UNIVERSITY OF Southampton

ESTATES & FACILITIES

Document Title

Briefing Notes for B M S

Document Number

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Revision Index.

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A	25/11/05	DA	For review
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U N I V E R S I T Y O F S O U T H A M P T O N

BUILDING MANAGEMENT SYSTEM (BMS) DESIGN NOTES,

FOR M&E DESIGN CONSULTANTS

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BMS Design Notes

SECTION A
A.01 General

All control systems are to be designed around current TREND intelligent outstations.

The complete system, including the H&V control panels are to be designed, supplied, installed, tested, programmed, documented and commissioned by Trend Control Systems or an accredited Trend Technology Centre.
(Referred to hereafter as 'the Specialist Sub-Contractor').

Approved Specialist Sub-Contractors

1.	TREND CONTROL SYSTEMS LTD Field Services Division PO Box 34 Horsham West Sussex RH12 2YF	**f.a.o. Mr Harry Barnes** 01403 211888 Fax: 01403 226321 email: harry.barnes@trendcontrols.com
2.	DALKIA ENERGY & TECHNICAL SERVICES LTD The Connect Centre Kingston Crescent Portsmouth Hants. PO2 8AD	**f.a.o. Mr Paul Thompson** 023 9262 9615 Fax: 023 9262 9663 Email: paul.thompson@dalkiaets.co.uk
3.	ENERGY EFFICIENT CONTROLS LTD Presentation House Kings Business Centre Reeds Lane Sayers Common West Sussex BN6 9LS	**f.a.o. Mr C Gravenor** 01273 835540 Fax: 01273 835541 email: sales@eecltd.co.uk
4.	DWEC LTD Atlantic House 8 Bell Lane Uckfield East Sussex TN22 1QL	**f.a.o. Mr D Woodhams** 01825 760444 Fax: 01825 760446 email: dwec.limited@virgin.net
5.	BRUNEL CONTROL SYSTEMS LTD Gloucester House Gloucester Road Avonmouth Bristol BS11 9AQ	f.a.o. Mr Paul Richardson 0117 923 5955 Fax: 0177 938 1489 email: paul@brunelcontrols.co.uk

The specialist sub-contractor may employ the services of an Electrical Installation sub-contractor for part of the works, but only from the following list of University Approved contractors :-

1.	BSA Regal Electrical Services	Tel : 02380 366401. Mr Richard Weeks
2.	R.F. Webb	Tel : 02380 783666.
3.	Rigfone Electrics Ltd	Tel : 02380 215100. Mr Stuart Young
4.	ACP Electrical Services Ltd	Tel : 02380 328406 Mr S Mathews
5.	N G Bailey	Tel: 02380 230844

Only contractors registered under NICEIC and/or ECA are to be used.

SECTION A

A.02 General

Software configuration, programming and commissioning of the intelligent outstations shall be carried out by the Specialist Sub-Contractor.

The programming is to be written by the Specialist Sub-Contractor in conjunction with the requirements of the appointed Consultant Engineer (Referred to hereafter as 'the Engineer') and the University BMS Engineer.

NOTE :

1. After the Specialist Sub-Contractor has been nominated, they are to arrange a meeting with the Engineer and the University BMS Engineer early in the contract period, to formulate specific software requirement, based on the University Standard Application Macros.

2. Software documentation will then be prepared in provisional form by the Specialist Sub-Contractor, for submission to the University BMS Engineer for approval and comment.
   Early provision of this documentation is vital, to ensure that all requirements are met, prior to any outstation being programmed on site.

3. **All** University software programming notes, as detailed under Section 'B' of this document, will apply and will form the basis of the preliminary software meeting.

A.03 H&V Control Panels

H&V Control Panels shall be manufactured from sheet steel with a minimum thickness of 2.5mm, rigid construction with stove enamel finish and a minimum degree of protection to IP42 as detailed in BS5490.

Paint colour shall be light-grey gloss or other approved BS or RAL standard colour.

Panels shall be constructed for floor or wall mounting with suitable plinths and/or fixing brackets and removable lifting eye-bolts. Removable grand-plates shall be provided at top and bottom for cable, trunking or conduit entry.

Terminals shall be located to suit the outgoing wiring.

A main earth terminal or bar shall be provided within the panel for connection of all incoming earth conductors. All non-current carrying metalwork in the panel shall be connected to earth.

The control panel shall house the motor starters, control relays, contactors, indicator lamps, manual control switches, electronic controllers and intelligent outstations required to meet the operational functions.

All control circuits for starter/contactor coils, indicator lamps, etc., will be **24V ac.** where possible.

Transformer/s for this will be of suitable size to ensure proper operation in the event of power off/power on.

SECTION A
A.03 H & V Control Panels cont.
The panel shall be constructed with two compartments which shall house the equipment as follows :-

Compartment 1

This will house all 415/240V including MCBs/Fuses, Motor Starters, Transformers and control relays with a voltage in excess of 24V ac.

This compartment is to have a main isolator which is **NOT** interlocked with the door. The isolator shall be fitted via an extension back-plate to extend the operator through cut-outs in both inner and outer doors.
This compartment shall be provided with an inner door constructed of clear 'Makralon' sheet, hinged and secured with 'Allen' key drive cap head screws and captive washers.

The Main external door and inner door shall be able to be opened without the need to isolate the supply. The internal door shall be fitted with an appropriate warning labels. "**Caution 415/240V Isolate Elsewhere Before Opening**" and "**Authorised Personnel only**".
The main Isolator shall also be provided with auxiliary contacts, if required, and have facilities for padlocking in the "OFF" position.

Outer doors to be fitted with door locks of approved type.

Indicator lamps are to be mounted on the outer door of Compartment 1 with engraved white/black/white 'Traffolyte' legend plates.

Compartment 2

To have an independently openable hinged door.

Generally only the ELV control voltage (i.e. 24V) shall be present within this section, except where absolutely necessary.

(E.g. Power supplies for Intelligent Outstations, etc.) All wiring and terminals within this compartment with an applied voltage in excess of 55V to earth, shall be fully shrouded, so as to prevent any direct contact during normal routine maintenance. Caution notices shall be fitted to all shrouds and the LV wiring to be kept within separate, labelled cableways.

Panel Components
The integral components of the control panels shall be of the following manufacturer's supply or equal and approved:-

i)	MCBs	-	Klockner-Moeller or Merlin Gerin M9.
ii)	Fuses	-	GEC Redsport with HRC Fuse-links to BS88. (Use only when particularly specified)
iii)	Contactors/Starters	-	Klockner-Moeller. **N.B.** Where Grundfos 'canned' pumps are specified, overload protection is not required, it being built into the pump units.
iv)	Indicator Lamps	-	R.S. Components. 564-914 Control circuit fail. (AMBER) 564-942 Run indicators and panel live. (GREEN) 564-058 Trip/Alarm. (RED)
v)	Main Isolator	-	R.S. Components (Klockner-Moeller). 333-394 or equal and approved.
vi)	Relays	-	R.S. Components Octal or 11 pin plug in types.
vii)	Terminals	-	Klippon 'SAK' or 'W' series. Entrelec 'miniature' series in ELV section, if appropriate.

viii)	Control Switches	-	R.S. Components R.S. 340-229 typical. Miniature rotary cam to IP65. (Kraus & Naimer)

ix)	Cables	-	BASEC approved.
x)	Current Switches	-	Veris Industries Hawkeye H-708 / Sontay PM-CS250 For monitoring all rotating equipment, belt or direct drive.
xi)	APD Controllers	-	Allen-Martin APD/PS or Trend OCC/UP/SW. **N.B.** For presence monitoring requirements in Lecture Theatres, etc. (Associate field equipment see A.05.vi).
xii)	Cable Markers used	-	All internal wiring to be furnished with cable markers at **each** termination point and bootlace ferrules for terminations.

A.04 TREND INTELLIGENT OUTSTATIONS

Outstations shall be complete with all necessary hardware required to provide a fully operational control package integrated onto the existing University network. (Input/output cards, SRMVs, 2RMs, INC units, EINC units, modems, etc.,

N.B. It shall be the Specialist Sub-Contractor's responsibility to ensure that the complete operational requirements are achieved to the satisfaction of the University BMS Engineer. The University BMS Engineer to assign all outstation and LAN numbering.

The Specialist Sub-Contractor shall ensure that the Intelligent outstations have sufficient internal logic/software modules to meet the programming requirements and additional outstations shall be provided if required.

The Specialist Sub-Contractor will be required to make all the appropriate changes to all existing BMS Supervisors, to allow interrogation, diary operation and alarm reporting from all new outstations/LANs installed.
All outstation module labelling to follow the standard as provided under Appendix 1.

The Specialist Sub-Contractor shall provide all 963 Schematic pages to adequately cover the installed systems, to the satisfaction of the University BMS Engineer.

The Specialist Sub-Contractor shall provide full documentation, produced using the Trend 'Set' package, of the installed systems, in duplicate, which must consist of at least the following elements :-

i) Basic control strategy descriptions.
ii) Schematic of any local networks.
iii) Wiring schedules - Trend standard, completed in **FULL.**
iv) Configuration schematics.
v) Sequence tables.
vi) Time zone details.
vii) OSS details.
viii) Sensor types.
ix) Knobs list.
x) Switches list.
xi) Sensor alarm settings.
xii) Inter-controller comms. list.
xiii) Module availability table.
xiv) Analogue and digital node availability tables.

Additionally,

xv) Plant schematics in A4 format, complete with all input/output locations.
xvi) Manufacturers Specification Sheets on all equipment fitted (In panel and remote).

SECTION A
A.O5 Remote Equipment

The Specialist Sub-Contractor shall be responsible for the supply, installation and commissioning of all standard remote equipment for the control system.

Standard Equipment

i)	Outside Air Temperature Sensors	-	TREND T/PO.
ii)	Immersion/Pocket Temperature Sensors Pocket	- -	TREND T/PI/110. TREND POC/SS/8.
iii)	Room Temperature Sensors	-	TREND T/320/C1.
iv)	Duct Air Temperature Sensors	-	TREND T/PD/length/range as specified
v)	Pressure/Altitude Sensors	-	Trend P/IL/4 ½" BSP normal range 0-4 bar or as specified.
vi)	APD Units (Automatic Personnel Detectors) **OR**	-	Allen Martin Ltd. Controllers - APD/PS Type. **N.B.** 1. For inclusion in H&V Control Panel, see A.03 xii for Sensors APD/S Type). 2. 3 wire and screen required between APD/PS & APD/S. Trend OCC/UD detector + OCC/UP/SW Power module and load switching
vii)	Filter Fail Sensor	-	TREND DPSG/300 typical.
viii)	High limit thermostats	-	Satchwell-Sunvic TKR 3501 Range 25°C - 95°C.+ suitable brass pocket.
ix)	Clamp-On Thermostats	-	Satchwell-Sunvic SA1452. Range 46°C - 90°C.
x)	Heat Detectors	-	Gent 7650 SET AT 85°C
xi)	Air Quality Detectors	-	Trend AQ/D

A.06 Remote Equipment not supplied by Specialist Sub-Contractor

The Specialist Sub-Contractor will be responsible for the wiring, connecting and operational checking of various other remote equipment supplied by the Main contractor. The commissioning of the actual equipment itself will be the responsibility of the Main Contractor via his nominated specialist (e.g. The Manufacturer).

Typical Equipment under this category :-

i)	All H&V Control Valves and Actuators	-	Samson Controls Ltd. unless otherwise specified.
ii)	Gas Safety Valves	-	Alexander HWA type.
iii)	Gas monitoring (Leak detection)	-	Sieger Ltd.
iv)	Gas meters	-	P.C. Computers or as specified.
v)	Water meters	-	Samson Controls Ltd.
vi)	Heat meters	-	Samson Controls Ltd.
vii)	Motor Speed Controllers	-	As specified.

SECTION A
A.07 H&V Controls Electrical Installation

The complete electrical installation shall be supplied, installed, tested and commissioned by the Specialist Sub-Contractor. The electrical installation shall comply with all requirements detailed by the Engineer on behalf of the University of Southampton and shall be tested and certified as required by the CURRENT EDITION of the Institution of Electrical Engineers Regulations complete with all amendments to date.

Generally the installation will comprise the following elements :-

i) All H&V Controls.
ii) Lighting and power requirements within boiler-houses and plant chambers.
N.B. Mains incoming supply by others, unless specified.
iii) Local fire interlocks within plant chambers and boiler houses.
iv) Gas leakage detection equipment within boiler houses.
v) Metering.

A.08 Plant Wiring

Within the boiler houses/plant chambers all 415/240V a.c. wiring shall be carried out in single hi-temp. PVC cable enclosed within galvanised screwed conduit and/or galvanised trunking. All signal cabling is to be segregated when sharing the same trunking with 415/240V a.c. lines, or is to be installed in a completely separate conduit/trunking system. Alternatively signal cables may be run on light gauge galvanised cable tray and affixed with cable ties.

Multi-core Signal cables will generally be individually screed types for all analogue inputs and overall screed types for digital inputs, their respective type will be indicated on the drawings.
N.B. Where a single multi-pair is used for a mix of both analogue and digital inputs, the higher spec. individually screened type must be used.

Final connections to plant and remote equipment will be via flexible conduits where applicable, or compression glanded into component-entry with any hanging cable protected with a nylon spiral-wrap, to afford some additional mechanical protection.
N.B. This latter method applies **ONLY** to ELV signal cables for transducers.

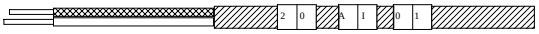
All conduits trunking and trays installed must be suitably bonded to earth. Copper bonding links will be used on all tray and trunking joints.

All pipework shall be bonded as it enters or leaves the boiler house or plant chamber using a suitably sized, PVC insulated copper conductors enclosed within a conduit/trunking network and shall be taken back to the main earth terminal on the H&V Control Panel, or where applicable, the local distribution board.

SECTION A
A.09 Cable Identification Outstation Input/Output)

All input/output cables are to be identified at each end using R.S. Components heat shrinkable cable markers of the appropriate size.

Coding will be to the following pattern :-



Outstation Ref. No.

Input/Output Number

Type of input/output

AI = Analogue input
DI = Digital input
AO = Analogue output
DO = Digital output

N.B. Multi-pair cables will require an overall identification Ref: on the outer sheath, using appropriate size heat shrink markers. Reference to be as per tender drawings.

SECTION A

A.10 Connections to Existing on Campus Network

Where buildings are to be connected to the existing Main Campus BMS network system, the **minimum** requirement for the cable link will be a **9 pair**, individually screened cable. Conductor size 7/0.25mm : 22 a.w.g.

Pairs	Designation
1	Network Tx
2	Network Rx
3	Audio for plug-in intercom system
4	FIRE ALARM
5	SECURITY ALARM
6	
7	
8	
9	

N.B. At design stage the number of screened pairs must be determined upon alarm requirements, plus at least two spares for future usage. Alarms would include such as :-

Lift Alarms
Emergency Lights/Power fail
Any special alarm by departments such as CO_2, Fluorine, etc.

N.B. More than one multi-pair cable may be used for cost effectiveness.

Cable Specification

	2 pair	3 pair	9 pair	12 pair	27 pair
R.S.	367.959	367.886	367.892	368.334	360.914
Alpha	2466	6010	6014	6017	6022
Belden	8723	8777	8774	9768	8773
UL	2493	2493	2493	2493	2919

A.11 Boiler House Safety Equipment

Every boiler house shall be furnished with the following safety components :-

1. Emergency lock/stop buttons adjacent to each entry/exit point.

2. Suitable Sieger gas-leakage detection system.

3. Fixed temperature heat detectors, mounted directly over the boilers. Number required will depend on number and layout of the boilers.

4. 2-pole changeover, fire alarm relay, - activated from the auxiliary of the local fire alarm panel.

5. Main gas safety shut-off valve (Maintained open type).

6. Any additional fire alarm components, compatible with installed/proposed building fire alarm system, as detailed at time of tender.

SECTION A
A.11 cont.

NOTES

Items 1 to 4 listed above are to form a hard-wired series safety interlock circuit, which will interrupt the main panel control circuit to provide plant shut-down, release of main gas valve and to provide an input signal to the local BMS.

The Sieger gas detection unit under item 2 will also provide a second input signal to the local BMS for low-level/fault condition monitoring.

The second pole of the fire alarm relay under item 4 will provide an input signal to the local BMS for software interlocking as required.

SOUTHAMPTON UNIVERSITY BMS Design Notes

SOFTWARE/CONFIGURATION

SECTION B
B.01 General

These notes are to be used in conjunction with the University **MACRO** file by the Specialist Sub-Contractor for the design of Caradon-Trend Outstation software for H&V Control in University buildings.

They will form the basis for the preliminary software briefing, which is to be held between the University BMS Engineer, the Consultant Engineer and the Specialist Sub-Contractor, shortly after his appointment.

The Specialist Sub-Contractor will retain **FULL** responsibility for the safe and proper operation of all equipment covered by the software, based on these notes and the macro files.

B.02 Major Alarm Inputs

The Main Campus is furnished with an extensive Trend BMS network and a separate Central Alarm System bus, this latter being used to handle all secure alarms on campus.
Alarms connected to the Central Alarm System bus are de-coded via Outstations 20-23 on Lan1 which are located in the north basement of Building 10. Outstations 20-23 report all alarms to the main supervisor on Node1 LAN1.

N.B. LAN 1 is regarded as secure and is capable of operation under complete power failure conditions.
The 24Hr Central Control Room (CCR), located in B35, is also part of the secure system and all equipment located here is backed by an emergency generator and individual UPS units.

Alarms connected to the Central Alarm System bus would include the following :-

i) FIRE ALARM
ii) SECURITY ALARMS
iii) EMERGENCY LIGHTS WARNING (or Power fail)
iv) Specific departmental alarms (CO_2, fluorine, etc.).

N.B. Where alarms of the above category are used by the local software for control and interlock purposes, they will be received by the local outstation via two sources :-

viz. i) Direct digital input.
ii) Inter-controller Comms. via Central Alarms outstation.

Example : FIRE ALARM
A local fire alarm panel, in the event of a 'Fire' condition, must provide a state-change for two voltage-free N/C contacts, (open on alarm). An auxiliary relay must be provided if this is not possible.

Contact 1 will provide a normally-closed contact for use by the direct digital input of the local outstation.
Contact 2 will provide a normally-closed contact for connection to the Central Alarms bus system.
The Central Alarms system will de-code the alarm and then signal the local outstation via Inter-Controller Comms.

N.B. It is essential that the Inter-Comms. signal is sent to the same local outstation as the direct digital input so they can be either/or'ed in software for simplicity. Secondary, local Inter-Comms. can then be sent to other outstations within the same building where necessary.
All local building outstation generated alarms which are designated as critical are to be routed to Node1 LAN1, with re-transmissions for all 'engineering' alarms as appropriate. (See, **B.20 Alarms**)
In the event of it being impossible/impractical to achieve connection to the main campus network/Central Alarms, the major alarms will be wired to a dedicated outstation directly adjacent to the associated autodial modem and all network components and local outstation shall be provided with battery back-up. This will ensure alarm transmission to the main supervisor in the event of power failure.
The Ethernet, TCP/IP link, though not guaranteed, is deemed an acceptable risk.

SECTION B
B.03 Master Switches

Where a single outstation provides control for a whole building, it shall have the following 'soft' master switches set-up.

Switch 1	(18,Ø) Holiday/Normal	ON = normal
Switch 2	(18,1) Summer/Winter	ON = winter
Switch 3	(18,2) Fireman's Smoke Vent	ON = ON (normally OFF)

Where more than one outstation provides control for a building, the lowest Ref: outstation shall be assigned to the main boilerhouse or plantroom and be provided with the above switches.
The master-switch logic will then be sent via Inter-controller Comms. to act on all other outstations within the building as required.
On the large complexes, consisting of a number of individual buildings, each building's lowest outstation will carry the three master switches. Switches 1 and 2 will then be over-written from one block (usually the lowest assigned e.g. Block 'A'), using global text comms. with an Attribute 2 set-up to represent the complex name. (E.g. Montefiore Hall = MONTY).

This set-up will allow easy mastering of the whole complex, but still allow individual blocks, required to be operational, to be locally over-written.

Switch 1 18,Ø) Holiday/Normal
When switch 1 is in the 'ON' mode all plant is to run normally under the dictates of the local time-zones.

When switch 1 is in the 'OFF' (Holiday) mode all plant operation is halted, but **FULL** frost protection is still available.

Switch 2 (18,1) Summer/Winter

When switch 2 is in the 'ON' mode all plant is to run normally under the dictates of local time-zones.

When switch 2 is in the 'OFF' (Summer) mode all heating plant, unless of a special nature, shall be blocked from operation.

N.B. i) Supply and extract ventilation fans are to be left fully operational, but their interlocks with LTHW supplies etc. will require blocking.

ii) HWS calorifiers with immersion-heater facilities will be automatically engaged and controlled, with any unnecessary primary pumps and controls blocked from operation.

iii) All high and low level space temperature alarms are to be blocked where cooling is not provided.

Switch 3 (18,2) Fireman's Smoke Vent

Switch 3 is only to be placed in the 'ON' mode at the dictate of a Fire Officer's request after a genuine fire. All extract fans are to run, clearing the building of smoke.

N.B. A Fire alarm signal will cease **ALL** fan operation.

On larger buildings where definitive fire zones are present, more than one Smoke-Vent switch may be required, where this is required all additional switches **MUST** be adjacent to 18,2, viz. 18,3; 18,4; etc.

N.B. When called for operation, the fire signal will possibly still be present and operating logic must allow for this contingency.

SECTION B
B.04 Frost Protection

Two-staged frost protection shall be provided for general plant protection, activated from a common boiler return or heating-calorifier return sensor.

Stage 1 (Water temperature <=2°C.)
Usually as set on soft-knob 1 (221). On activation, all duty water circulators are to operate.
N.B. All control valves held in closed positions are to be over-ridden to allow full circulation.

Stage 2 (Water temperature <=1°C.)
Usually as set on soft-knob 2 (222). On activation, boilers are to fire or calorifiers return to operating set-points.
N.B. i) A band of +/-0.5°C. is to apply to both stage levels to give hysteresis.
ii) During normal time-zone operation frost protection is to be over-ridden to allow plant to operate at normal parameters.

Where air-handling units are installed with water fed heating coils, separate frost provision shall be made to initiate operation of relevant constant temperature heating pumps and to fire boilers/bring calorifiers to normal operating set-points.

N.B. i) Ideally, a temperature sensor should be fitted adjacent to every heater battery on its down-stream side (off-coil) and configuration logic set up to monitor and control as :-
When plant is in the 'OFF' mode on sensing a temperature <4°C. at any of these sensors, constant temperature pumps to operate and boilers fire/calorifiers operate at normal, until a minimum temperature of 8°C. is realised by all sensors.

ii) The sensors described above will have the additional function of inhibiting fan operation at any time, should it sense a temperature <4°C. (Hysteresis will be required on this action and the logic used for the 8°C. minimum may be used for convenience of programming).

iii) During normal time-zone operation all air handling units will be provided with a minimum off-coil temperature requirement of 16°C. as part of the control function.

iv) All control valve over-ride signals are to be removed to allow proper operation of frost protection.

Internal space temperatures shall also be monitored for protection and key space sensors identified for this purpose. Protection level shall be 'on' <=8°C. 'off' >=10°C. Internal space protection shall be as zone control and will operate zone plant as if called by normal time-zone whilst within the protection band of temperature.

B.05 Boiler Control

Where more than two in number boilers are formatted together, they shall be operated under sequence control, generally as described under University Macro MAC/B2 + MAC/B3.

Soft knobs will be provided for :-

i) Max. flow temperature - desired temperature 82°C. for LTHW.
ii) Total number of boilers available for service.
iii) -x) Boiler stand-by assigned number.
viz. Ø = lead boiler
1 = 1st stand-by
2 = 2nd stand-by
etc.

Sequencing shall be mastered from a temperature sensor in the common return header.

SECTION B

B.05 cont.

LTHW boiler modules shall each be provided with a flow temperature sensor used to both monitor and control the boiler temperature. Normal boiler twin-thermostat shall be set to operate as a two-stage limit control.

viz. Normal control thermostat set at 90°C. for stage 1 limit with high limit thermostat set at 100°C. as normal.

All LTHW boiler modules will be furnished with an electrically operated two-port control valve (actuator to be 24V a.c. with 0-10V d.c. positioning signal) or a dedicated pump. A software test is to be made to identify the boiler selected for 'lead' duty and its associated valve/pump will be held in the fully-open/run mode position to ensure adequate water circulation via primary circuits during zone demand periods.

Stand-by modules will command the back-end valves/pumps to operate as they are required to fire, but provision must be made to ensure that this occurs prior to burner ignition, and for an adequate period after ignition 'off' to protect against excess temperature rise.

Where output channels are limited boiler/valve or boiler/pump units may be serviced from a single output using a 2RM.

Boiler modules are to be provided with alarms for a) common lockout and b) common high temperature trip.

B.06 Calorifiers from LTHW CHP nSource

Where calorifiers are used from the existing CHP source the primary 2-port control valve/actuator shall be operated under P+I control from a sensor within the secondary shell, (actuator to be 24V a.c. with 0-10V d.c. positioning signal).

N.B. Flow limitation and high-temperature limitation shall be provided by Samson direct-acting controls, which will also cover power-fail protection. Samson 2212 hi-limits shall be equipped with a dry-contact switch for indication of high-limit to the local outstation.

When any heating zone, taken from the calorifier secondary, is called into operation, the calorifier set-point will change from set-back (60°C.) to normal operation (82°C.). (Values quoted are general).

When the last heating time-zone requirement is removed, the set-point shall be automatically depressed to set-back level as defined by a soft knob. Logic timers with an off-delay, will be required for each zone to allow pump-down **after** calorifier set-point has been depressed.

N.B. During final pump-down, zones with 3-port valves must place them in the fully open position.

SOFTWARE/CONFIGURATION

SECTION B
B.07 Automatic Personnel Detectors (APDs)

All reasonably sized areas identified as not being permanently occupied, such as Common Rooms and Lecture Theatres, etc. are to be mastered by APDs to save energy and provide fully-automatic 'out-of-hours' operation.

Operating sequence is given as for a Lecture Theatre with ventilation plant :-

Assume, out of time-zone requirement and non-occupied as start of sequence.

i) Outside time-zone demand and no occupation
- Plant off (but Frost protected).

ii) Time-zone demand but, no occupation
- Constant temperature pump starts to supply heater battery, if not already operating for other demands.
- Constant temperature circuit flow to heater battery monitored.
- Control valve for heater-battery to demand position.
- On sensing constant temp. supply >55^{o}C. both supply and extract fans start.
- Loop set-point select to occupied at set-back level 17^{o}C. **N.B.** Min. off-coil 16^{o}C.

iii) Occupied during time zone demand
- APD triggers internal timer of control unit set for 30 sec. Control unit output signals outstation input and starts a delay 'on' logic timer set @ 60 sec. after both times have timed-out and assuming occupation still sensed, occupied set-point is raised to normal 19^{o}C. level.

iv) Non-occupancy sensed
- APD timer drop out and signal during time zone demand is lost to the outstation input delay 'on' logic timer set-up for also delay 'off' holds system on for 15 mins. To stop short-term pulsing.
- After 15 mins. system reverts to 17^{o}C. set-point.

v) Occupancy sensed out of time zone demand
- APD triggers internal timer of control unit which then triggers outstation logic timer after which control as under (ii) but set-point 19^{o}C.

vi) Outside time-zone demand and no occupation
- Plant off after 15 minutes.

SECTION B

B.08 Temperature Sensor Alarms

Generally all low-temperature heating and high temperature cooling space sensor alarms are to be blocked individually when outside their time-zone requirements.
Delay before enable will also be required on sensors controlled by OTP zones. OSS zone sensor alarms to be active between occupancy start and stop times.
Due regard is to be paid also for any plant called to operate normally outside their standard zone times, e.g. lecture theatres under APD control.

N.B. All high-temperature space alarms are to be blocked by the Summer/Winter switch when in the 'Summer' mode, with the exception of plant with cooling facilities.

