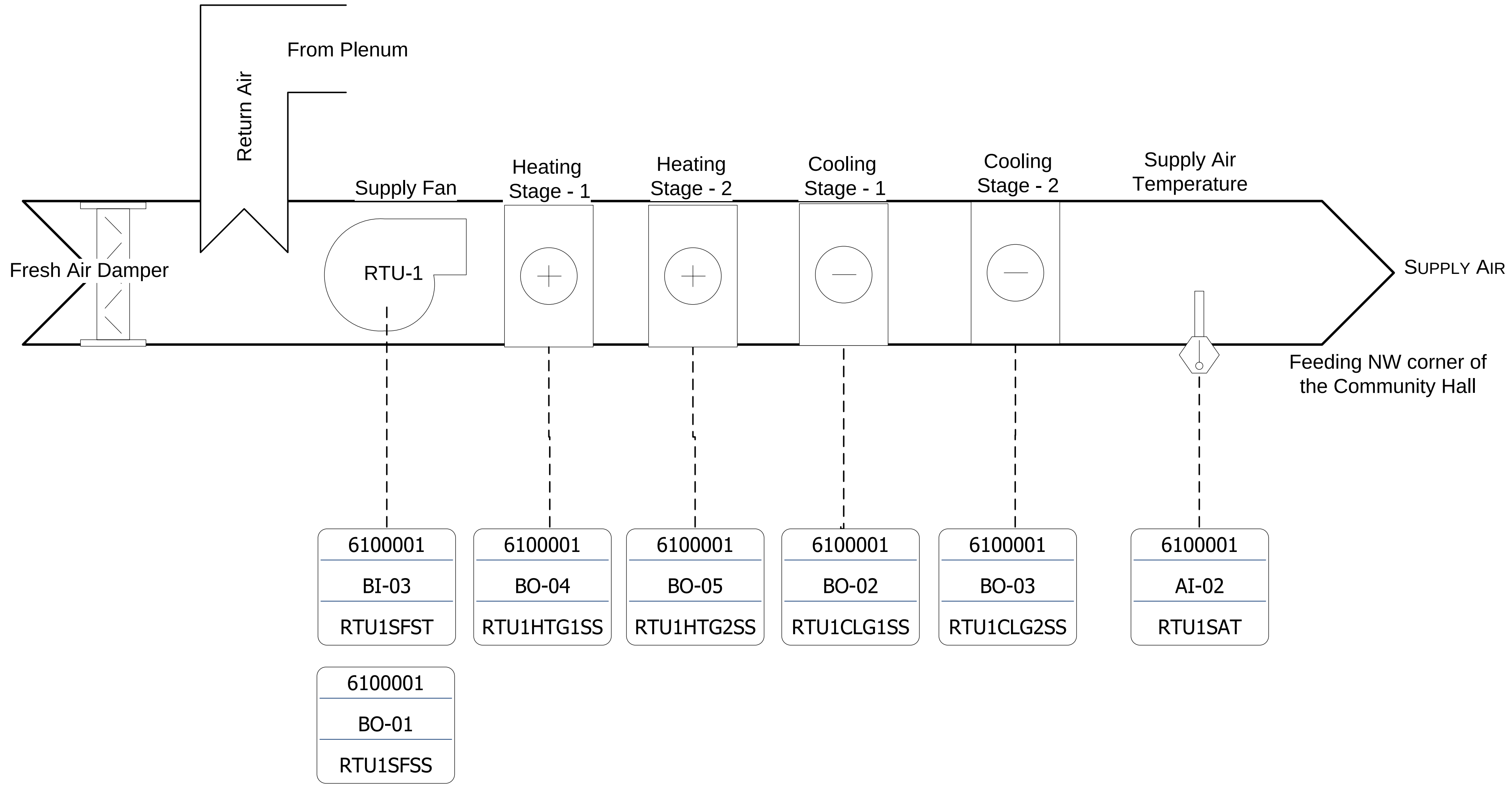


Lower Level

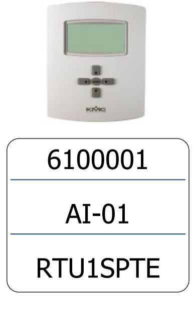
Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.	PROJECT: BAPS Swaminarayan Sanstha / BAPS Swaminarayan Sanstha / Shri Swaminarayan Mandir, Toronto / Community Hall HVAC + Floor Heating	TITLE: NETWORK LAYOUT	19	PROJ. MNGR: - / ENGINEER: Dipak Patel / CONTRACTOR: -	DATE: 24/01/2012 / BY: Dipak Patel	PROJ REF:	DWG REF: 000 – 000 – 02

Roof Top Unit - 1



Space Temperature



RTU – 1 Feeding NW corner of the Community Hall

Proposed way of controlling the system for optimum efficiency:

System will start up based on the time of day schedule (operator adjustable) or Occupancy.

Heating Mode
In the occupied mode system will maintain its setpoint, (operator adjustable);
In the winter mode; the system will maintain the setpoint by the heating coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable) if the system is below the night setpoint the system will be enabled until it reaches the night set back setpoint.

Cooling Mode:
In the occupied mode system will maintain its setpoint, (operator adjustable)
In the summer mode: the system will maintain the setpoint by the cooling coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable).

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha — BAPS Swaminarayan Sanstha, Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE: ROOF TOP UNIT - 1

20

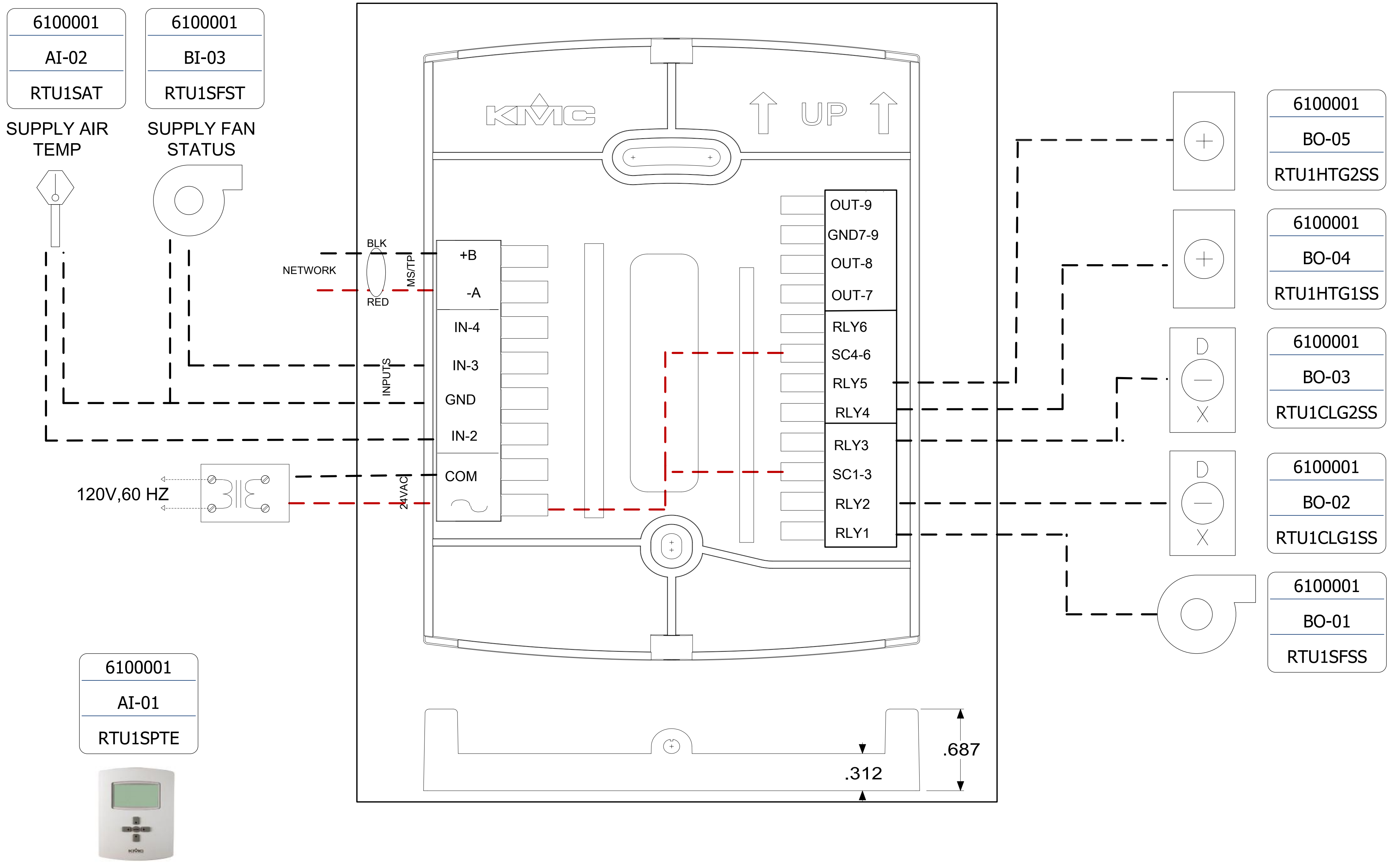
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR: -

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 03

RTU-1 CONTROL PANEL LAYOUT



DEVICE	POINT	IN/OUT	Description
6100001	RTU1SPTE	AI-01	Space Temperature
6100001	RTU1SAT	AI-02	Supply Air Temperature
6100001	RTU1SFST	BI-03	Supply Fan Status
6100001		AI-04	
6100001	RTU1SFSS	BO-01	Supply Fan Start/Stop
6100001	RTU1CLG1SS	BO-02	Cooling 1 Start/Stop
6100001	RTU1CLG2SS	BO-03	Cooling 2 Start/Stop
6100001	RTU1HTG1SS	BO-04	Heating 1 Start/Stop
6100001	RTU1HTG2SS	BO-05	Heating 2 Start/Stop
6100001		AO-06	
6100001		AO-07	
6100001		AO-08	
6100001		AO-09	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha — Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE: RTU – 1 FLEXSTAT CONTROLLER LAYOUT

21

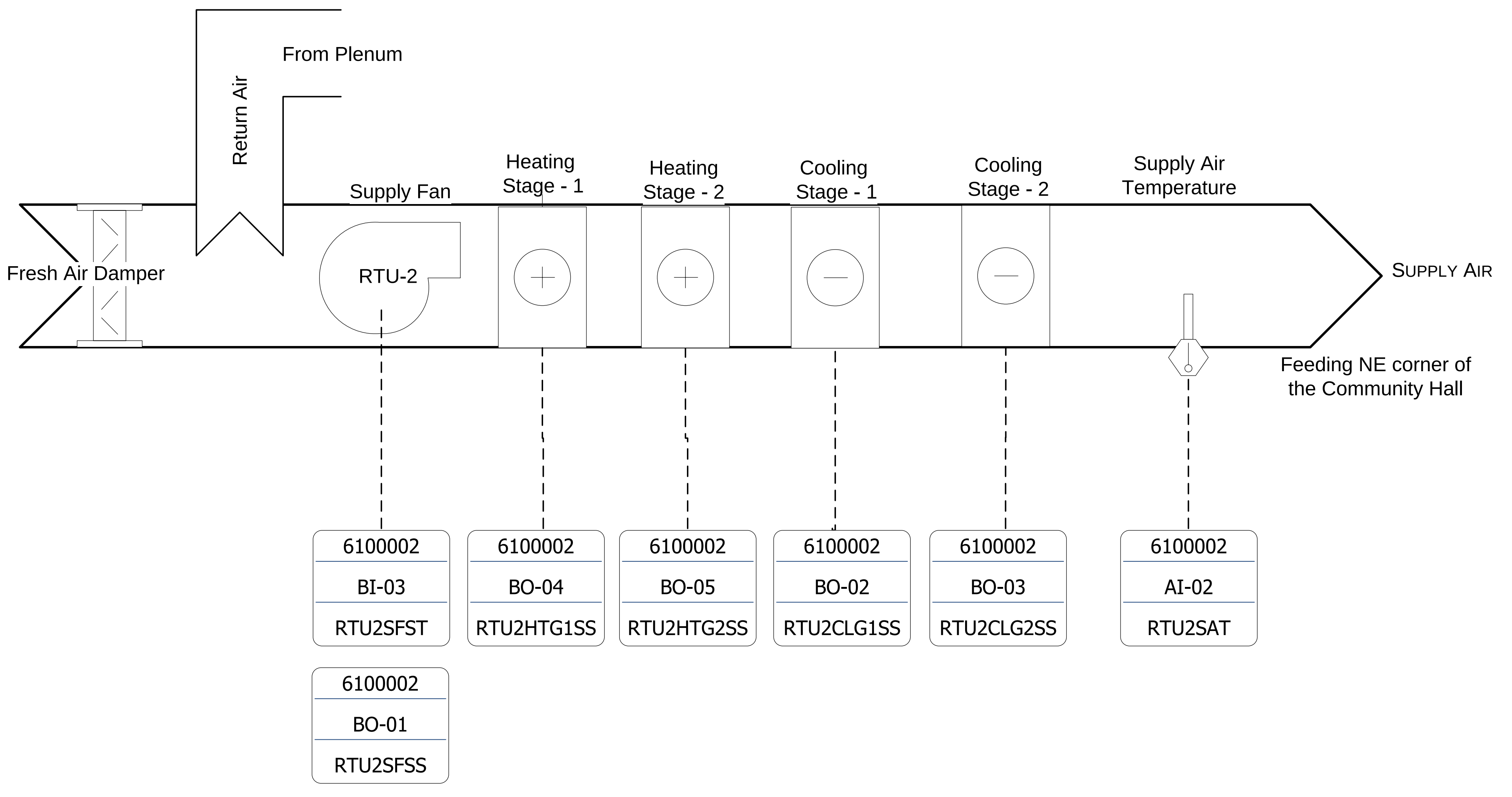
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR:

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 04

Roof Top Unit - 2



Space Temperature

6100002
AI-01
RTU2SPTE

RTU – 2 Feeding NE corner of the Community Hall

Proposed way of controlling the system for optimum efficiency:

System will start up based on the time of day schedule (operator adjustable) or Occupancy.

Heating Mode
In the occupied mode system will maintain its setpoint, (operator adjustable);
In the winter mode; the system will maintain the setpoint by the heating coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable) if the system is below the night setpoint the system will be enabled until it reaches the night set back setpoint.

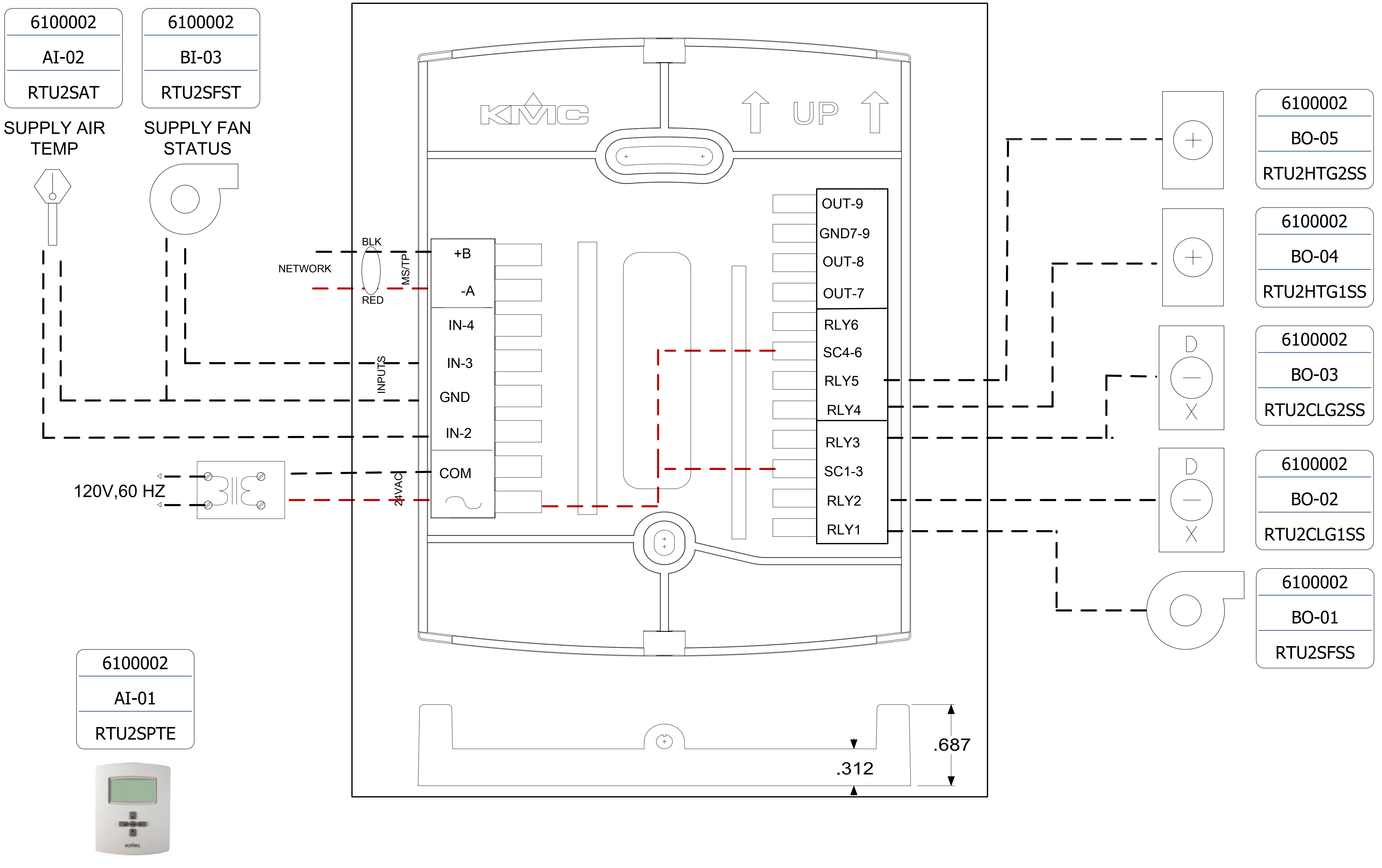
Cooling Mode:
In the occupied mode system will maintain its setpoint, (operator adjustable)
In the summer mode: the system will maintain the setpoint by the cooling coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable).

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.	PROJECT BAPS Swaminarayan Sanstha BAPS Swaminarayan Sanstha Shri Swaminarayan Mandir, Toronto Community Hall HVAC + Floor Heating	TITLE ROOF TOP UNIT - 2 22	PROJ. MNGR: - ENGINEER: Dipak Patel CONTRACTOR: -	DATE: 24/01/2012 BY: Dipak Patel	PROJ REF:	DWG REF: 000 – 000 – 05

RTU-2 CONTROL PANEL LAYOUT



DEVICE	POINT	IN/OUT	Description
6100002	RTU2SPTE	AI-01	Space Temperature
6100002	RTU2SAT	AI-02	Supply Air Temperature
6100002	RTU2SFST	BI-03	Supply Fan Status
6100002		AI-04	
6100002	RTU2SFSS	BO-01	Supply Fan Start/Stop
6100002	RTU2CLG1SS	BO-02	Cooling 1 Start/Stop
6100002	RTU2CLG2SS	BO-03	Cooling 2 Start/Stop
6100002	RTU2HTG1SS	BO-04	Heating 1 Start/Stop
6100002	RTU2HTG2SS	BO-05	Heating 2 Start/Stop
6100002		AO-06	
6100002		AO-07	
6100002		AO-08	
6100002		AO-09	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha — Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE: RTU-2 FLEXSTAT CONTROLLER LAYOUT

23

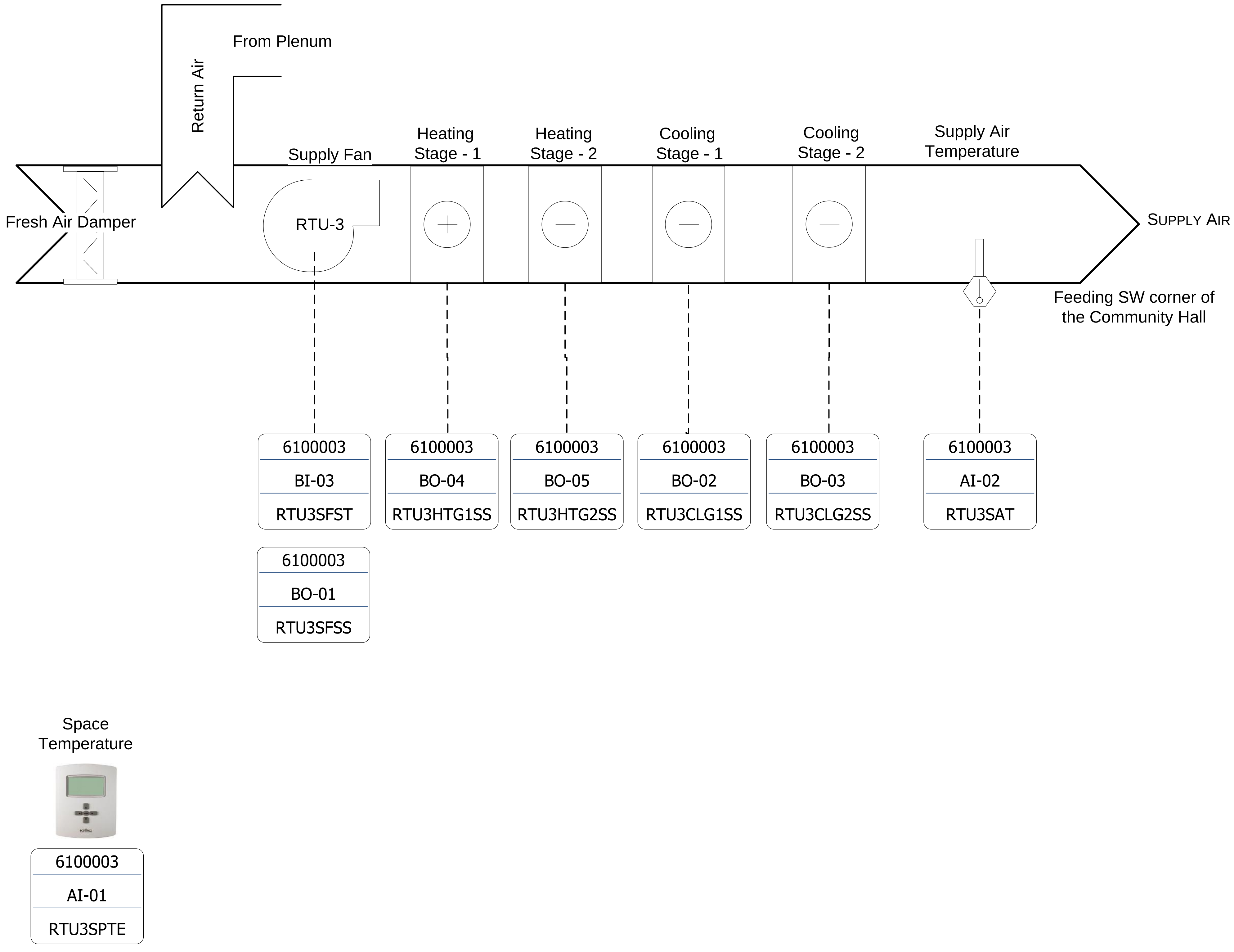
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR:

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 06

Roof Top Unit - 3



RTU – 3 Feeding SW corner of the Community Hall

Proposed way of controlling the system for optimum efficiency:

System will start up based on the time of day schedule (operator adjustable) or Occupancy.

Heating Mode
In the occupied mode system will maintain its setpoint, (operator adjustable);
In the winter mode; the system will maintain the setpoint by the heating coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable) if the system is below the night setpoint the system will be enabled until it reaches the night set back setpoint.

Cooling Mode:
In the occupied mode system will maintain its setpoint, (operator adjustable)
In the summer mode: the system will maintain the setpoint by the cooling coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable).

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha
BAPS Swaminarayan Sanstha
Shri Swaminarayan Mandir, Toronto
Community Hall HVAC + Floor Heating

TITLE: ROOF TOP UNIT - 3

24

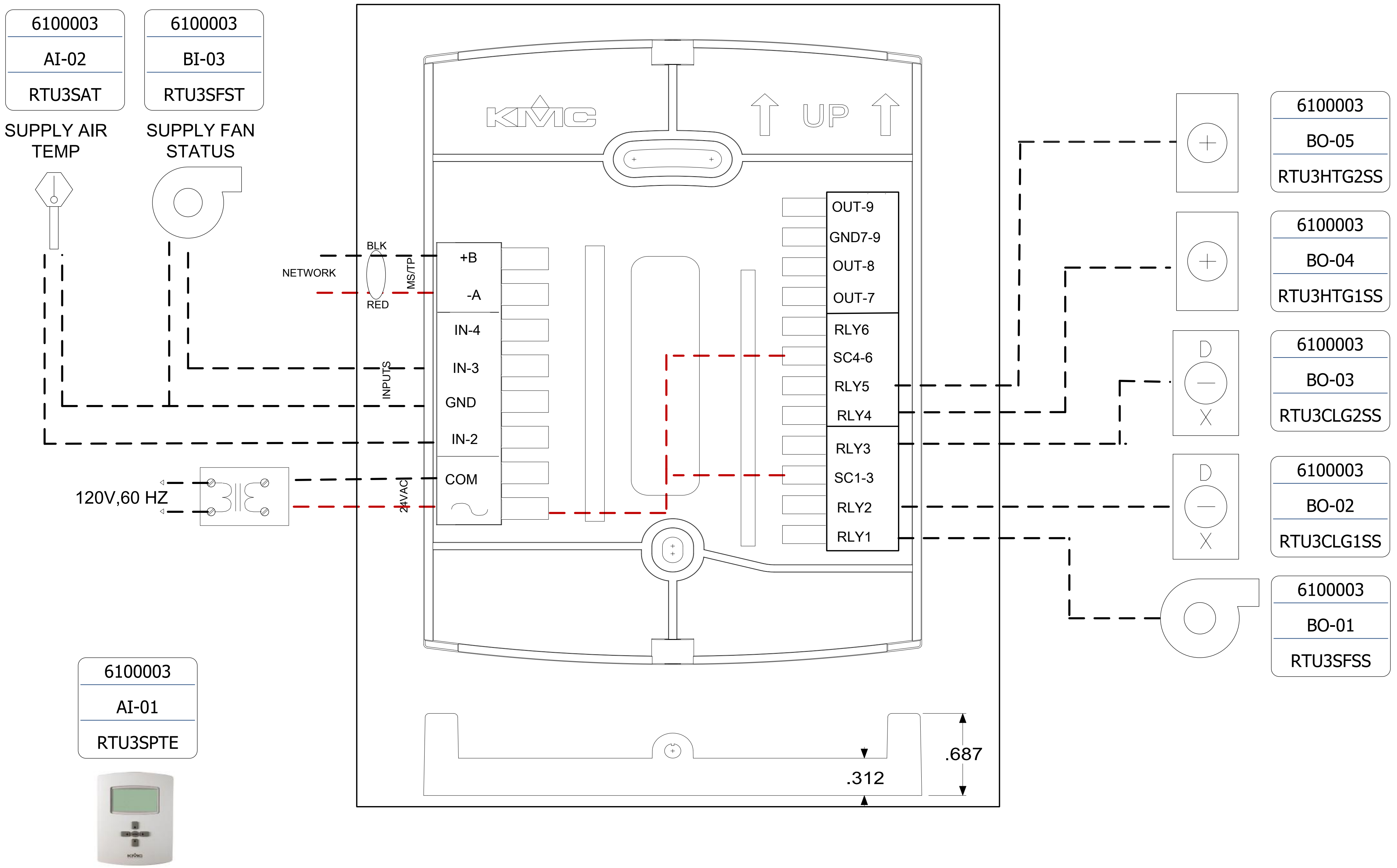
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR: -

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 07

RTU-3 CONTROL PANEL LAYOUT



DEVICE	POINT	IN/OUT	Description
6100003	RTU3SPTE	AI-01	Space Temperature
6100003	RTU3SAT	AI-02	Supply Air Temperature
6100003	RTU3SFST	BI-03	Supply Fan Status
6100003		AI-04	
6100003	RTU3SFSS	BO-01	Supply Fan Start/Stop
6100003	RTU3CLG1SS	BO-02	Cooling 1 Start/Stop
6100003	RTU3CLG2SS	BO-03	Cooling 2 Start/Stop
6100003	RTU3HTG1SS	BO-04	Heating 1 Start/Stop
6100003	RTU3HTG2SS	BO-05	Heating 2 Start/Stop
6100003		AO-06	
6100003		AO-07	
6100003		AO-08	
6100003		AO-09	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha, Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE: RTU-3 FLEXSTAT CONTROLLER LAYOUT

25

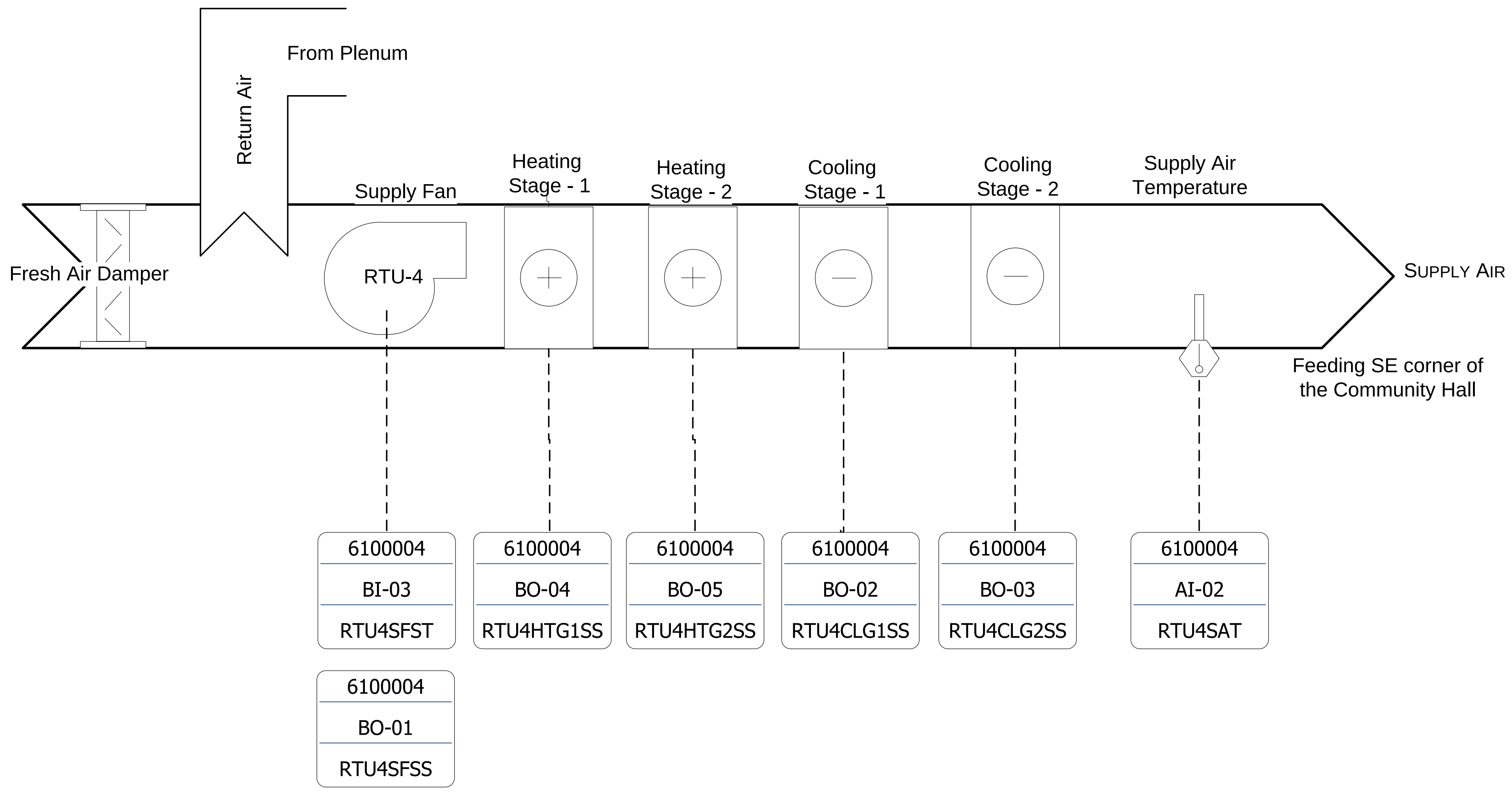
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR: -

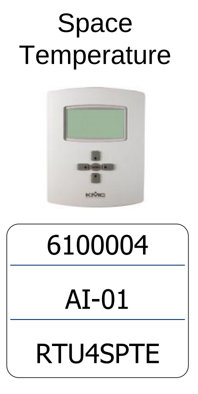
DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 — 000 — 08

Roof Top Unit - 4





RTU – 4 Feeding SE corner of the Community Hall

Proposed way of controlling the system for optimum efficiency:

System will start up based on the time of day schedule (operator adjustable) or Occupancy.

Heating Mode
In the occupied mode system will maintain its setpoint, (operator adjustable);
In the winter mode; the system will maintain the setpoint by the heating coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable) if the system is below the night setpoint the system will be enabled until it reaches the night set back setpoint.

Cooling Mode:
In the occupied mode system will maintain its setpoint, (operator adjustable)
In the summer mode: the system will maintain the setpoint by the cooling coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable).

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha – Shri Swaminarayan Mandir, Toronto – Community Hall HVAC + Floor Heating

TITLE: ROOF TOP UNIT - 4

26

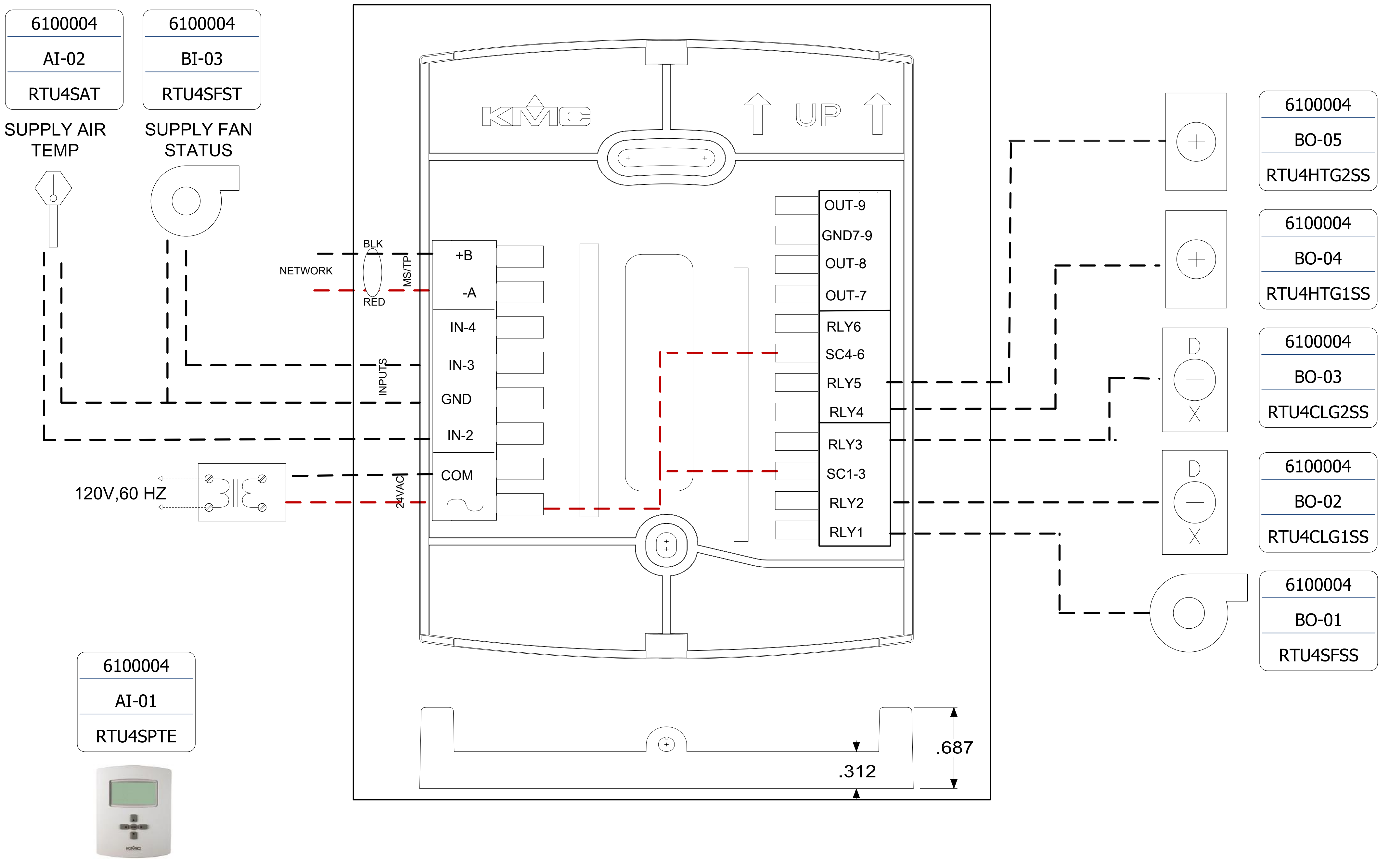
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR: -

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 09

RTU- 4 CONTROL PANEL LAYOUT



DEVICE	POINT	IN/OUT	Description
6100004	RTU4SPTE	AI-01	Space Temperature
6100004	RTU4SAT	AI-02	Supply Air Temperature
6100004	RTU4SFST	BI-03	Supply Fan Status
6100004		AI-04	
6100004	RTU4SFSS	BO-01	Supply Fan Start/Stop
6100004	RTU4CLG1SS	BO-02	Cooling 1 Start/Stop
6100004	RTU4CLG2SS	BO-03	Cooling 2 Start/Stop
6100004	RTU4HTG1SS	BO-04	Heating 1 Start/Stop
6100004	RTU4HTG2SS	BO-05	Heating 2 Start/Stop
6100004		AO-06	
6100004		AO-07	
6100004		AO-08	
6100004		AO-09	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha, Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE: RTU-4 FLEXSTAT CONTROLLER LAYOUT

27

PROJ. MNGR: -

ENGINEER: Dipak Patel

CONTRACTOR:

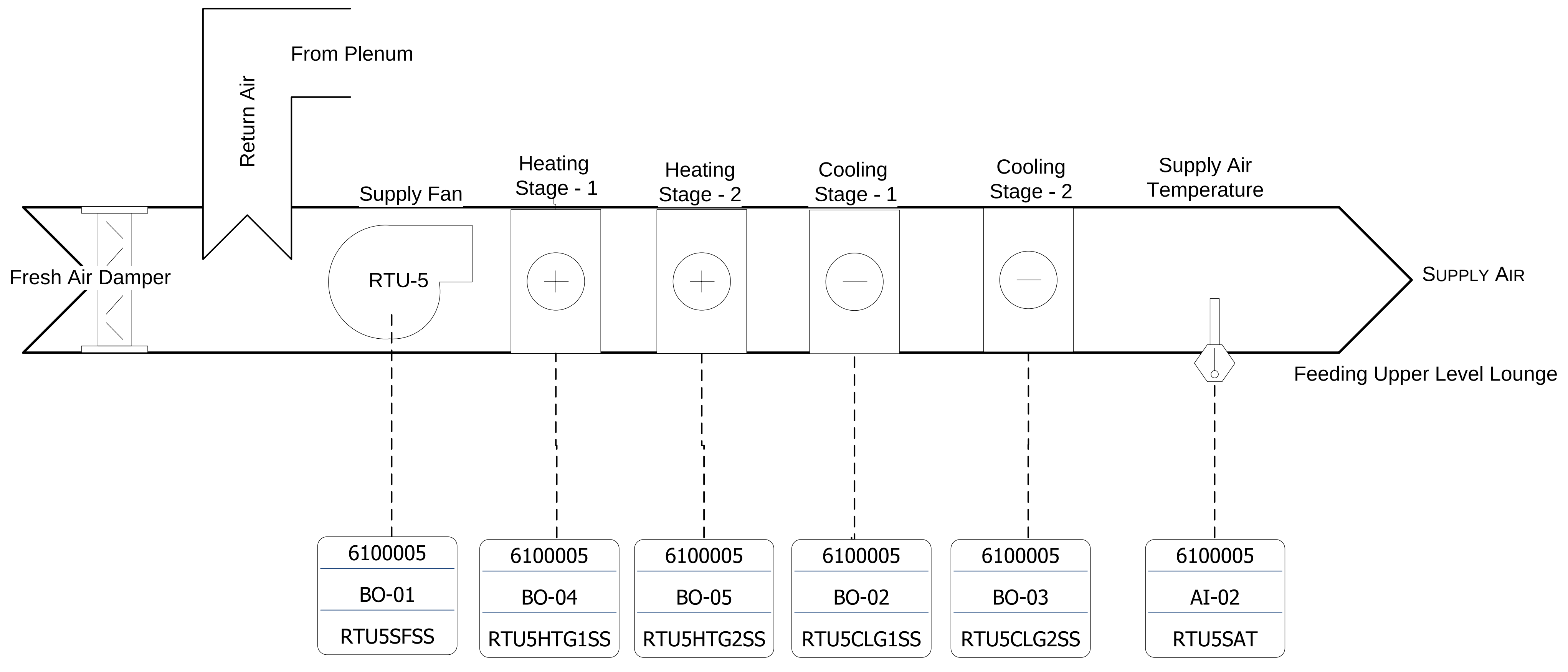
DATE: 24/01/2012

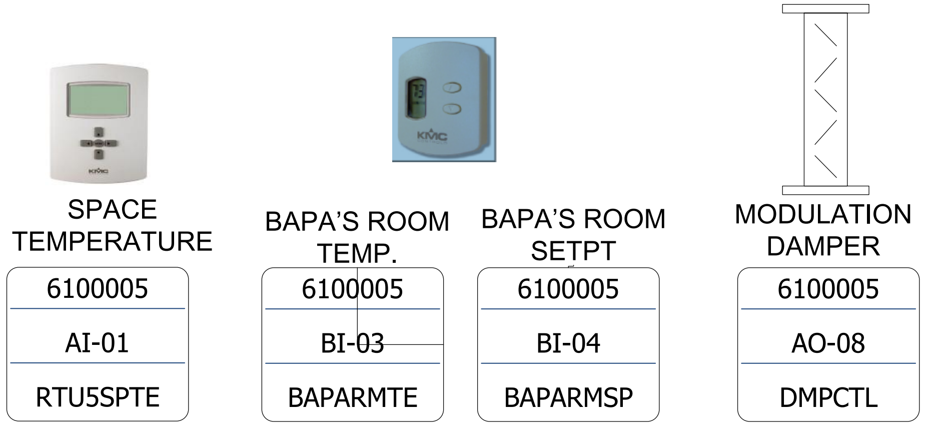
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 010

Roof Top Unit - 5





RTU – 5 Feeding Upper Level Lounge

Proposed way of controlling the system for optimum efficiency:

System will start up based on the time of day schedule (operator adjustable) or Occupancy.

Heating Mode
In the occupied mode system will maintain its setpoint, (operator adjustable);
In the winter mode; the system will maintain the setpoint by the heating coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable) if the system is below the night setpoint the system will be enabled until it reaches the night set back setpoint.

Cooling Mode:
In the occupied mode system will maintain its setpoint, (operator adjustable)
In the summer mode: the system will maintain the setpoint by the cooling coil of the HVAC unit.