When plant is selected for summer and holiday modes (W1 = 0 & W2 = 0) a global sensor inhibit may be placed on all high and low alarms if no altitude or water-meter dummy sensors are present, as this mode is a total plant shut-down with no frost protection.

B.09 Altitude Sensor Interlocks

All water systems are to be fitted with altitude sensors and their high and low alarm limit levels are to be permanently enabled. Both limit levels are to activate a single, common critical alarm.
High/Low altitude shall also be interlocked with the plant to afford protection, e.g.

LTHW Systems

i) Burner operation is to be halted.
ii) Pump operation is to be halted.

HTG/HWS Calorifiers

i) Primary controls to be driven to the closed position.
ii) Secondary pump operation is to be halted.

B.10 Air Handling Unit Filters

Unless specified, AHU filters will be monitored only for 'clogged' condition, no plant control action is necessary unless particularly specified (e.g. Clean-Rooms).

B.11 Duty/Stand-by Pumps

Duty/Stand-by pumps will **not** be programmed for auto-changeover unless specifically requested. A soft switch will provide this facility for operation by the staff at the main supervisor, on receipt of the relevant read-back alarm.

Duty/stand-by pumps are to be controlled via a single output channel switching both duty and stand-by via an 2RM.

Pump status monitoring for duty/stand-by pump sets will be via a single current switch. Similar phases from each starter are to be run through the current transformer.

N.B. Additional logic is required to block read-back signals from the un-selected pump.

SECTION B

B.12 Plant Soft Switches

Where possible all individual plant components are to be provided with soft OFF/AUTO switches.
Where the number of available switches is limited, duty/stand-by pumps/fans may be switched OFF/AUTO as a pair.

B.13 Valve/Actuator Over-Ride

All 2 and 3 port control valves are to be driven to the 'closed' position (or fully by-pass) when not required to operate as normal, to stop gravitational heat losses.
N.B. Frost protection must over-ride this where necessary.

B.14 Valve Actuators Generally

Unless specified all control valves are to operate from 24 a.c. with a 0 - 10V d.c. positioning signal.

B.15 Output Cards

Only analogue output cards shall be used for plant switching and control via the relevant output modules.
(SRMVs, 2RM, etc.).

B.16 Counter Re-Sets

All counter re-set bits are to be assigned to specific internal digital bits, to restrict access to configuration users only, and to save switch availability.

B.17 Inter-Controller Comms.

Where possible all I.C. Comms. shall be set-up as the 'TO' variety with a time interval set to Ø minutes.
Transmission only to occur due to a specified 'significant signal change', thus keeping network transmissions to a minimum.

B.18 Metering

The following metering equipment will be provided where applicable :-

a) **Gas Meters**
Pulse count facility from Gas Board's meter to monitor boilerhouse consumption.

N.B. Where a single main meter of the Gas Board supplies several individual boilerhouses, auxiliary meters per boilerhouse must be provided.

Meters are to provide a voltage-free contact pulse with a closure of not less than 16mSeconds (=> 16mS).
Preferred pulse value = 100 $ft.^3$.
Preferred Manufacture - P.C. Compters Ltd.

SECTION B
B.18 Metering cont.

b) **Heating Cold Feed to F & E Tank Meter**

Pulse-count facility from make-up cold-water meter to monitor for system leakage.

Meter to provide a voltage-free contact pulse with a closure of not less than 16mSeconds (=> 16mS).

Preferred pulse value = 1 litre.
Preferred Manufacturer - Samson/Spanner-Pollux.

c) **DHWS cold-water supply Meter**

Pulse-count facility from make-up cold water meter to monitor usage.

Meter to provide a voltage-free contact pulse with a closure of not less than 16mS (=> 16mS).

Preferred pulse value = 100 litres.
Preferred Manufacturer - Samson/Spanner-Pollux.

d) **Fuel Oil (35 sec. Redwood) Meter**

Individual line metering is not required for BMS purposes. Where oil storage tanks are installed tank contents are to be monitored by static head pressure transducers.

Transducer Type : 4 - 20mA or 0-10v d.c. Range. As required.
Preferred Manufacturers : KDG. GEC. Bailey and Mackey.

B.19 Plant Soft Start-Up

All driver outputs are to be provided with a start delay time (Option 'T' within driver module), to provide a soft-start sequence for power on.

B.20 Alarms

All alarms are to be received by the main supervisor at Node 1, LAN 1.
But, only particular alarms requiring immediate attention 24/7 are to be displayed on the Main Supervisor and these will all require specific user pages to be prepared to detail the action required by the CCR staff.
All alarms received at the main supervisor are to be processed by the existing alarm filters which operate by Building number, those not required for display are to be re-transmitted as appropriate to the following locations:

Energy Centre	Node 95 LAN7.	All alarms not displayed at the main supervisor.
North Halls	Node 95 LAN32.	All alarms associated with north Halls.
South Halls	Node 95 LAN22.	All alarms associated with south Halls.
B62 Boldrewood	Node 01 LAN19.	All alarms associated with B62.

SOUTHAMPTON UNIVERSITY M&E Services **APPENDIX 1**

BMS ABBREVIATIONS FOR CONFIGURATION LABELS **SHEET 1 OF 3**

AHU	Air-handling unit
AL	Alarm
ALT	Altitude
AT	Area Temperature (or Room temperature)
APD	Automatic personnel detector
AUTO	Automatic
AVE	Average
B	Building
BH	Boilerhouse
BLR	Boiler
BST	Boost
C	Compensated
CAL	Calorifier
CHTGV	Compensated heating valve
CON	Constant
CON.T	Constant temperature
CONV	Convector
CLG	Cooling
CTL	Critical
CNTR	Centre
CUM	Cumulative
CV	Control Valve
D	Dummy
DMD	Demand
DP	Differential pressure
DTY.SL	Duty select
E	East
EF	Extract Fan
EXTN	Extension
F	Fan
FCU	Fan cool unit
FLOW	Flow
FLT	Filter
Fcoil	Frost coil
FpLv	Frost protection level
G	Gauge
GNL	General
GP	Gauge pressure
HBCV	Heater-battery control valve
H	Hand
HI	High
HL	High-limit
HM	Heat-meter
Hol	Holiday
HTG	Heating
HUM	Humidity
HWh	Heat-wheel
HWS	Hot-water service (Domestic)
IC	Inter-communications
IH	Immersion heater
IU	Induction unit
Lv	Level

Lh	Left (hand)
LL	Low-limit
Lo	Low
L.Rm	Lecture-room
LT	Lecture-theatre
LTHW	Low temperature hot water
MAN	Manual
MAX	Maximum
Min	Minimum
MPHW	Medium-pressure hot water
N	North
No	Number
NORM	Normal
NOCT	Non-occupied temperature
O/A	Off/Auto
OAT	Outside-air temperature
OCCT	Occupied temperature
OFC.HUM.	Off-coil humidity
ONCT	On-coil temperature
OFCT	Off-coil temperature
OFF	Off
ON	On
O/R	Over-ride
OSS	Optimiser Stop/start
OTP	Optimum Time Profile
PRI	Primary
PCV	Primary control valve
PMP	Pump
PR	Plant room
RH	Right (hand)
%RH	% Relative Humidity
RM	Room
Rset	Re-set
RTN	Return
S	South
S.BY	Stand-by
SCV	Secondary control valve
SEC	Secondary
SEQ	Sequence
SF	Supply fan
Sl	Select
SP	Set-point
SPLY	Supply
ST	Status
STG	Stage
SW	Switch
T	Temperature
V	Valve
W	West
WM	Water-Meter
WT	Water temperature
Z	Zone

Examples:-

Label$	Unit %	Type
NZ CHTG PMP 1 O/A		switch
NZ CHTG PMP 2 O/A		switch
NZ PMP 1/2 DTY.SL		switch
HTG SYSTEM ALT	bar	sensor
AHU 1 OFCT	deg C	sensor
BOILERS NOCT	deg C	knob
BOILERS OCCT	deg C	knob
AHU 1 RTN AIR HUM	%RH	sensor
STG 1 FpLv	deg C	knob

BMS STANDARD SETTINGS **SHEET 1 OF 4**

Sensor Types (Only 'badged' Trend sensors are to be used)

1 Trend PRT Immersion sensor	T/PI/110
2 Trend PRT Space sensor	T3/320/C1
3 Trend PRT Duct sensor	T/PD-S /40 or T/PD-L/40
4 Trend PRT OAT sensor	TB/TO
5 Trend Pressure sensor	PIL/4 0-4bar
6 Trend air quality(%CO2) sensor	AQ/S or AQ/D
7 Trend PRT High temp. Immersion sensor	T/PI/160
8 Trend Humidity sensors	H/ST or H/DT

OSS Modules

Desired internal Set-point	20	degC
Warm-up limit	240	mins.
Cool-down limit	120	mins.
Start elevation (HTG)	-1	degC
Stop elevation (HTG)	0	degC
Start elevation (CLG)	1	degC
Stop elevation (CLG)	0	degC
Real medium temperature used where possible by specifying address		
Medium temperature if address set 0	65 -80	degC

Normal time-zones for Teaching Blocks

09:00 - 17:00	Mon. - Fri.
00:00 - 00:00	Sat. - Sun.

Normal time-zones for Residential Blocks

06:30 - 09:30 16:30 - 23:00	Mon. - Fri.
06:30 - 23:00	Sat. - Sun.

Frost Protection

Boiler return temperature and/or OAT		
General 1st Stage frost protection (Pumps on)	2	degC
General 2nd Stage frost protection (Pumps & Boilers on)	1	degC

NB If Hysteresis modules used for control set as:

Stage 1 level=2.5 degC:Band=1 degC
Stage 2 level=1.5 degC:Band=1 degC

Minimum Space-temperature to over-ride Htg. plant on	6	degC
Off level for above over-ride	8	degC

NB If Hysteresis module used for control set as:

(level=7 degC:Band=2 degC)

AHUs minimum ONCT/OFCT for frost protection	3	degC

NB If Hysteresis module used for control set as:

(level=3.5 degC:Band=1 degC)

MPHW Systems

Boiler flow sensors	High alarm	Delay 4min.	165	degC
	Low alarm	Delay 4min.	115	degC

NB Low alarm only active when boiler called for operation and delay timer operated for pre-purge cycle/warm-up.

Control settings:-

Sliding 2-Stage types:

High-limit thermostat/sensor		Diff. 8 degC.	155	degC
Flame-out thermostat/sensor		Diff. 5 degC.	144	degC
High/Low flame thermostat/sensor	Diff. 5 degC.	141	degC	
Night Set-back if fitted		Diff. 8 degC.	120	degC

NB Differentials are additive.

System operating pressures

Normal operating pressures	7	bar
High alarm setting	7.8	bar
Low alarm setting	6.5	bar

Alarms enabled at all times

LTHW Boilers/Calorifiers

Normal Htg. Control OCC set-point		82	degC
Sensor high alarm Permanently enabled	Delay 10 min.	95	degC
Sensor low alarm Enabled OCC period only	Delay 10 min.	70	degC

NB Pre-heat and frost-protection do not enable low alarm

NOC Set-point Calorifiers	60	degC
NOC Set-point Boilers(LTHW)	15	degC

LTHW system altitude sensors

High alarm set. Norm.system press.	+15%	Delay 4 min.	x	bar
Low alarm set. Norm.system press.	-15%	Delay 4 min.	y	bar

NB Alarms permanently enabled

Auxiliary High-limit trip thermostats	95	degC

DHWS Systems

Normal control set-point		55	degC
High alarm setting	Delay 4 min.	60	degC
Low alarm setting	Delay 15 min.	50	degC

NB Alarms permanently enabled where systems operate 24 hrs.

Kitchen control set-point		60	degC
High alarm setting	Delay 4 min.	65	degC
Low alarm setting	Delay 15 min.	55	degC

System altitude settings

High alarm set. Norm.system press.	+15%	Delay 4 min.	x	bar
Low alarm set. Norm.system press.	-15%	Delay 10 min.	y	bar

NB Alarms permanently enabled.

Air Handling Units

Constant temperature discharge systems

OFCT OCC Set-point		22	degC
OFCT NOC Set-point		2	degC
High alarm setting	Delay 4 min.	28	degC
Low alarm setting	Delay 10 min.	18	degC

NB Alarms only enabled during OCC after a delay of 15 mins.

Compensated Temperature discharge system

Schedule	20 degC OFCT @ 20 degC OAT 35 degC OFCT @ 0 degC OAT		
Minimum OFCT		18	degC
Space temperature set-point, if applicable		20	degC
OFCT high alarm setting	Delay 4 min.	45	degC
OFCT low alarm setting	Delay 10 min.	15	degC

NB Low alarm enabled only after 15 mins from OCC start

Set-Point control system

Space temperature set-point	20	degC	
Minimum OFCT (Low limit)	18	degC	
OFCT band for cascade operation	18 - 35	degC	
Space sensor high alarm setting	Delay 10 min.	25	degC
Space sensor low alarm setting	Delay 10 min.	17	degC
OFCT sensor high alarm setting	Delay 4 min.	40	degC
OFCT sensor low alarm setting	Delay 4 min.	18	degC

NB Space and OFCT sensor alarms enabled 15 mins. after OCC during winter mode only.

Minimum water flow temperature for fan operation	50	degC	
High alarm setting	Delay 4 min.	90	degC
Low alarm setting	Delay 10 min.	50	degC

NB Alarms enabled 15 mins. after OCC during winter mode only

ONCT sensor high alarm setting	Delay 10 min.	28	degC
ONCT sensor low alarm setting	Delay 4 min.	-1	degC
ONCT Fan operation inhibit SP		-5	degC
ONCT Frost protection SP		2	degC
Minimum valve position at Frost protection SP		8	%

Air-Quality Control

Maximum %CO2 set-point	0.4	%
High alarm setting	0.45	%
Low alarm setting	N/A	

LTHW Compensated Heating

Schedule	20 degC flow @ 20 degC OAT 82 degC flow @ 0 degC OAT			
Minimum flow set at			30	degC
Flow sensor high alarm setting	Delay 4 min.		90	degC
Flow sensor low alarm setting	Delay 10 min.	30	degC	

NB Alarms only enabled during OCC/Winter mode

Room temperature re-set when used:-				
Flow temperature reduction for every 1 degC above room-set-point.			2.5	degC
Space temperature set-point			20	degC
Space high alarm setting	Delay 10 min.		25	degC
Space low alarm setting	Delay 10 min.		17	degC

NB Alarms enabled only during Winter OCC mode.

Loop deviation alarm set during Winter OCC mode			+/- 5	degC

Constant Temperature Heating

Set-point		82	degC	
Flow sensor high alarm setting	Delay 4 min.		90	degC
Flow sensor low alarm setting	Delay 10 min.	50	degC	

NB Sensor alarms enabled 15 mins. after OCC during winter mode only.

OAT sensor high alarm setting	Delay 10 min.		28	degC
OAT sensor low alarm setting	Delay 10 min.	-2	degC	

CRITICAL ALARMS

General Plant critical alarms report to	PNC+	Node #14 LAN 1
Security alarms report to	PNC+	Node #15 LAN 1

Critical alarms used for:-
Fire alarms
Lift alarms
NB All above ONLY when connection to CENTRAL ALARMS SYSTEM not possible.
Boiler lockout alarms
Pressurisation Unit alarms
Special alarms
e.g.Clean-room pressure fail
Gas alarms
Equipment failure

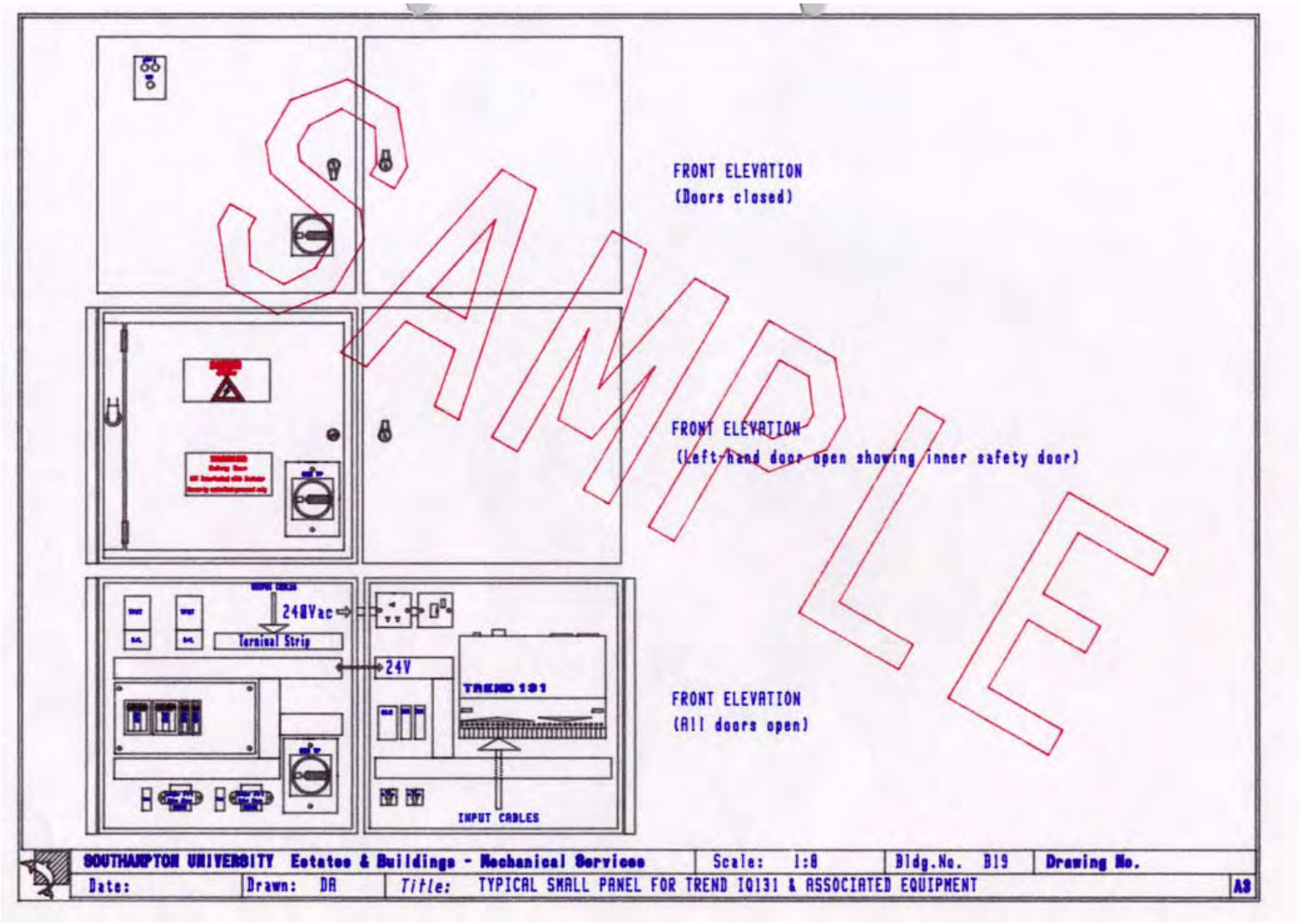
Due to the small number of critical alarms available within the IQ panels, some boilerhouse service alarms may be required to be integrated.

e.g. 1. HWS system and HTG system altitude alarms.		Send as 'Altitude fault'.
2. Boiler high-limit trip(s) and boiler lockout(s).		Send as 'Boiler fault'.

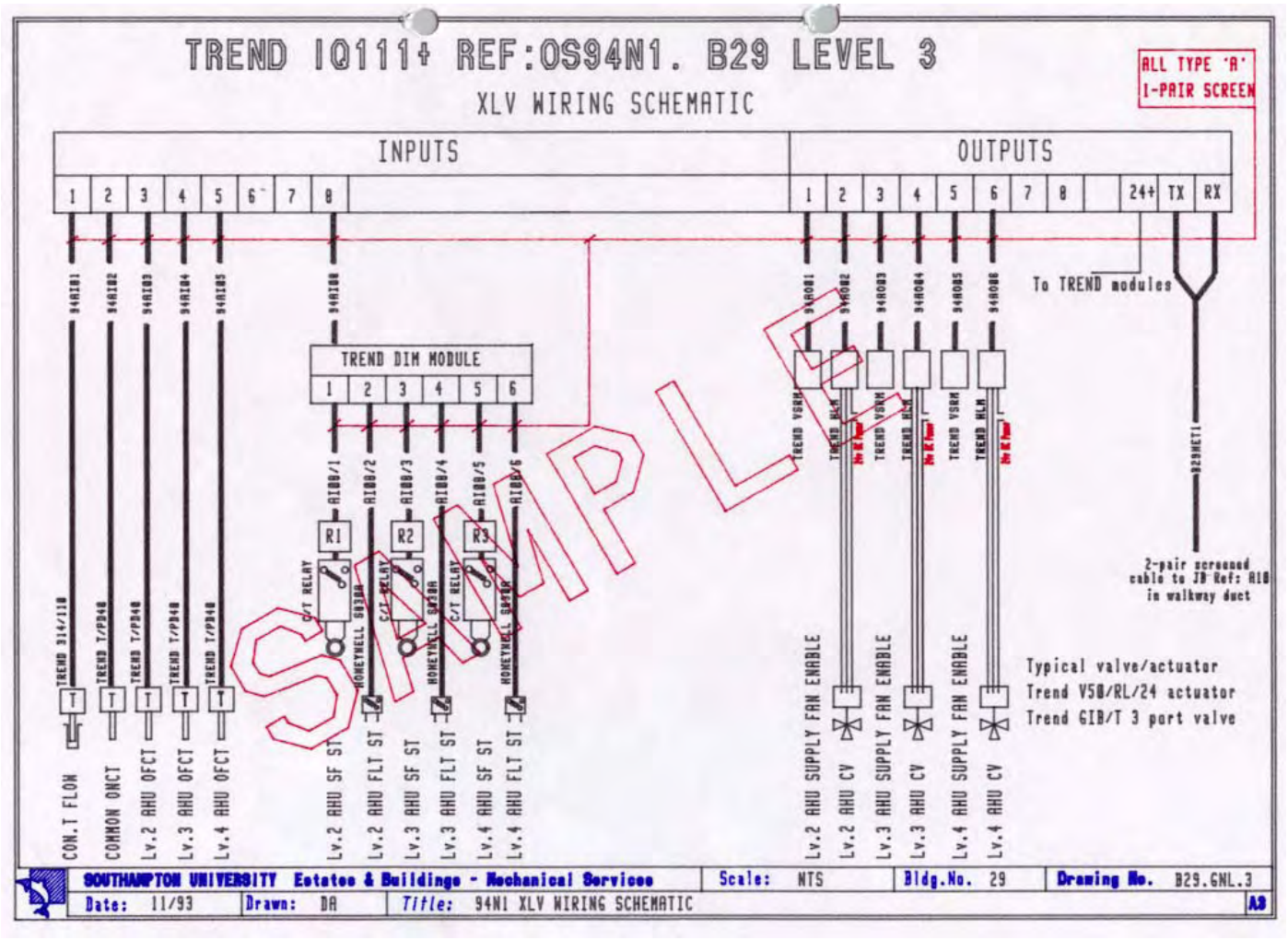
SOUTHAMPTON UNIVERSITY M&E Services **APPENDIX 2**

TYPICAL CONTROL PANEL **SHEET 1 OF 6**

BMS CONTROL PANEL LAYOUT

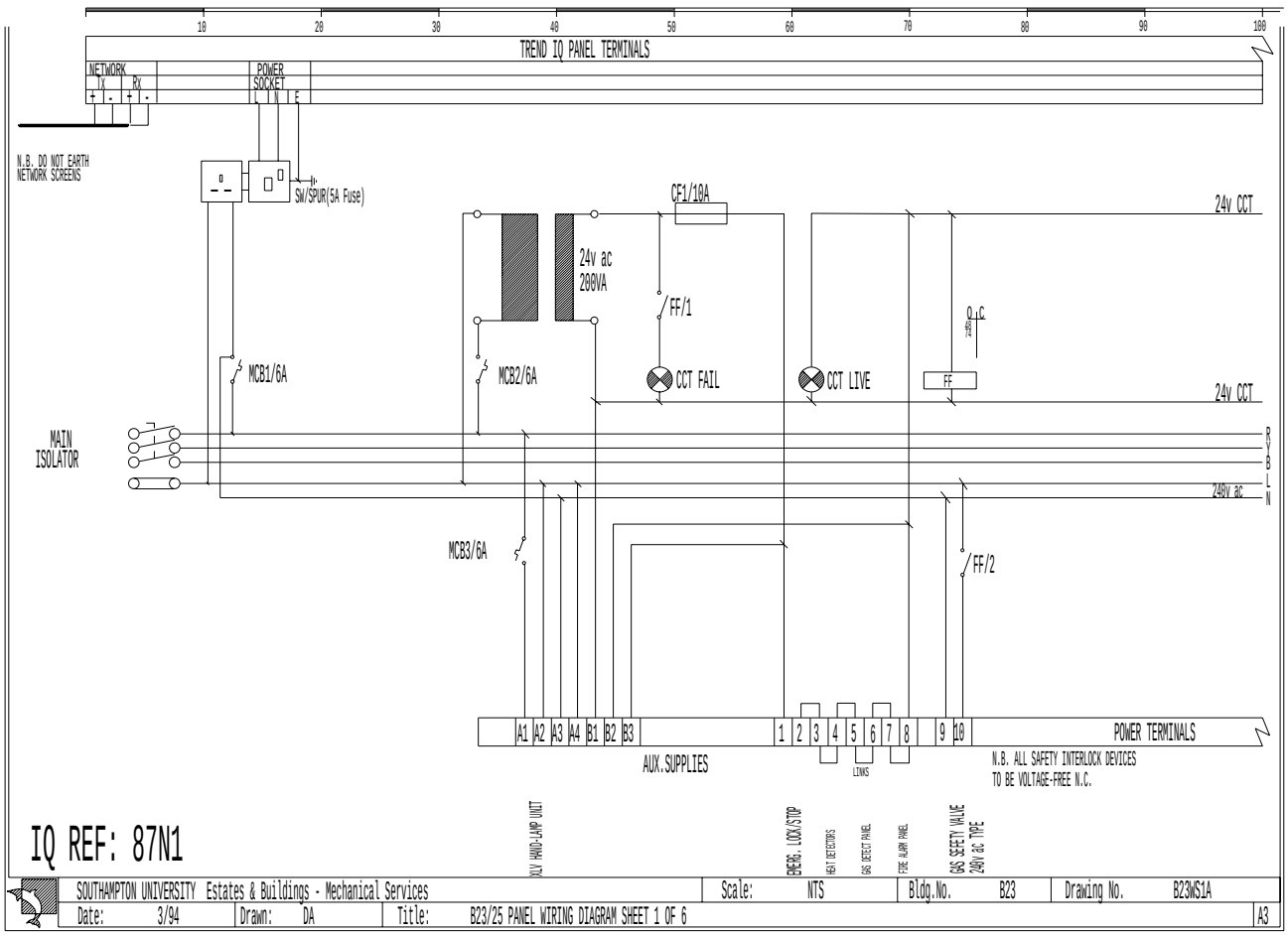


BMS CONTROL PANEL I/O SCHEMATIC



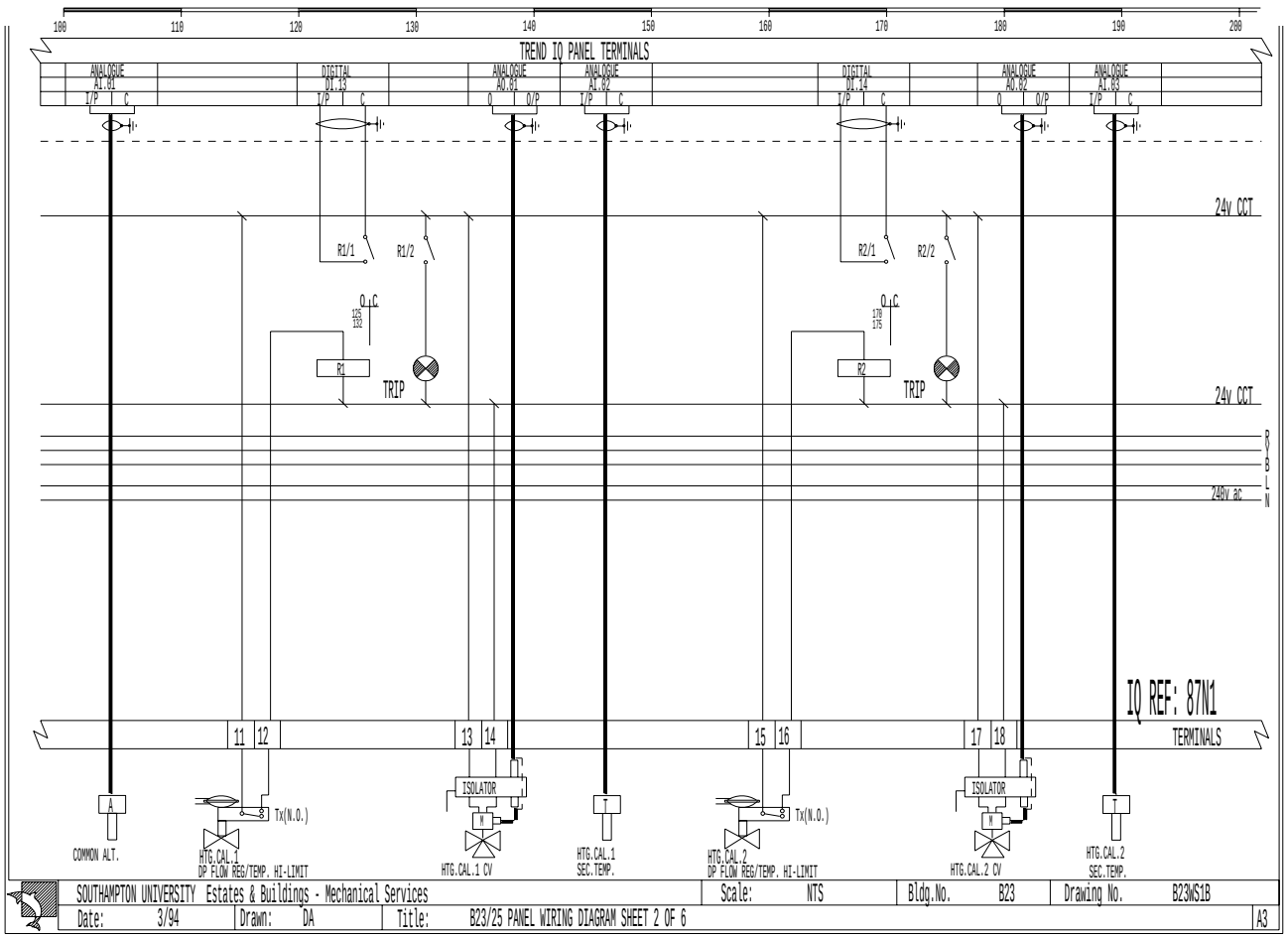
BMS CONTROL PANEL LAYOUT **SHEET 3 OF 6**