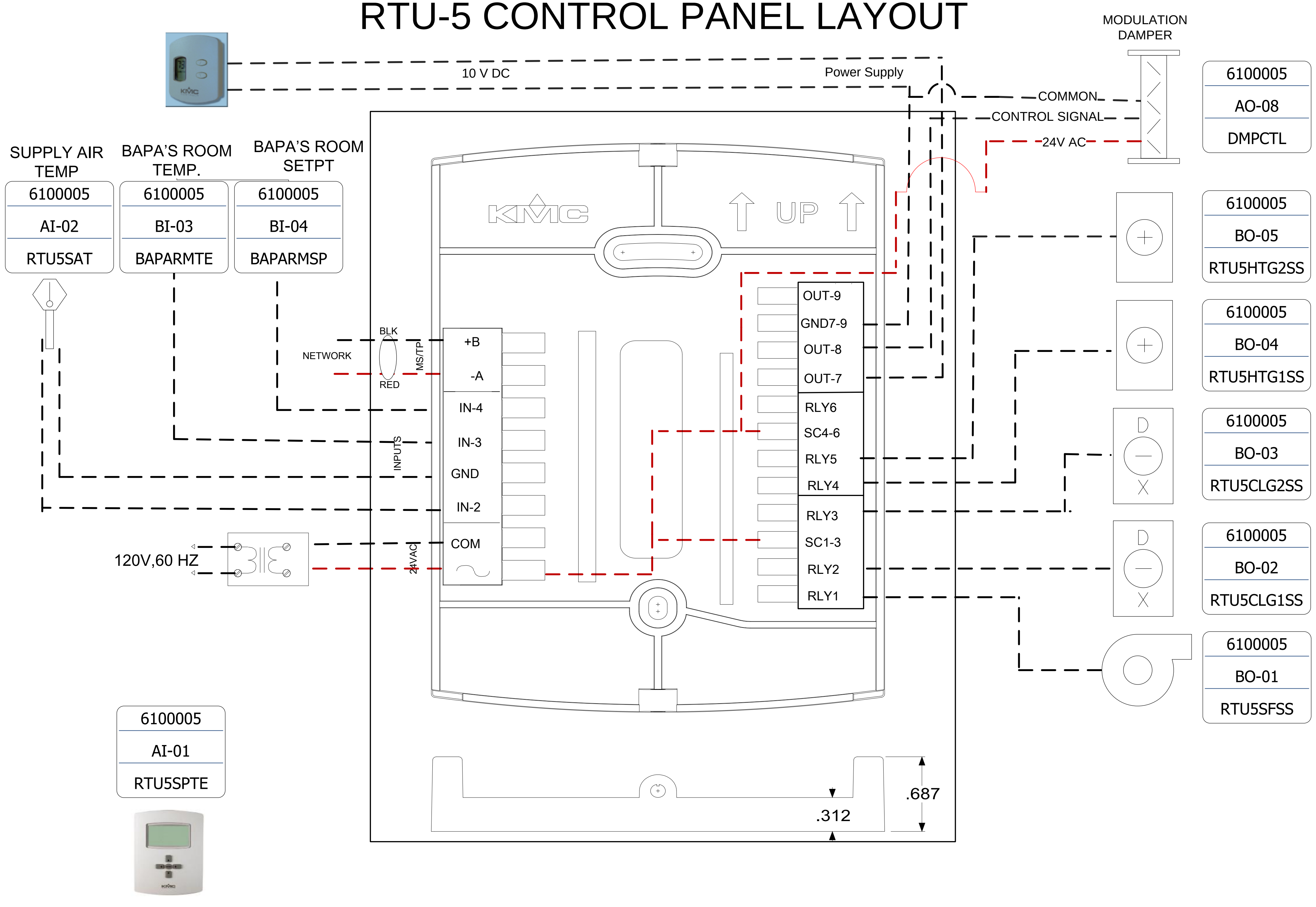
In the unoccupied mode, the system will be in the night set back mode, (operator adjustable).

<u>BAPA's Room Damper Control</u>
Space Temperature with display and setpoint is located in the BAPA's Room. Space temperature and setpoint are sent to the Flexstat –5. Modulation output is connected to the damper actuator located in the Duct feeding BAPA's room. Damper is modulated based on the set point set by the end-user.

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.	PROJECT: BAPS Swaminarayan Sanstha, BAPS Swaminarayan Sanstha, Shri Swaminarayan Mandir, Toronto, Community Hall HVAC + Floor Heating	TITLE: ROOF TOP UNIT - 5	28	PROJ. MNGR: - ENGINEER: Dipak Patel CONTRACTOR:	DATE: 24/01/2012 BY: Dipak Patel	PROJ REF:	DWG REF: 000 – 000 – 011

RTU-5 CONTROL PANEL LAYOUT



DEVICE	POINT	IN/OUT	Description
6100005	RTU5SPTE	AI-01	Space Temperature
6100005	RTU5SAT	AI-02	Supply Air Temperature
6100005	BAPARMTE	AI-03	BAPA's Room Temp.
6100005	BAPARMSP	AI-04	BAPA's Room SetPt
6100005	RTU5SFSS	BO-01	Supply Fan Start/Stop
6100005	RTU5CLG1SS	BO-02	Cooling 1 Start/Stop
6100005	RTU5CLG2SS	BO-03	Cooling 2 Start/Stop
6100005	RTU5HTG1SS	BO-04	Heating 1 Start/Stop
6100005	RTU5HTG2SS	BO-05	Heating 2 Start/Stop
6100005		BO-06	
6100005	PWRSUP	AO-07	Power supp for Sp.Temp
6100005	DMPRCTL	AO-08	BAPA's Room Damp.Ctl
6100005		AO-09	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha — BAPS Swaminarayan Sanstha, Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE:

29

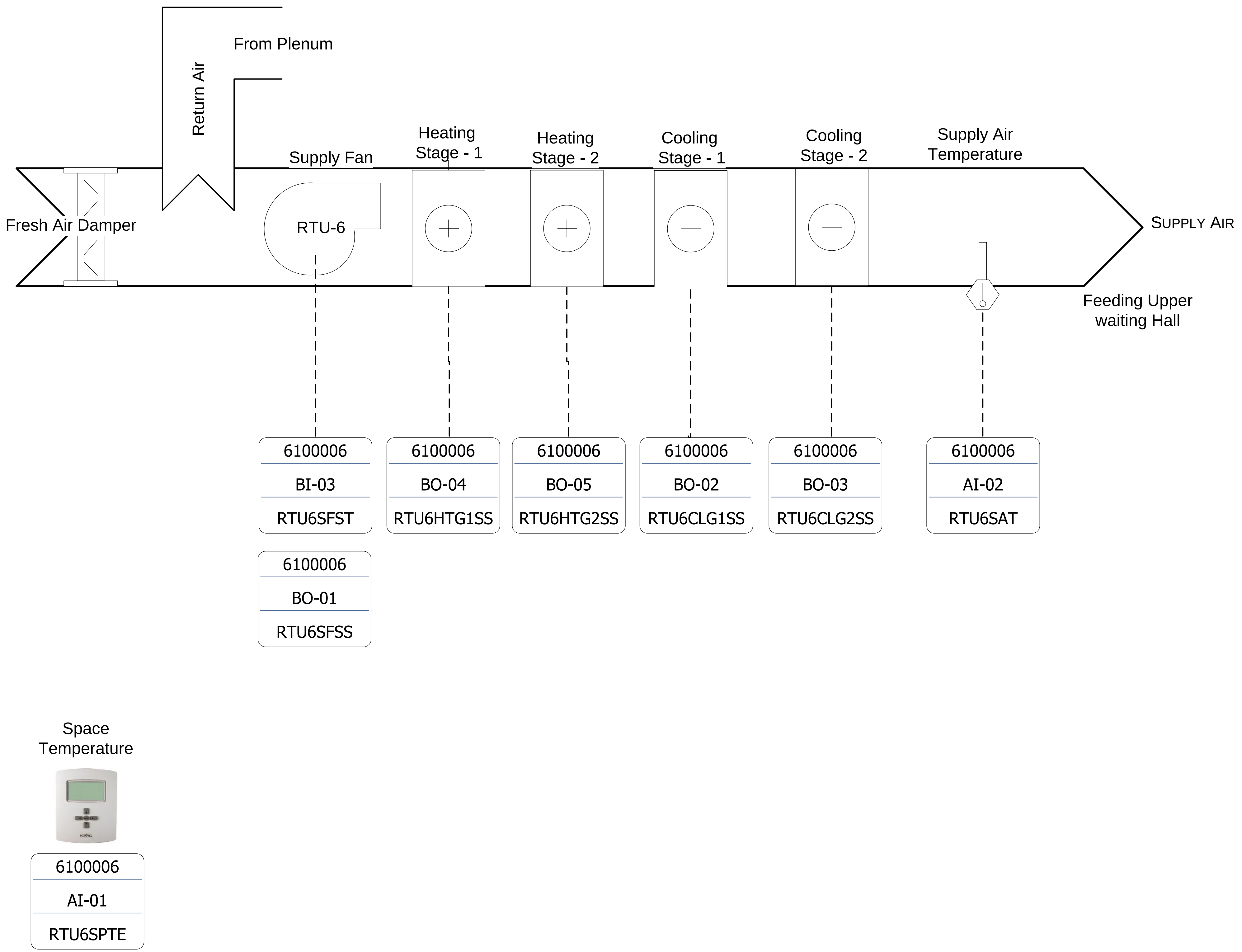
PROJ. MNGR: Dipak Patel
ENGINEER: -
CONTRACTOR:

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 012

Roof Top Unit - 6



RTU – 6 Feeding Upper Waiting Hall

Proposed way of controlling the system for optimum efficiency:

System will start up based on the time of day schedule (operator adjustable) or Occupancy.

Heating Mode
In the occupied mode system will maintain its setpoint, (operator adjustable);
In the winter mode; the system will maintain the setpoint by the heating coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable) if the system is below the night setpoint the system will be enabled until it reaches the night set back setpoint.

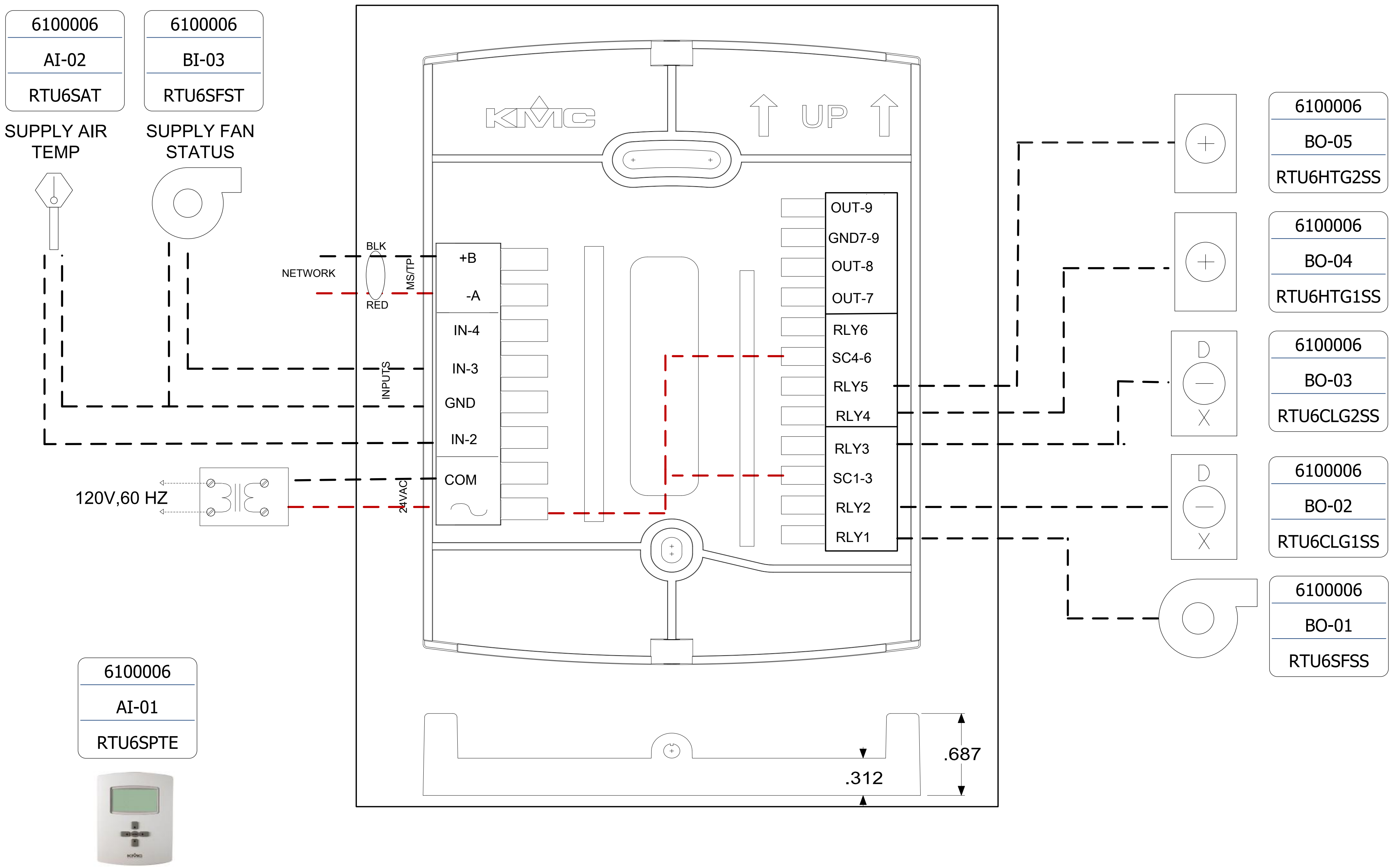
Cooling Mode:
In the occupied mode system will maintain its setpoint, (operator adjustable)
In the summer mode: the system will maintain the setpoint by the cooling coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable).

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.	PROJECT BAPS Swaminarayan Sanstha BAPS Swaminarayan Sanstha Shri Swaminarayan Mandir, Toronto Community Hall HVAC + Floor Heating	TITLE AC5-SCALE HOUSE 30	PROJ. MNGR: - ENGINEER: - Dipak Patel CONTRACTOR:	DATE: 24/01/2012 BY: Dipak Patel	PROJ REF:	DWG REF: 000 — 000 — 013

RTU- 6 CONTROL PANEL LAYOUT



DEVICE	POINT	IN/OUT	Description
6100006	RTU6SPTE	AI-01	Space Temperature
6100006	RTU6SAT	AI-02	Supply Air Temperature
6100006	RTU6SFST	BI-03	Supply Fan Status
6100006		AI-04	
6100006	RTU6SFSS	BO-01	Supply Fan Start/Stop
6100006	RTU6CLG1SS	BO-02	Cooling 1 Start/Stop
6100006	RTU6CLG2SS	BO-03	Cooling 2 Start/Stop
6100006	RTU6HTG1SS	BO-04	Heating 1 Start/Stop
6100006	RTU6HTG2SS	BO-05	Heating 2 Start/Stop
6100006		AO-06	
6100006		AO-07	
6100006		AO-08	
6100006		AO-09	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha
Shri Swaminarayan Mandir, Toronto
Community Hall HVAC + Floor Heating

TITLE: AC4 FLEXSTAT CONTROLLER LAYOUT

31

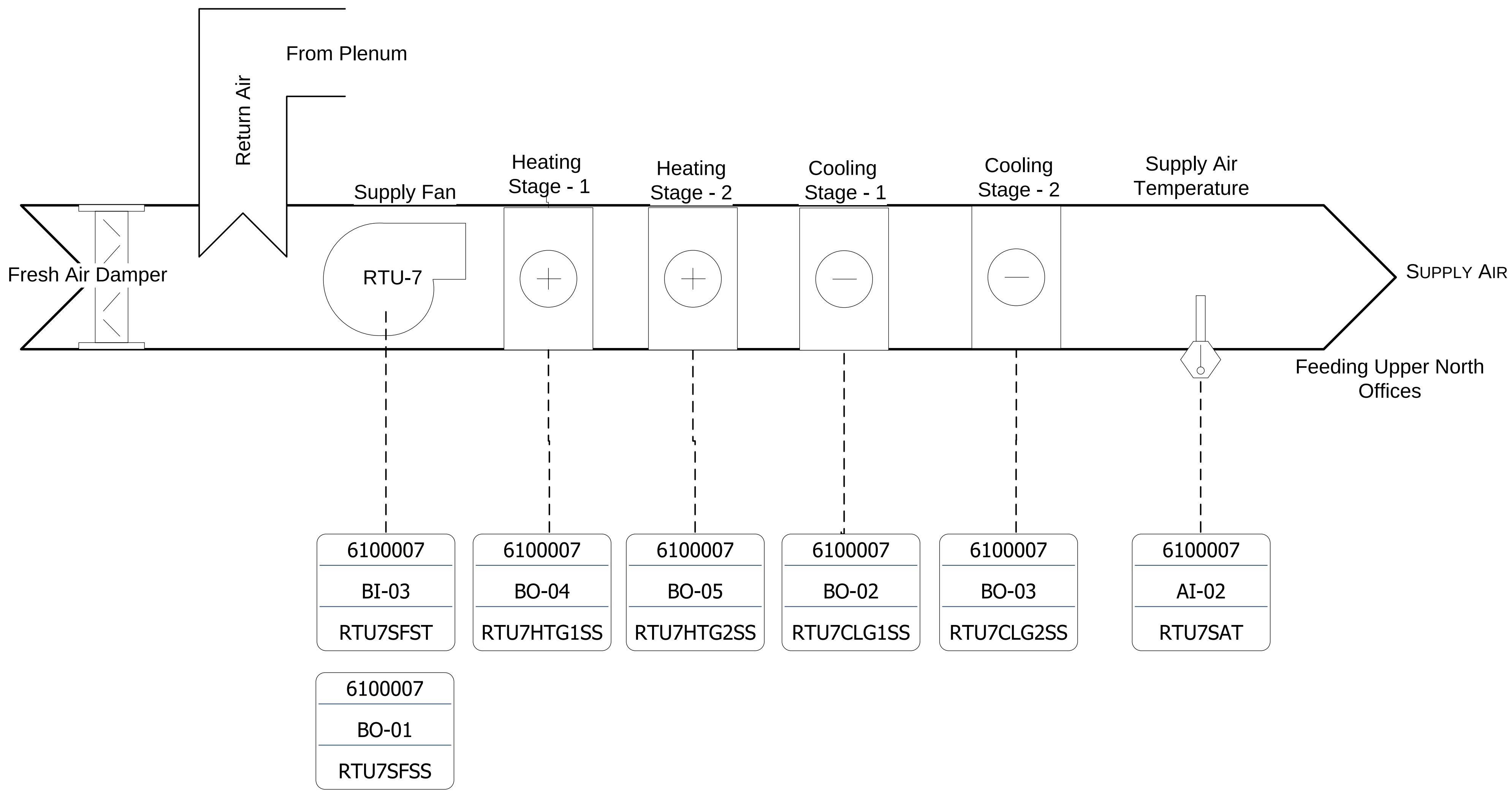
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR:

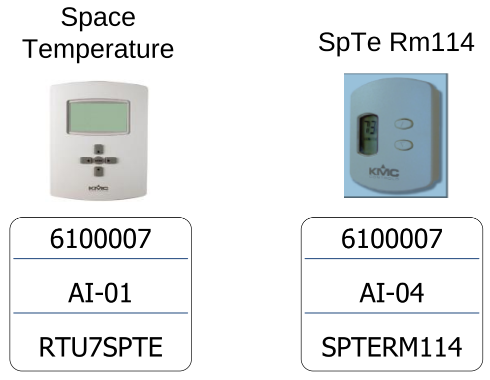
DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 014

Roof Top Unit - 7





RTU – 7 Feeding Upper North Offices

Proposed way of controlling the system for optimum efficiency:

System will start up based on the time of day schedule (operator adjustable) or Occupancy.

Heating Mode
In the occupied mode system will maintain its setpoint, (operator adjustable);
In the winter mode; the system will maintain the setpoint by the heating coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable) if the system is below the night setpoint the system will be enabled until it reaches the night set back setpoint.

Cooling Mode:
In the occupied mode system will maintain its setpoint, (operator adjustable)
In the summer mode: the system will maintain the setpoint by the cooling coil of the HVAC unit.

In the unoccupied mode, the system will be in the night set back mode, (operator adjustable).