BMS CONTROL PANEL WIRING SCHEMATIC



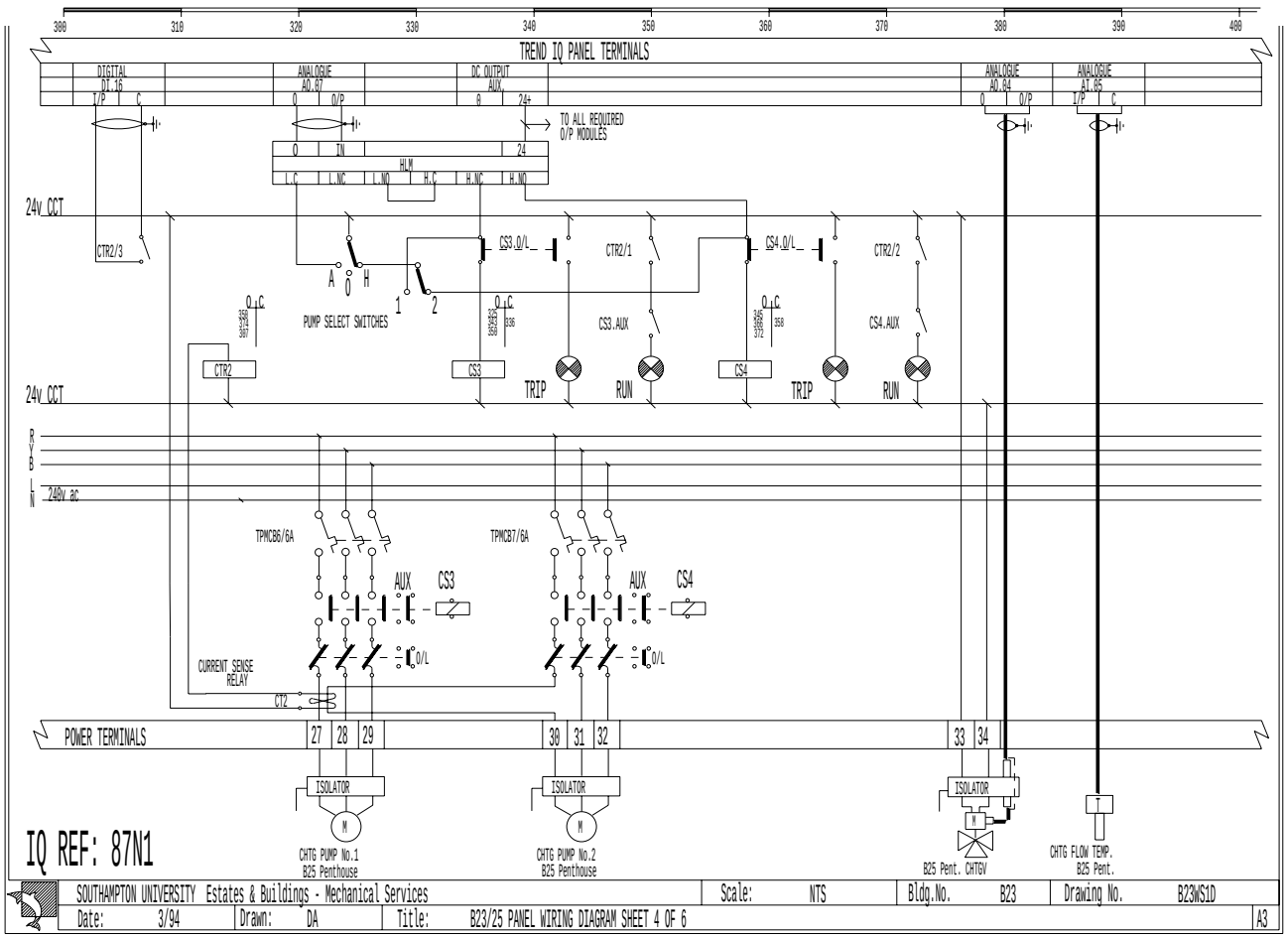
BMS CONTROL PANEL LAYOUT **SHEET 4 OF 6**

BMS CONTROL PANEL WIRING SCHEMATIC



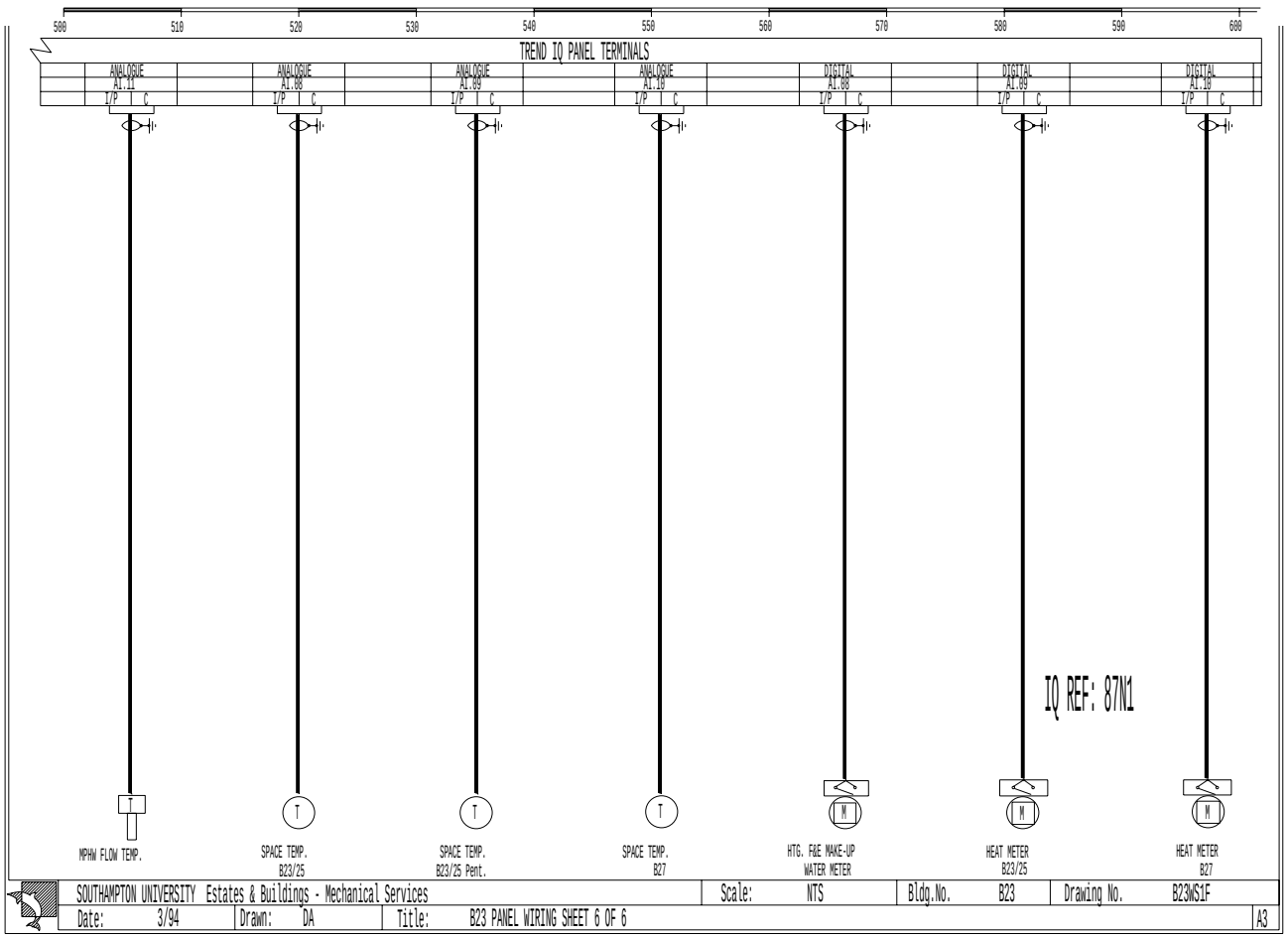
BMS CONTROL PANEL LAYOUT **SHEET 5 OF 6**

BMS CONTROL PANEL WIRING SCHEMATIC



BMS CONTROL PANEL LAYOUT **SHEET 6 OF 6**

BMS CONTROL PANEL WIRING SCHEMATIC



SOUTHAMPTON UNIVERSITY M&E Services **APPENDIX 3**

BMS APPLICATIONS MACROS

GENERAL INTRODUCTION

The University Macros have been produced primarily to maintain some standardisation of the BMS software, where various Caradon-Trend, Trend Technology Centres (TTCs) are involved in providing fully operational systems. This will normally occur, where consultants are engaged on the larger services refurbishment projects, or new, green-field projects are actioned through the Capitol Works division of the University Estates and Buildings.

In the past the briefing of the TTCs in sufficient detail, with regard to particular requirements, has proved costly in University staff time and the Macro approach has therefore been introduced.

The Macros presented here, provide similar control functions to those offered by Caradon-Trend, but more emphasis is placed on alarm blocking and safety interlock devices, to minimise the briefing requirements. This will increase the effectiveness of the Macro approach and minimise any oversights in the alarm handling requirements.

The applications Macros listed, have been designed to cover many individual control requirements, to achieve this they have been broken down into individual facets for ease of adaptation and clarity of the general strategies.

To form a complete strategy for an individual application several Macros will need to be integrated.
E.g. For a single-zone compensated heating system Macro MAC/C1 (Control Valve), will need to be integrated with MAC/F1 (Pumps).

Use of the Macros will in no way relieve the Specialist Contractor or TTC of his obligations to provide a fully operational system in accordance with the consultant's specifications or, to not liase fully with the University BMS Engineer for exact requirements.

SOUTHAMPTON UNIVERSITY M&E Services **APPENDIX 3**

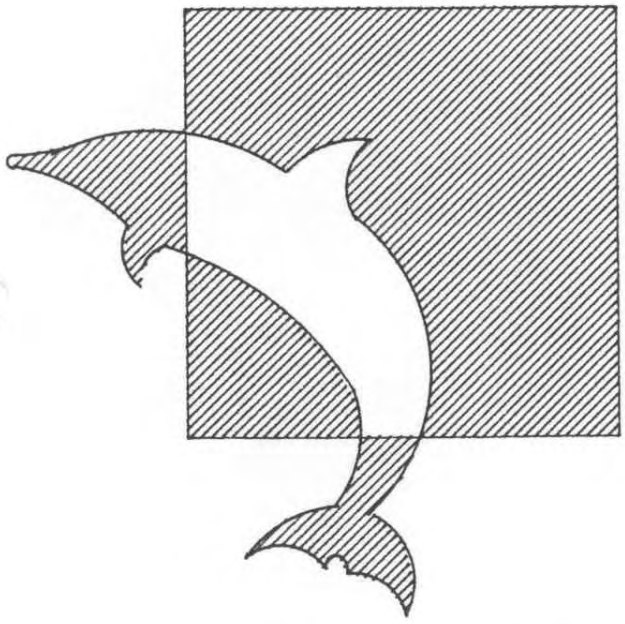
BMS APPLICATIONS MACROS

INDEX

BMS

APPLICATIONS MACROS

TREND



University of Southampton

CONTACT: Mr D Andrews

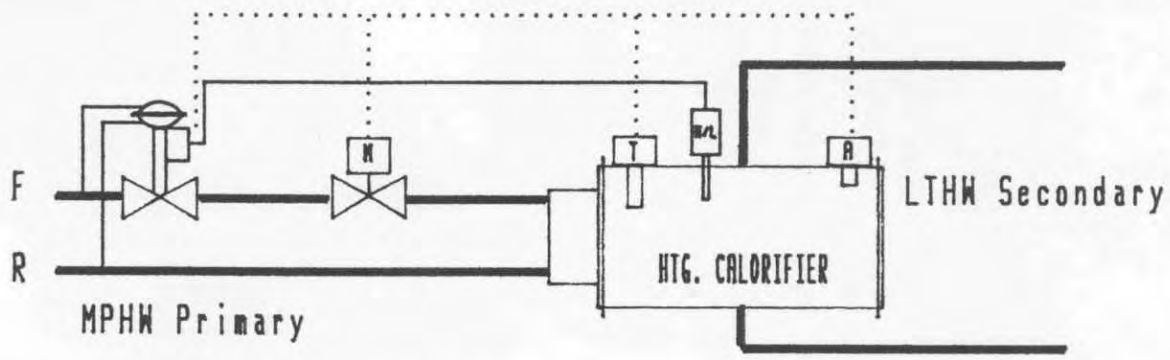
Estates and Buildings Department

MECHANICAL SERVICES SECTION B30a

Highfield Southampton SO9 5NH

Tel. 0703 592632/593525 Fax. 0703 593037

HEATING CALORIFIER PRIMARY CONTROL



Application:

Temperature reduction of district-heating MPHW for use as local heating source.

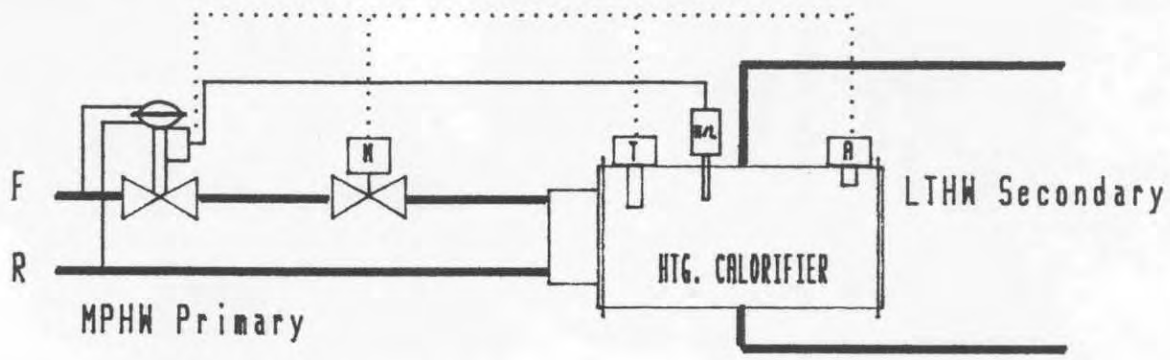
Typical operating parameters:

MPHW Flow T:	150.C with theoretical return of 100.C
MPHW Pressure:	7 bar
Calorifier Sec. T:	82.C (OCC); 65.C (NOC)
Sec. Temp. Alarms:	95.C High; 60.C Low
Sec. Altitude:	As provided by F&E tank (x.bar)
Sec. alt. Alarms:	(x+10%)bar High;(x-10%)bar Low
Sec. D/A High-Limit:	95.C

Notes:

1. Calorifier secondary F&E tank cold-water supply to be furnished with water-meter with pulse counting facility.
2. Software dummy sensors to provide cumulative total and rate of use per minute. Rate sensor to generate alarm >=15 ltrs/min

HEATING CALORIFIER PRIMARY CONTROL



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Sec. Temp. Alarms:	95.C High; 60.C Low
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Sec. alt. Alarms:	(x+10%)bar High;(x-10%)bar Low
Sec. D/A High-Limit:	95.C

Notes:

1. Calorifier secondary F&E tank cold-water supply to be furnished with water-meter with pulse counting facility.
2. Software dummy sensors to provide cumulative total and rate of use per minute. Rate sensor to generate alarm >=15 ltrs/min

HEATING CALORIFIER PRIMARY CONTROL

Features:

1. Close control of secondary flow temperature from sensor.
2. Safety interlock with secondary altitude sensor.
3. High-limit and power failure protection.
4. Summer/Winter and Holiday/Normal interlocks.
5. Secondary sensor low alarm blocking outside demand.
6. Set-point elevation on demand and frost-protection.

Standard components:

Secondary temperature sensor:	Trend T314/110 + S/S pocket
Secondary altitude sensor:	Trend P/XL 0-6 bar
Primary control valve:	Samson 241 2-port
Primary control valve actuator:	Samson 3274-11 0-10v position
Flow-regulation:	Samson type 42 controller
High-limit/power fail:	Samson 2212

Notes:

1. Samson type 42 controller set to maintain constant pressure-drop across control valve.
2. MPHW primary system is variable volume.

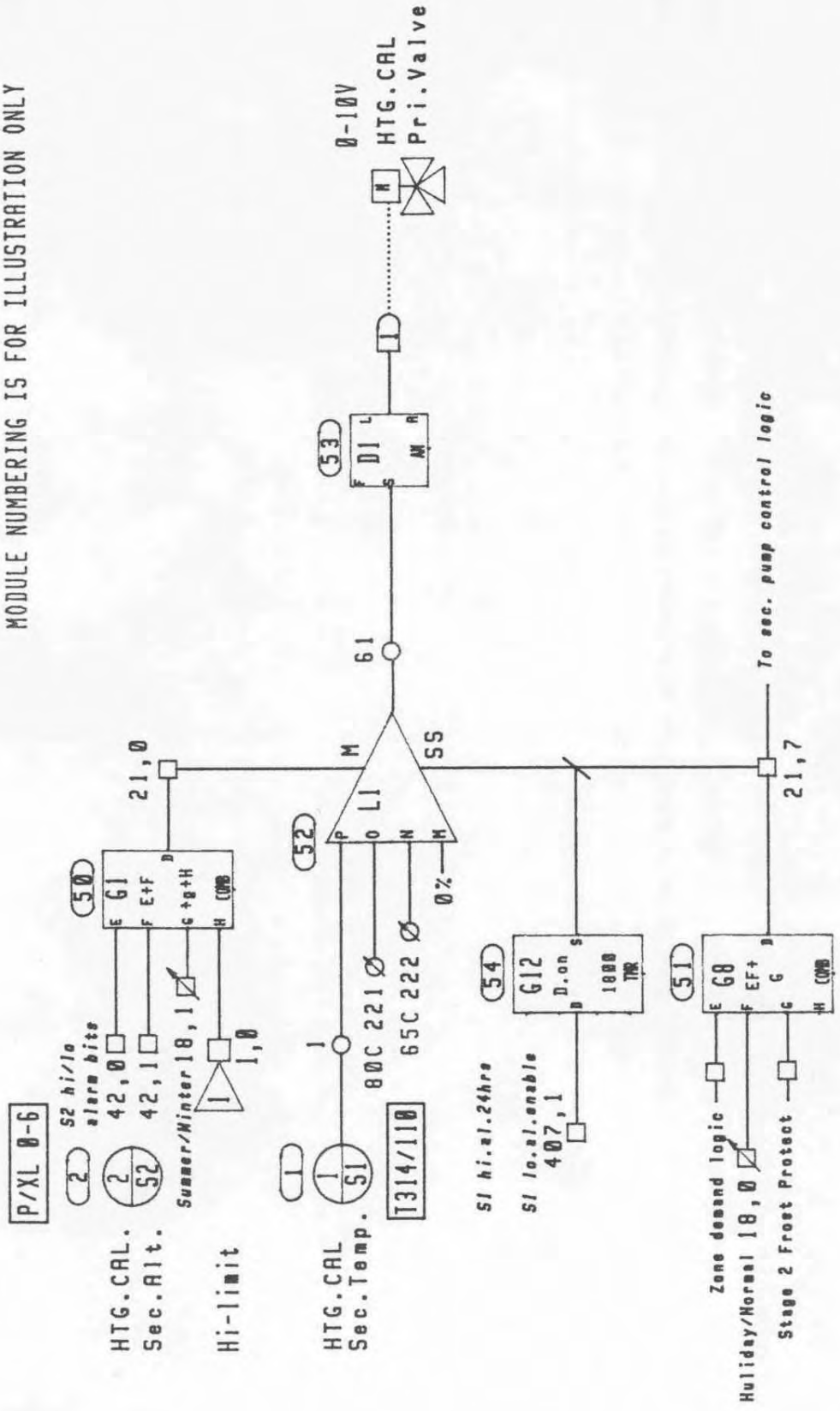
HEATING CALORIFIER PRIMARY CONTROL

Description:

The secondary calorifier temperature is controlled via the primary valve from the secondary temperature sensor(S1), by measuring the difference between actual sensed temperature and that required as dictated by knobs 1(OCC) or 2(NOC).
Any error is then converted to a primary valve position by the P+I action of loop(L1) and output directly to the valve actuator as a 0-10v signal which will correct the error via analogue driver(D1).
The secondary sensor(S1) low alarm bit is enabled only during winter demand periods and after pre-heat delay timer(G12) has timed out.
The secondary altitude sensor(S2) permanently monitors the system pressure and allows control only when the pressure is within the safety limits as set in (S2) high and low alarm values. Outside these limits, loop(L1) is forced to a fixed 0% output which will close the primary control valve via driver(D1).
A direct-acting independent hi-limit device within the calorifier secondary provides additional safety and caters for power-failure, this device will also provide the clean contact to initiate the alarm input(DI1) via its auxiliary Tx unit.

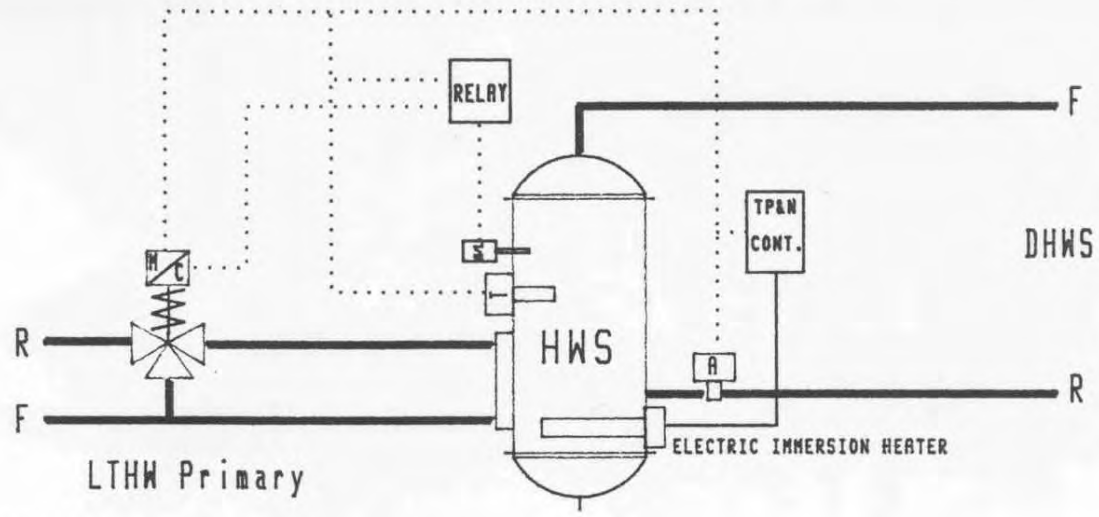
SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/A1

HEATING CALORIFIER PRIMARY CONTROL



04/93DA

HWS CALORIFIER PRIMARY CONTROL



Application:

Generation of DHWS from district heating MPHW or local boiler LTHW heat source.

Typical operating parameters:

MPHW Flow T:	150.C with theoretical return of 100.C
MPHW Pressure:	7 bar
Calorifier Sec. T:	55.C (OCC); 50.C (NOC)
Sec. Altitude:	As provided by F&E tank (x.bar)
Sec. Alt. Alarms:	(x+10%)bar High; (x-10%)bar Low
Sec. High-Limit:	65.C
LTHW Flow T:	82.C
LTHW Altitude:	As provided by F&E tank (x.bar)

Notes:

1. (MPHW) Primary control components as MAC/A1.
2. (LTHW) Primary 3-port mixing valve has spring-return actuator with clutch circuit maintained from manual-reset high-limit thermostat in conjunction with auxiliary relay. Relay is to be a 2-pole device, one to de-clutch the second to provide a clean contact for digital alarm input.

HWS CALORIFIER PRIMARY CONTROL

Features:

1. Close control of secondary temperature from secondary sensor.
2. Safety interlock with secondary altitude sensor.
3. High-limit and power failure protection.
4. Summer/Winter and Holiday/Normal interlocks.
5. Secondary temperature low alarm blocking outside demand.
6. Frost protection set-point elevation.
7. Summer operation on electric immersion heaters.

Standard components:

Secondary temperature sensor:	Trend T314/110 + S/S pocket
Secondary altitude sensor:	Trend P/XL 0-6bar
Immersion contactor control:	Trend TRM
Primary control valve(MPHW):	Samson 241 2-port
Primary valve actuator(MPHW):	Samson 3274-11 0-10v
Primary hi-limit/regulation(MPHW):	Samson type 42 +2212Tx
Primary control valve(LTHW):	Samson 243-2 3-port
Primary valve actuator(LTHW):	Samson 3274-22 0-10v
High-limit(LTHW):	Satchwell/Sunvic TKR 3501 (25-95.C) + brass pocket
Auxiliary Relay(LTHW):	11-pin plug in and base

Notes:

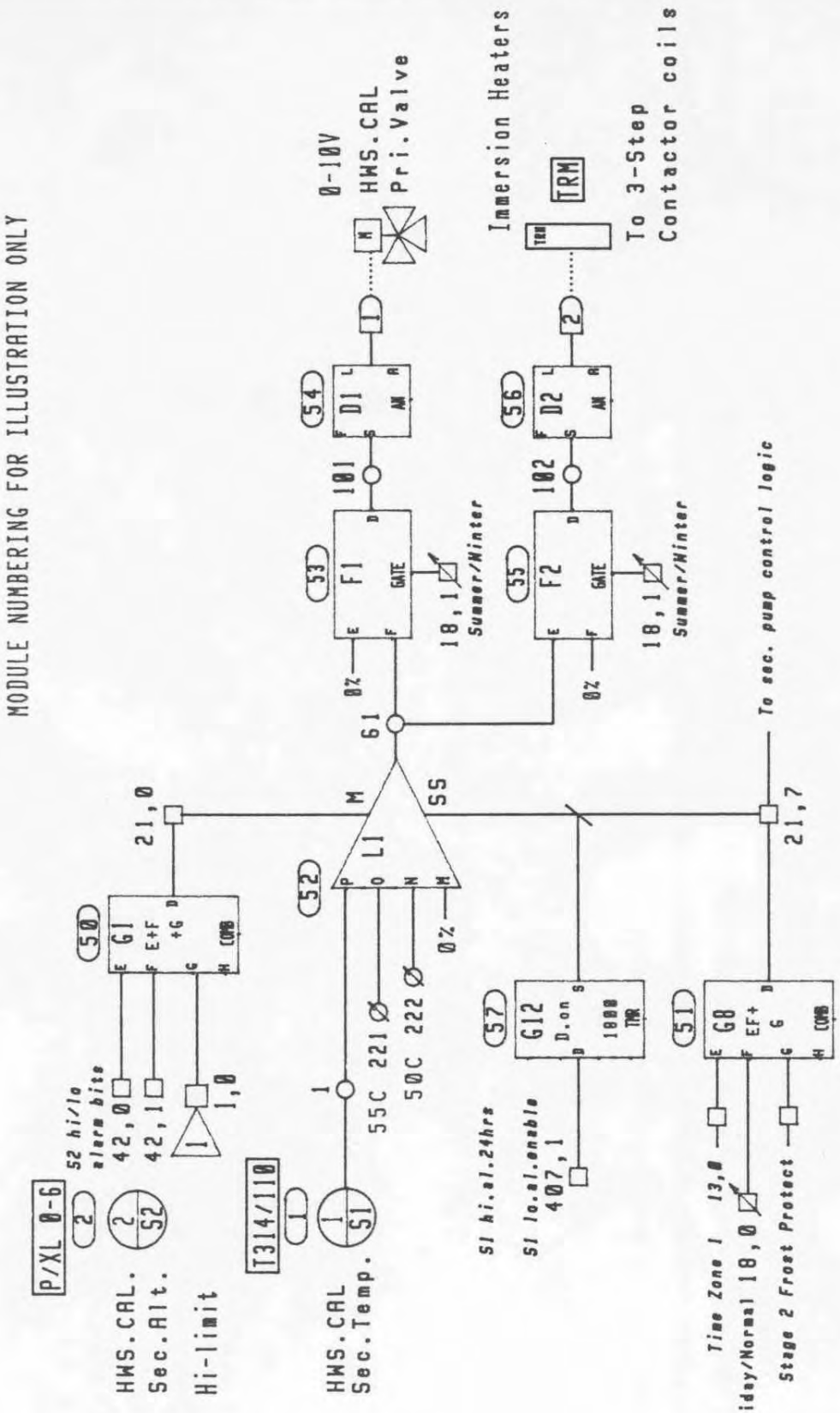
1. (MPHW) Samson type 42 controller set to maintain a constant pressure drop across control valve.
2. MPHW system is variable volume.

HWS CALORIFIER PRIMARY CONTROL

Description:

The secondary calorifier temperature is controlled via the primary control valve(winter) or the immersion heater step-controller(summer) from the secondary temperature sensor(S1), by measuring the difference between actual sensed temperature and required temperature as dictated by knobs 1 or 2(OCC;NOC).
Any error is converted to an output signal by the P+I action of loop(L1) and fed to the output driver D1(winter) or D2(summer) via function gates F1 and F2 respectively.
Driver(D1) provides a 0-10v output signal for the direct positioning of the primary control valve during winter mode; driver(D2) provides the required output signal to the Trend TRM 3-step controller to engage the immersion heater contactors during summer mode.
The low level (S1) alarm bit is enabled only during demand periods and after pre-heat delay timer (G12) has timed out.
The high level (S1) alarm bit is permanently enabled.
The secondary altitude sensor(S2) permanently monitors system pressure and allows control only when the pressure is within the safety limits as set in (S2) high and low alarm values.
Outside these limits loop(L1) is forced to 0% output which will close the primary control valve(winter) or release immersion contactor control(summer).
A direct wired high-limit thermostat within the calorifier secondary provides additional safety via an associate auxiliary relay. This relay provides three independent outputs, one to de-clutch the safety spring on the primary control valve actuator, the second to release immersion contactor operation and the third to signal alarm condition to digital input(DI1).
For MPHW operation a direct-acting independent high-limit device within the calorifier secondary provides safety and caters for power failure, this device will also provide the clean contact for alarm input(DI1) via its auxiliary Tx unit. Control action from this device is imposed onto the primary flow regulator.
See MAC/A1 for general set-up.

HWS CALORIFIER PRIMARY CONTROL



SINGLE BOILER MODULE/SHUNT PUMP CONTROL

Features:

1. Control of boiler flow temperature from single temperature sensor.
2. Ignition and shunt-pump controlled via single output channel using a standard HLM.
3. Provision for full safety and frost-protection interlocks.
4. Boiler temperature sensor alarms blocked outside demand and delayed for warm-up.

Standard components:

Boiler flow sensor:	Trend T314/110 + S/S pocket
Boiler/Pump control:	Trend HLM
Pump status monitor:	R.S.Components Current-sensing Relay 349-800. Associated C/T 346-182 or 346-192

Notes:

1. Auxiliary relays for boiler lock-out and high-temperature will normally be required to provide the clean contacts for BMS digital inputs. These would be housed local to the boiler module.
2. Safety device requirements are integrated at module(G10).
3. Demand input at module(G10) will depend on the number of zones calling boiler operation, additional module(s) may be required.
4. Boiler flow sensor(S2) may be used for frost protection, generally as MACRO MAC/E2 in place of the boiler return temp. sensor, which would not be necessary on such a small system. Protection would not require two stages.

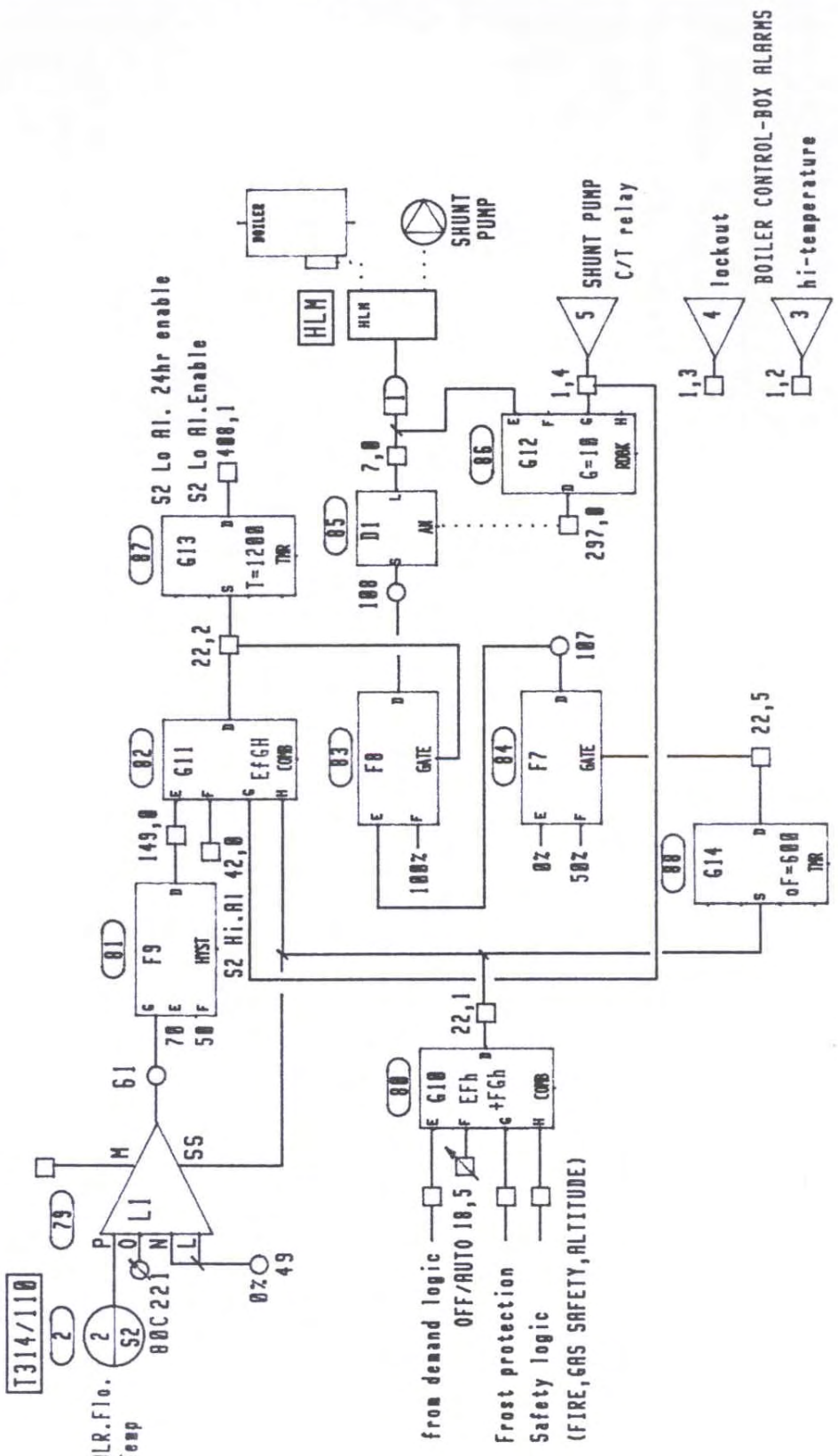
SINGLE BOILER MODULE/SHUNT PUMP CONTROL

Description:

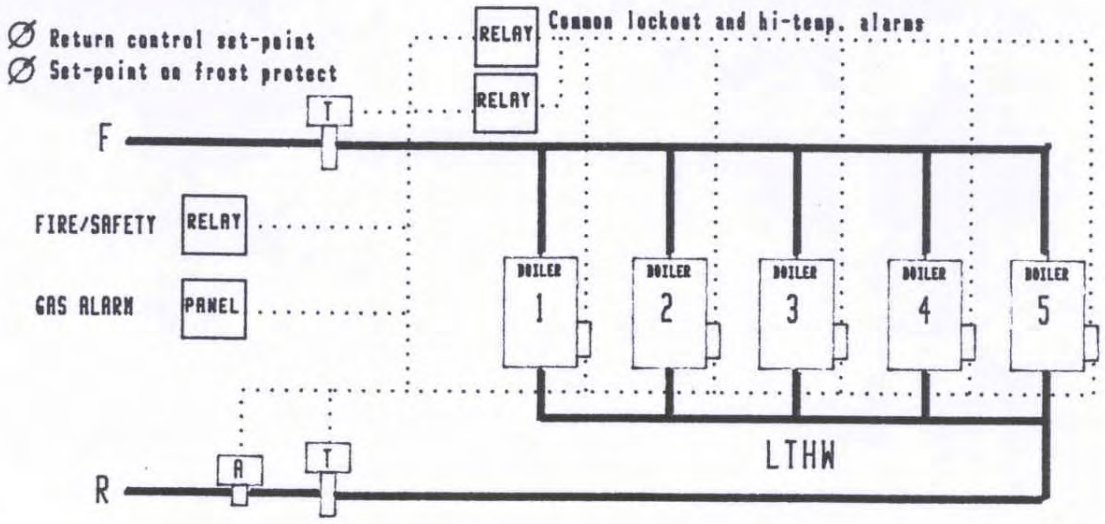
Boiler and shunt-pump are controlled independently from an HLM via analogue driver(D1). During OCC periods of demand, as dictated by master logic module(G10), the pump is run continuously to maintain a minimum flow rate through the boiler module by gate(F7) which places 50% on the driver(D1) input. Additionally, Timer(G14) provides pump-down at the end of each demand period to ensure dissipation of boiler shell temperature. Pump failure is monitored by logic(G12) during demand periods and the proving signal on digital input(DI5) will block burner ignition when in the off state.

During OCC demand periods the actual boiler flow is sensed by S2 and compared with the desired valve set on knob(K1), any error is then calculated by the P+I action of loop(L1) and fed directly to the hysteresis module(F9). The digital output from F9 will call burner ignition by gating module(F8) which places 100% on the input to driver(D1) to engage both relay stages of the HLM. Note that module(F8) can only gate if the safety logic at module (G11) is correct. viz. There is an OCC demand.
Sensor(S2) is not in high alarm.
There is a demand from module(F9).
Shunt-pump proved on by digital input(DI5).
When burner ignition is requested by module(F9) and proved via module(G11) timer(G13) will start the delay count before enabling the boiler flow sensor(S2) low alarm bit.
Digital inputs for boiler lockout(DI4) and boiler high-temperature (DI3) provide additional alarm information derived directly from the burner control wiring and therefore do not require any software blocking. As a rule, these alarms would also be integrated by an additional logic module to generate a common critical alarm labeled 'BOILER FAULT'.

SINGLE BOILER MODULE/SHUNT PUMP CONTROL



BOILER SEQUENCE CONTROL



Application:

Sequencing of multiple gas atmospheric boiler modules in a medium sized boilerhouse.

Typical operating parameters:

Common boiler return set-point:	70.C
Common boiler flow temperature:	82.C (At full-load demand)
Common boiler system altitude:	As provided by F&E tank (x bar)
Common boiler flow alarms:	95.C High; 50.C Low:
Common boiler return alarms:	95.C High; 5.C Low:
Common boiler return set-point for frost protection:	60.C

Notes:

1. Fire alarm input(DI11) would normally be from an auxiliary relay combining fire, fixed temperature detection and manual lock-stop signals.

BOILER SEQUENCE CONTROL

Features:

1. Sequence control of multiple boiler modules to match load demand from return temperature sensor.
2. Safety interlocks to halt burner operation.
3. Operation only on heat demand.
4. Frost protection interlock.
5. Demand logging.
6. Common sensor alarm blocking.
7. Holiday/Normal and System OFF/AUTO soft switches.

Standard components:

Common boiler flow sensor:	Trend T314/110 + S/S pocket
Common boiler return sensor:	Trend T314/110 + S/S pocket

Notes:

1. System delta/T (Flow/Return) must not be too small to avoid fast cycling of boiler modules. 10.C is a typical value to keep the throttling range at a reasonable level.
2. Loop(L1) operates best with low gain / high integral, typicaly Gain=2.5; I=15:
3. This macro provides an internal analogue value for use with multiples of MACRO MAC/B3.
4. For details of altitude sensor input refer to MACRO MAC/G5.

BOILER SEQUENCE CONTROL

Description:

Common boiler return temperature is monitored by sensor(S9) and compared to the set-point selection of loop(L1). Any error is then calculated by the P+I action of loop(L1) and output as a 0-100% demand for use by the other software macros (MAC/B3),which will correct the error from set-point. Note, the number of boiler modules enabled to fire is dependent on the output level of loop (L1) and generally arranged for equal percentage.
viz. For four boiler modules:

25% demand = 1 boiler
50% demand = 2 boilers
75% demand = 3 boilers
100% demand = 4 boilers

Output demand from loop(L1) is logged by dummy sensor(S33) set Daily(15min intervals).
During NOC periods second stage frost protection is provided by gate(F1) which will change the normal 0.C(0%)NOC set-point to the level set by the soft knob(B15). Normally 60.C.
Logic module(G1) constantly monitors the safety interlocks and mode selection, and any deviation from the required logic will cause the output to place loop(L1) into manual mode, which being fixed to 0% will halt all burner action.
NOC/OCC set-point selection is dictated by the demand inputs to the logic module(s) (G2/G3). During demand periods from the various time zones, with the the holiday/normal soft switch(W1) in 'normal' mode, loop(L1) will control to its OCC set-point as dictated by soft knob(B11). Usually 70.C. Outside the time-zone demands or 'holiday' mode selection loop(L1) will control at 0% unless called for frost protection.
Common boiler flow temperature sensor(S8) is for monitoring only but, during demand periods its low alarm bit is enabled after delay timer(G4) allows for plant warm up.

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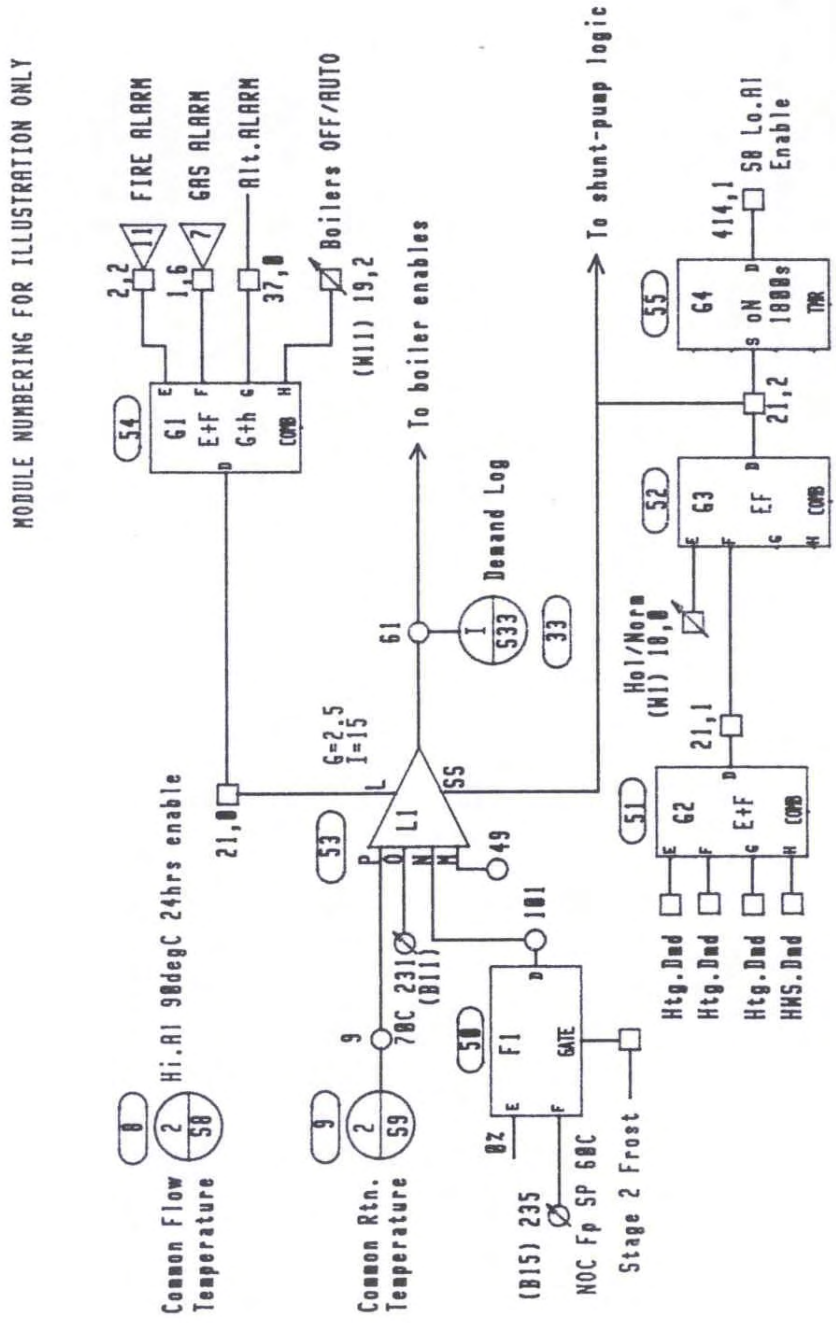
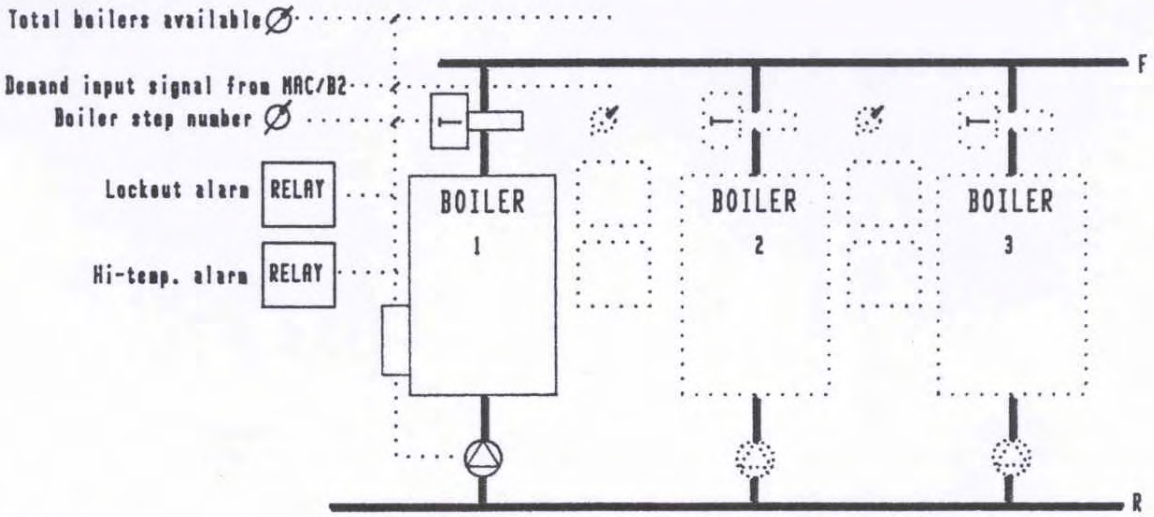
	MAC/B2

BOILER SEQUENCE CONTROL



BOILER MODULE/SHUNT PUMP SEQUENCE CONTROL



Application:

Individual control and sequencing of boiler/pump modules from a master command, derived from MACRO MAC/B2.

Typical operating parameters:

Boiler flow temp:	82.C
Boiler flow alarms:	95.C High; 50.C Low:
System altitude:	As provided by F&E tank (x bar)

Notes:

1. For details of safety interlocks refer to MACRO MAC/G5.
2. For use with master sequence MACRO MAC/B2.

BOILER MODULE/SHUNT PUMP SEQUENCE CONTROL

Features:

1. Local control of burner module from boiler sensor.
2. Master control from sequencing demand macro.
3. Lead/Stand-by sequence step number selectable.
4. Automatic test for lead selection to maintain pump for minimum flow rate.
5. Full safety interlock capability.
6. Associated shunt-pump monitoring and interlock.
7. Sensor low alarm enabled only during operation after warm-up delay.

Standard components:

Boiler flow sensor:	Trend T314/110 + S/S pocket
Boiler enable relay:	Trend VSRM
Pump enable relay:	Trend VSRM
Pump status monitor:	R.S.Components Current sense relay 349-800. Associated C/T 346-182 or 346-192.

Notes:

1. Under light load conditions the common flow temperature provided by the boiler modules will migrate down to the return temperature control set-point and the lead boiler will not actually reach its own control point before halted by the action of the master sequence control. This will provide no problems for H&V applications and actually conserves energy. If this feature is undesirable, see addendum MACRO MAC/B3a.
2. Read in conjunction with MACRO MAC/B2.
3. Common boiler lockout and high-temperature alarms will be provided as direct digital inputs, but no action is required by this software.

BOILER MODULE/SHUNT PUMP SEQUENCE CONTROL

Description:

The master sequence demand signal from MACRO MAC/B2 is presented to input 'H' of function module(F11). This signal level is then adjusted depending on the values set for the sequence step number set on knob(B1) and total number of boilers available, set on knob(B8). If the resultant signal is 95% or greater, boiler operation is called via function modules(F12)&(F13). Module(F12) simply re-scales the signal to 0-100% and hysteresis module(F13) provides the digital switching as ON=95%;OFF=45%. This wide hysteresis band is to prevent fast cycling due to the large input swing caused by the F11 calculation.

Logic module(G6) accepts the digital output from (F13), tests to ensure that the module is in 'auto' mode from soft-switch(W4) and that the associated shunt pump is not in a readback condition. The output then initiates logic for both pump and burner ignition.

Logic module(G7) will allow pump operation under two conditions, demand from logic(G6) via input 'E'(normal boiler demand) or an integration of inputs 'F,G &H'(run pump continuously during demand periods if module is selected as lead unit).

Lead boiler selection is tested for by function(F14) comparing with knob(B1) sequence step number, if <.5 then knob must be at 0 and lead duty is selected. Before pump logic is finally passed to the output driver(D2), it passes through off-delay timer(G8) to provide boiler pump down, ensuring that excess heat is dissipated when operation is halted which could cause a high temperature lock-out condition. Note that input 'H' at module(G7) prevents continuous 24hr operation.

Initiation of burner ignition from module(G6) output passes to two timer modules (G11)&(G9), G11 delays the boiler flow sensor (S1) low alarm enable to allow warm up and G9 provides a short delay to allow pump to attain full flow rate prior to placing loop(L2) into OCC mode for burner ignition.

Burner module flow temperature is controlled from flow sensor(S1) by comparison with the set-point level on knob(B1), any error being calculated by the P+I action of loop(L2) and the corrective output passed directly to the binary switch driver(D1). The binary driver is set to provide ignition ON @ 20% and OFF @ 1% to provide a wide band hysteresis to further block short duration ignition under light load conditions.

Full safety interlocking is provided by forcing loop(L2) into a manual condition which is preset to 0%. Interlocking would normally be provided with Fire, Gas safety and system altitude, sourced from the same logic module(G1) shown on MACRO MAC/B2.

Output demand logging is provided by internal sensor(S34) for analysis.

BOILER MODULE/SHUNT PUMP SEQUENCE CONTROL

Loop Demand	Add module outputs %					Re-scale module outputs					Hysteresis
	Blr0	Blr1	Blr2	Blr3	Blr4	Blr0	Blr1	Blr2	Blr3	Blr4	o=95;f=45
0%	0	-100	-200	-300	-400	0	0	0	0	0	
10%	50	-50	-150	-250	-350	50	0	0	0	0	No1 off 9%
20%	100	0	-100	-200	-300	100	0	0	0	0	No1 on 19%
30%	150	50	-50	-150	-250	100	50	0	0	0	No2 off29%
40%	200	100	0	-100	-200	100	100	0	0	0	No2 on 39%
50%	250	150	50	-50	-150	100	100	50	0	0	No3 off49%
60%	300	200	100	0	-100	100	100	100	0	0	No3 on 59%
70%	350	250	150	50	-50	100	100	100	50	0	No4 off69%
80%	400	300	200	100	0	100	100	100	100	0	No4 on 79%
90%	450	350	250	150	50	100	100	100	100	50	No5 off89%
100%	500	400	300	200	100	100	100	100	100	100	No5 on 99%

LOOP DEMAND SWITCHING %

Notes:

Calculation table for 5 boiler modules.