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha — Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE:

32

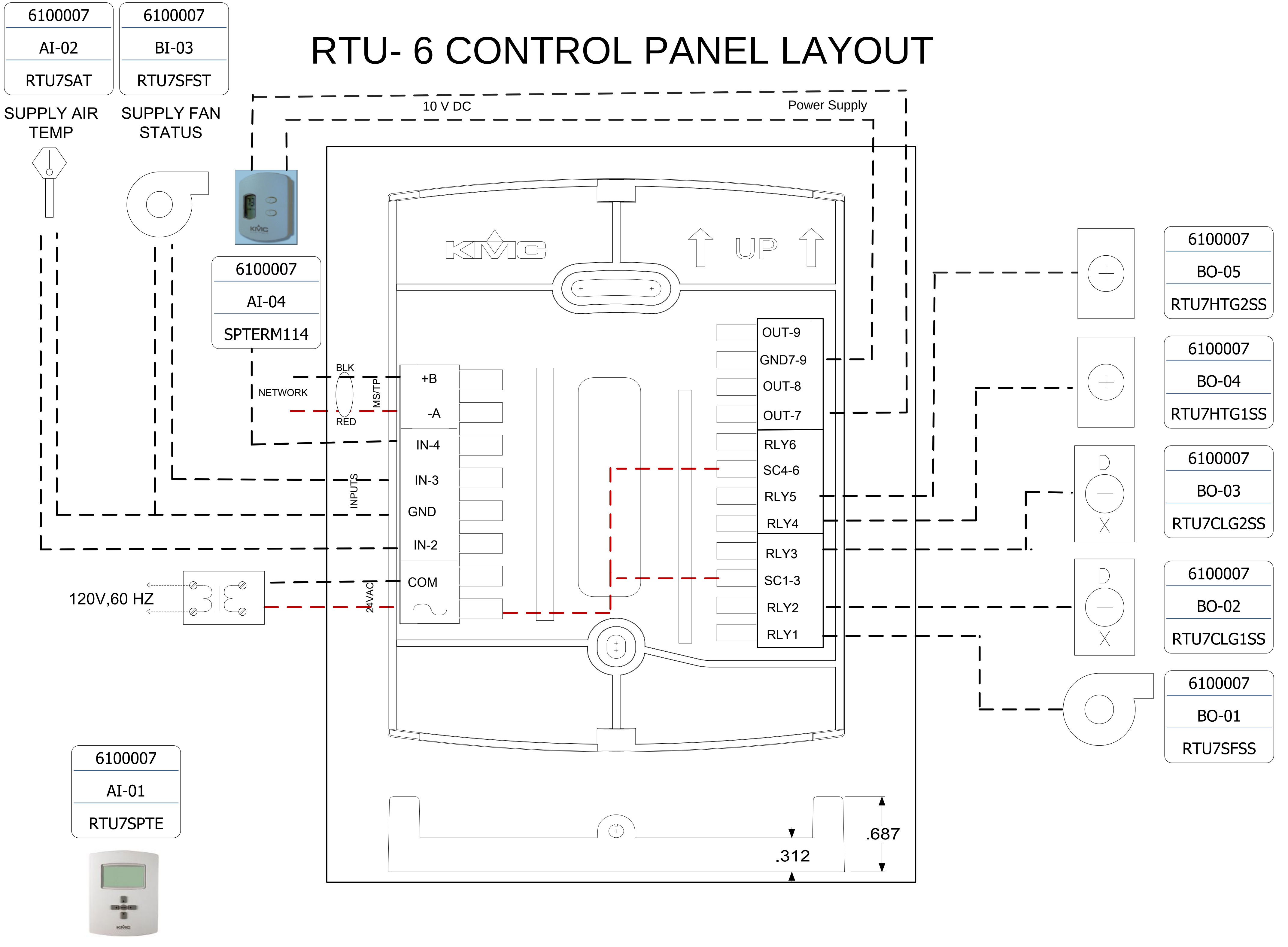
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR:

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 015

RTU- 6 CONTROL PANEL LAYOUT



DEVICE	***POINT***	***IN/OUT***	***Description***
6100007	RTU7SPTE	AI-01	Space Temperature
6100007	RTU7SAT	AI-02	Supply Air Temperature
6100007	RTU7SFST	BI-03	Supply Fan Status
6100007	SPTERM114	AI-04	Space Temp Rm 114
6100007	RTU7SFSS	BO-01	Supply Fan Start/Stop
6100007	RTU7CLG1SS	BO-02	Cooling 1 Start/Stop
6100007	RTU7CLG2SS	BO-03	Cooling 2 Start/Stop
6100007	RTU7HTG1SS	BO-04	Heating 1 Start/Stop
6100007	RTU7HTG2SS	BO-05	Heating 2 Start/Stop
6100007		AO-06	
6100007		AO-07	
6100007		AO-08	
6100007		AO-09	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha — BAPS Swaminarayan Sanstha, Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE:

33

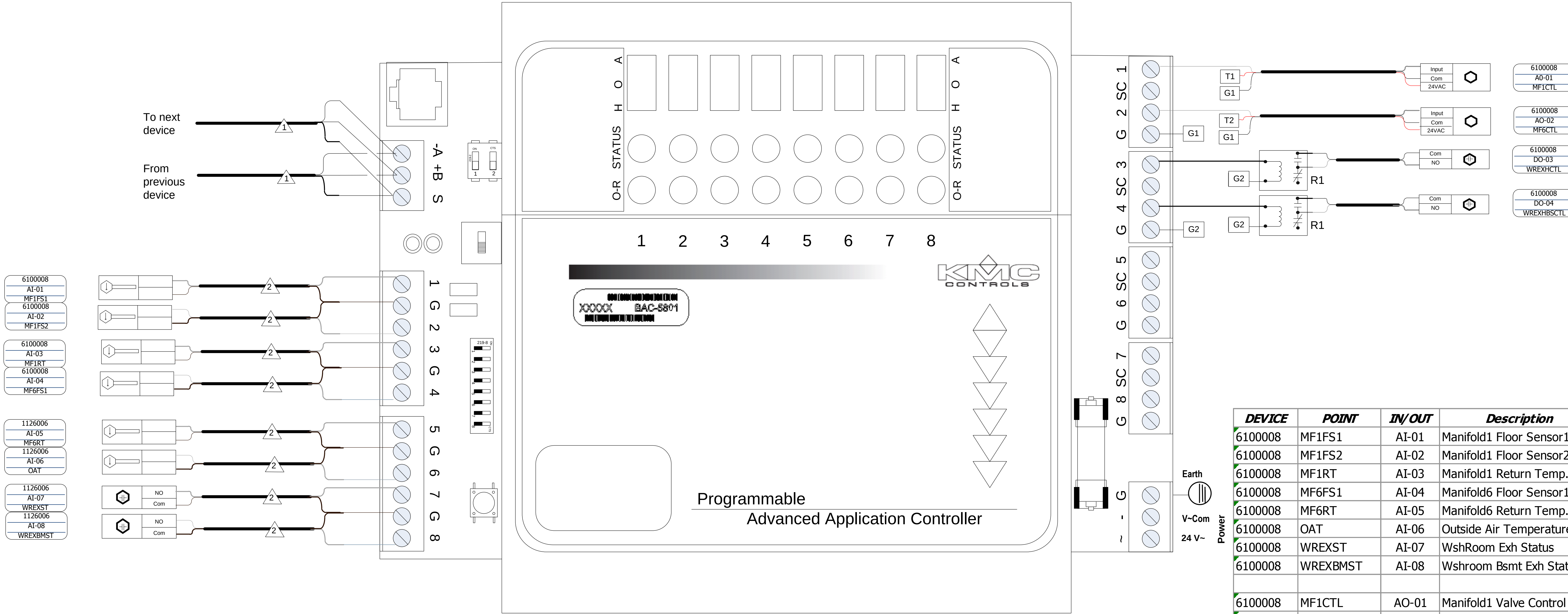
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR: -

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 016

MANIFOLD1-MANIFOLD6-CONTROL

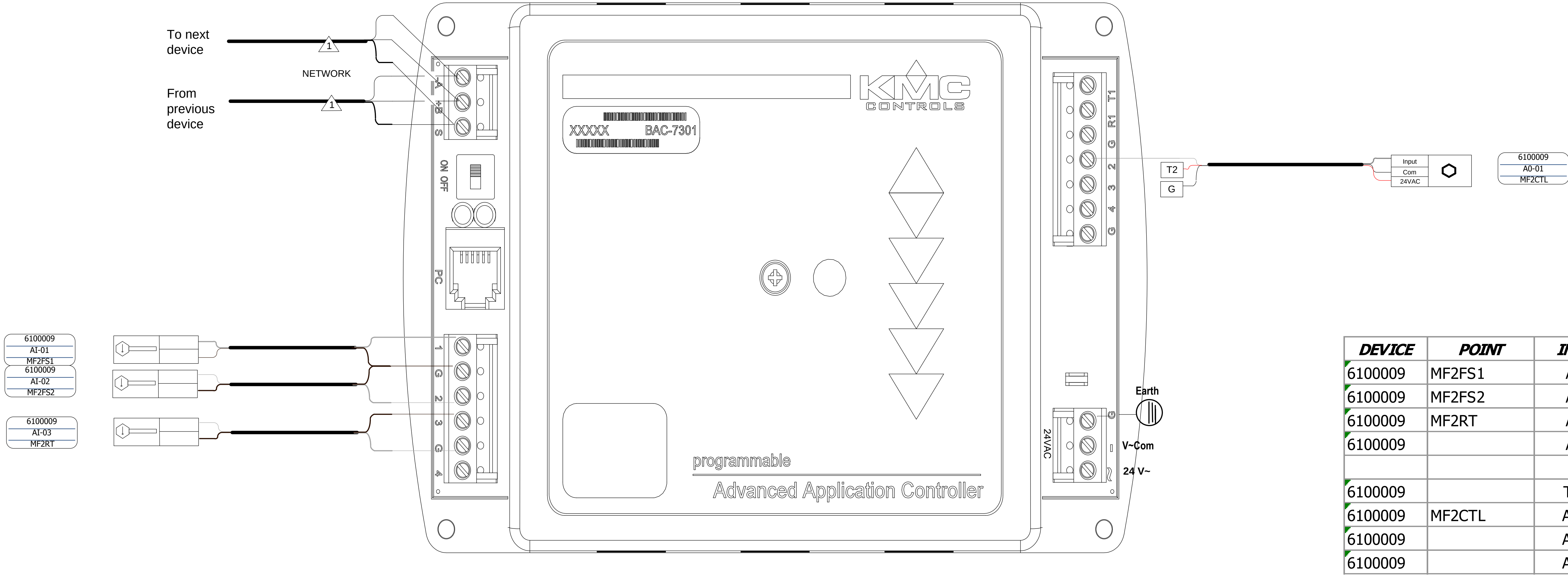


DEVICE	POINT	IN/OUT	Description
6100008	MF1FS1	AI-01	Manifold1 Floor Sensor1
6100008	MF1FS2	AI-02	Manifold1 Floor Sensor2
6100008	MF1RT	AI-03	Manifold1 Return Temp.
6100008	MF6FS1	AI-04	Manifold6 Floor Sensor1
6100008	MF6RT	AI-05	Manifold6 Return Temp.
6100008	OAT	AI-06	Outside Air Temperature
6100008	WREXST	AI-07	WshRoom Exh Status
6100008	WREXBMST	AI-08	Wshroom Bsmt Exh Status
6100008	MF1CTL	AO-01	Manifold1 Valve Control
6100008	MF6CTL	AO-02	Manifold6 Valve Control
6100008	WREXHCTL	AO-03	Washroom Exh Control
6100008	WREXHBSCTL	AO-04	Washroom Bsmt Exh Control
6100008		AO-05	
6100008		AO-06	
6100008		AO-07	
6100008		AO-08	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.	PROJECT: BAPS Swaminarayan Sanstha, Shri Swaminarayan Mandir, Toronto, Community Hall HVAC + Floor Heating	TITLE: MANIFOLD1-MANIFOLD6-CONTROL	34	PROJ. MNGR: - ENGINEER: Dipak Patel CONTRACTOR:	DATE: 24/01/2012 BY: Dipak Patel	PROJ REF:	DWG REF: 000 — 000 — 017

MANIFOLD 2-CONTROL



DEVICE	POINT	IN/OUT	Description
6100009	MF2FS1	AI-01	Manifold2 Floor Sensor 1
6100009	MF2FS2	AI-02	Manifold2 Floor Sensor 2
6100009	MF2RT	AI-03	Manifold2 Return Temp.
6100009		AI-04	
6100009		TR-01	
6100009	MF2CTL	AO-02	Manifold 2 Control
6100009		AO-03	
6100009		AO-04	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha — BAPS Swaminarayan Sanstha, Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE: MANIFOLD2 - CONTROL

35

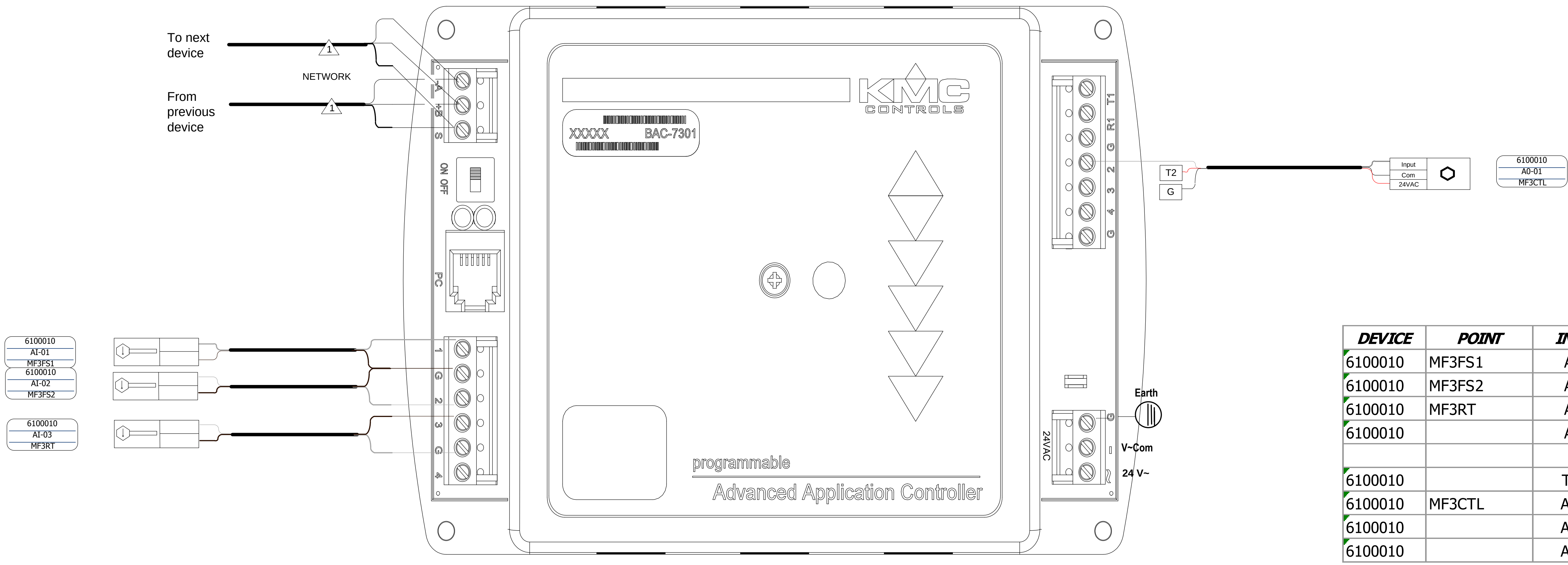
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR:

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 018

MANIFOLD 3-CONTROL



DEVICE	POINT	IN/OUT	Description
6100010	MF3FS1	AI-01	Manifold3 Floor Sensor 1
6100010	MF3FS2	AI-02	Manifold3 Floor Sensor 2
6100010	MF3RT	AI-03	Manifold3 Return Temp.
6100010		AI-04	
6100010		TR-01	
6100010	MF3CTL	AO-02	Manifold 3 Control
6100010		AO-03	
6100010		AO-04	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha — BAPS Swaminarayan Sanstha, Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE: MANIFOLD3 - CONTROL

36

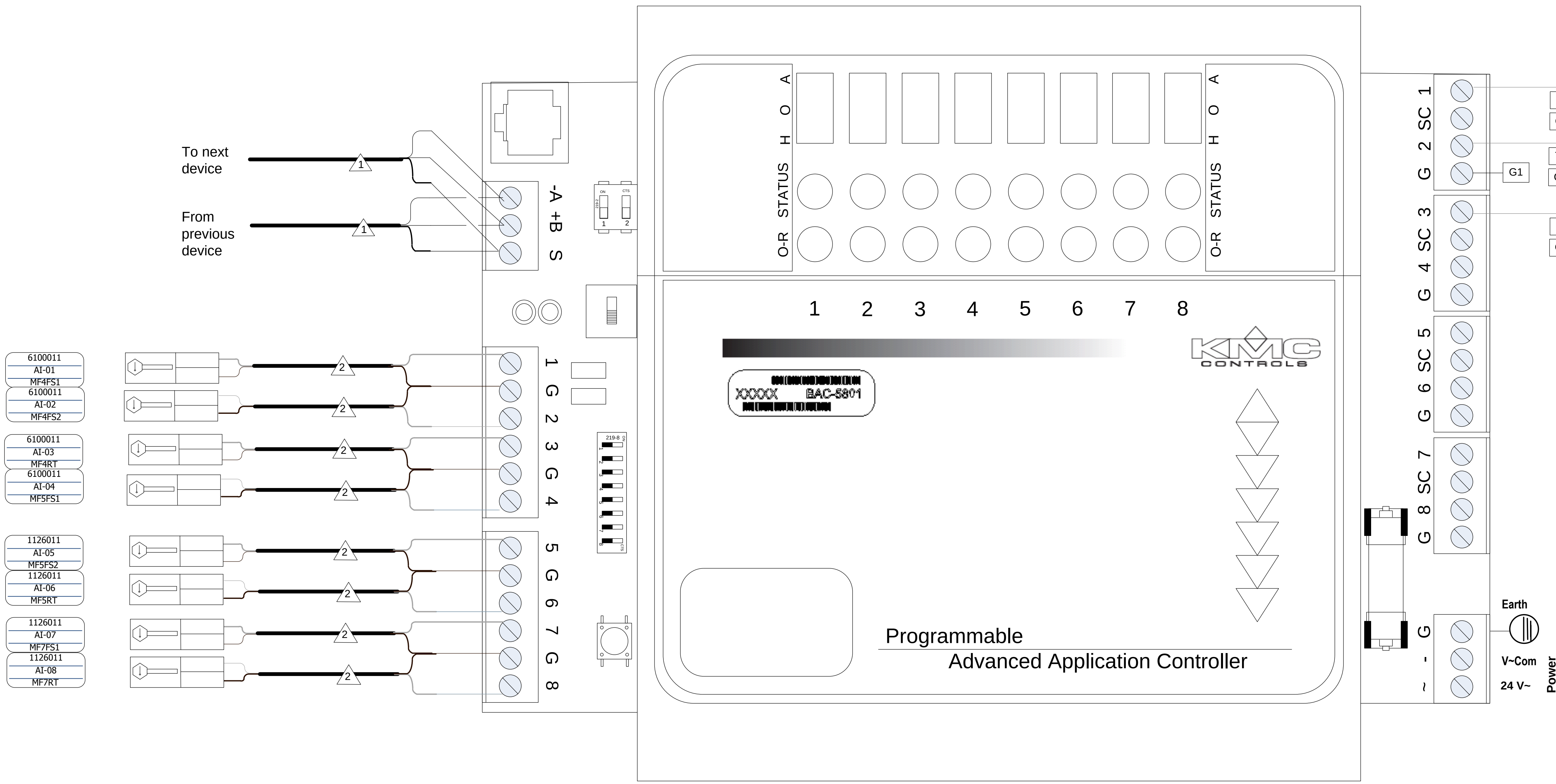
PROJ. MNGR: -
ENGINEER: Dipak Patel
CONTRACTOR:

DATE: 24/01/2012
BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 019

MANIFOLD4-MANIFOLD5-MANIFOLD7-CONTROL



DEVICE	POINT	IN/OUT	Description
6100011	MF4FS1	AI-01	Manifold4 Floor Sensor1
6100011	MF4FS2	AI-02	Manifold4 Floor Sensor2
6100011	MF4RT	AI-03	Manifold4 Return Temp.
6100011	MF5FS1	AI-04	Manifold5 Floor Sensor1
6100011	MF5FS2	AI-05	Manifold5 Floor Sensor2
6100011	MF5RT	AI-06	Manifold5 Return Temp.
6100011	MF7FS1	AI-07	Manifold7 Floor Sensor 1
6100011	MF7RT	AI-08	Manifold7 Return Temp.
6100011	MF4CTL	AO-01	Manifold4 Valve Control
6100011	MF5CTL	AO-02	Manifold5 Valve Control
6100011	MF7CTL	AO-03	Manifold7 Valve Control
6100011		AO-04	
6100011		AO-05	
6100011		AO-06	
6100011		AO-07	
6100011		AO-08	

Rev	Description	Date	By
3	-	-	-
2	-	-	-
1	Issued for Review	24/01/2012	-

Econoptimal Automation Inc.

PROJECT: BAPS Swaminarayan Sanstha — Shri Swaminarayan Mandir, Toronto — Community Hall HVAC + Floor Heating

TITLE: MANIFOLD4-MANIFOLD5-MANIFOLD7-CONTROL

37

PROJ. MNGR: -

ENGINEER: Dipak Patel

CONTRACTOR: -

DATE: 24/01/2012

BY: Dipak Patel

PROJ REF:

DWG REF: 000 – 000 – 020

2.2 Coding Example

Line By Line code example

Below is the example of the Dehumidity Control. This code execures if Dehumidity control is enable. Once it enable, it compares Space humidity with its setpoint. If space humidity is more than its setpoint than it will start Dehumidity mode other wise it stops it. Again it checks again and executes function based on humidity parameters.(18).(20)

```
DEHUM_CONTROL:

REM DEHUMIDIFICATION MODE
IF DEHUM_ENABLE THEN
REM EVALUATE DEHUM STATUS BASED - HOW IS BASED ON WHETHER DEHUM IS ALLOWED TO OPERATE IN HTG
MODE
IF ALLOW_HTG_DEHUM THEN
IF+ SPACE_HUM > DEHUM_STPT THEN START BV21 , START DEHUM_MODE
ELSE
IF+ SPACE_HUM > DEHUM_STPT AND HTG_CLG_MODE THEN START BV21 , START DEHUM_MODE
ENDIF
IF SPACE_HUM < DEHUM_STPT - DEHUM_DEADBAND THEN STOP BV21 , STOP DEHUM_MODE
REM START FAN IF DEHUM MODE IS ACTIVE
IF DEHUM_MODE THEN START BV6
ENDIF
```

Functional Block Coding Example

Below is the example of Heating valve control with temperatures of floor sensors and return temperature using the temperature set point. Input parameters are temperatures of floor or return temperature from floor. It has temperature set point. All input parameters are connected to PID loop which calculates based on its internal parameters. If temperatures are lower than the set point, it opens the heating valve to provide more heating. Once it match the set point, valve closes.(24)(22)

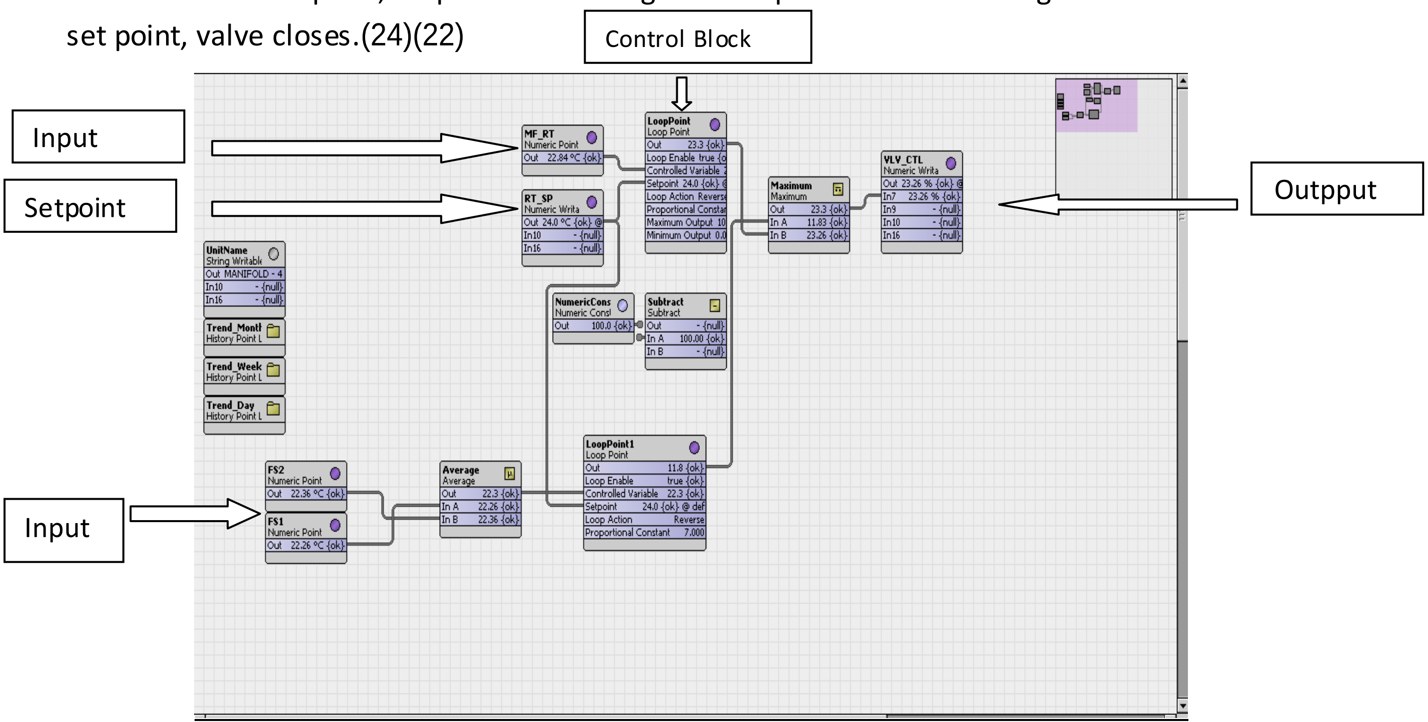


Figure - 6 Functional Block Coding Example

2.3 Graphics Example

Graphics

Main Page

Below image is created as main page of the graphics. This represents the link for main systems of the graphics and system functions.