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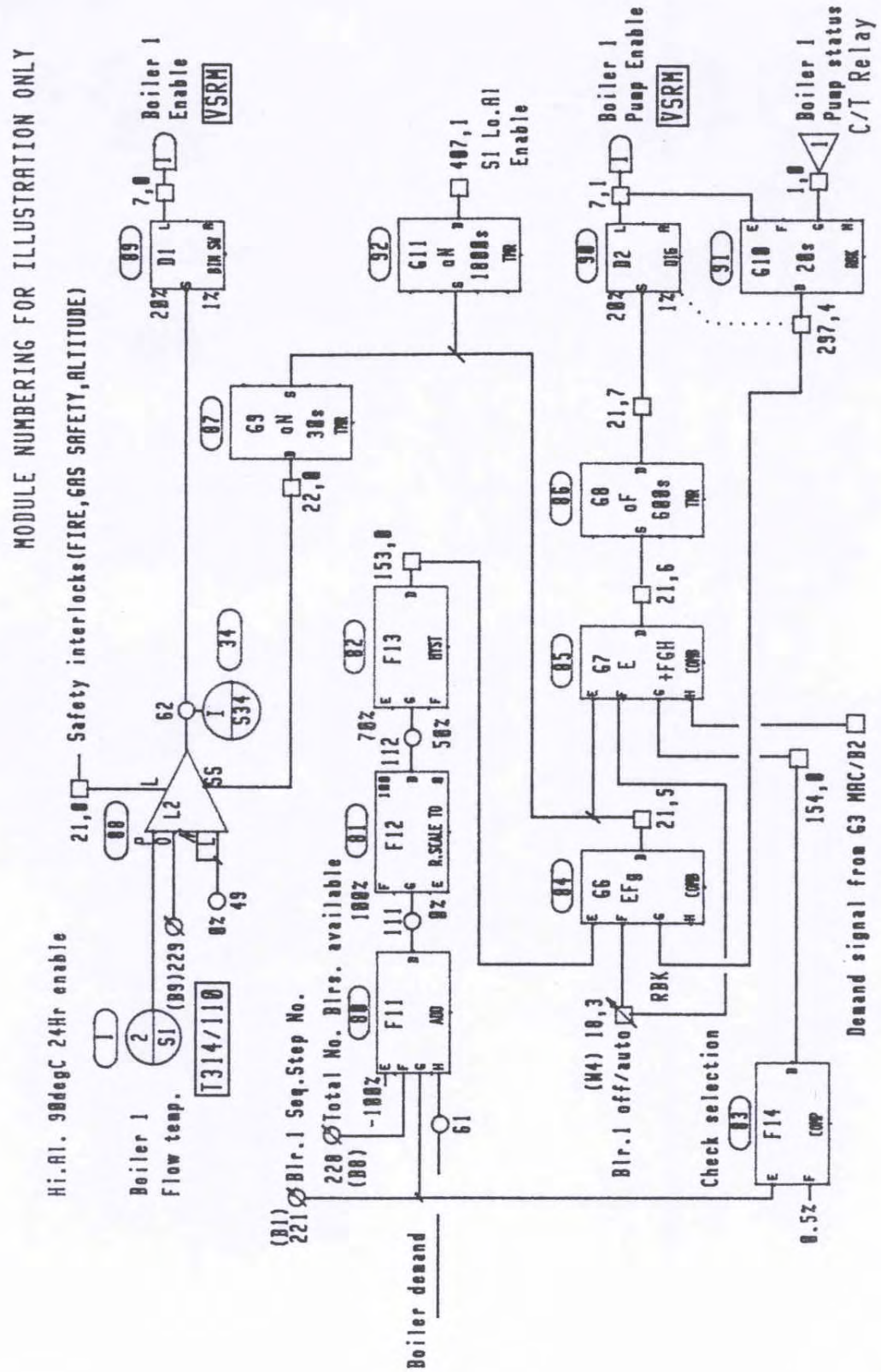
	MAC/B3

BOILER MODULE/SHUNT PUMP SEQUENCE CONTROL



04/93DA

BOILER MODULE/SHUNT PUMP SEQUENCE CONTROL (Addendum)

Description:

In certain circumstances, where a critical item of plant requiring a constant-temperature supply is installed, it may be found that the reduction of the common flow temperature under light-load conditions, caused by the standard sequencing algorithm, may be unacceptable.
To overcome this, the software variation presented here, provides the added facility to leave the selected 'lead' boiler module enabled to fire under its own flow sensor control, even when no sequence demand is present. Additionally the 'lead' boiler is automatically provided with a small set-point elevation to overcome, to some extent, the drop in the common flow-header temperature caused by the flow dilution of non-firing modules.

The check for 'lead' selection is performed by module(F14) and with the output set, will engage the boiler for controlled firing, even though there is no demand from the sequencer at module(F13), by the either/or action of logic module(G12).
Module(F14) output is also utilized to switch from normal, to an elevated boiler flow set-point, by the action of function gate-(F15). The degree of elevation is set by the constant 'F' on add module(F16) which would normally be 3.C above the the usual knob(B9) setting of 82.C. Note, a soft knob is NOT recommended here, to protect against high elevations being inadvertently imposed.

Notes:

1. As with the MACRO MAC/B3 the associated shunt pump runs when the boiler module is selected as 'lead' unit and all boiler operation is halted when there is no time or load demand.
2. Load demands only, are inappropriate here, unless the critical plant item requiring constant temperature has its software provided with a means of maintaining an appropriate signal.
3. Function module(F15) would be common to all boiler module configuration sheets.

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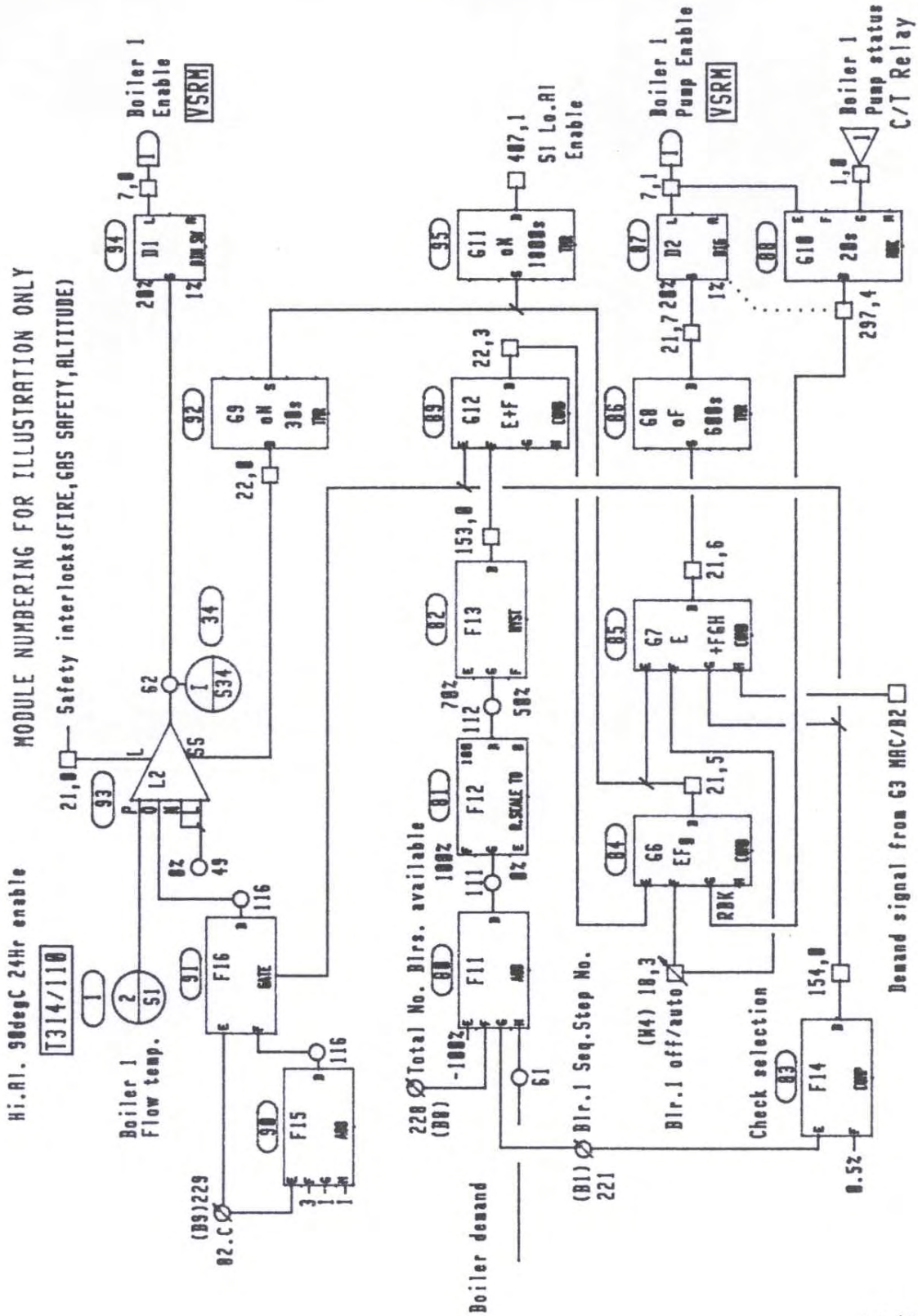
ADDENDUM | MAC/B3a

BOILER MODULE/SHUNT PUMP SEQUENCE CONTROL (Addendum)



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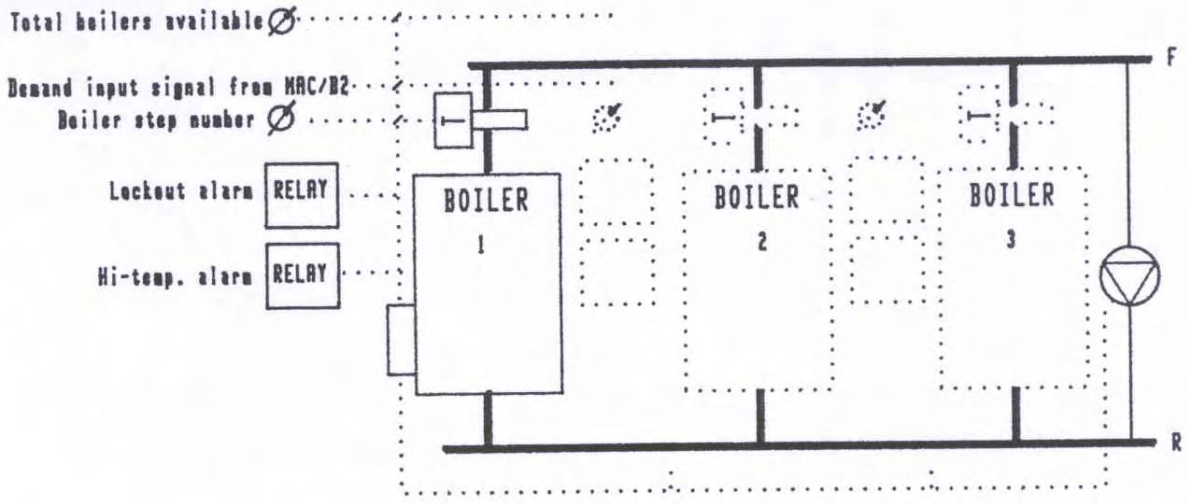
BOILER MODULE SEQUENCE CONTROL(Common shunt pump)



Application:

Individual control and sequencing of boiler modules with a common header shunt pump, from master command derived from MACRO MAC/B2.

Typical operating parameters:

Boiler flow temperature:	82.C
Boiler flow temperature alarms:	95.C High; 50.C Low.
Boiler system altitude:	As provided by F&E tank (x bar)

Notes:

1. For details of safety interlocks refer to MACRO MAC/G5.
2. For use with MACRO MAC/B2.

BOILER MODULE SEQUENCE CONTROL(common shunt pump)

Features:

1. Local control of burner module from boiler flow sensor.
2. Master control from sequencing demand macro.
3. Lead/standby sequence number selectable.
4. Full safety interlock capability.
5. Shunt pump interlocked.
6. Boiler sensor low alarm enabled only during demand operation after warm-up delay.

Standard components:

Boiler flow sensor:	Trend T314/110 + S/S pocket
Boiler enable relay:	Trend VSRM

Notes:

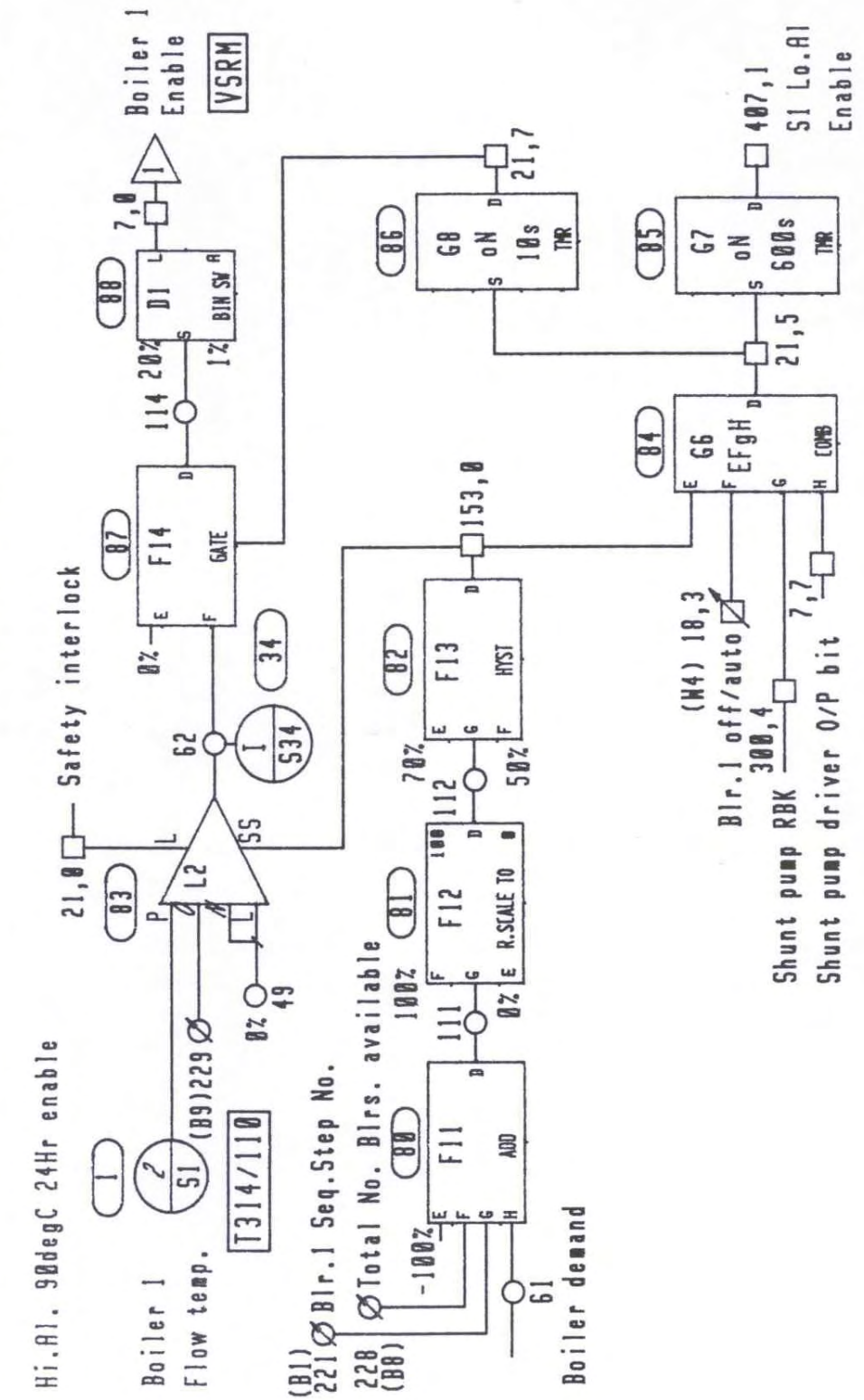
1. Under light load conditions the common boiler flow temperature will migrate down towards the return temperature control point and the lead boiler will not reach its flow set-point before being sequenced out. This will provide no problems for H&V applications and is actually energy conserving.
2. Read in conjunction with MACRO MAC/B2 and MAN/B5.
3. Common boiler lockout and high temperature alarms would be provided as direct digital inputs and not required for any interlock action of this software.
4. Full table of calculated module outputs and boiler switching points as for MACRO MAC/B3.

BOILER MODULE SEQUENCE CONTROL(common shunt pump)

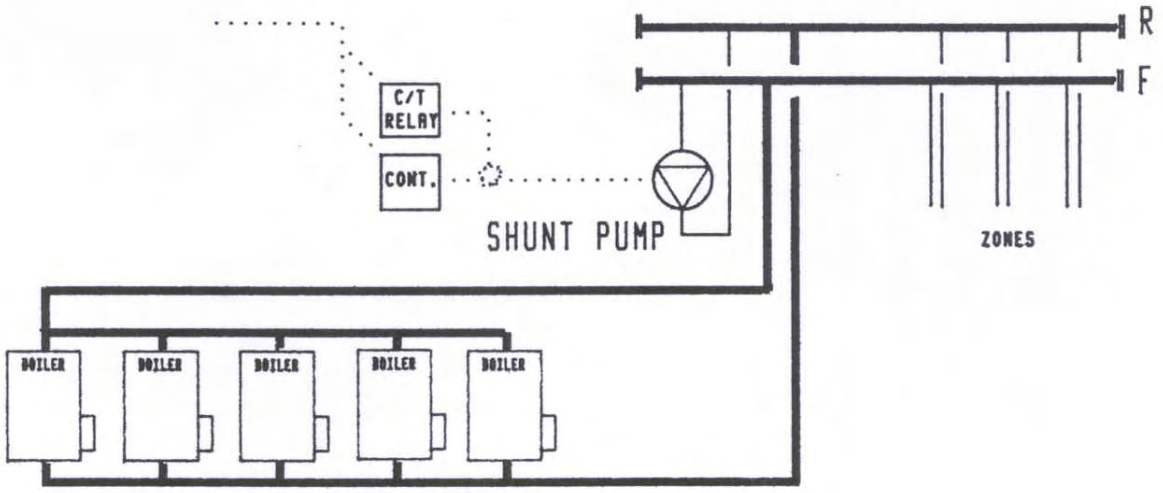
Description:

The master demand signal from MACRO MAC/B2 is presented to input 'H' of function module(F11), where it is adjusted depending on the values set for sequence step number(Knob 1) and total number of boilers available(Knob 2). If the resultant signal is =>95% boiler operation is called via function modules (F12) & (F13). Module(F12) simply re-scales the signal level back to 0-100% and module(F13) hysteresis, provides digital switching as ON=95%; OFF=45%. The wide hysteresis band is necessary to stop fast cycling due to the large input swings caused by the (F11) calculation. Module(F13) output is then passed directly to the loop(L2) set-point selection bit placing it in the OCC condition.
Logic module(G6) also accepts the digital output from (F13), tests to ensure that switch(W4) is in 'AUTO' mode and that the common shunt pump output driver is on with no readback alarm, before initiating logic for burner ignition and starting warm-up delay timer(G7) for flow sensor(S1).
On-delay timer(G8) provides a short delay period to allow the shunt pump flow rate to establish prior to allowing loop(L2) output onto final driver(D1) via gate(F14) for burner ignition.
The common shunt pump must run continuously when module(G3) in MACRO MAC/B2 is engaged and must provide pump-down through an additional off-delay timer as detailed in MACRO MAC/B5.
Boiler module flow temperature is controlled from the sensor(S1) by comparison with the desired set-point on knob(B9), any error being calculated by the P+I action of loop(L2) and output via gate(F14) to the binary switch driver(D1).
Binary driver(D1) is set as ON=20%; OFF=1% to provide a wide hysteresis to further discourage short term cycling under light load conditions.
Full safety interlocking is provided by forcing loop(L2) into a manual condition, pre-set to 0%, when any of the safeties (FIRE, GAS or ALTITUDE) are off normal. These are all sourced from the same logic module(G1) shown on MACRO MAC/B2.
Output demand logging is provided by the internal dummy sensor (S34) for analysis of the burner firing.

BOILER MODULE SEQUENCE CONTROL(Common shunt pump)



COMMON BOILER SHUNT PUMP



Application:

Common header shunt pump control for multiple LTHW boiler modules.

Typical operating parameters:

Maintenance of minimum flow rate through boiler modules as required by specification: x litres/min.

Pump-down run on time: 10 mins.

Notes:

1. Use in conjunction with MACROS MAC/B2 and MAC/B4.

COMMON BOILER SHUNT PUMP

Features:

1. Read-back failure monitoring.
2. Delay off timer for pump-down.

Standard components:

Direct Coupled:	R.S.Components Current sensing relay 349-800. R.S.Components associated C/T. 351-099 or 351-106.
Belt driven:	R.S.Components Shaft rotation relay 347-696. R.S.Components associated proxistor. 256-332. (M18NPN Type).

Notes:

1. If shunt-pump is not of the direct coupled type, input(DI10) will be sourced from an R.S. Shaft rotation relay and its associated proxistor. Proxistor to be targeted on the pump pulley wheel.
2. On direct coupled type pumps, current-transformer is to be installed on the same phase from which the control circuit is derived,(normally red phase) adjacent to the associated contactor.

COMMON BOILER SHUNT PUMP

Description:

During periods of heat demand, as dictated by the output of logic module(G3) in MACRO MAC/B2, the shunt pump will run regardless of sequence demand when soft switch(W12) is in the 'AUTO' mode at logic module(G9). When the heat demand period ends, off-delay timer(G10) provides pump-down for 10 minutes ensuring dissipation of boiler heat.
During pump operation status is monitored via digital input(DI10) and will cause a read-back alarm via module(G9) in the event of failure and halt any boiler activity. Input (DI10) is sourced from either an R.S. Current sensing relay,(for a direct drive pump), or an R.S. Shaft rotation relay (for a belt driven pump).

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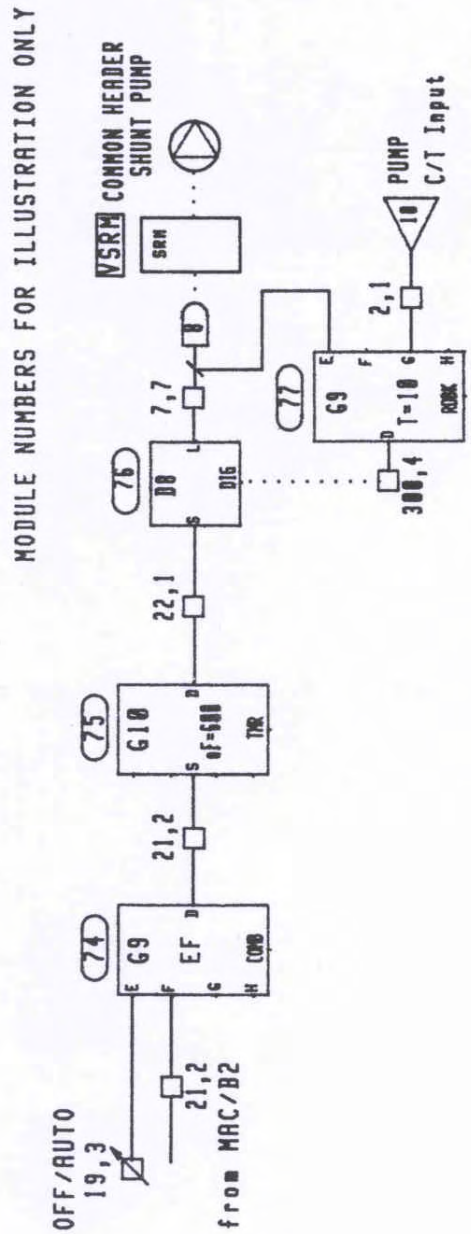
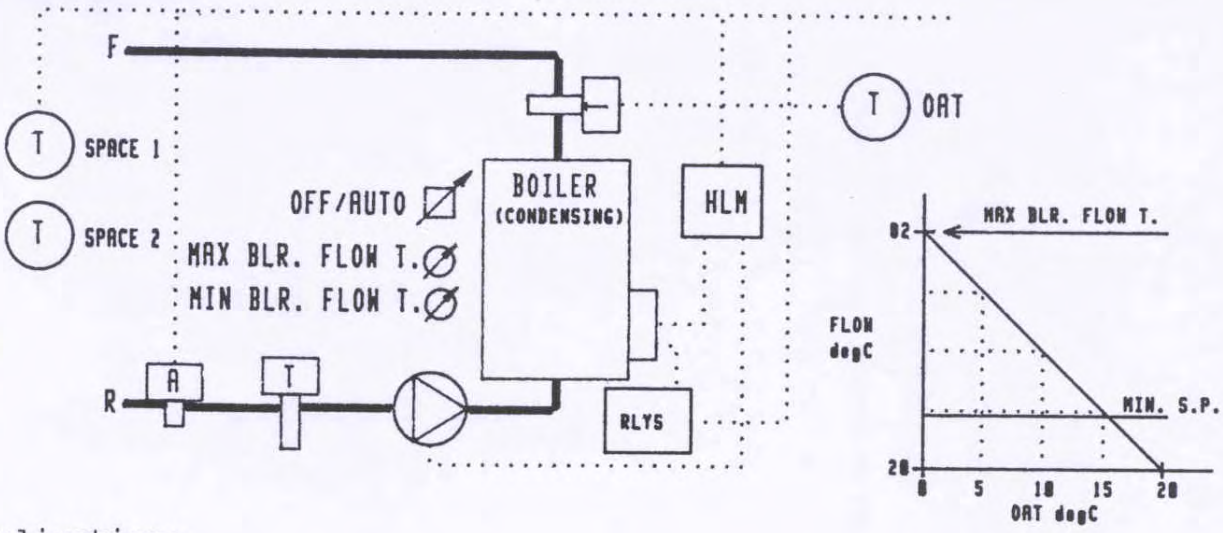
MAC/B5

COMMON BOILER SHUNT PUMP



CONDENSING BOILER/SHUNT PUMP CONTROL



Application:

Small building heating source with weather compensation.

Typical operating parameters:

Boiler flow temp:	30-82.C Schedule 22.C @ 20.C (OAT) 82.C @ 0.C (OAT) Min. flow T=30.C
Boiler flow alarms:	95.C High; 5.C Low:
System altitude:	As provided by F&E tank (x bar)
Loop deviation alarm:	+/- 10.C

Notes:

1. For details of safety interlocks refer to MACRO MAC/G5.

CONDENSING BOILER/SHUNT PUMP CONTROL

Features:

1. Ignition and pump control from single analogue output with HLM.
2. Integrated weather compensation with space schedule re-set.
3. Full safety interlock facility.
4. Associated shunt pump control and monitoring.
5. Loop deviation alarm blocking.
6. Two-stage frost protection interlocked.
7. Full temperature boost on start-up.
8. Min. and Max. boiler flow temperature limits via soft knobs.

Standard components:

Boiler flow sensor:	Trend T314/110 + S/S pocket
Boiler return sensor:	Trend T314/110 + S/S pocket
Boiler/Pump enable relay:	Trend HLM
Pump status monitor:	R.S. Components Current sense relay 349-800. Associated C/T 351-099 or 351-106.
Space sensors:	Trend T320
OAT sensor:	Trend T/PO

Notes:

1. Common boiler lockout and high-temperature alarms are provided by two independent relays supplying a common digital input, but no action is required by this software.
2. Boiler return temperature is for monitoring only.

CONDENSING BOILER/SHUNT PUMP CONTROL

Description:

Sheet 1. Weather compensation with space re-set.
Function module(F1) passes the minimum space temperature to module(F2) where any deviation from a 20.C pre-set will cause the elevation or depression of the weather compensation at function module(F4).(2.5.C flow for every 1.C space deviation).
OAT sensor(S3) signal is passed to function module(F4) via module (F3),and combined with the output of module(F2) to determine the required boiler flow set-point to match the conditions.
Gate module(F3) will normally allow OAT signal from (S3) to pass through to module(F4) but in boost periods a fixed 0% signal is gated to impose maximum boiler set-point.
Logic modules(G1-G5) determine the boost period as:-
G1 Initiates boost between zone OSS start and OCC start periods
G2 Halts boost at OCC start.
G3 Integrates G1 and G2 outputs.
G4 Sets maximum boost time regardless of G1 and G2 demands.
G5 Integrates G3 and G4 outputs.
Logic modules(G6-G9) enable sensors(S1 and S2) alarms during OCC periods when summer/normal modes are selected at switches (W1) and (W2).
Function module(F5) limits the output calculation of function(F4) between the limits set for minimum and maximum boiler flow temperature as set on soft knobs(B1 and B2).
Sheet 2. Boiler/Pump control.
During OSS demand any error between the boiler flow temperature, sensor(S3) and the calculated requirement of function module(F5) is determined by the P+I action of loop(L1) and output to hysteresis module(F7). F7 is set for:- ON=17.5% OFF=2.5% and its digital output is the prime source for burner ignition and shunt pump demand. Outside the OSS demand, loop(L1) set-point is taken from gate(F6) which is normally at 0% unless stage-2 frost protection is called, when a pre-fixed level as set on knob(B3) will be obeyed. At any time loop(L1) may be forced into manual mode to give a 0% output by logic module(G10), this integrates all required safety devices and halts burner and pump operation.
The module(F7) digital output is combined with the pump readback signal (output of (G16) and,if this is not in alarm, gates module (F8) from 0% to 100% which is passed via function modules(F10) & (F11) to driver(D1) to call both pump and burner ignition.
Module(F10) allows pump only operation via first stage frost or OSS demand from logic module(G12) and pump down via timer(G14) by gating between 0% and 40% at module(F9). NB. 40% signal on(D1) will allow the shunt pump to run via the HLM with no ignition.
Loop(L1) set-point selection is dictated by logic module(G11) which combines zone OSS demands, summer/winter and holiday/normal switch modes to determine selection. Output from logic(G11) is also passed to on-delay timer(G13), which after the set time will enable the loop(L1) deviation alarm for operational monitoring.
Function gate(F11) provides the OFF/AUTO facility via soft-switch (W4), when not gated driver(D1) is held to 0% to stop operation.