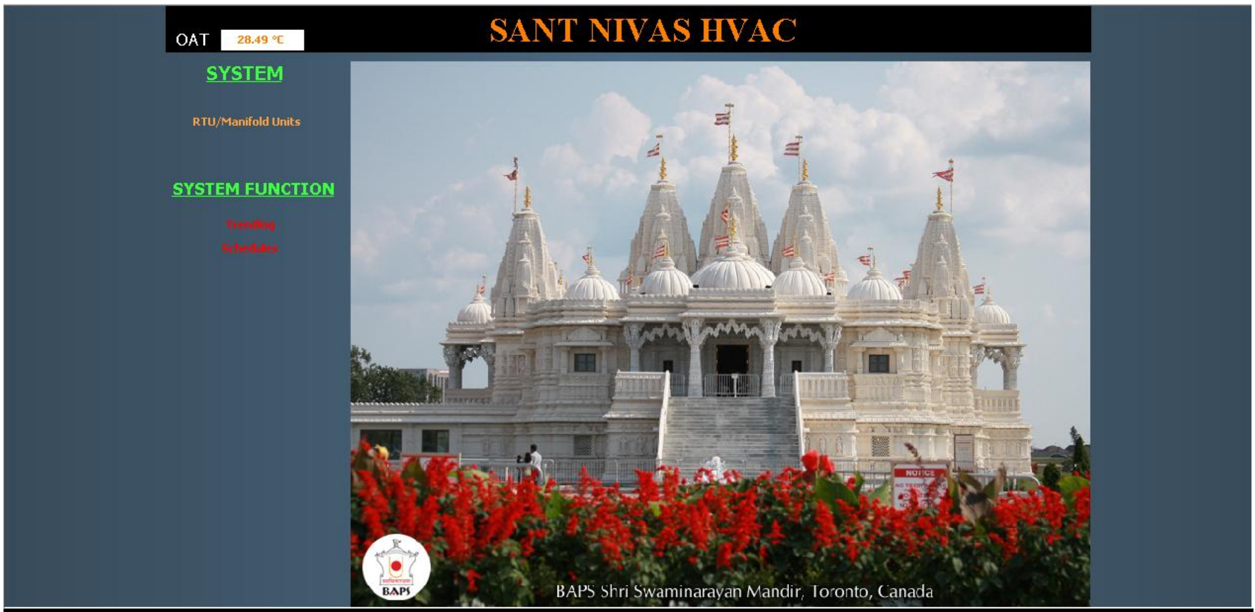


Figure -7 Graphics

Roof Top Unit

Below is the image for Roof Top Unit. This graphics contains all control component for this unit. It has also contains set points for heating and cooling. It has all real time data showing the present condition of the unit.

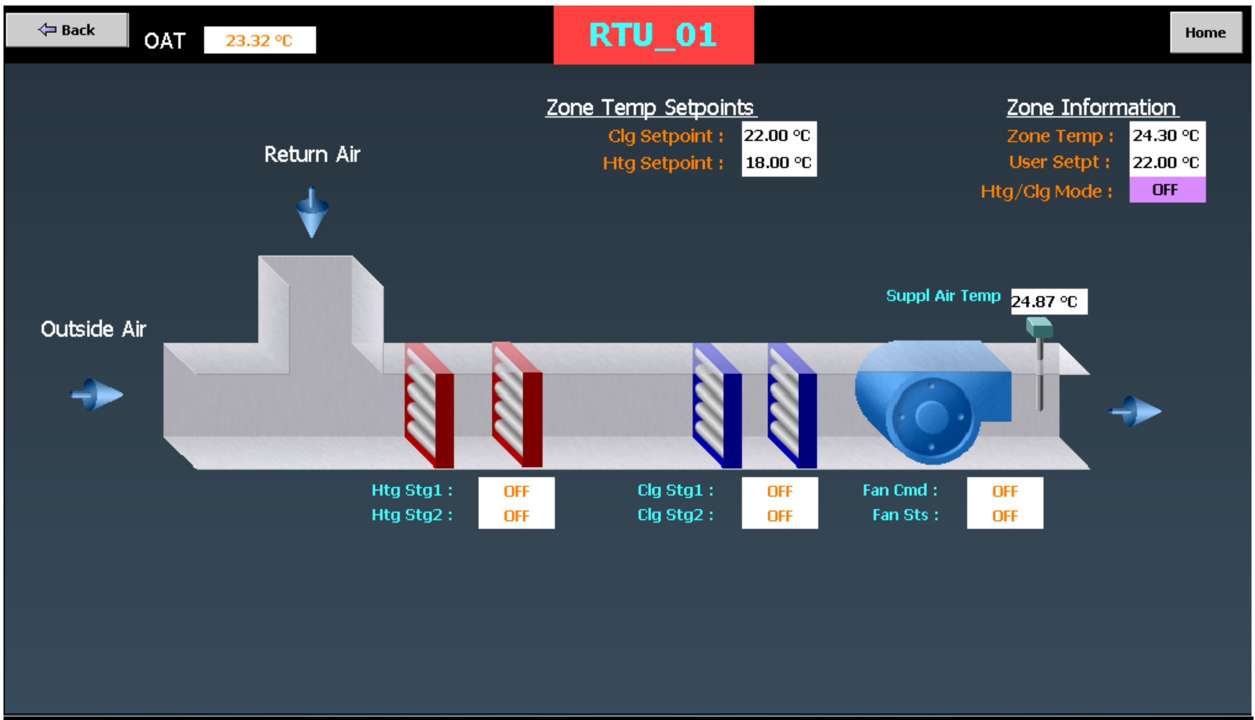


Figure - 8 Roof Top Unit

Manifold

Below graphics shows the details about the under floor heating controls. It shows the floor sensor reading and its set point. It also represents the heating valve operation via its position. It also represents daily, weekly and monthly trend for temperature vs set point.

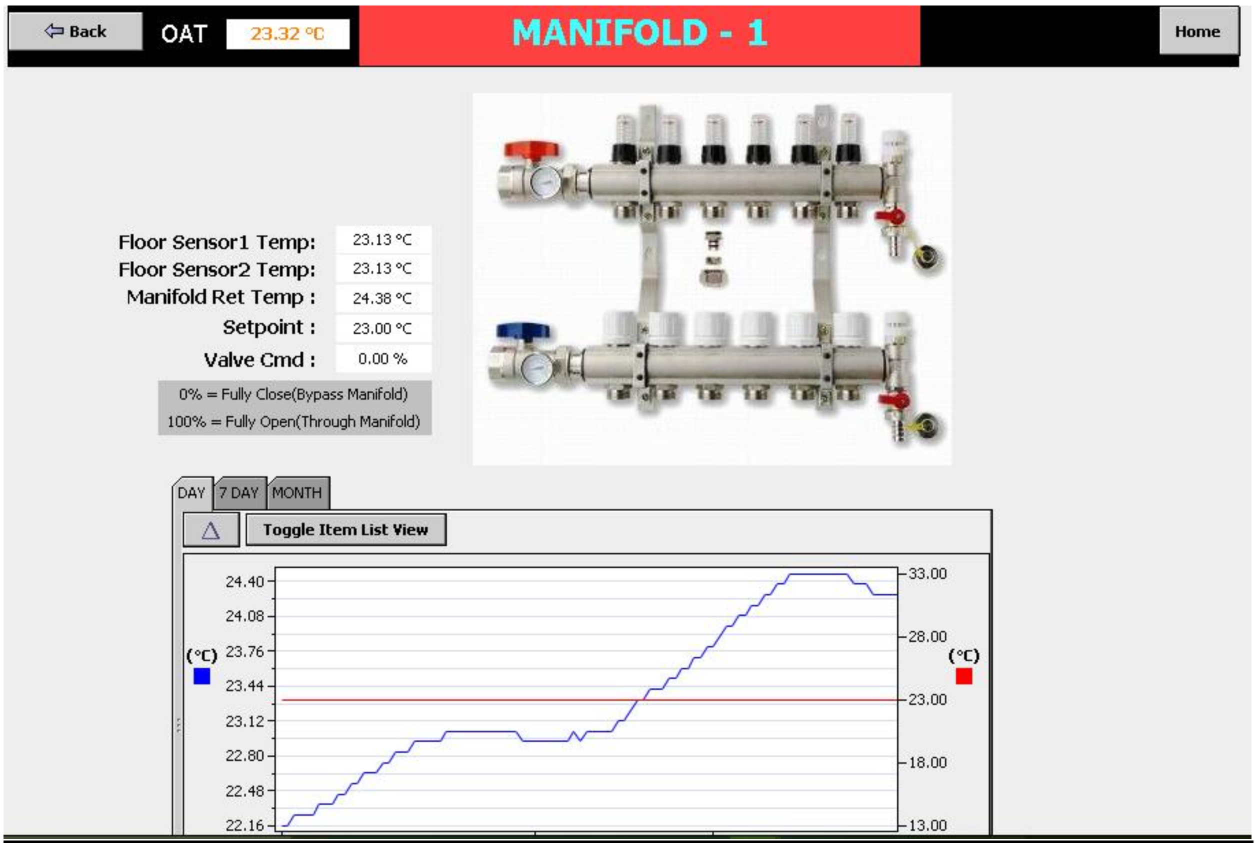


Figure - 9 Manifold

2.4 Live Presentation of the Intelligent Building Project

As we seen until now that we design the project using different phases. First of all design the wiring layout in detail for control wiring. After that choosing the right hardware for particular application. Then design the control drawing for details about the controller wiring. Then write the code to perform the sequence of operation. Later create the graphics template and configure data to the graphics for real time operation. (23)

Now using internet web browser with username and password we can watch, operate and control the entire site using the graphics. All equipment are control using graphics.

2.5 Conclusion

In conclusion, we can state that based on the requirement of the project, entire site was designed to implement the Intelligent building automation system.(21)

These building needs control system design which requires detail study of mechanical equipment and how it functions using controls. First of all, I designed a sequence of operation for each mechanical equipment. Then, choose controller and peripheral devices to accommodate the sequence of operation. After hardware selection, need wiring diagram to do wiring between controller and equipment. To perform centralized control system, there is a need for network between controllers and communicate them to one another over common protocol language. Now, peripheral devices like space sensors, duct sensors, relay wiring to control the equipment and under floor sensors, control valves etc. All these controllers are wired and programmed as per sequence of operation. Next step is to commission the controller and verify the operation of the mechanical equipment as per design sequence.(24)(20)

Graphics are created and display all points as per requirement. In nutshell, this project describe the details about design and implementation of intelligent building automation system.

Appendix I

Wiring Diagram with layout

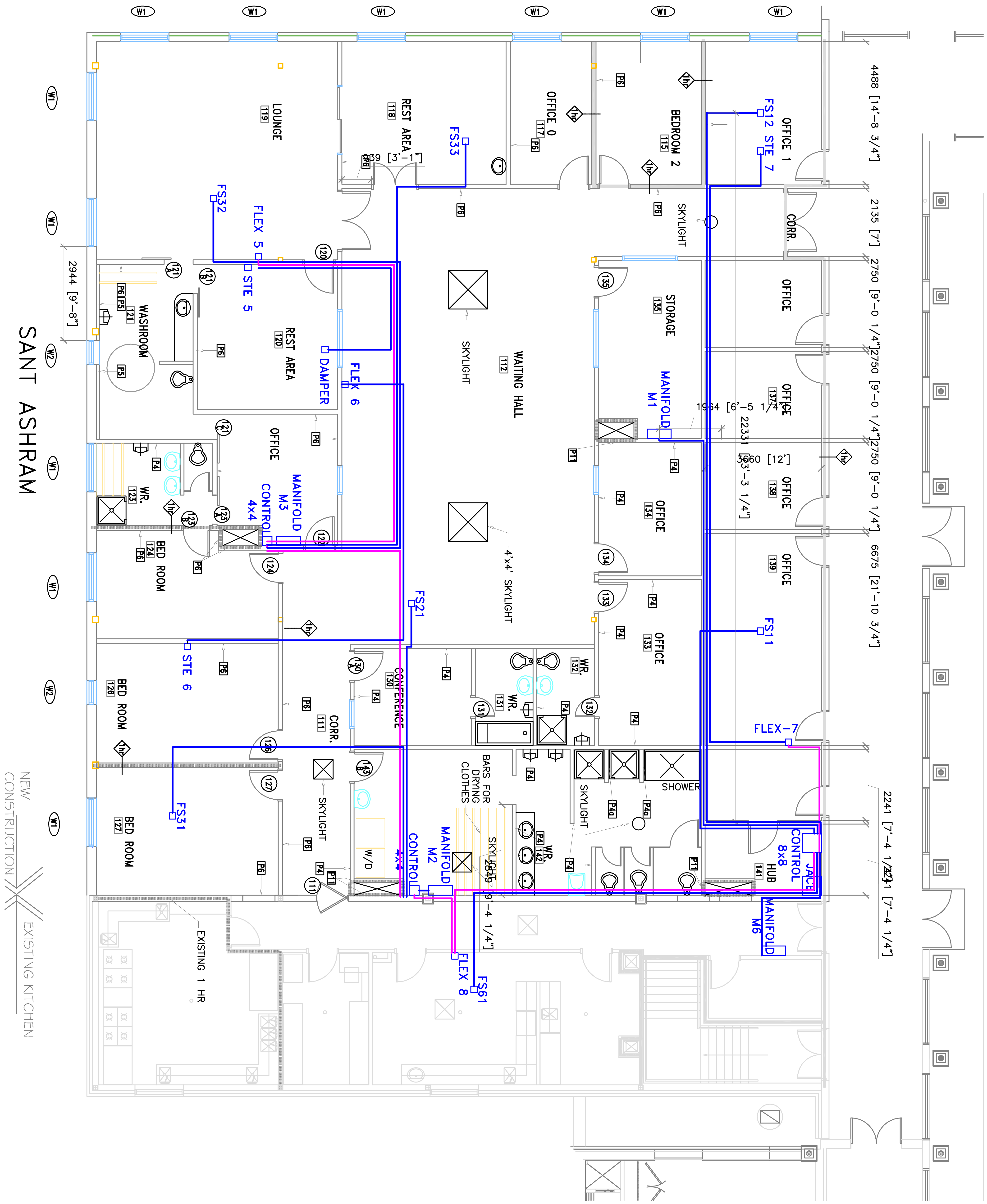


Figure - 10 Wiring Diagram-1

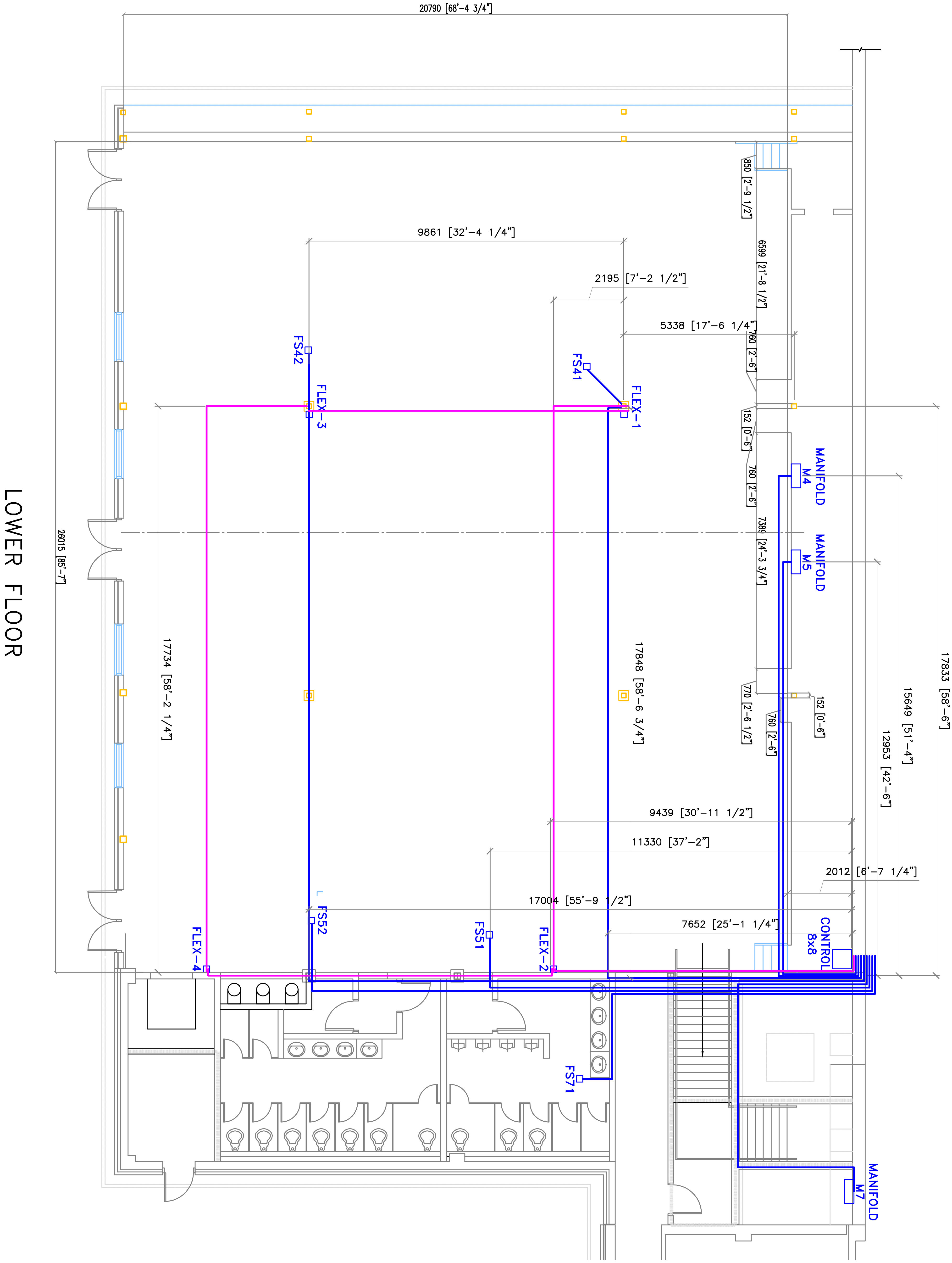
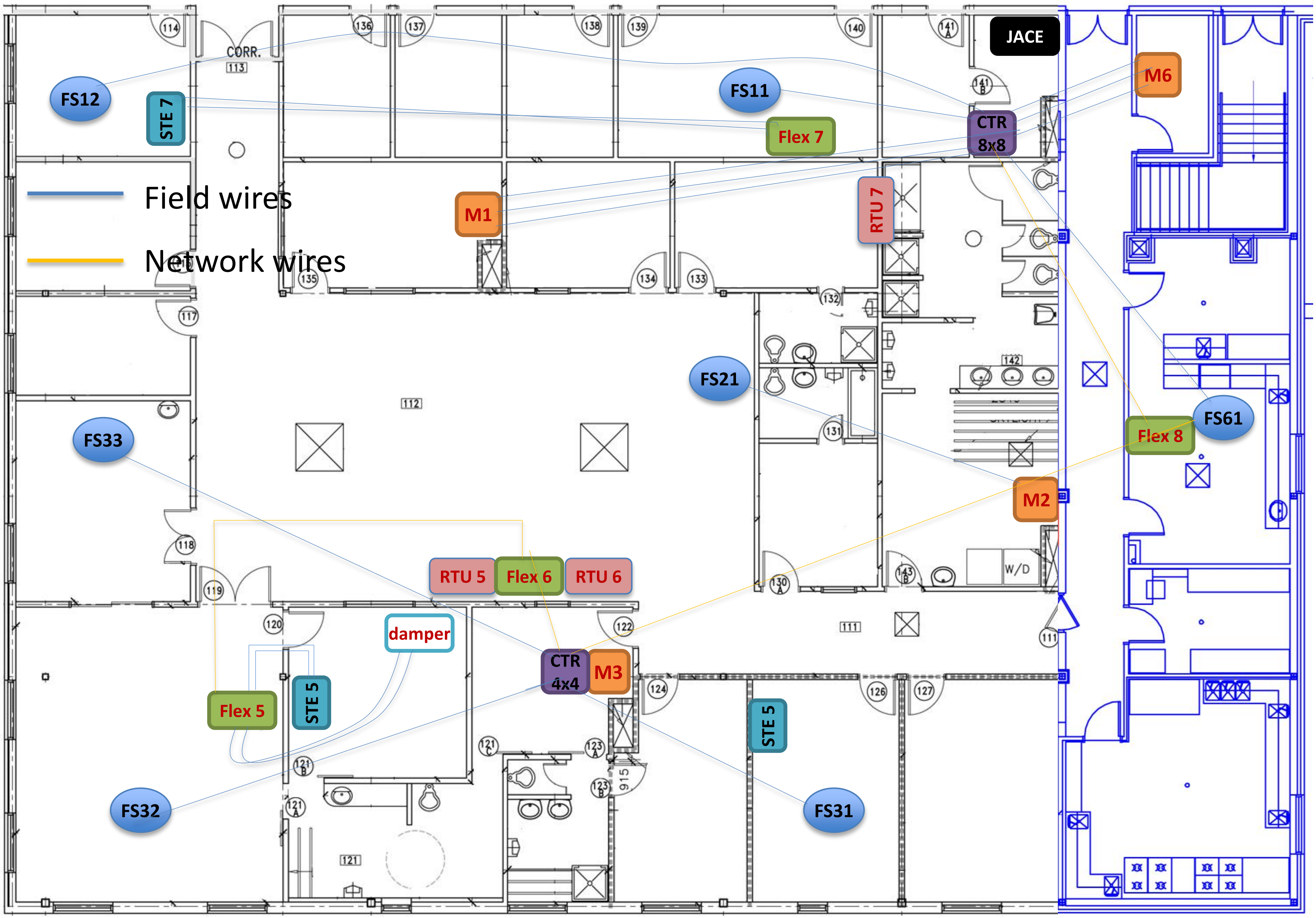


Figure - 11 Wiring Diagram-2



MX Manifold No. X

FSX# Floor Sensor from Manifold X, Fr sensor #

Figure - 12 Wiring Diagram-3

UPPER FLOOR

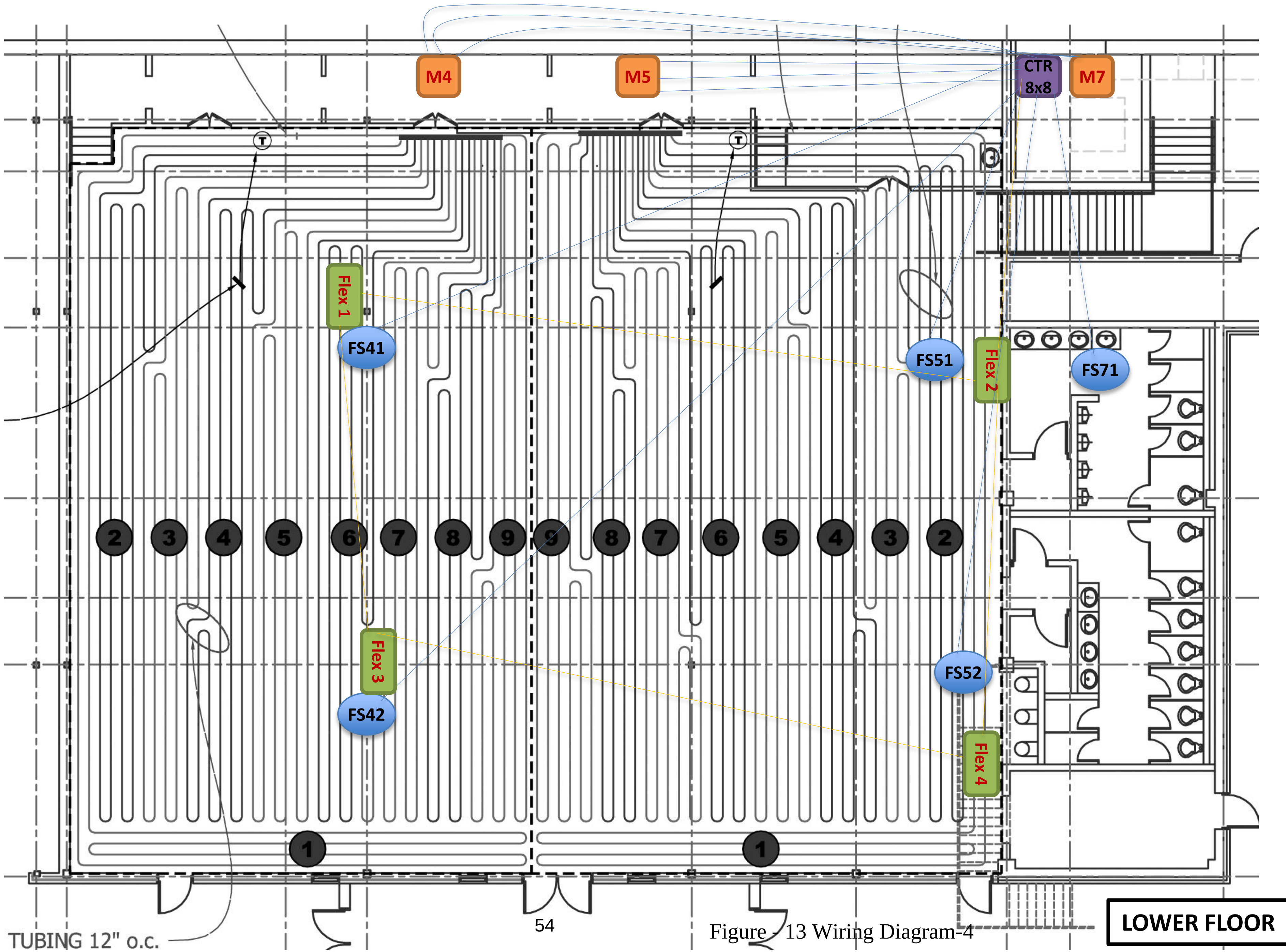


Figure - 13 Wiring Diagram-4

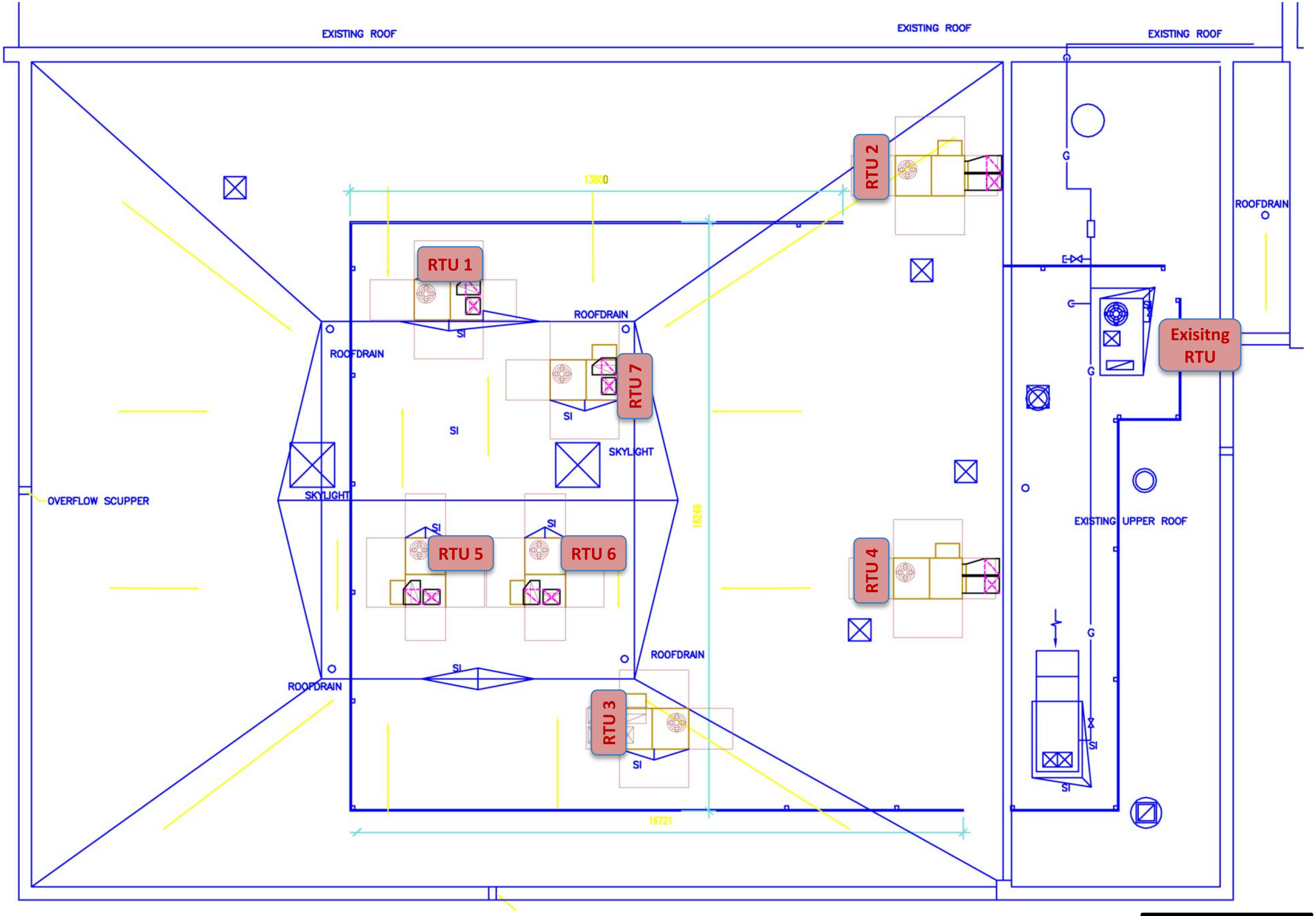


Figure - 14 Wiring Diagram-5

ROOF FLOOR

Appendix II

Technical Documentation on Hardware Selection and its Specification

JENE-PC1000 Controller

Product Description

The Lynxspring JENE-PC1000 controller is a compact, embedded controller/server platform. It combines integrated control, supervision, data logging, alarming, scheduling and network management functions with Inter-net connectivity and web serving capabilities in a small, compact platform. The JENE makes it possible to control and manage external devices over the Internet and present real time information to users in web-based graphical views.

The JENE is a member of the JENEsys™ suite of Java-based controller/server products, software applications and tools, which are designed to integrate a variety of devices and protocols into unified, distributed systems. JENEsys™ products are powered by the revolutionary NiagaraAX Framework®, the industry's first software technology designed to integrate diverse systems and devices into a seamless system. Niagara supports a wide range of protocols including LonWorks™, BACnet™, Modbus™ and Internet standards. The AX Framework also includes integrated network management tools to support the design, configuration, installation and maintenance of interoperable networks.

Features and Application Highlights

The JENE-PC1000 is ideal for smaller facilities, remote sites, and for distributing control and monitoring throughout large facilities. Optional input/output modules can be plugged in for applications where local control is required. The JENE-PC1000 also supports a wide range of fieldbuses for connection to remote I/O and stand-alone controllers. In small facility applications, the JENE-PC1000 is all you need for a complete system.

The JENE-PC1000 serves data and rich graphical displays to a standard web browser via an Ethernet LAN or remotely over the Internet, or dial-up modem. In larger facilities, multi-building applications and large-scale control system integrations, NiagaraAX Supervisor™ software can be used to aggregate information (real-time data, history, alarms, etc.) from large numbers of JENEs into a single, unified application. The AX Supervisor can manage global control functions, support data passing over multiple networks, connect to enterprise level software applications, and host multiple, simultaneous client workstations connected over the local network, the Internet, or a dial-up modem.

- Standard: Two RJ-45 Ethernet Ports, one RS-232 port, and one RS-485 port
- Interoperable: BACnet, LON, Fox or Modbus ready, with the addition of a license and/or communication modules
- Versatile: Fully-customizable with an array of software drivers and custom modules
- Reliable: All program data is backed up in nonvolatile EEPROM; battery back-up
- Fast: Onboard Ethernet communication provides rapid data transmission

Mounting

WARNING: Do not mount in a location subject to electrical noise. This includes the proximity of large electrical contactors, variable frequency drives, electrical machinery, welding equipment, spark igniters, and any high-voltage-producing equipment.

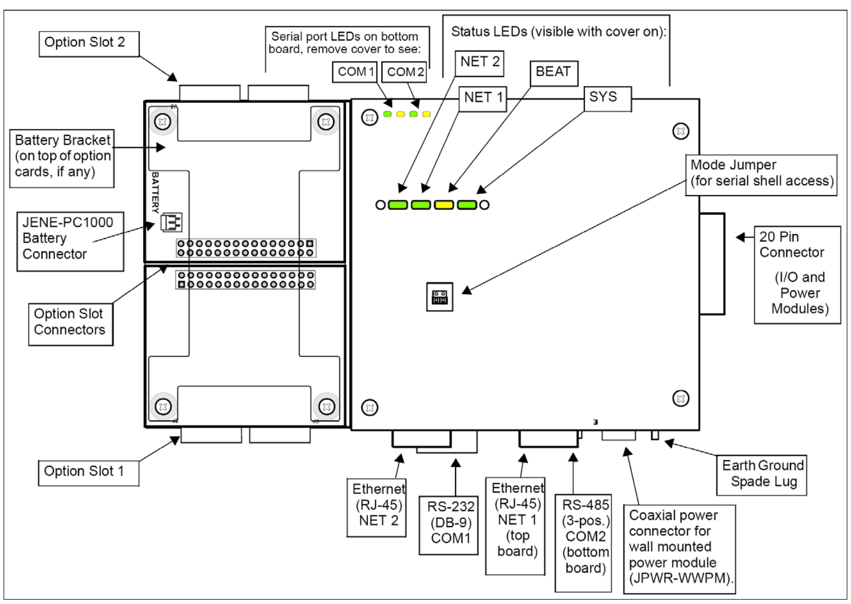
You must remove the JENE cover to install this unit. The cover snaps onto the base with four plastic tabs (two on each end). To remove the cover, press in the four tabs on both ends of the unit, and lift the cover off. To replace the cover, orient it so the cutout area for communications ports are cor-rect, and then push inwards to snap in place.

Mount the JENE in a horizontal position. It is necessary to remove the cover before mounting. Mount on a 35mm wide DIN rail. The JENE unit base has a molded DIN rail slot and locking clip. The following procedure provides step-by-step DIN rail mounting instructions for the JENE.

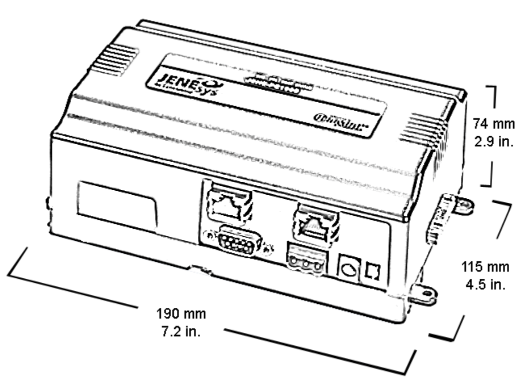
Step 1 Securely install the DIN rail using at least two screws, near both ends of the rail.
Step 2 Position the JENE on the rail, tilting to hook DIN rail tabs over one edge of the DIN rail.
Step 3 Push down and in to force the DIN rail clip to snap over the other edge of the DIN rail.
Step 4 To prevent the JENE from sliding on the DIN rail, place a screw in two of the four mounting tabs in the base of the JENE.

Technical Data

Platform	• IBM PowerPC 405EP 250 MHz processor • 64MB SDRAM & 64 MB Serial Flash • Battery Backup - 5 minutes typical - shutdown begins within 10 seconds • Real-time clock - 3 month backup max via battery
Communications	• 2 Ethernet Ports – 10/100 Mbps (RJ-45 Connectors) • 1 RS 232 Port (9 pin D-shell connector) • 1 RS 485 non isolated port (3 Screw Connector on base board)
Optional Communi-cations Cards	• JCOM-1LON - Optional 78 Kbps FTT10 A LON Adapter • JCOM-1232 - Optional RS-232 port adapter with 9 pin D-shell connector • JCOM-2485 - Optional dual port RS-485 adapter; electrically isolated
Operating System	• QNX RTOS • IBM J9 JVM Java Virtual Machine • NiagaraAX
Power Supply	• JPWR-DRPM - Optional: 24 Volt AC/DC power supply module, Din Rail mounted • Optional Wall Power Modules – (Note: All modules are universal input 90 – 240 volts, 50/60 Hz.; the model numbers below represent the various plug configurations only) • JPWR-WWPM-US - 120 Vac, 50- 60 Hz. US • JPWR-WWPM - 230 Vac, 50-60 Hz. Europe/Asia • JPWR-WWPM - 230 Vac 50-60 Hz. UK
Chassis	• Construction: Plastic, Din rail or screw-mount chassis, plastic cover • Cooling: Internal air convection
Environment	• Operating temperature range: 0° to 50°C (32°F to 122°F) • Storage Temperature range: -20°C to 60°C (-4°F to 140°F). • Relative humidity range: 5% to 95%, non-condensing
Agency Listings	• UL 916, C-UL listed to Canadian Standards Association (CSA) C22.2 No. 205-M1983 "Signal Equipment", CE, FCC part 15 Class A, C-Tick (Australia)



DIMENSIONS



Ordering Information

Model #	Description
JENE-PC1064	JENE-PC1000 Controller w/64 MB RAM
JENE-PC1128	JENE-PC1000 Controller w/128 MB RAM
JENE-PC1-128-LIC	128MB Upgrade License
See Price Sheet for Additional PC1000 Options	

BAC-5801 and BAC-5802
Advanced Application Controllers, 8 x 8

Description and application

The BAC-5801 and BAC-5802 are native BACnet, fully programmable, direct digital controllers. Use these versatile general purpose controllers in stand-alone environments or networked to other BACnet devices. As part of a complete facilities management system, the BAC-5801 and BAC-5802 controllers provide precise monitoring and control of connected points.

- ◆ BACnet MS/TP compliant
- ◆ Automatically assigns the MAC address and the device instance
- ◆ Easy to install, simple to configure, and intuitive to program
- ◆ Controls room temperature, humidity, fans, monitors refrigeration, lighting, and other building automation functions.

Specifications

Inputs

- ◆ 8 universal inputs, each of which is programmable as an analog, binary, or accumulator object. Accumulators limited to three per controller.
- ◆ Standard units of measure
- ◆ Pull-up resistors for switch contacts and other unpowered equipment. Switch selects none or 10K ohms.
- ◆ Removable screw terminal blocks, wire size 14–22 AWG
- ◆ 10-bit analog-to-digital conversion
- ◆ Pulse counting to 16 Hz
- ◆ 0–5 volts DC analog input range
- ◆ Overvoltage input protection
- ◆ Compatible with KMD-1160 and KMD-1180 series NetSensors

Outputs

- ◆ 8 universal outputs, each of which is programmable as an analog or binary object
- ◆ Standard and custom units of measure
- ◆ Slots for HPO-6700 series output override boards
- ◆ Removable screw terminal blocks, wire size 14–22 AWG
- ◆ 0–10 volts DC for analog objects
- ◆ 0 or 12 volts DC for binary objects
- ◆ Short-protected outputs, output current limited

Programmable features

- ◆ 10 Control Basic program areas
- ◆ 40 analog and 40 binary value objects
- ◆ Real time clock with power backup for 72 hours (BAC-5801 only)
- ◆ 8 PID loop objects
- ◆ See PIC statement for supported BACnet objects

Schedules

- ◆ 8 Schedule objects
- ◆ 3 Calendar objects

Alarms and events

- ◆ Supports intrinsic reporting
- ◆ 8 Notification class objects

Trends

- ◆ 8 Trend objects

Memory

- ◆ Programs and program parameters are stored in nonvolatile memory
- ◆ Auto restart on power failure

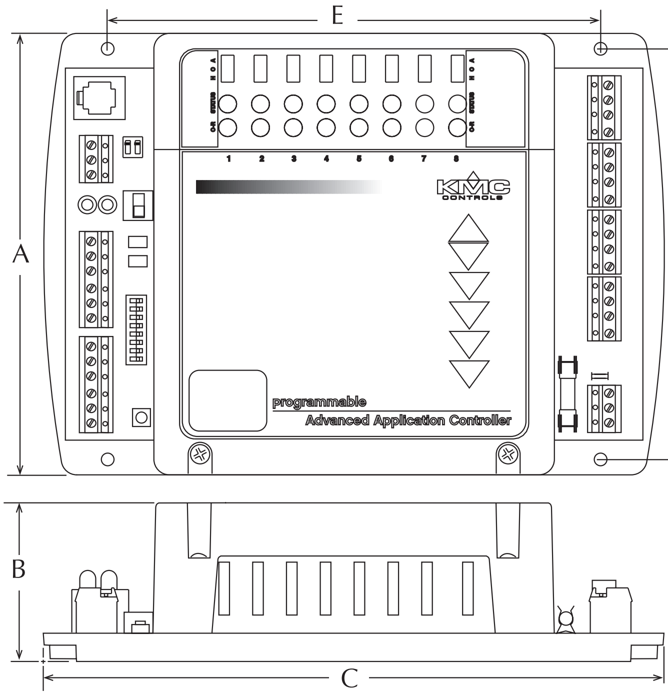
Communications

- ◆ MS/TP operating at up to 76.8 kilobaud (network connections are supervised in smoke control applications)
- ◆ Automatically assigns MAC addresses and device instance numbers
- ◆ Modular jack for NetSensor connection (5 VDC at 25 mA typical)

Specifications based on firmware 2.0. Specifications and design subject to change without notice.

Specifications ((continued)

Dimensions



A	B	C	D	E
5.38 in.	1.98 in.	7.55 in.	5.0 in.	6.0 in.
137 mm	50 mm	192 mm	127 mm	152 mm

Installation

Supply voltage

24 volts AC (–15%, +20%), 60 Hz, 36 VA, Class 2 only, non-supervised (all circuits, including supply voltage, are power limited circuits)

Weight 14 ounces (395 g)

Case material Green and black flame retardant plastic

Environmental limits

Operating 32 to 120° F (0 to 49° C)
Shipping –40 to 140° F (–40 to 60° C)
Humidity 0–95% RH (non-condensing)

Regulatory

- FCC Class B, Part 15, Subpart B
- BACnet Testing Laboratory listed
- CE compliant
- UL 916 Energy Management Equipment listed
- UL 864 Smoke Control Equipment listed (UUKL) (for smoke control applications, see Smoke Control Manual For BACnet Systems, P/N 000-035-08)

Software compatibility

Requires the current version of BACstage or TotalControl for full configuration and programming features.

Accessories

Connectors and fuses

902-602-04	Replacement three-pin removable terminal block
031-602-02	Replacement four-pin removable terminal block
883-602-17	Replacement six-pin removable terminal block
902-600-04	Replacement fuse, 1.0 A, fast acting, 5 x 20 mm
HPO-0054	Replacement fuse bulb
HPO-0063	Replacement two-pin jumper

Enclosure

HCO-1102 Steel control enclosure, 10.1 W x 2.4 H x 7.1" D (257 x 62 x 181 mm)

NOTE: For smoke control applications, the controller must be mounted in a UL Listed FSCS enclosure or listed enclosure with minimum dimensions—see Smoke Control Manual For BACnet Systems (P/N 000-035-08)

Output override boards (HPO-6700 series)

NOTE: See the (P/N 902-035-10) HPO-6700 series data sheet (only the HPO-6701/6704 boards are approved for smoke control applications)

Power transformers

XEE-6111-40	Transformer, 120-to-24 VAC, 40 VA, single-hub
XEE-6112-40	Transformer, 120-to-24 VAC, 40 VA, dual-hub
XEE-6112-100	Transformer, 120-to-24 VAC, 96 VA, dual-hub (required in smoke control applications)

Models

BAC-5801	Controller with real-time clock
BAC-5802	Controller w/o real-time clock

BACnet International

KMC Controls, Inc.
19476 Industrial Drive, New Paris, IN 46553
574.831.5250
www.kmccontrols.com; info@kmccontrols.com

KMC CONTROLS

BAC-10000 Series
FlexStat™

Description and Application

The award-winning FlexStat is a **controller and sensor** in a single, attractive package that creates a flexible solution to stand-alone control challenges or BACnet network challenges. Temperature sensing is standard with **optional humidity and motion sensing**. Flexible input and output configurations and built-in or custom programming ensure that a variety of application needs can be met. Such applications include single- and multi-stage packaged, unitary, and split systems (including high SEER/EER variable speed packaged equipment), as well as factory-packaged and field-applied economizers, water-source and air-to-air heat pumps, fan coil units, central station air handling units, and other similar applications.