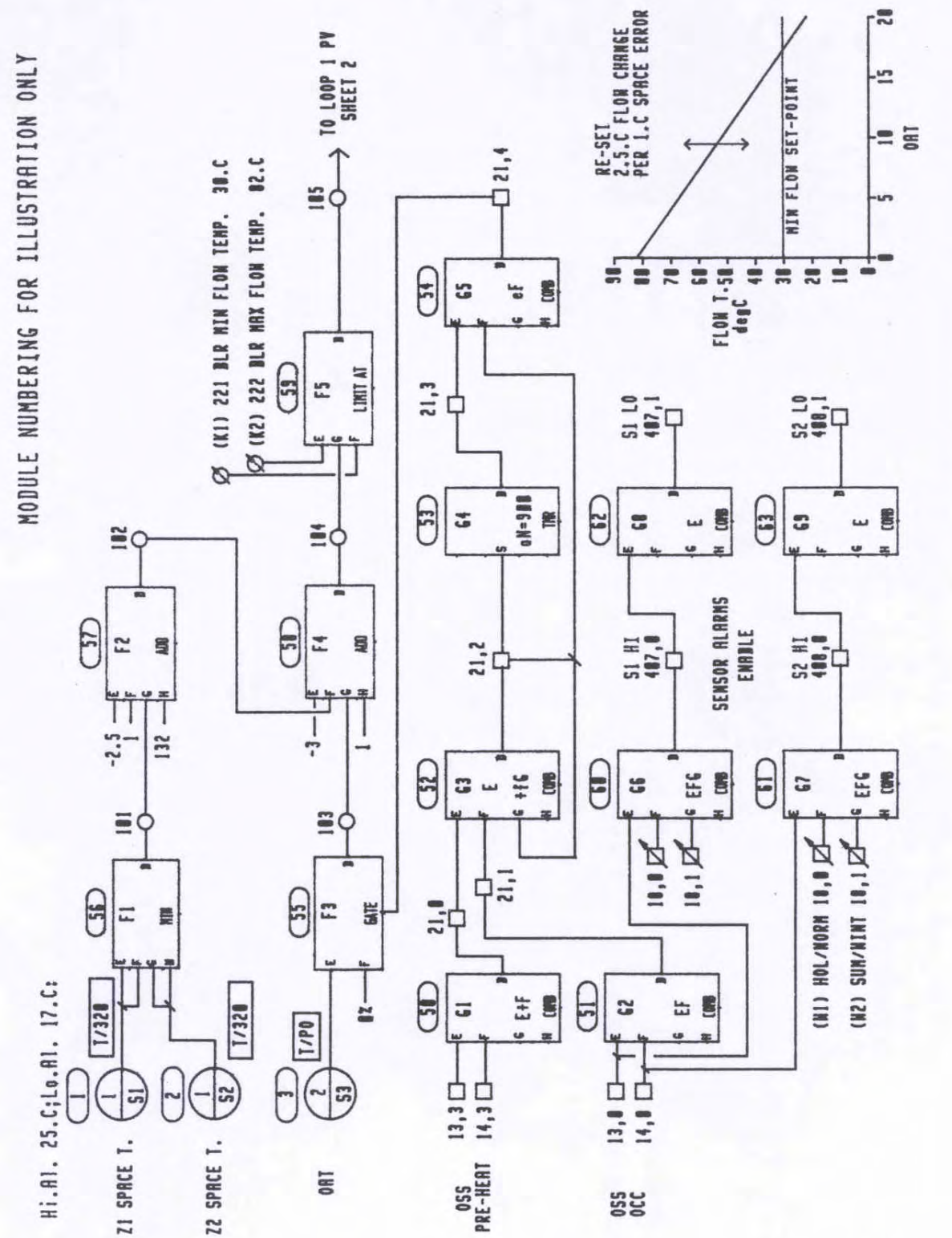
CONDENSING BOILER/SHUNT PUMP CONTROL

Description:

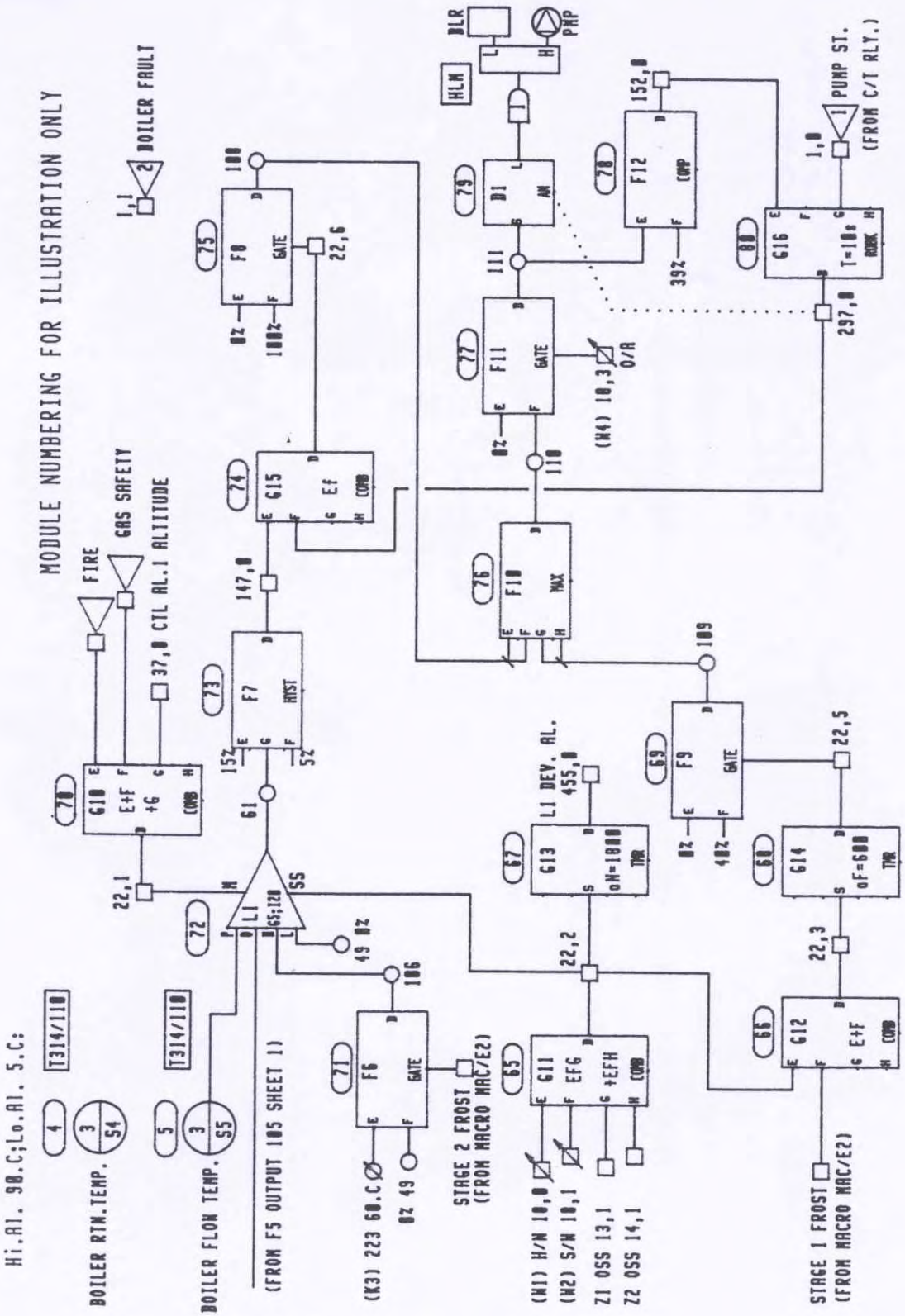
Function module(F12) compares the output of module(F11) to the constant of 39% and if => , will assume pump demand and start the grace time period of the readback module(G16). If digital input (DI1) does not receive a status signal from the current sensing-relay, then an alarm is generated and any ignition signal blocked via the action of module(G15).

Notes:

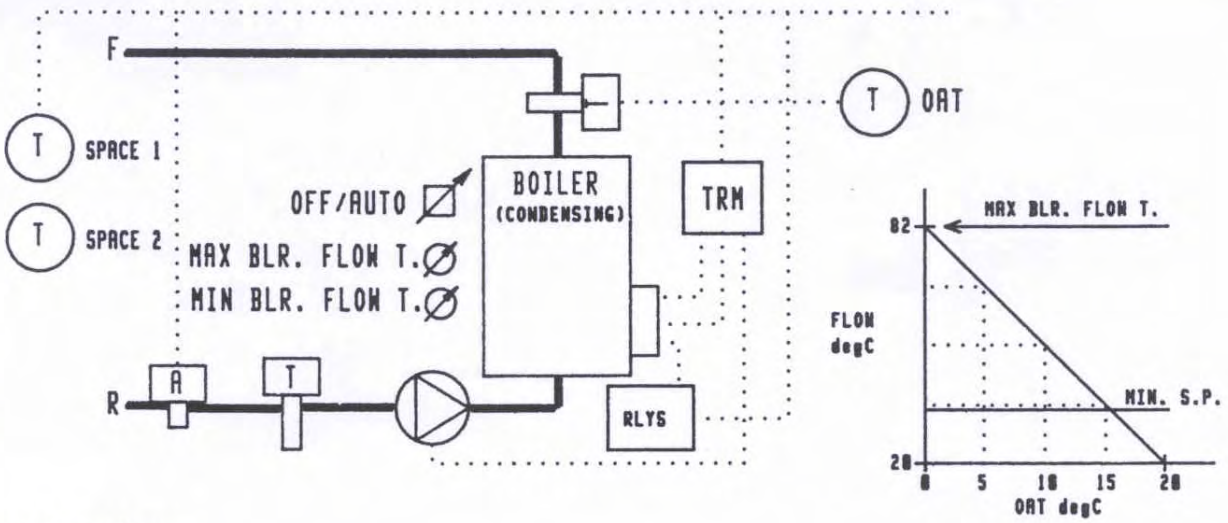
CONDENSING BOILER/SHUNT PUMP CONTROL



CONDENSING BOILER/SHUNT PUMP CONTROL



2-STAGE CONDENSING BOILER/SHUNT PUMP CONTROL



Application:

Small building heating source with weather compensation.
Sliding two-stage burner control.

Typical operating parameters:

Boiler flow temp:	30-82.C Schedule 22.C @ 20.C (OAT) 82.C @ 0.C (OAT) Min. flow T=30.C
Boiler flow alarms:	95.C High; 5.C Low:
System altitude:	As provided by F&E tank (x bar)
Loop deviation alarm:	+/- 10.C
Stage-2 Flame-out:	75.C

Notes:

1. For details of safety interlocks refer to MACRO MAC/G5.
2. Hamworthy boiler second stage operation called by opening demand relay contact of the TRM (use N.C>.)

2-STAGE CONDENSING BOILER/SHUNT PUMP CONTROL

Features:

1. Ignition and pump control from single analogue output with TRM.
2. Integrated weather compensation with space schedule re-set.
3. Full safety interlock facility.
4. Associated shunt pump control and monitoring.
5. Loop deviation alarm blocking.
6. Two-stage frost protection interlocked.
7. Full temperature boost on start-up.
8. Min. and Max. boiler flow temperature limits via soft knobs.
9. Sliding 2-stage burner operation.

Standard components:

Boiler flow sensor:	Trend T314/110 + S/S pocket
Boiler return sensor:	Trend T314/110 + S/S pocket
Boiler/Pump enable relay:	Trend TRM
Pump status monitor:	R.S. Components Current sense relay 349-800. Associated C/T 351-099 or 351-106.
Space sensors:	Trend T320
OAT sensor:	Trend T/PO

Notes:

1. Common boiler lockout and high-temperature alarms are provided by two independent relays supplying a common digital input, but no action is required by this software.
2. Boiler return temperature is for monitoring only.

2-STAGE CONDENSING BOILER/SHUNT PUMP CONTROL

Description:

Sheet 1. Weather compensation with space re-set.
Function module(F1) passes the minimum space temperature to module(F2) where any deviation from a 20.C pre-set will cause the elevation or depression of the weather compensation at function module(F4).(2.5.C flow for every 1.C space deviation).
OAT sensor(S3) signal is passed to function module(F4) via module (F3),and combined with the output of module(F2) to determine the required boiler flow set-point to match the conditions.
Gate module(F3) will normally allow OAT signal from (S3) to pass through to module(F4) but in boost periods a fixed 0% signal is gated to impose maximum boiler set-point.
Logic modules(G1-G5) determine the boost period as:-
G1 Initiates boost between zone OSS start and OCC start periods
G2 Halts boost at OCC start.
G3 Integrates G1 and G2 outputs.
G4 Sets maximum boost time regardless of G1 and G2 demands.
G5 Integrates G3 and G4 outputs.
Logic modules(G6-G9) enable sensors(S1 and S2) alarms during OCC periods when summer/normal modes are selected at switches (W1) and (W2).
Function module(F5) limits the output calculation of function(F4) between the limits set for minimum and maximum boiler flow temperature as set on soft knobs(B1 and B2).
Sheet 2. Boiler/Pump control.
During OSS demand any error between the boiler flow temperature, sensor(S3) and the calculated requirement of function module(F5) is determined by the P+I action of loop(L1) and output to hysteresis modules(F7&F8). F7 is set for:- ON=17.5% OFF=2.5% and its digital output is the prime source for burner ignition and shunt pump demand. F8 is set for:- ON=27.5% OFF=22.5% and determines high or low fire operation by providing the correct signal levels for the TRM output module.
Outside the OSS demand, loop(L1) set-point is taken from gate(F6) which is normally at 0% unless stage-2 frost protection is called, when a pre-fixed level as set on knob(B3) will be obeyed. At any time loop(L1) may be forced into manual mode to give a 0% output by logic module(G10), this integrates all required safety devices and halts burner and pump operation. The module(F7) digital output is combined with the pump readback signal (output of G16) and,if this is not in alarm, gates module (F10) from 0% to the output level of gate(F9) which is passed via function modules (F12) & (F13) to driver(D1) to call both pump and burner ignition.
Module(F11) allows pump only operation via first stage frost or OSS demand from logic module(G12) and pump down via timer(G14) by gating between 0% and 40% at module(F11). NB. 40% signal on (D1) will allow the shunt pump to run via the TRM with no ignition.

2-STAGE CONDENSING BOILER/SHUNT PUMP CONTROL

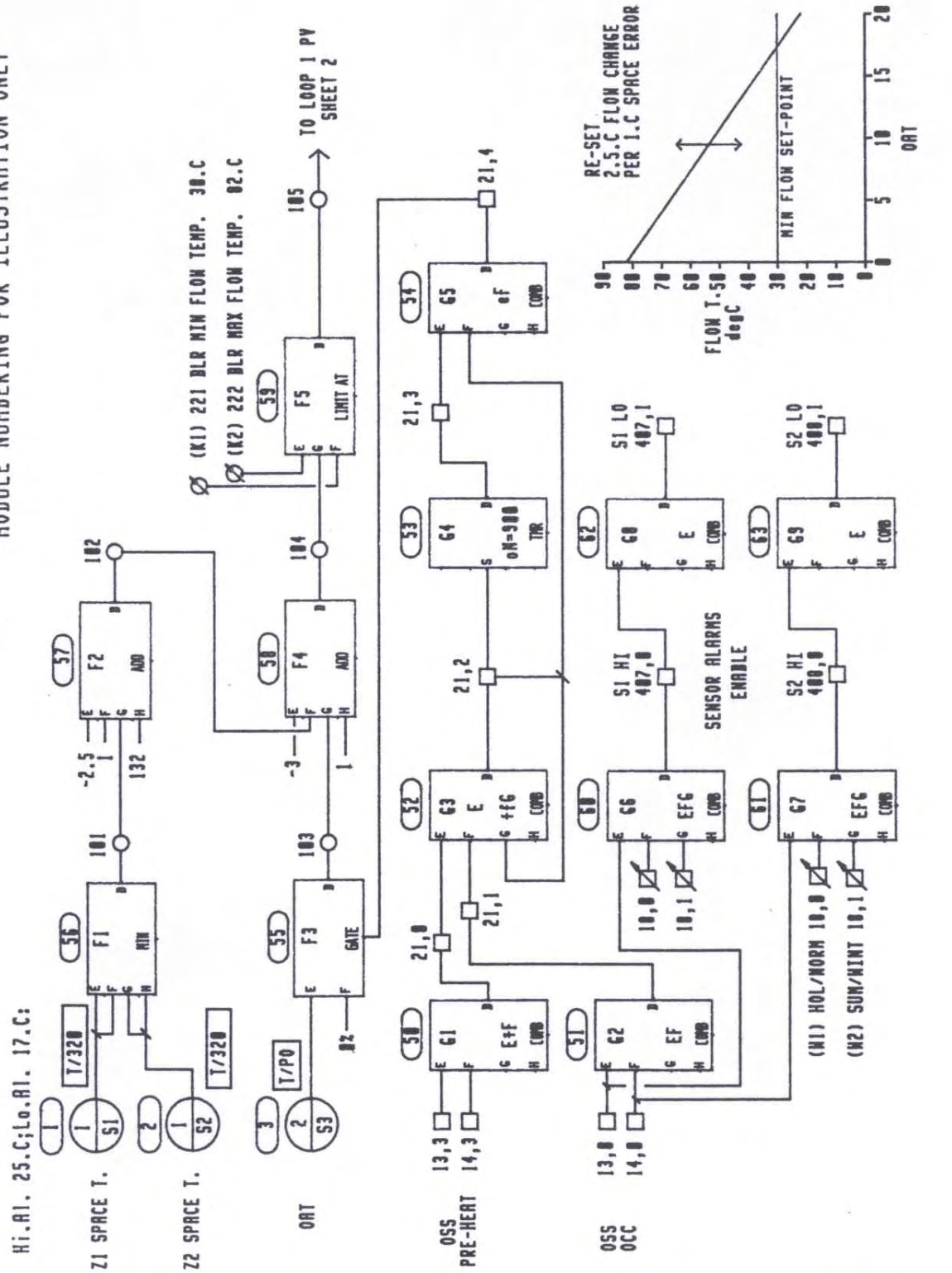
Description:

Loop(L1) set-point selection is dictated by logic module(G11) which combines OSS demands, summer/winter and holiday/normal switch modes to determine selection. Output of logic module(G11) is also passed to on-delay timer(G13), which after the set time will enable the loop(L1) deviation alarm for operational monitoring.
Function gate(F13) provides the OFF/AUTO facility via soft switch (W4), when not gated driver(D1) is held to 0% to stop operation.
Function module(F12) compares the output of module(F11) to the constant of 39% and if => , will assume pump demand and start the grace time period of the readback module(G16). If digital input (DI1) does not receive a status signal from the current sensing-relay, then an alarm is generated and any ignition signal blocked via the action of module(G15).

Notes:

1. TRM 0% output signal..... Boiler OFF shunt pump OFF
   40% output signal..... Boiler OFF shunt pump ON
   70% output signal..... Boiler LOW shunt pump ON
   100% output signal..... Boiler HIGH shunt pump ON
2. Hamworthy 2-stage burner requires high-fire circuit to open for operation. Therefore stage 3 of TRM is wired using N.C. contacts.

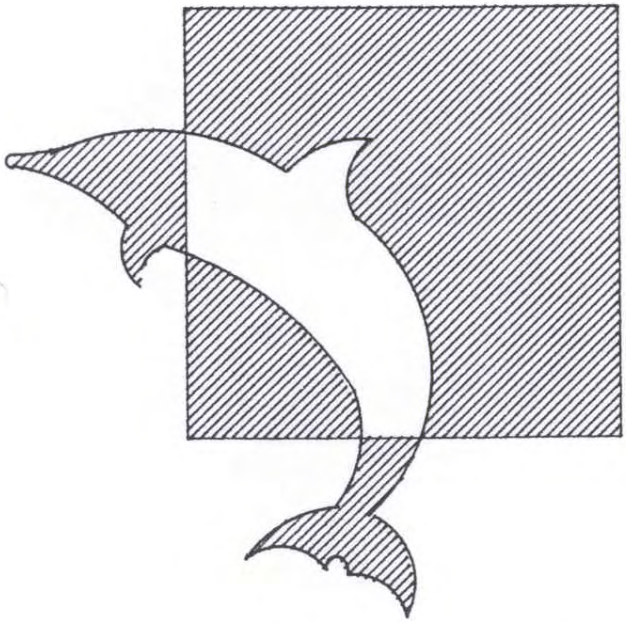
2-STAGE CONDENSING BOILER/SHUNT PUMP CONTROL



BMS

APPLICATIONS MACROS

TREND



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MECHANICAL SERVICES SECTION B30a
Highfield Southampton SO9 5NH
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MINIMUM %RH CONTROL OPTION FOR MACRO MAC/D3

Features:

1. Step control of sterile steam humidifier.
2. High and Low level %RH alarms.
3. Alarm blocking.
4. Unit fault alarm input.
5. Supply fan interlock.
6. Supply air high-limit.

Standard components:

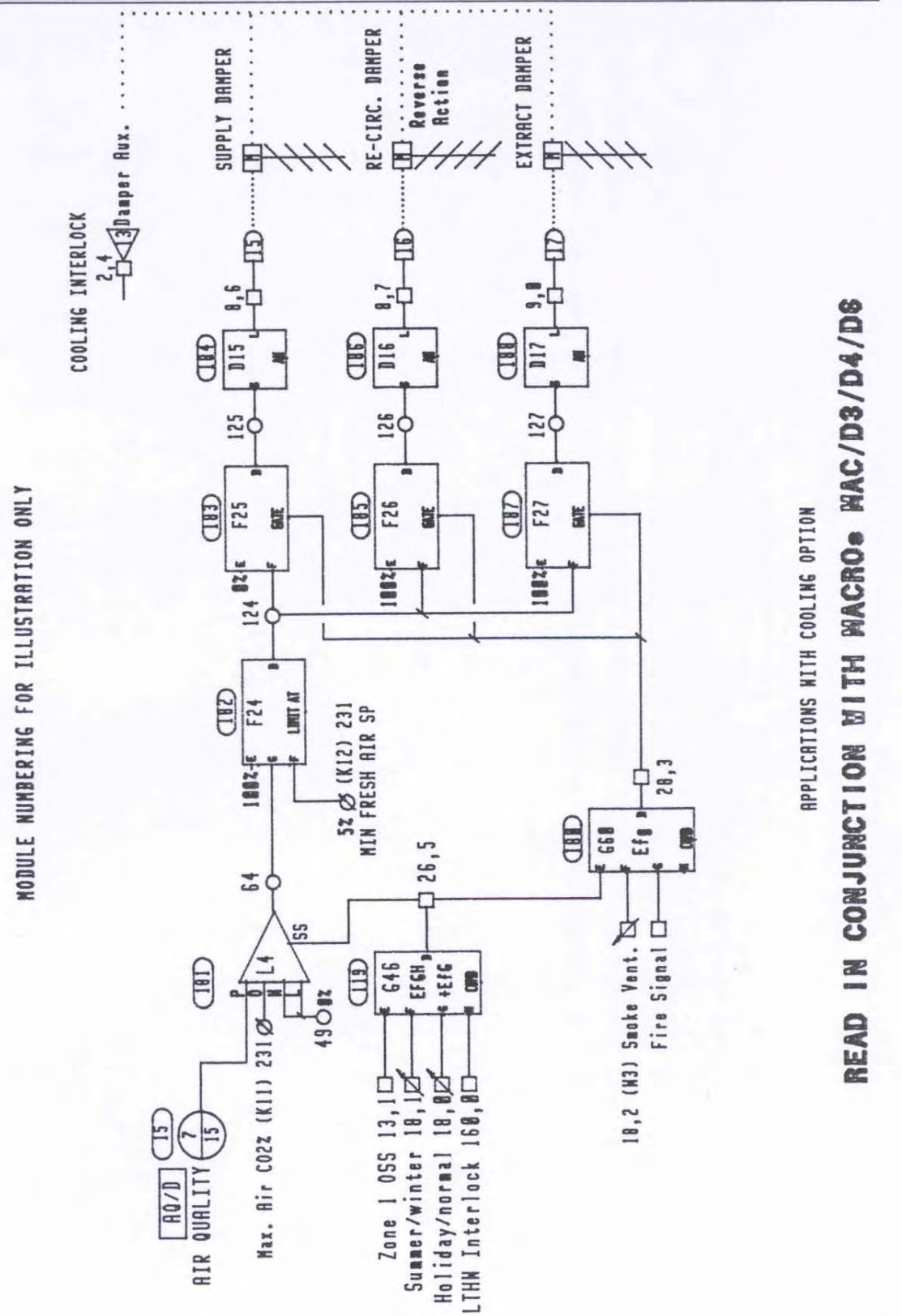
%RH Space sensor:	Trend H/ST or H/D
%RH High-limit sensor:	Trend H/D
Output drive relay:	Trend HLM TRM CRM as applicable

Notes:

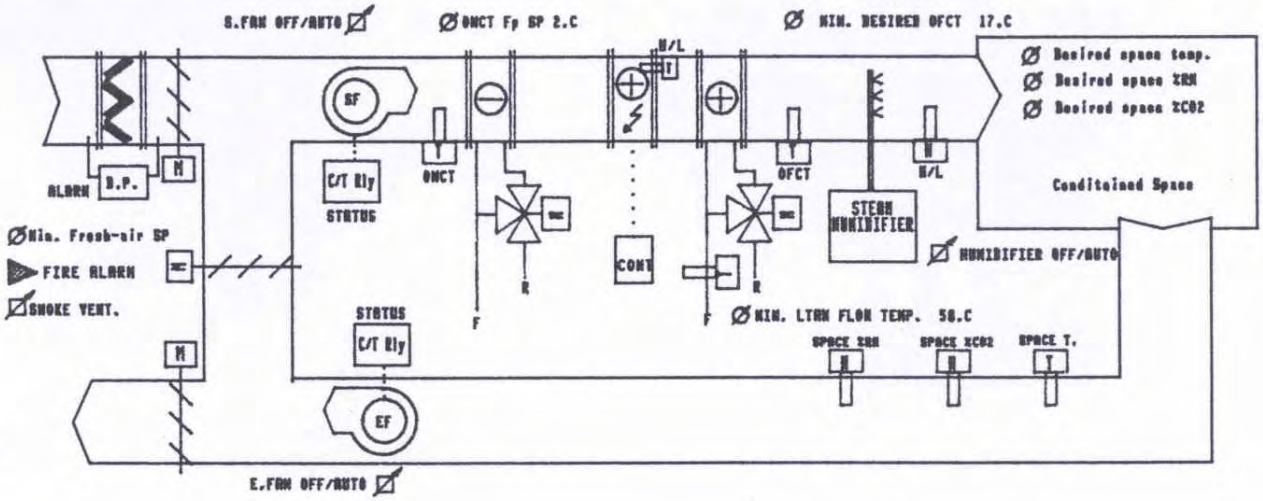
1. Output may be a direct analogue (0-10v/4-20mA) for units with built-in facility.
2. Select output relay to match unit load step requirements.
3. %RH control sensor may be space or extract-duct mounted.

SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/D7

AIR QUALITY(CO2) CONTROL OPTION FOR MACROs MAC/D3/D4/D6



BASIC AIR CONDITIONING CONTROL



Application:

Machine rooms and special storage areas requiring 24hr conditioned environment.

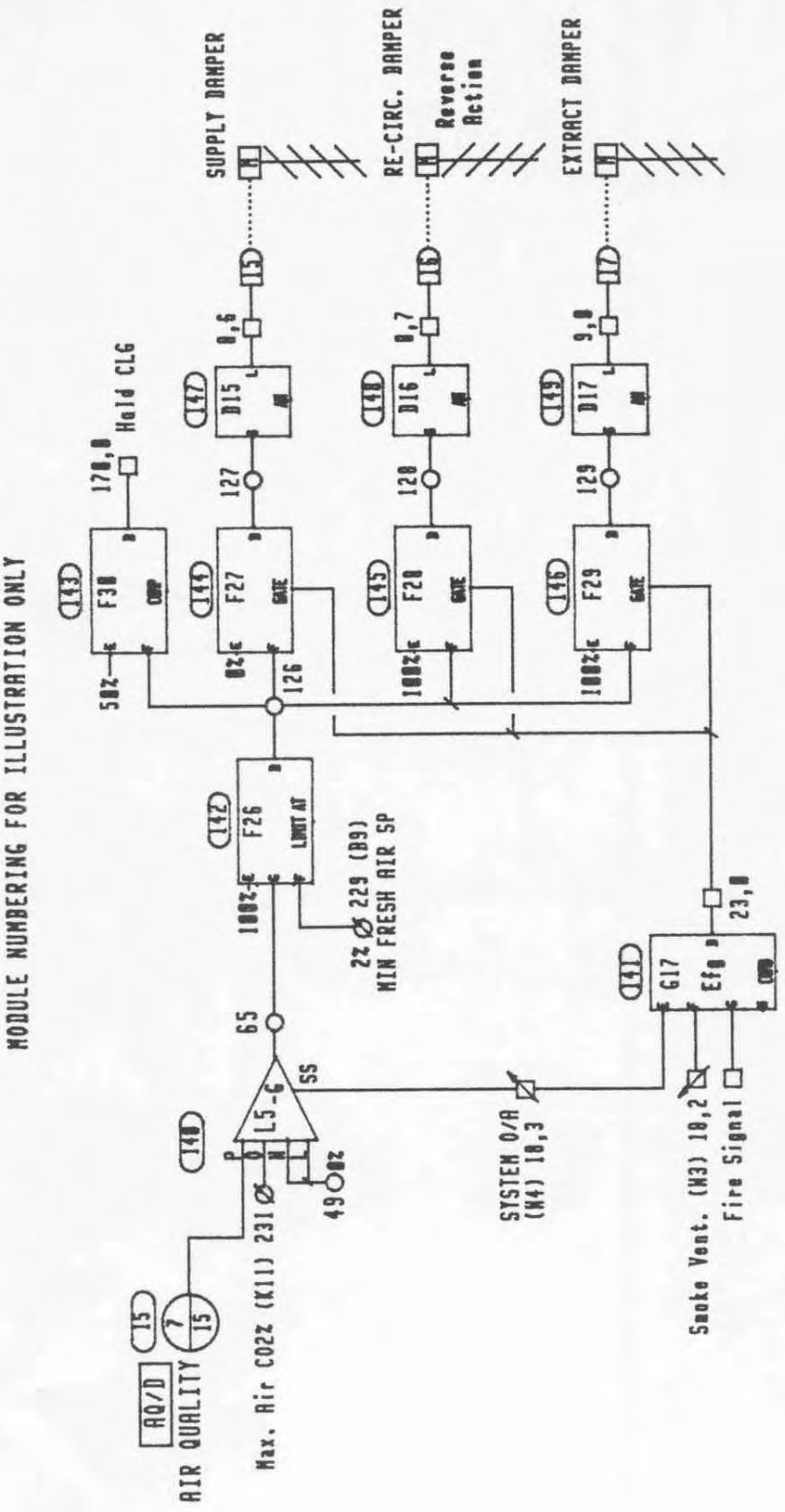
Typical operating parameters:

LTHW supply:	82.C
LTHW min.temp interlock:	50.C
Discharge temperature(OFCT):	15.C - 35.C
OFCT sensor alarms:	40.C High; 13.C Low:
Min. valve position @ 2.C (ONCT):	5%
Min.OFCT limit:	8.C
Desired space temperature:	20.C -22.C (Fixed dead-band)
Space sensor alarms:	26.C High; 17.C Low:
%RH set-point:	55%
Space %RH alarms:	65% High; 50% Low:
Supply %RH alarms:	75% High; 40% Low:
Electric H.Battery H/L SP:	85.C
Max. %CO2 SP:	0.4% CO2

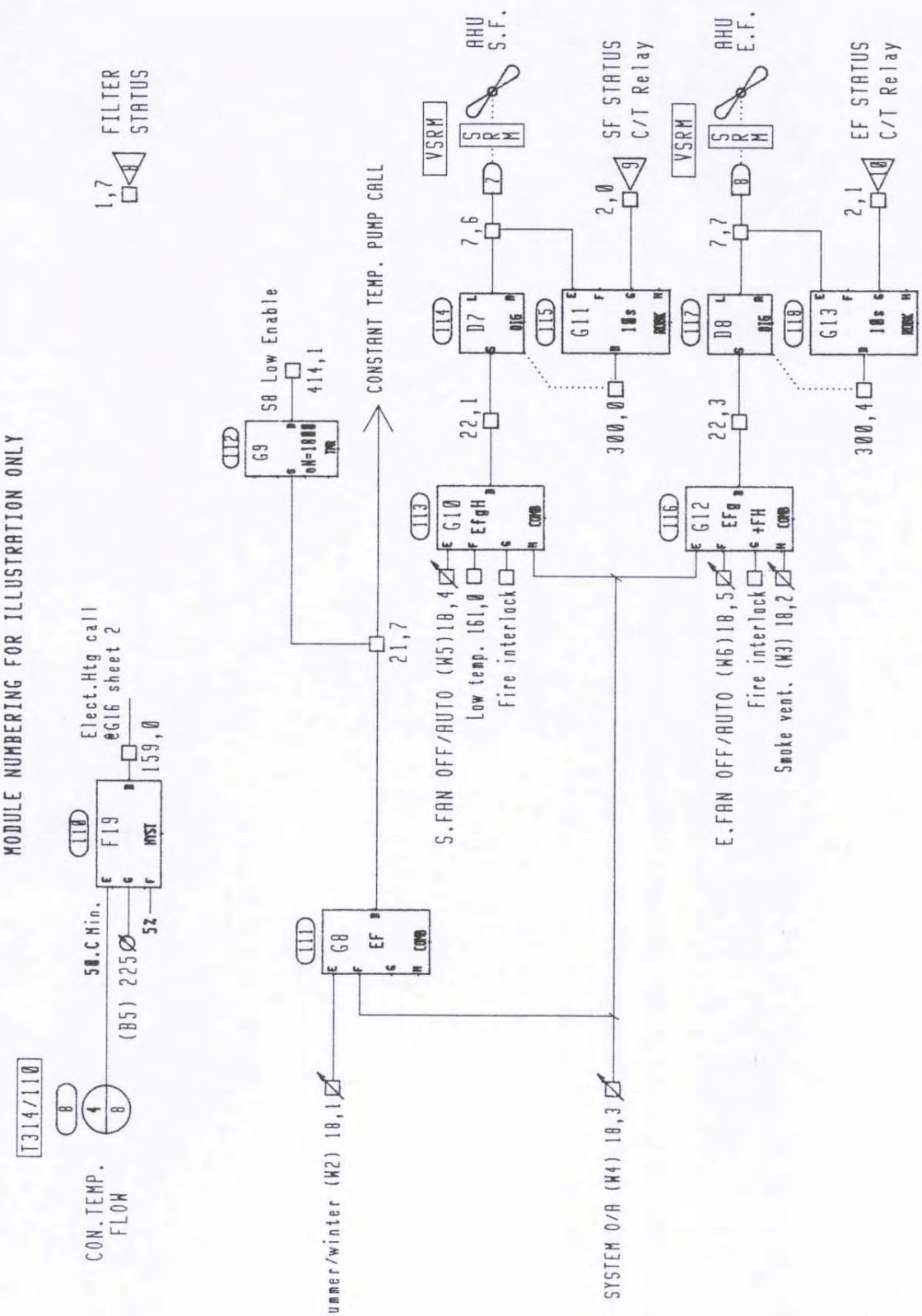
Notes:

1. Basic system for fixed %Fresh-air make up with non-motorised, direct acting fire interlocked dampers.
2. Option given for basic damper drive with %CO2 control.
3. Additional operational options are too numerous to cover and will require particular specification.

BASIC AIR CONDITIONING CONTROL



BASIC AIR CONDITIONING CONTROL



BASIC AIR CONDITIONING CONTROL

Description:

The basic air-conditioning MACRO presented here is primarily intended for control of machine/computer rooms or special storage areas, required to operate on a 24hr basis.
Systems of this general type normally operate on a fixed quantity %Fresh-Air make-up, as set on non-motorised, direct-acting fire interlocked dampers.(Fusible link/spring close types).
For reasons of economy, in particular with systems operating on a 24hr basis, it is recommended that the option for control of the dampers under %CO2 (Air-quality) be provided.
The system indicated utilizes chilled-water for cooling and LTHW for winter heating, both supplied from other central plant.
Back-up and summer heating requirements are catered for by an additional electric heater battery.
Humidification would normally be provided by a sterile-steam unit with its associated sparge pipe mounted in the supply duct as the last down-stream component, with the exception of the %RH high-limit sensor.
De-humidification is provided by the action of the cooling and heating batteries, the cooling battery is brought into action to cause condensing on its surface to remove moisture from the air which is then re-heated to lower the %RH.
Various plant status/alarms are provided and all remain active whilst in operation, with the exception of the low LTHW flow sensor alarm, which is active only during the winter mode.

Sheet 1 Configuration.
The system is brought into action by the system master soft switch (W4). Logic module(G8) checks summer/winter mode at switch(W2) and if required will call for constant temperature pump operation and enable the sensor(S8) low alarm via timer module(G9).
If summer mode is active the pump call and alarm enable is held and electric heating is utilised.(Logic at module G16 on Sheet 2).
The constant-temperature flow sensor(S8) is fed into hysteresis module(F19) and compared to the low level setting for LTHW flow on knob(B5), normally set at 50.C. When below the hysteresis level electric heating is called via logic module(G16) on Configuration Sheet 2.
The supply fan is mastered by logic module(G10) which allows operation only when the master O/A switch(W4) is in 'AUTO', a low temperature is not detected by function module(F21), a fire signal is not present and the fan O/A switch(W5) is in 'AUTO' mode. Module(G10) output will engage driver(D7) for fan operation via its associated SRM at output(AO7) and during operation is monitored by input(DI9) and its associated C/T status relay.
Read-back module(G11) will initiate a driver alarm should fan operation cease whilst module(G10) is engaged.

BASIC AIR CONDITIONING CONTROL

Description:

The extract fan is mastered by logic module(G12) which allows operation under two specific circumstances only, the first 'normal' operation requires the system master O/A switch(W4) and the fan O/A switch(W6) both to be in 'AUTO' mode and no fire signal present. The second, when called to run for smoke-venting after a genuine fire, requires fan O/A switch(W6) to be in 'AUTO' mode and Smoke Vent. switch(W3) in the 'ON' mode. Module(G12) output will engage driver(D8) for fan operation via its associated SRM at output(AO8) and during operation is monitored by input (DI10) and its associated C/T status relay. Read-back module(G13) will initiate a driver alarm should fan operation cease whilst module(G12) is engaged.

The supply air filter is permanently monitored for a 'clog' condition by the action of the associated d.p. switch, monitoring the pressure-drop across the media. At a pre-set level the switch will change the state of digital input(DI8) to generate a general alarm. No control action is required.

Sheet 2 Configuration.

The ONCT, which is a mixture of fresh-air and return-air, is monitored by sensor(S10) to provide frost protection to the LTHW heater battery. Module(F17) compares the sensed temperature on sensor(S10) with the set point of soft knob(B6) and if below the value set, will gate module(F18) to impose a minimum 5% position on the LTHW control valve or electric heaters via function(F19). This action is regarded as an additional safety and should not, under normal circumstances, be called to operate due to the small fresh-air quantities usualy required by the system. Note, the electric heater battery is located up-stream of the LTHW battery to afford the later protection under summer operation when a chiller battery malfunction could cause a frost condition on the LTHW battery.

The space temperature is monitored by sensor(S9) and utilised directly for the control of both heating and cooling loops(L1,L2). For heating the P+I action of loop(L1) will modulate the LTHW valve, via maximum module(F19), from driver(D9) and its associated output(AO9). Note module(F19) will not allow the output to fall below 5%, when the OFCT at sensor(S10) < Knob(B6) set-point(2.C). Function module(F19) output is also presented to input 'F' of gate module(F25) ready for electric heater battery operation.

Electric heater battery operation is dictated by logic module(G16) which switches function gate(F25) from its normal 0% position to control from loop(L1) via function(F19). Output from function(F25) acts directly on driver(D10) and associated output(AO10) to provide step control of the electric battery from the auxiliary CRM.

Electric heating, as dictated by logic module(G16),is active under two circumstances, summer mode selected or low LTHW flow detected. Both require the associated electric heater battery high-limit status to be off at input(DI11) and the O/A switch(W8) to be in 'AUTO' mode.

BASIC AIR CONDITIONING CONTROL

Description:

Cooling for space temperature control is provided by the P+I action of loop(L2) where the space temperature sensor(S9) is compared to the desired heating set-point on knob(B7) plus the required heat/cool dead-band provided by the add module(F16). Note loop(L2) set for negative gain factor.
The loop(L2) output passes through maximum module(F20), where any de-humidification requirements are integrated, and gate module (F22), for interlock action by module(G14), to driver(D11) and its associated output(AO11) for modulation of the chilled-water control valve. The interlock action of module(G14) will close the chilled-water valve under the following circumstances:-

i. OFCT <7.C Actioned by (F21).
ii. ONCT <2.C Actioned by (F17).
iii. Smoke-vent switch(W3) in 'ON' mode.
iv. Fresh-air dampers >50% open. Actioned by (F30).
(CLG not practical and uneconomic)

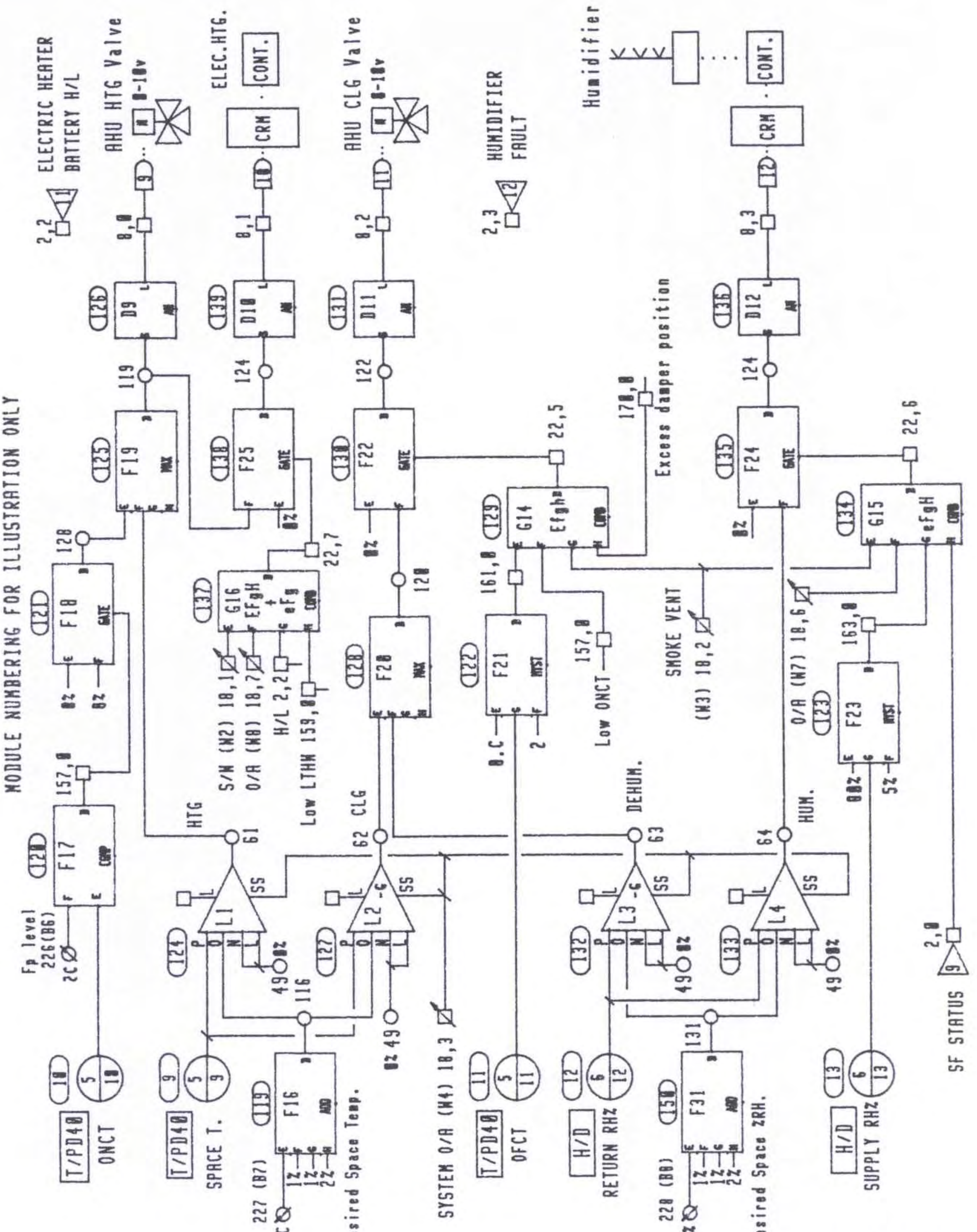
Humidification control is provided by the P+I action of loop(L4) where the return-air %RH sensor(S12) is compared with the desired set-point on knob(B8). Output from loop(L4) is then directed to driver(D12) and its associated output(AO12), via gate module(F24), to provide step control of the humidifier from the auxiliary CRM. Module(F24) is mastered from logic module(G15), which allows operation only when, O/A switch(W7) is in 'AUTO' mode, supply %RH high-limit sensor(S13) is below the threshold limit set by hysteresis module(F23) and the supply fan is proved running by digital input(DI9).
Digital input(DI12) permanently monitors the humidifier for a fault condition and will generate a general alarm when activated, but is not utilised for interlocking.
De-humidification control is provided by the P+I action of loop (L3), where the space %RH sensor(S12) is compared with set-point on knob(B8) plus the hum/de-hum. dead-band provided by the add module(F31). Note loop(L3) has a negative gain factor.
Loop(L3) output is presented to the maximum function module(F20) where the greater of cooling or de-humidification demands is obeyed.
The option shown for damper control, at the dictates of the air-quality(CO2) sensor(S15), will provide individual damper drives for supply, extract and re-circulation via drivers(D15-D17) and their associated outputs(AO15-AO17), from the proportional only action of loop(L5) set for a negative gain factor. Module(F26) and knob(B9) provide a means of imposing a minimum fresh-air damper position, although in practice, this should not be found necessary. System O/A and interlocking for fire and smoke-venting is provided by logic module(G17), where for normal operation the criteria is:- Switch(W4) in 'AUTO' mode,smoke vent switch(W3) in 'OFF' mode and no fire signal present. With this condition met function gates(F27-F29) allow the function(F26) output directly onto the damper drivers(D15-D17) for modulation at the dictates of loop(L5). At all other timers dampers are in FIRE/VENT mode.

SOUTHAMPTON UNIVERSITY BMS

Applications MACRO

MAC/D8

BASIC AIR CONDITIONING CONTROL



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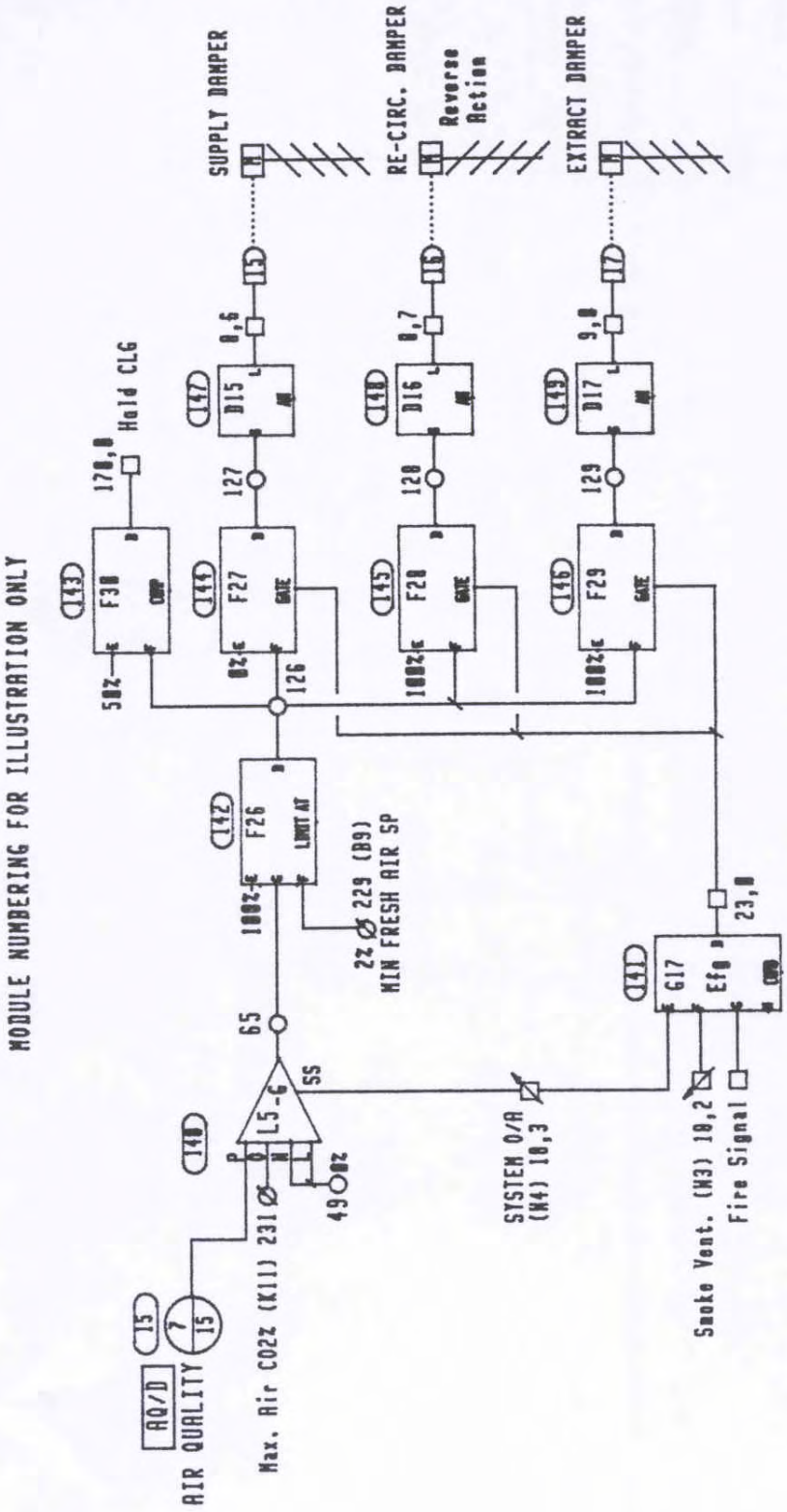
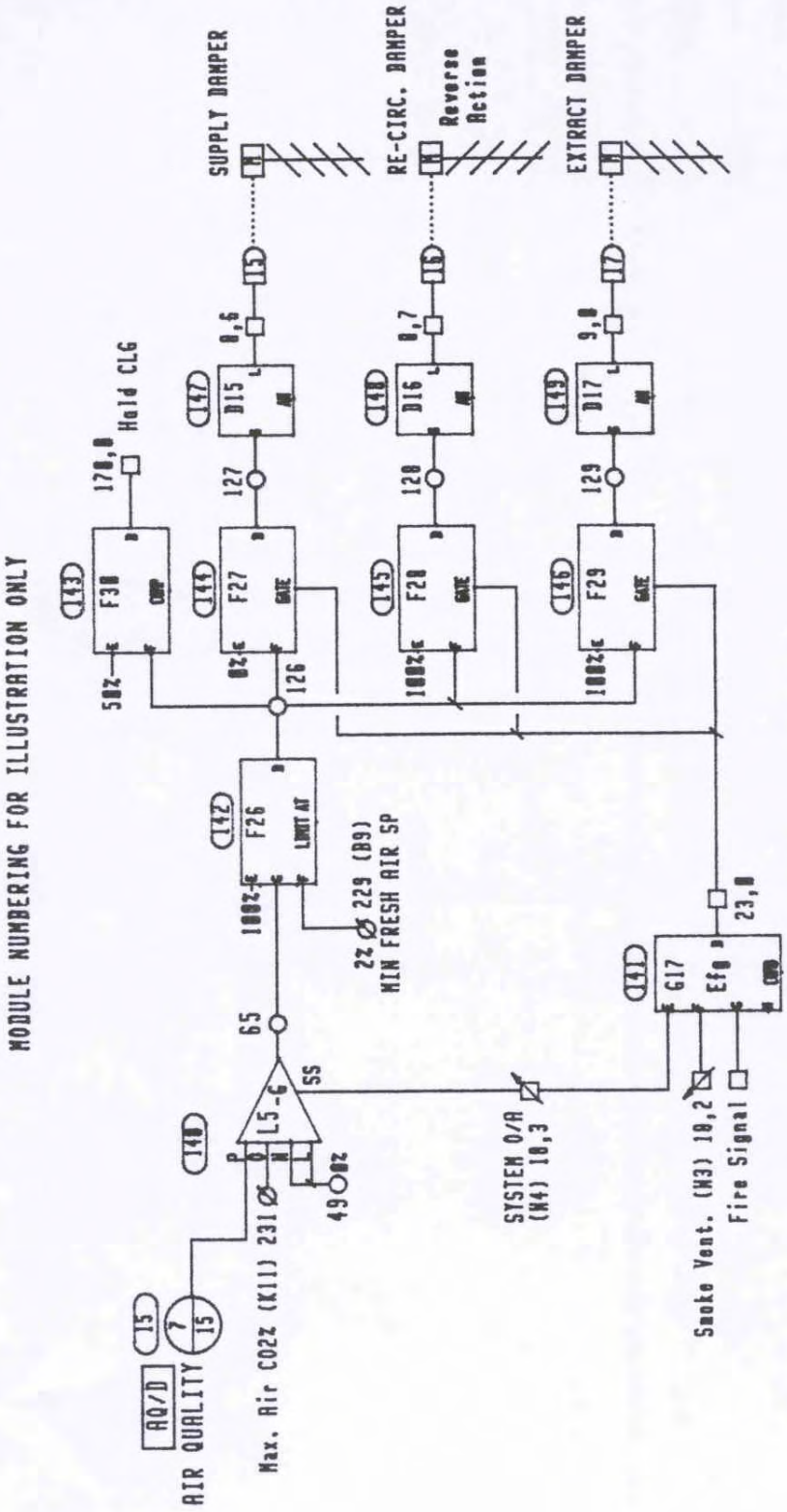
BASIC AIR CONDITIONING CONTROL

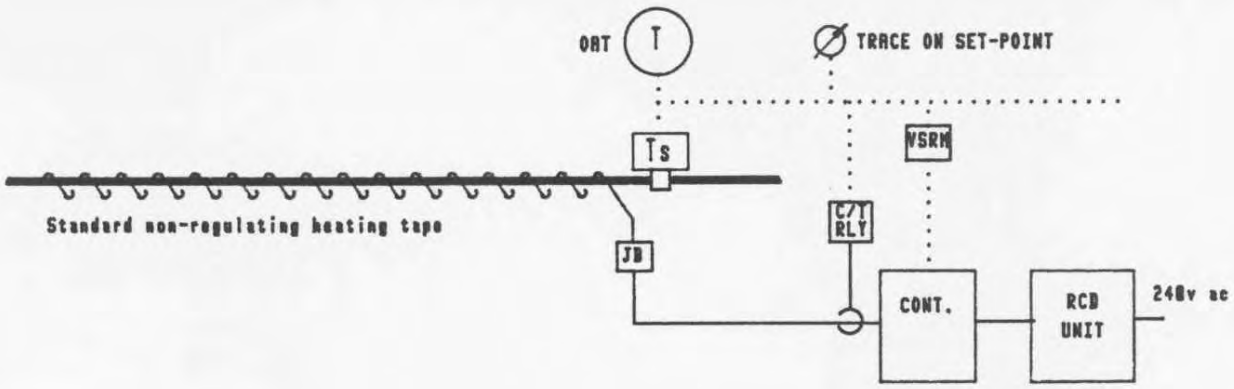


SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/D8

BASIC AIR CONDITIONING CONTROL



TRACE HEATING FOR EXTERNAL PIPED SERVICES



Application:

Frost protection for external piped services.
Main heating flow and returns during off periods.
System cold-feed and expansion pipework.
HWS secondary distribution on gravity systems.