In addition, an on-board library of programs permits a single model to be rapidly configured for a wide range of HVAC control applications. Thus, a single "one size fits all" FlexStat model can replace multiple competitor models. A single BAC-10163CW, for example, can be configured for any and all of these application options:

- Air handling unit, with proportional heating and cooling valves, and with optional economizer, dehumidification, and/or fan status
- Fan coil unit, 2-pipe or 4-pipe, proportional or 2-position valves, with optional dehumidification (w/ 4-pipe option) and/or fan status
- Heat pump unit, with up to two compressor stages, and with optional auxiliary heat, emergency heat, dehumidification, and/or fan status
- Roof top unit, with up to two H/C stages, and with optional economizer, dehumidification, and/or fan status

FlexStats also provide the capability to customize the standard library of sequences using KMC's BACstage programming tool. This enables a local authorized KMC installing contractor to adapt the standard library to the unique site needs and application specific requirements of a particular project.

Standard hardware options include a mix of output configurations (relays and universal outputs), optional on-board humidity/motion sensing, and inputs for additional remote external sensors such as outside air temperature and fan status sensors.

Consulting-Specifying Engineer 2010 Product of the Year Gold

c UL US LISTED

(Shown with Optional Motion and Humidity Sensors)

Still . . . Made in the U.S.A.

Features

Interface and Function

- User-friendly English-language menus (no obscure numeric codes) on a 64 x 128 pixel, dot-matrix LCD display with 5 buttons for data selection and entry
- Built-in, factory-tested libraries of configurable application control sequences
- Integral energy management control with deadband heating and cooling setpoints and other advanced features
- Schedules can easily be set uniquely by weekdays (Mon.–Fri.), weekend (Sat.–Sun.), entire week (Mon.–Sun.), individual days, and/or holidays
- Six On/Off and independent heating and cooling setpoint periods are available per day
- Three levels of password-protected access (user/operator/administrator) prevent disruption of operation and configuration—plus Hospitality mode and Locked User Interface mode offer additional tamper resistance
- Integral temperature and optional humidity and/or motion sensors (shown in photo above)
- Model choices enable "best fit" of sequence in new and retrofit applications with other field devices, such as proportional or 3-wire "floating" actuators and staged equipment; functionally replace most Viconics and other competitors' products
- All models have 72-hour power (capacitor) backup and a real time clock for network time synchronization or full stand alone operation

Features (Cont.)

Inputs

- Three analog inputs (that can also be mapped as binary inputs in Control Basic) for use with external devices such as mixed air temperature, fan status, outside air, and CO_2 sensors
- Analog inputs accept industry-standard 10K ohm thermistor sensors or dry contacts
- Inputs can be configured via a switch for 10K ohm pull-up resistors (for unpowered contacts or devices) or 0–12 VDC
- Input overvoltage protection (24 VAC, continuous)
- 12-bit analog-to-digital conversion on inputs

Outputs

- Up to nine outputs, analog and binary (relays)
- Each short-circuit protected analog output capable of driving up to 20 mA (at 0–12 VDC)
- The NO, SPST (Form "A") relays carry 1 A max. per relay or 1.5 A per bank of 3 relays (relays 1–3, 4–6, and 7–9) @ 24 VAC/VDC
- 8-bit digital-to-analog conversion on outputs

Installation

- Backplate mounts on a standard vertical 2 x 4-inch wall handy-box (or, with an HMO-10000 adapter, a horizontal or 4 x 4 handy-box), and the cover is secured to the backplate by two concealed hex screws
- Two-piece design provides easy, flexible wiring and installation (see the Dimensions and Connectors section)
- Attractive white (standard) or light almond (optional) plastic case

Connections

- Screw terminal blocks, wire size 14–22 AWG, for inputs, outputs, power, and BACnet network
- Integral peer-to-peer BACnet MS/TP LAN network communications on all devices (with configurable baud rate from 9600 to 76.8K baud)
- A four-pin EIA-485 (formerly RS-485) data port on the underside of the case enables easy temporary computer connection to the BACnet network (access with a KMD-5624 cable—requires use of KMD-5576 or third-party interface)

BACnet Standards

- Meets or exceeds BACnet AAC specifications in the ANSI/ASHRAE BACnet Standard 135-2008

Configurability

I/O

- Up to 7 analog input objects (IN1 is space temperature, IN2–IN4 are 0–12 VDC inputs, IN5 is reserved for humidity, IN6 is reserved for motion detection, IN7 is reserved for CO_2)
- Up to 9 analog or binary output objects

Value

- 60 analog value objects
- 40 binary value objects
- 20 multi-state value objects (with up to 16 states each)

Program and control

- 10 PID loop objects
- 10 program objects (contains a library of 5 built-in programs and customized Control Basic programming in the other 5 program objects can be done through BACstage or TotalControl)

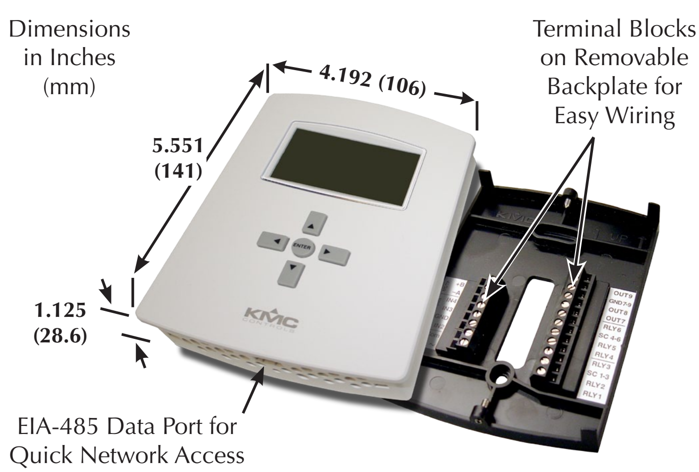
Schedules and trends

- 2 schedule objects
- 1 calendar object
- 8 trend objects, each of which holds 256 samples

Alarms and events

- 5 notification class (alarm/event) objects
- 10 event enrollment objects

Dimensions and Connectors



NOTE: Two-piece design allows field rough-in and termination of field wiring to the backplate without needing the FlexStat at the site—permitting FlexStats to be bulkconfigured off-site and plugged into the wired backplates at a later time if desired.

Models

If your application is a:

- Packaged Unit, AHU (Air Handling Unit), RTU (Roof Top Unit)—see all models.
- FCU (Fan Coil Unit)—see the BAC-1xx**36**CW and BAC-1xx**63**CW models.
- HPU (Heat Pump Unit)—see the BAC-1xx**63**CW models or, for one compressor only, BAC-1xx-**30**CW models.
- Other 1 Heat or 1 Cool Unit—see the BAC-1xx-**30**CW models.

For more details, see the Application/Model Selection Guide on the next page.

Model*	Outputs**	Optional Sensors***	Typical Applications
BAC-10030CW	3 Relays (Binary Outputs) (All models have 3 analog inputs)	None	• 1H/1C packaged and split systems • 1H 2-position economizer applications • 1H/1C heat pumps (no auxiliary or emergency heat) • Unit heaters • Single-stage cooling applications
BAC-10130CW		Humidity	• Same as BAC-10030CW • Dehumidification sequence (AHU)
BAC-11030CW		Motion/Occupancy	• Same as BAC-10030CW • Occupancy-based operation
BAC-11130CW		Humidity and Motion/Occupancy	• Same as BAC-10130CW • Occupancy-based operation
BAC-10036CW	3 Relays and 6 Analog Outputs	None	• 1H/1C, fan, and 6 universal outputs • 3-speed fan, 2- or 4-pipe FCUs with modulating valves • Central station AHUs with modulating/1/2 Heat/Cool • Variable-speed fan output • Single-stage applications
BAC-10136CW		Humidity	• Same as BAC-10036CW • Dehumidification sequence • Humidification sequence (AHU or 4-pipe FCU)
BAC-11036CW		Motion/Occupancy	• Same as BAC-10036CW • Occupancy-based operation
BAC-11136CW		Humidity and Motion/Occupancy	• Same as BAC-10136CW • Occupancy-based operation
BAC-10063CW	6 Relays and 3 Analog Outputs	None	• 1 or 2 H and 1 or 2 C, fan • Multi-stage packaged or split systems • Multi-stage heat pumps with or without factory-packaged economizers • Central station AHUs with modulating Heat/Cool • 3-speed fan, 2- or 4-pipe FCUs with modulating or 2-position valves
BAC-10163CW		Humidity	• Same as BAC-10063CW • Dehumidification sequence (AHU, 4-pipe FCU, or RTU)
BAC-11063CW		Motion/Occupancy	• Same as BAC-10063CW • Occupancy-based operation
BAC-11163CW		Humidity and Motion/Occupancy	• Same as BAC-10163CW • Occupancy-based operation

*__The standard color is white. To order the optional light almond color, remove the "W" at the end of the model number__ (e.g., BAC-11163C instead of BAC-11163C**W**). All models have a real-time clock. All models have optional discharge air temperature monitoring/trending **or** fan status monitoring.

****Analog outputs** produce 0–12 VDC @ **20 mA** maximum, and **relays** carry **1 A** max. **per relay or 1.5 A per bank** of 3 relays (relays 1–3, 4–6, and 7–9) @ 24 VAC/VDC.

***All models have an internal temperature sensor and 3 analog **inputs**. Optional sensors include humidity and/or motion.

Applications and Options	FlexStat Models and Outputs											
	6 Relays & 3 Analog				***3 Relays & 6 Analog***				***3 Relays & 0 Analog***			
	BAC-10063CW	**BAC-10163CW** (+ Humidity)	**BAC-11063CW** (+ Motion)	**BAC-11163CW** (+ Humidity/Motion)	**BAC-10036CW**	**BAC-10136CW** (+ Humidity)	**BAC-11036CW** (+ Motion)	**BAC-11136CW** (+ Humidity/Motion)	**BAC-10030CW**	**BAC-10130CW** (+ Humidity)	**BAC-11030CW** (+ Motion)	**BAC-11130CW** (+ Humidity/Motion)
Packaged Unit (Air Handling Unit and Roof Top Unit) (See also Heating OR Cooling Unit)									*D/E can select dehumidification* ***or*** *economizer (not both)*			
1 Heat and 1 Cool					X	X	X	X	X	X	X	X
1 or 2 Heat and 1 or 2 Cool (in RTU Menu Only)	RTU	RTU	RTU	RTU								
1 or 2 Heat and Modulating Cool					X	X	X	X				
Modulating Heat and 1 or 2 Cool					X	X	X	X				
Modulating Heat and Modulating Cool (in AHU Menu Only)	AHU	AHU	AHU	AHU	X	X	X	X				
Opt. Outside Air Damper, Modulating	X	X	X	X	X	X	X	X				
Opt. Outside Air Damper, 2 Position (in RTU Menu Only)	RTU	RTU	RTU	RTU	X	X	X	X	X	D/E	X	D/E
Opt. Mechanical Cooling									X	X	X	X
Opt. Fan Speed Control					X	X	X	X			X	
Opt. Dehumidification		X		X		X		X		D/E		D/E
Opt. Humidifier						X		X				
Opt. Motion/Occupancy Sensor			X	X			X	X			X	X
FCU (Fan Coil Unit)	*With 3-speed fan*				*With 3-speed fan*							
2 Pipe, Modulating	X	X	X	X	X	X	X	X	N/A			
2 Pipe, 2 Position	X	X	X	X								
4 Pipe, Modulating	X	X	X	X	X	X	X	X				
4 Pipe, 2 Position	X	X	X	X								
Opt. Dehumidification (4 pipe only)		X		X		X		X				
Opt. Humidifier (4 pipe only)						X		X				
Opt. Motion/Occupancy Sensor			X	X			X	X				
HPU (Heat Pump Unit)	*1 or 2 compressors with auxiliary and emergency heat*								*1 compressor (only)*			
Opt. Outside Air Damper, Modulating	X	X	X	X	N/A							
Opt. Dehumidification		X		X								
Opt. Motion/Occupancy Sensor			X	X							X	X
Heating OR Cooling Unit												
1 Heat (Only) **or** 1 Cool (Only)	N/A				N/A				X	X	X	X
Opt. Motion/Occupancy Sensor											X	X

All models have a real-time clock. They also have optional discharge air temperature monitoring/trending or fan status monitoring (but not both).

To order light almond instead of white, remove W from the end of the model number (e.g., BAC-10036C).

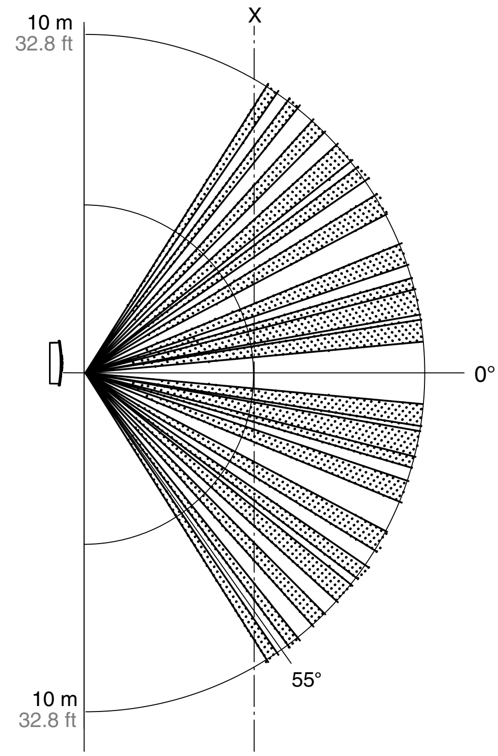
Model "Code" for BAC-1*mhra*CW:
- BAC = BACnet Device
- 1 = Model Series
- *m* = Motion Sensor (0/1)
- *h* = Humidity Sensor (0/1)
- *r* = Number of Relays (3/6)
- *a* = Number of Analog Outputs (0/3/6)
- C = Real-Time Clock
- W = White Color (no W = light almond)

Specifications

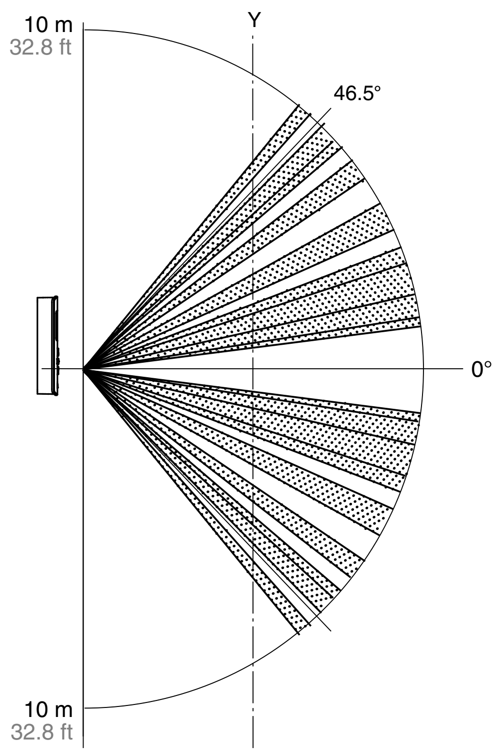
Supply Voltage	24 VAC (+20%/–15%), Class 2
Supply Power	13 VA
Connections	Wire clamp type terminal blocks; 14–22 AWG, copper Four-pin EIA-485
Outputs (up to 9)	Analog outputs (if any) produce 0–12 VDC, **20 mA** maximum Binary outputs (NO, SPST, Form “A” relays) carry **1 A** max. per relay **or** a total of **1.5 A per bank** of 3 relays (relays 1–3, 4–6, and 7–9) @ 24 VAC/VDC
Inputs (IN2–IN4)	Analog 0–12 VDC (active/passive contacts, 10K thermistors)
Display	64 x 128 pixel dot matrix LCD
Case Material	White (standard) or light almond flame-retardant plastic
Dimensions	5.551 x 4.192 x 1.125 inches (141 x 106 x 28.6 mm)
Approvals	UL 916 Energy Management Equipment FCC Class B, Part 15, Subpart B BTL listing pending
Weight	0.48 lbs. (218 g)
Humidity Sensor (Optional)	
Sensor Type	CMOS
Range	0 to 100% RH
Accuracy @ 25°C	±2% RH (10 to 90% RH)
Response Time	Less than or equal to 4 seconds
Motion Sensor (Opt.)	Passive infrared with 10 meter (33 feet) range (see diagrams at right)
Temperature Sensor (without Humidity)	
Sensor Type	Thermistor, Type II
Accuracy	±0.36° F (±0.2° C)
Resistance	10,000 ohms at 77° F (25° C)
Operating Range	48 to 96° F (8.8 to 35.5° C)
Temperature Sensor (with Humidity)	
Sensor Type	CMOS
Accuracy	±0.9° F offset (±0.5° C) from 40 to 104° F (4.4 to 40° C)
Operating Range	36 to 120° F (2.2 to 48.8° C)
Environmental Limits	
Operating	34 to 125° F (1.1 to 51.6° C)
Shipping	–40 to 140° F (–40 to 60° C)
Humidity	0 to 95% RH (non-condensing)

Motion/Occupancy Sensor
Detection Performance

Top View



Side View

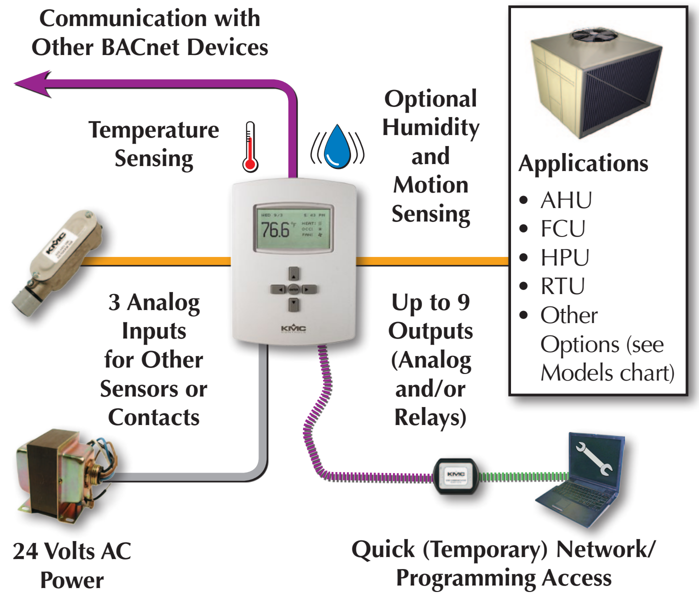


For more details about operation of the motion sensor, see the FlexStat Application Guide (913-019-03).

Accessories

	HMO-10000	Horizontal or 4 x 4 handy box wall mounting plate, light almond (shown)
	HMO-10000W	HMO-10000 in white
	HPO-0044	Replacement cover hex screw
	HTO-1103 (*formerly KMD-5699*)	FlexStat firmware flash upgrade kit
	KMD-5567	Network surge suppressor
	KMD-5575	Network repeater/isolator
	KMD-5576	EIA-485 to USB Communicator
	KMD-5624	PC data port (EIA-485) cable (FlexStat to USB Communicator)—included with the KMD-5576 (buy for third-party EIA-232 interfaces)
	SP-001	Flat blade and hex end screwdriver (with KMC logo) for cover hex screws
	XEE-6111-040	Transformer, 120-to-24 VAC, 40 VA, single-hub
	XEE-6112-040	Transformer, 40 VA, dual-hub

Sample Installation



Support

FlexStats come with a printed Installation Guide. Additional award-winning resources for configuration, application, operation, programming, upgrading and much more is available on the KMC Controls web site (**www.kmccontrols.com**).

KMC Controls, Inc.
19476 Industrial Drive, New Paris, IN 46553
574.831.5250
www.kmccontrols.com
info@kmccontrols.com

STE-6000 Series
Room Temperature Sensors/Transmitters

Description

These compact, stylish, and economical room temperature sensors and transmitters are designed for use in KMC Digital controllers or other building automation systems. They incorporate a 10,000 ohm (@ 77° F) thermistor for precise, stable temperature sensing and offer a variety of features.

The durable, low-profile, thermostat-style cover is visually appealing. These sensors may be surface mounted on a hollow wall or (using an HMO-6036 universal backplate) to a 2 x 4 in. electrical box.

Models

The following models are available:

STE-601x Model Number	Setpoint Adjust		Other Interface Features			Cable Connections			Temperature Output	
	Rotary Dial*	Up/Down Buttons	Override Button(s)	LCD Display	LED Status Indicator	Screw Clamp Terminals	RJ-45 Connector**	EIA-485 Data Port***	10K Ohms Thermistor	0 to 5 VDC Transmitter
6010-10							X	X	X	
6011-10						X			X	
6013-10			X		X	X			X	
6015-10			X		X		X	X	X	
6012-10		X	X	X		X				X
6016-10		X	X	X			X	X		X
6014-10	X						X	X	X	
6017-10	X		X				X	X	X	
6019-10	X		X			X			X	
6018-10	X		X		X		X	X	X	
6020-10	X		X		X	X			X	

*Earlier rotary dial models were marked with ° F or ° C, but dials now have warmer/cooler icons instead of numbers
**Requires KMD-569x sensor to controller cable
***Requires KMD-5624 PC data port cable (see Accessories)

The standard color is almond. To order in white, add a "W" in the place of the hyphen near the end of the model number (e.g., STE-6012**W**10).

STE-6010/6011 STE-6013/6015 STE-6012/6016

STE-6014 STE-6017/6019 STE-6018/6020

Features and Applications

An STE-6014/6017/6019/6018/6020 includes a **rotary setpoint dial** with warmer/cooler icons.

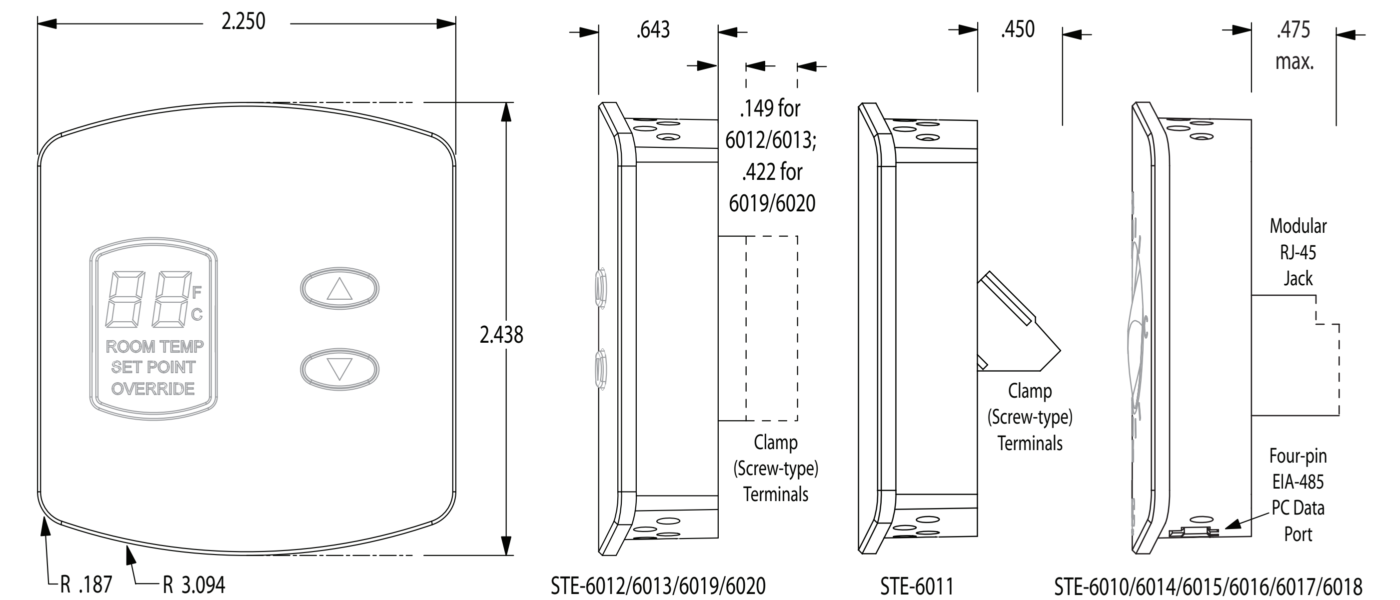
An STE-6013/6015/6017/6019/6018/6020 allows selection of an **override** condition by pushing the **button** on the front. A **green status LED** (not on the STE-6017/6019) illuminates according to the user-defined controller configuration (e.g., during setback/setup or during normal/override modes).

An STE-6012/6016 transmitter includes an **LCD display** for the room temperature and setpoint. The temperature display can be toggled between Fahrenheit and Celsius scales. The **setpoint** is **adjustable via** the **up and down arrow buttons** on the front panel. If the system is in normal/override mode, pressing a button will raise or lower the setpoint. When either button is pushed, the display will toggle from room temperature to the setpoint. When the button is released, the number displayed is the new setpoint, and the display will return to room temperature after ten seconds. If the system is in setback/setup (for heating/cooling) mode, pressing either button selects **override** mode. (See Power Requirements in the Specifications section.)

An STE-6010/6014/6015/6016/6017/6018 includes a four-pin **EIA-485** (formerly RS-485) **data port** on the cover's underside for easy temporary computer connection to the network. (Access with a KMD-5624 cable.)

Dimensions

All dimensions are in inches



Specifications

Connections	Clamp (screw-type) terminals or modular RJ-45 jack (see Models chart)
Material	Flame-retardant plastic, light almond or white
Weight	Approx. 1.25 oz. (35 grams)
Sensor	
Type	Type II thermistor
Accuracy	± 0.36° F (± 0.20° C)
Resistance	10,000 ohms @ 77° F (25° C)
NTC	4.37%/° C @ 25° C
Dissipation Constant	2 mW/° C
Temp. Reading	Thermistor resistance only from all models except the 0–5 VDC voltage output from the STE-6012/6016 transmitter
Rotary Setpoint Pot.	0–10K ohms ±20% (54–90° F or 12–32° C) linear

Front Buttons

STE-6013/6015/6017/6019/6018/6020	One momentary push button, shunts temperature sensor to signal override condition
STE-6012/6016	Two momentary push buttons, signal override condition, adjust setpoint, toggle ° C or F, calibrate temperature reading

Power Requirements

LED Indicator	**10 VDC** (12 VDC max); 5 mA max. current draw at 12 VDC
LCD Display	**7.5 VDC** (10.4 mA max. current draw) for setback/setup mode or **12 VDC** (9.7 mA) for normal/override modes

Approvals CE compliant

Environmental Limits

Display (6012/6016)	35° to 90° F (2° to 32° C)
Operating	34° to 125° F (1.1° to 51.6° C)
Shipping	–40° to 140° F (–40° to 60° C)
Humidity	0 to 95% RH non-condensing

Accessories

HMO-6036	Universal Backplate, Almond
HMO-6036W	Universal Backplate, White
KMD-569**x**	STE-6010/6014/6015/6016/6017/6018 to Controller Cable with RJ-45 to RJ-11 Connectors (-569**3** = 25 ft.; -569**4** = 50 ft.; -569**5** = 75 ft.)
KMD-5624	PC Data Port (EIA-485) Cable
KMD-5576	EIA-485 to USB Communicator

KMC Controls, Inc.
19476 Industrial Drive, New Paris, IN 46553
574.831.5250
www.kmccontrols.com; info@kmccontrols.com

KMC CONTROLS

STE-1400 Series Temperature Sensors

Descriptions and Applications

STE-1400 Series 10,000 ohm, Type III thermistor, temperature sensors are available in different housings for surface, duct, duct averaging, immersion, strap-on, and outside air applications. All probes are constructed to provide good heat transfer and fast response. The averaging sensors are available in both plenum-rated cable or with a copper probe.

Each **STE-1401/1402/1404/1405/1405 duct sensor** is encapsulated in a 1/4-inch OD stainless-steel probe. The probe protrudes from the bottom of the sensor housing (if included), minimizing lead-length error. The probe can be inserted directly into the duct for single-point monitoring, and mounting holes are provided to rigidly support the assembly.

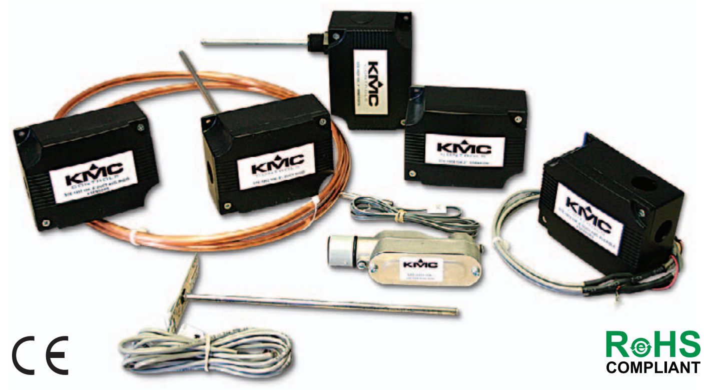
An **STE-1411/1412/1413/1414/1415/1416/1417 averaging duct sensor** incorporates numerous sensors inside a copper tube and is available in a 5/16-inch OD bendable copper probe or in a flexible plenum-rated cable. The completed assembly acts as a single sensor and any temperature change is averaged across the sensor. The probes can be bent to fit any size duct.

An **STE-1421/1422 immersion sensor** is encapsulated in a 1/4-inch OD 304 stainless-steel probe. The probe protrudes from the bottom of the sensor housing, minimizing lead length error. The probe has a 1/2-inch NPT fitting to be screwed into the HMO-4533/4543 brass well or HMO-4534/4544 stainless-steel well.

The **STE-1455 strap-on sensor** is encapsulated in a two-inch-long, 1/4-inch OD stainless-steel probe. The probe has a five-foot lead wire. The **STE-1454** strap-on sensor also comes with an enclosure.

The **STE-1451 outside air sensor** is mounted in a weatherproof gasketed enclosure with a sun shield for protection against the outdoor elements. It comes with an LB c/w 1/2" NPT fitting for connection to conduit.

The **STE-1430 room sensor**, designed for temperature measurement of occupied spaces, can be mounted on an interior hollow wall in a standard single-gang electrical box. The sensor is mounted behind a flat brushed stainless-steel plate.



Features

- Type III 10,000 ohm thermistor encapsulated temperature sensors.
- Available in a number of models to accommodate various installation applications.
- Some models are available in either a black ABS plastic utility box or optional metal enclosure.

Models

STE-1401	8-inch Duct Rigid (w/ 10-ft. plenum-rated cable and w/o enclosure)
STE-1402	8-inch Duct Rigid (w/ 5-ft. non-plenum-rated cable)
STE-1404	12-inch Duct Rigid
STE-1405	4-inch Duct Rigid (w/o enclosure)
STE-1411	6-ft. Duct Averaging (copper)
STE-1412	12-ft. Duct Averaging (copper)
STE-1413	24-ft. Duct Averaging (copper)
STE-1414	20-ft. Duct Averaging (copper)
STE-1415	6-ft. Duct Averaging (flexible)
STE-1416	12-ft. Duct Averaging (flexible)
STE-1417	24-ft. Duct Averaging (flexible)
STE-1421	4-inch Immersion (without well)
STE-1422	6-inch Immersion (without well)
STE-1430	Room, Flat Plate
STE-1451	Outside Air
STE-1454	2-inch Strap-On
STE-1455	2-inch Strap-On (w/o enclosure)

Specifications

Sensor	Type III thermistor, 10K ohm @ 77° F (25° C)
Accuracy	±0.36° F (±0.20° C)
Temperature Limits	
Std. Limits:	–4 to 221° F (–20 to 105° C)
Outdoor Air only:	–40 to 221° F (–40 to 105° C)
Wiring	22 AWG wire leads
Mfg. Process	ISO 9001 registered quality system
Regulatory	CE and RoHS Compliant
Enclosure Ratings	

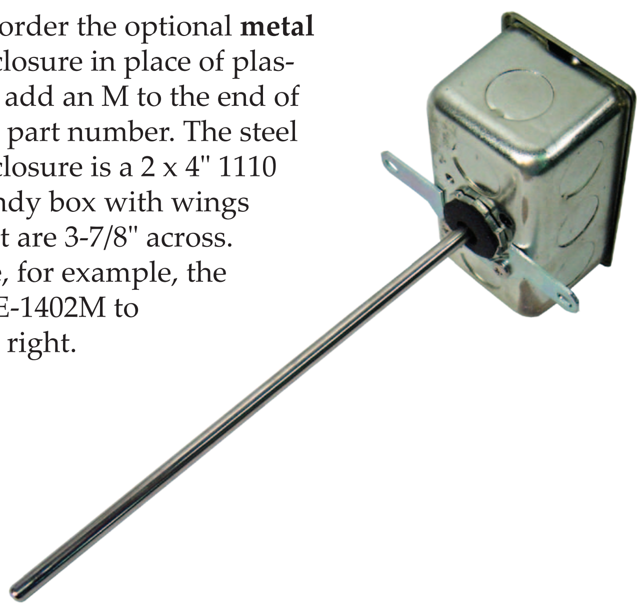
STE-1451 OAT, Aluminum LB	NEMA 4 & IP66
Other metal (steel) enclosures	NEMA 1 & IP30
Rectangular ABS enclosures	NEMA 12 & IP64
STE-1405, STE-1430, STE-1455	(*No Enclosure*)

Enclosures

A black 3.3 x 2.1 x 4.55" (84 x 53 x 116 mm) ABS **plastic** utility box comes as the standard enclosure for these sensors:

STE-1402	STE-1412	STE-1422
STE-1403	STE-1413	STE-1454
STE-1404	STE-1414	
STE-1411	STE-1421	

To order the optional **metal** enclosure in place of plastic, add an M to the end of the part number. The steel enclosure is a 2 x 4" 1110 handy box with wings that are 3-7/8" across. See, for example, the STE-1402M to the right.

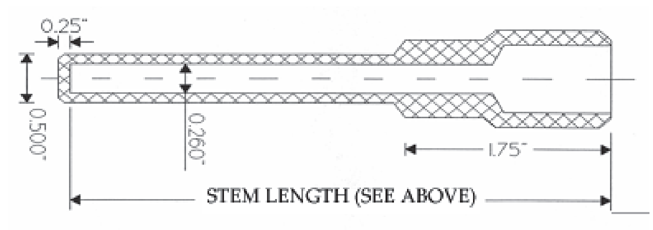


Accessories

For the **STE-1421** and **STE-1422,** these thermowells and thermal compound are available:

HMO-4532	Thermal compound for wells, 1 oz.
HMO-4534	4" 304 Stainless-steel well
HMO-4544	6" 304 Stainless-steel well

NOTE: NPT Thread Size = 1/2"

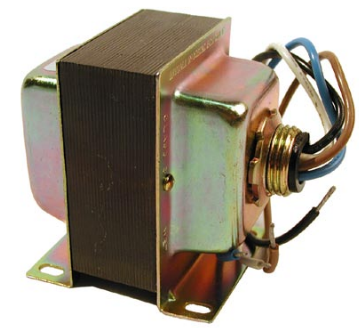


KMC Controls, Inc.
19476 Industrial Drive
New Paris, IN 46553
574.831.5250
www.kmccontrols.com
info@kmccontrols.com

XEE-6000 Series
Transformers

Description and Application

XEE-6000 series transformers can be mounted using either the mounting base pad or the threaded hub(s). Models are available to provide power for UL Listed or UL Recognized applications. All XEE-6100 series transformers 75 VA and higher and all XEE-6300 series multi-tap transformers have a manual reset circuit breaker on the secondary output.



(Single hub shown above—specifications and design subject to change without notice)

Models and Specifications

Model Selection Guide

24 VAC Secondaries—all circuits are non-supervised and all secondaries (except for XEE-6111-150) are power limited

Model #	Primary Voltage	Power Rating	Circuit Breaker	Threaded Hub	UL*	Dimensions (w/o hubs) (inches/millimeters)	Mounting Hole Dimensions
XEE-6111-040	120 VAC 60 Hz	40 VA	None	Single	R C 2	2.7 W x 2.9 H x 2.2" D (68.6 x 73.7 x 55.9 mm)	2.0 W x 1.8" D (50.8 x 45.7 mm)
XEE-6112-040				Dual	L C 2		
XEE-6111-050		50 VA		Single	R C 2	2.8 W x 2.9 H x 2.2" D (71.1x 73.7 x 55.9 mm)	2.0 W x 1.8" D (50.8 x 45.7 mm)
XEE-6112-050				Dual	L C 2		
XEE-6211-050	277 VAC 50/60 Hz			Single	R C 2	2.8 W x 2.9 H x 2.2" D (71.1x 73.7 x 55.9 mm)	2.0 W x 1.8" D (50.8 x 45.7 mm)
XEE-6212-050				Dual	L C 2		
XEE-6311-050	120/240/277/480 VAC 50/60 Hz		Included	Dual	L C 2	3.5 W x 3.1 H x 2.5" D (88.9 x 78.7 x 63.5 mm)	1.9 W x 2.0" D (48.3 x 50.8 mm)
XEE-6111-075	120 VAC 60 Hz	75 VA		Single	R C 2	3.9 W x 3.1 H x 2.5" D (99.1 x 78.7 x 63.5 mm)	2.3 W x 2.0" D (58.4 x 50.8 mm)
XEE-6112-075				Dual	L C 2	3.9 W x 3.1 H x 2.5" D (99.1 x 78.7 x 63.5 mm)	2.3 W x 2.0" D (58.4 x 50.8 mm)
XEE-6311-075	120/208/240/480 VAC 50/60 Hz			Single	R C 2	3.9 W x 3.0 H x 2.5" D (99.1 x 76.2 x 63.5 mm)	2.3 W x 2.0" D (58.4 x 50.8 mm)
XEE-6111-100	120 VAC 60 Hz	96 VA		Single	R C 2	4.1 W x 3.1 H x 2.5" D (104.1 x 78.7 x 63.5 mm)	2.5 W x 2.0" D (63.5 x 50.8 mm)
*XEE-6112-100***				Dual	L C 2 UUKL**		
XEE-6311-100	120/240/277/480 VAC 50/60 Hz			Dual	L C 2	4.3 W x 3.1 H x 2.5" D (109.2 x 78.7 x 63.5 mm)	2.6 W x 2.0" D (66.1 x 50.8 mm)
*XEE-6111-150****	120 VAC 60 Hz	150 VA		Single	REC***	3.5 W x 3.3 H x 3.8" D (88.9 x 83.8 x 96.5 mm)	2.5 W x 3.2" D (63.5 x 81.3 mm)

***UL Certification** R C 2 = UL Recognized Class 2
L C 2 = UL Listed Class 2
UUKL** = Approved for use in smoke control systems
REC*** = UL Recognized (*not for use with Class 2 devices*)

(See Smoke Control Manuals 000-035-08 (BACnet) and/or 000-035-09 (KMDigital) for smoke control application information.)

Configuration Split bobbin design, steel end bells

Wiring 18 AWG leads, 7.5 to 9.5" (191 to 241 mm) long, stripped & tinned

Weight 2.4 to 5.3 lbs. (1.09 to 2.4 kg)

KMC Controls, Inc.
19476 Industrial Drive
New Paris, IN 46553
574.831.5250
www.kmccontrols.com; info@kmccontrols.com

3.3 Literature Review

1. KMC Controls. "Understanding Building Automation and Control Systems". Archived from the original on 19 May 2013. Retrieved 27 March 2013.

2. "CEDIA Find: Cool Automation Integrates Smart Air Conditioners with Third-Party Control Systems". CEPro. Retrieved 16 Jun 2015.

3. Dragoicea, M.; Bucur, L.; Patrascu, M. (2013). "A Service Oriented Simulation Architecture for Intelligent Building Management". Proceedings of the 4th International Conference on Exploring Service Science 1.3. LNBIP 143: 14–28. doi:10.1007/978-3-642-36356-6_2.

4. Asadullah, Muhammad (22 Dec 2016). "An Overview of Home Automation Systems". Conference Paper. IEEE. Retrieved 22 Dec 2016.

5. "Lighting control saves money and makes sense" (PDF). Daintree Networks. Retrieved 2009-06-19.

6. "About VAV". SimplyVAV. Retrieved 5 October 2015.

7. US Dept. of Energy, Pacific Northwest National Laboratory, Building Re-Tuning Training Guide: AHU Discharge-Air Temperature Control

8. TAYLOR ENGINEERING, Resetting Setpoints Using Trim & Respond Logic\

9. TRANE, Engineers Newsletter, Energy-Saving Control Strategies For Rooftop VAV Systems, Supply-Air-Temperature Reset. (Page 2, Column 2, Paragraph 1) Volume 35–4, ADM-APN022-EN (October 2006)

10. "Building Automation System Clawson Michigan Clawson Manor". Retrieved January 3, 2016.

11. Patrascu, M.; Dragoicea, M. (2014). "Integrating Services and Agents for Control and Monitoring: Managing Emergencies in Smart Buildings". Service Orientation in Holonic and Multi-Agent Manufacturing and Robotics. Studies in Computational Intelligence Volume 544: 209–224. doi:10.1007/978-3-319-04735-5_14.

12. Intelligence, Critical (12 April 2014). "European researchers explore the possibility of BACnet botnets". Retrieved 4 September 2016.

13. Khera, Mandeep (1 September 2016). "Is IoT Security a Ticking Time Bomb?". /securityintelligence.com. Retrieved 4 September 2016.

14. Dickson, Ben (16 August 2016). "How to prevent your IoT devices from being forced into botnet bondage". techcrunch.com. Retrieved 4 September 2016.

15. Wendzel, Steffen (1 May 2016). "How to increase the security of smart buildings?". Communications of the ACM. **59** (5): 47–49. doi:10.1145/2828636. Retrieved 4 September 2016.

16. Granzer, Wolfgang; Praus, Fritz; Kastner, Wolfgang (1 November 2010). "Security in Building Automation Systems". IEEE Transactions on Industrial Electronics. **57** (11): 3622–3630. doi:10.1109/TIE.2009.2036033. Retrieved 4 September 2016.

17. Buckman, A. H., Mayfield, M., & B.M. Beck, S. (2014). What is a Smart Building? Smart and Sustainable Built Environment, 3(2), 92–109. https://doi.org/10.1108/SASBE-01-2014-0003

18. DDC Online. (n.d.). An Overview of Direct Digital Controls. Retrieved November 14, 2016, from http://www.ddc-online.org/Digital-Control-Systems/Introduction-to-Direct-Digital-Control-Systems.aspx

19. IEA. (2013). Transition to sustainable buildings: strategies and opportunities to 2050. Paris: International Energy Agency. Retrieved from http://www.iea.org/publications/freepublications/publication/Building2013

20. Brambley, M. (2013, April). Small- and Medium-Size Building Automation and Control System Needs: Scoping Study. Retrieved from http://energy.gov/sites/prod/files/2013/12/f5/emrgtech05_brambley_040213.pdf

21. Granderson, J., Piette, M. A., Rosenblum, B., & Hu, L. (2011). Energy Information Handbook: Applications for Energy-Efficient Building Operations. Lawrence Berkeley National Laboratory, LBNL5272E. Retrieved from http://eis.lbl.gov/downloads/energy-information-handbook.pdf

22. Navigant Research. (2014). Commercial Building Automation Systems. Retrieved from http://www.navigantresearch.com/research/commercial-building-automation-systems

23. The Ultimate Guide to Building Automation. (2015, January 22). Retrieved October 24, 2016, from http://controlyourbuilding.com/blog/entry/the-ultimate-guide-to-building-automation

24. U.S. EIA. (2012). Commercial Building Energy Consumption Survey (CBECS) 2012. Washington, D.C: U.S. Energy Information Administration. Retrieved from https://www.eia.gov/consumption/commercial/data/2012/bc/pdf/b7.pdf