Typical operating parameters:

OAT set-point:	3.C
Pipe thermostat set-point:	As manufacturer's recommendation

Notes:

1. Two basic types of heating tape are available:-
   Standard
   Self temperature regulating

TRACE HEATING FOR EXTERNAL PIPED SERVICES

Features:

1. RCD protection.
2. OAT set-point control.
3. C/T relay read-back monitoring.
4. Local pipe temperature control from strap-on thermostat.
5. Summer/winter interlocked.

Standard components:

OAT sensor:	Trend T/PO
Pipe thermostat:	As tape manufacturer's recommendation
Output drive relay:	Trend SRM
Status relay:	R.S. C/T Relay 349-800
	R.S. C/T 351-099

Notes:

1. Multiple tapes may be activated from the single contactor, if this is done the C/T must be placed on the common supply cable.
2. Pipe thermostat is usualy of the strap-on variety.
3. Positioning of the pipe thermostat is critical.
   For distribution F & R pipework the return near the heat-source should be selected as the coldest position.
   On cold feed and expansions a position near the tankage should be selected.
   When switching multiple tapes the coldest individual location should be selected.

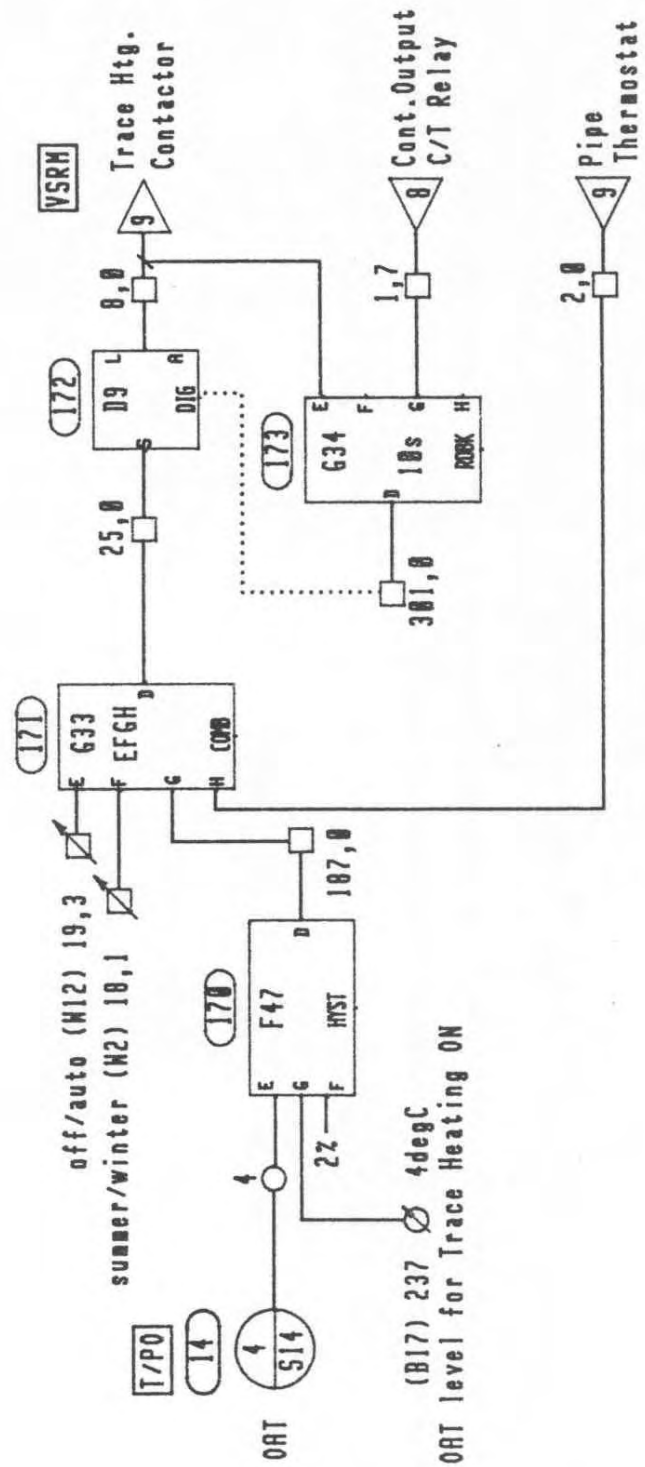
TRACE HEATING FOR EXTERNAL PIPED SERVICES

Description:

STANDARD TRACE TAPE.
OAT sensor(S14) is monitored by hysteresis module(F47) and compared with the level set on soft knob(B17) and the fixed 2.C band. With knob(B17) set at 4.C output switching will be provided as ON=3.C; OFF=5.C: Logic module(G33) integrates the (F47)output with summer/winter soft-switch(W2), off/auto switch(W12) and pipe-thermostat input(DI9), allowing driver(D9) to be engaged only under winter+auto+stat demand conditions.
When engaged driver(D9) is monitored for operation by read-back module(G34) which will generate an alarm if the input at (DI8) fails wilst the driver is on.
Note. Pipe thermostat will switch off the tape heating when a sensible temperature is available in the piped service. (5.C)

SELF-REGULATING TRACE TAPE.
Normally as above.
Status monitoring without the auxiliary pipe thermostat is difficult due to the change in current draw caused by the self-regulation. If no aux. thermostat is incorperated monitoring should be left off. Omitt G34 DI8 and DI9.

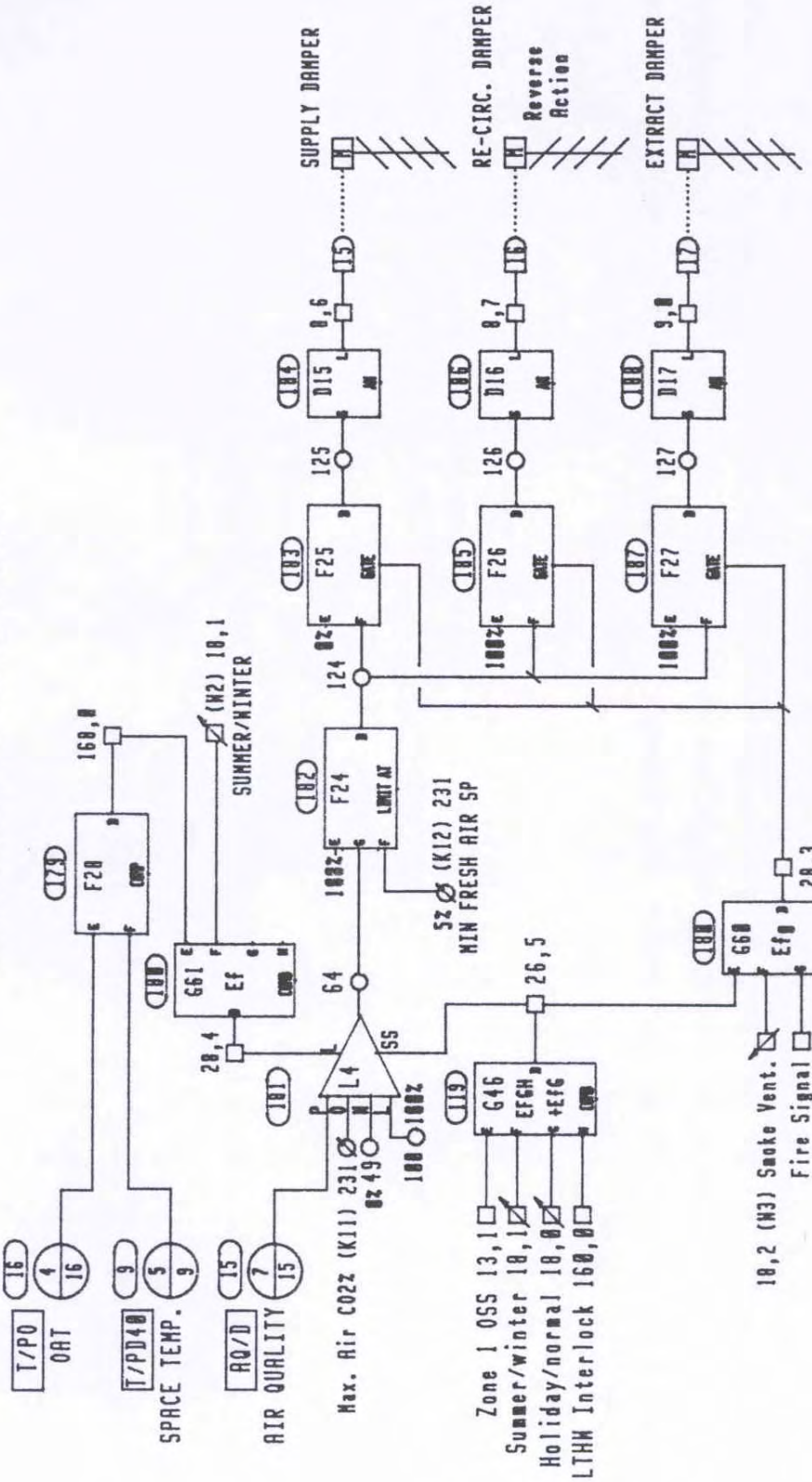
TRACE HEATING FOR EXTERNAL PIPED SERVICES



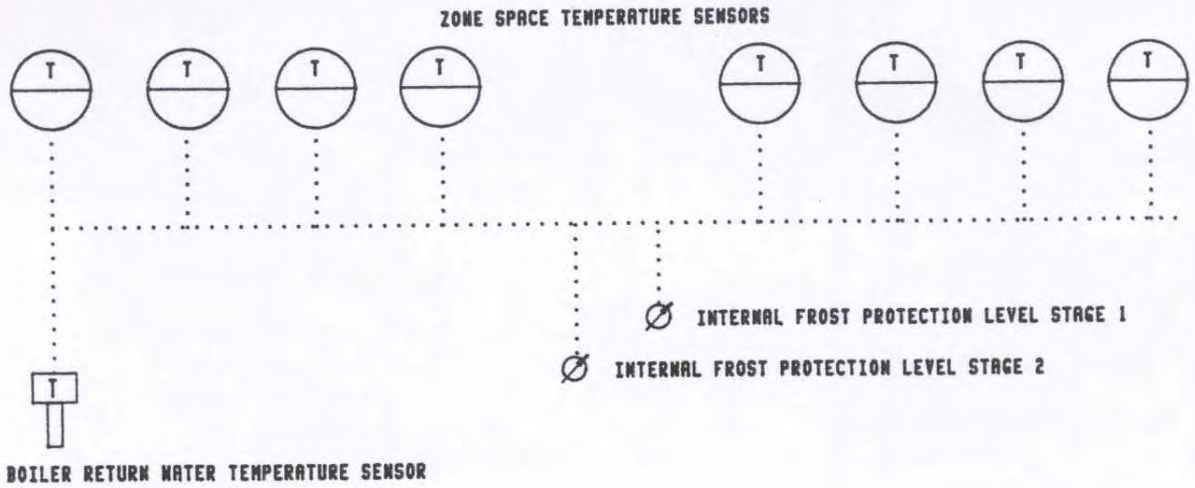
MODULE NUMBERING IS FOR ILLUSTRATION ONLY

STANDARD TRACE TAPE(NON SELF-REGULATING)

AIR QUALITY(CO2) CONTROL OPTION FOR MACROs MAC/D3/D4/D6



GENERAL FROST PROTECTION



Application:

Two stage frost protection of fabric and piped services.

Typical operating parameters:

1st STAGE set-point: (Common boiler return or OAT)	2.C
2nd STAGE set-point: (Common boiler return or OAT)	1.C
1st STAGE set-point: (Minimum internal space)	5.C
2nd STAGE set-point: (Minimum internal space)	4.C

Notes:

1. Stage 1 protection for piped services will run all circulating pumps.
   Stage 2 protection for fabric and piped services will run all circulating pumps and activate heat source.
2. Where applicable common boiler return sensor may be replaced or supplemented by OAT sensor.

GENERAL FROST PROTECTION

Features:

1. Two-stage operation with adjustable set-points.
2. Monitoring of both space and piped service temperatures.
3. Boiler return sensor may be replaced by, or supplemented with, OAT sensor.

Standard components:

Space sensors:	Trend T/320
Pipe sensor:	Trend T314/110
OAT sensor: (Optional)	Trend T/PO

Notes:

1. Space sensors must be selected from each controlled zone, as indicative of the local conditions as possible.
2. Boiler return water temperature sensor may be substituted with or substituted by an OAT sensor.
3. Special attention should be paid on systems containing AHU heater-batteries to ensure frost protection is adequate.

GENERAL FROST PROTECTION

Description:

The basic strategy presented here will provide two-stage frost protection for installed piped services and building fabric.
Stage 1. Actions circulating pumps and moves control valves to fully open position to create a water movement, thus ensuring there are no localised pockets of water in danger of freezing as the ambient temperature falls prior to operation of stage 2.
Stage 2. Actions the heat source to be made available, in some cases at set-back levels, may be boilers and/or heat-exchangers.

Space temperature sensors used for the algorithm must be indicative of the zones they protect and all zones are recommended to be sampled. Although in practise the north facing zones should be the coldest.
Piped services are monitored from the common boiler return temperature, this usually being the coldest point on the system. OAT sensing may be substituted for the boiler return, or indeed both may be integrated, but it is generally accepted that OAT alone tends to call frost protection in advance of the actual building's needs, and is therefore not energy efficient.
Particular attention must be paid to AHUs with wet heater-batteries as these are particularly vulnerable to frost damage.
ONCT/OFCT sensors for each particular system should be utilised to directly call operation of required plant.
HWS systems usually require no frost protection as they operate on a 24hr basis to prevent legionella problems.
Common boiler return temperature sensor(S9) is presented to the comparator modules(F45 & F46) where the level is compared with the fixed stage 1 & stage 2 constants of 2.C and 1.C respectively.

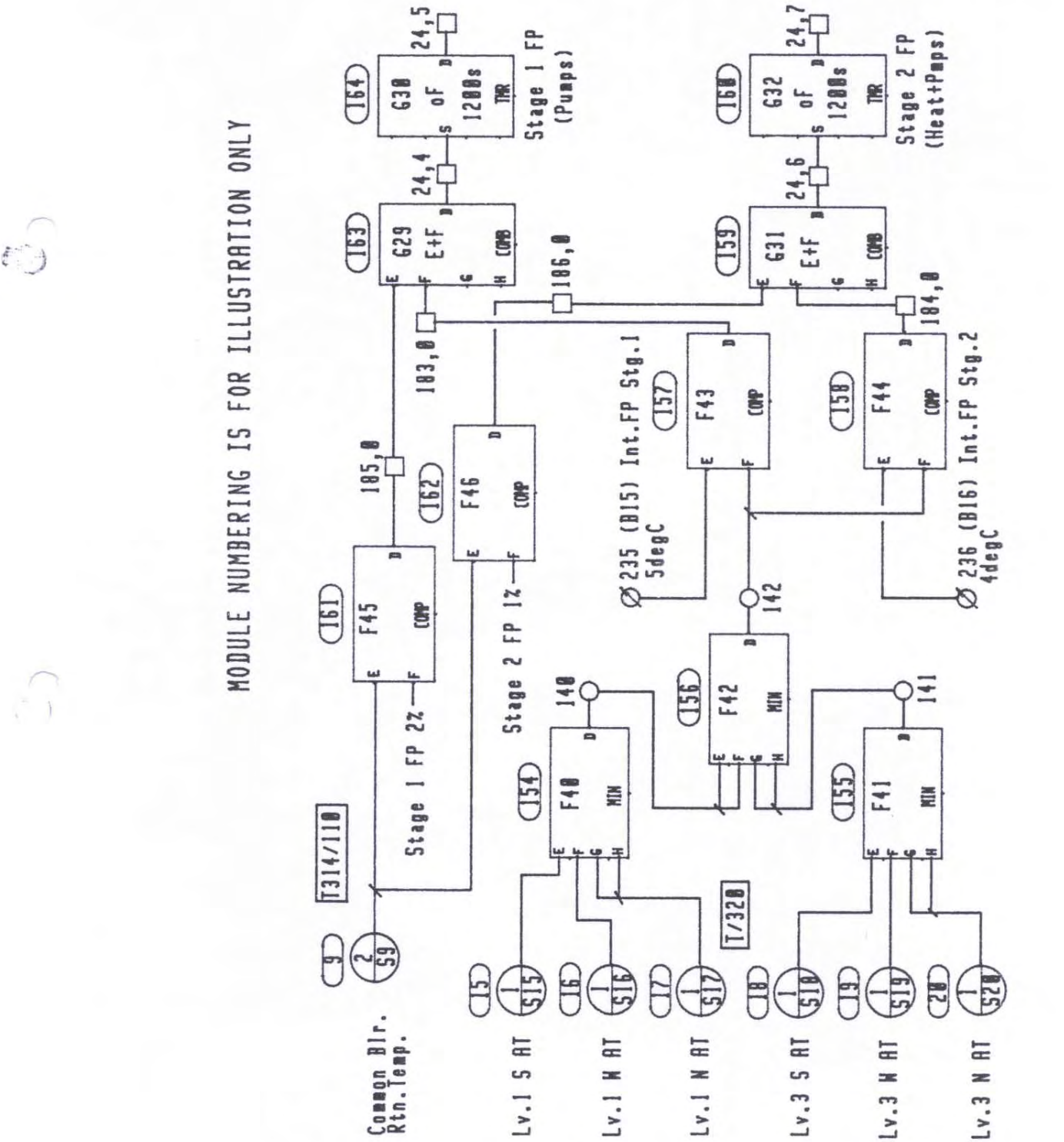
Key zone internal space temperature sensors(S15-S20) are presented to minimum function modules(F40 & F41). These are further integrated by module(F42) before being compared with the settings of soft knobs (B15 stage 1)(B16 stage 2) at modules(F43 & F44).

Module(G29) either/or's both stage 1 outputs from modules(F45/F43) and, via delay-off timer(G30) set at 1200secs, initiates pump action via its output bit(24,5). Off-timer(G30) prevents short term cyclic operation due to no hysteresis being present at modules(F45 & F43).

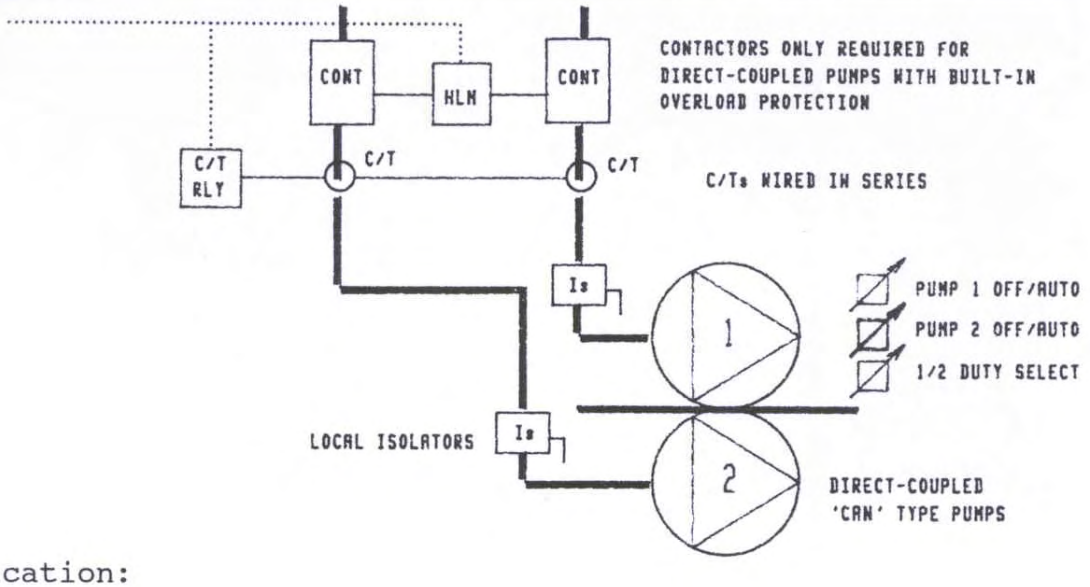
Module(G31) either/or's both stage 2 outputs from modules(F46/F44) and, via delay-off timer(G32) set at 1200sec, initiates activation of the heat-source via its output bit(24,7). Off-timer(G32) stops short term cyclic operation due to no hysteresis being present at modules(F43 & F46).

Note. Modules(F43-F46) could be set as hysteresis types as opposed to comparators but, in practise this tends to keep frost-protect on longer than actually required.

GENERAL FROST PROTECTION



DUTY/STAND-BY PUMP CONTROL



Application:

Control of secondary HWS/Heating zone pumps.

Typical operating parameters:

N/A

Notes:

1. This version requires manual starting of stand-by pump when duty pump fails.

DUTY/STAND-BY PUMP CONTROL

Features:

1. Use of one output for control of both pumps via HLM.
2. Manual selection of duty/stand-by via soft switch.
3. Manual selection for OFF/AUTO via soft switch(s).
4. Read-backs via single digital input.

Standard components:

Pump enable relay:	Trend HLM
Read-back equipment:	
Direct coupled:	R.S. Components 349-800 C/T relay.
	R.S. Components 351-099 or 351-106 C/Ts. (2-OFF).
Belt-driven:	R.S. Components 347-696 Rotation relays.
	R.S. Components 256-332 Proxistors. (2-OFF each)

Notes:

1. Where soft switches are at a premium a single OFF/AUTO switch may be used for both pump sets.
2. Shaft-rotation relay outputs to be wired in parallel to single digital input.
3. Where insufficient current is available (on the smaller fractional HP motors) to switch the relay positively, motor-phase may be taken through the C/T several times to multiply its output level.
4. When using proxistors on belt-driven pumps, sensing target must be securely fixed to the PUMP pulley, inside the safety-guard.
5. Proxistor mounting to be via R.S. Components bracket 256-001 or equal and approved.

DUTY/STAND-BY PUMP CONTROL

Description:

Demand requirements from time-zone, master switches(W1 & W2) and stage-1 frost-protection are integrated by the two logic modules (G9 & G10). Final pump demand is derived from logic module(G10), whilst heat-demand (if required) is taken from logic(G9) output. This is to stop a heat-demand being generated when stage-1 frost-protection is called.

Logic module(G11) provides a pump overrun to dissipate any excess temperature build up in the heat source, after the demand is removed.

Module(G11) output is integrated at logic modules(G13 & G14) with OFF/AUTO switch(W4), 1/2 duty select switch(W5) and the system altitude interlock from logic module(G16) to set gate(F6) or (F7) to run the selected pump.

When gate(F5) is selected a pre-set 100% signal is passed to the analogue driver(D2) to engage the 'HIGH' relay of the associated HLM, thus running pump No.1.

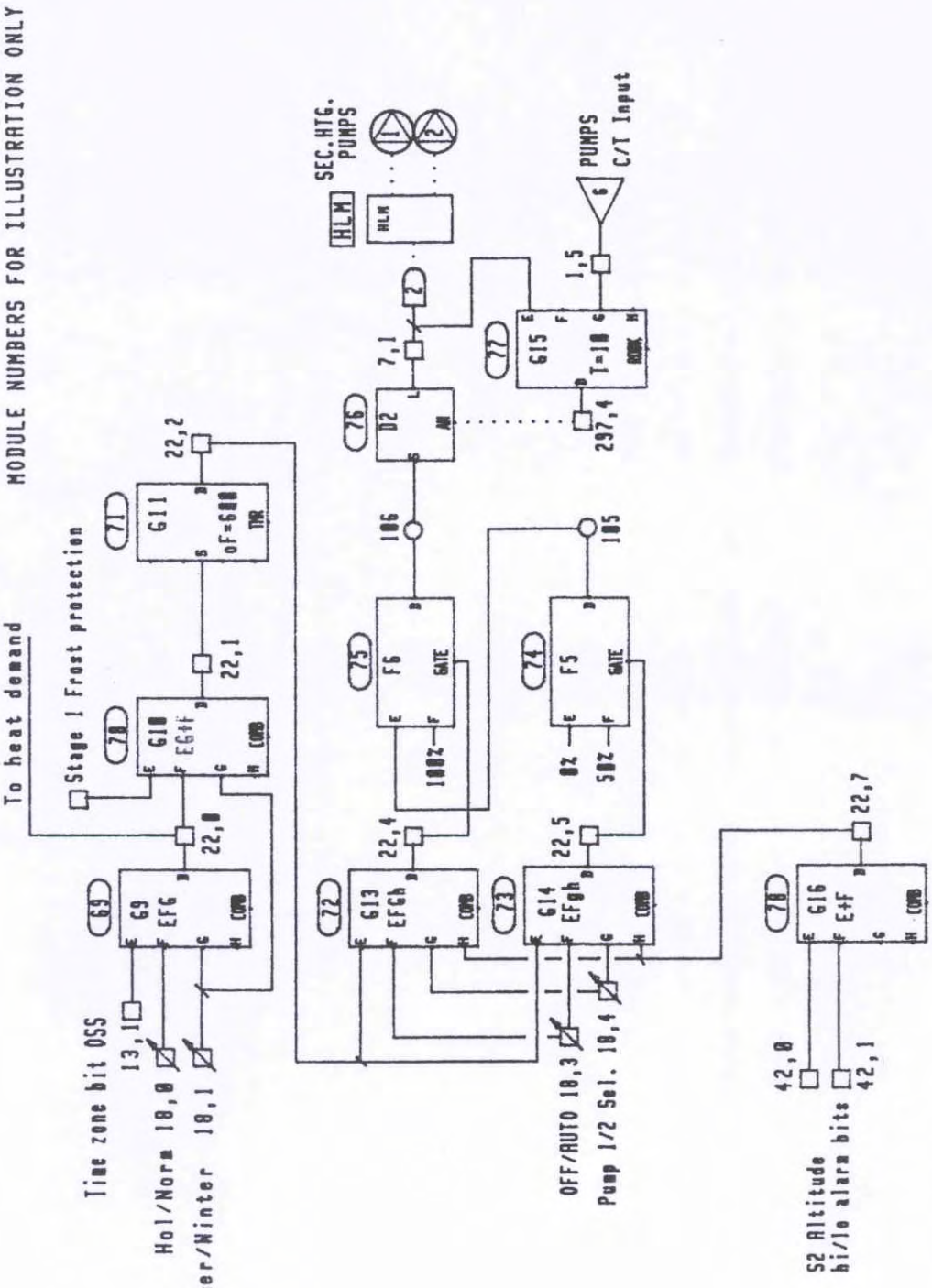
When gate(F6) is selected a pre-set 50% signal is passed to driver(D2), the 'LOW' relay of the HLM is engaged and pump No.2 will run.

When driver(D2) is demanding pump operation, read-back module(G15) becomes active after a grace-time of 10 seconds and will monitor the pump status signal from the associated current sensing relay on digital input(DI6). Failure of(DI6) during a pump demand will cause a read-back alarm to be generated for driver(D2).

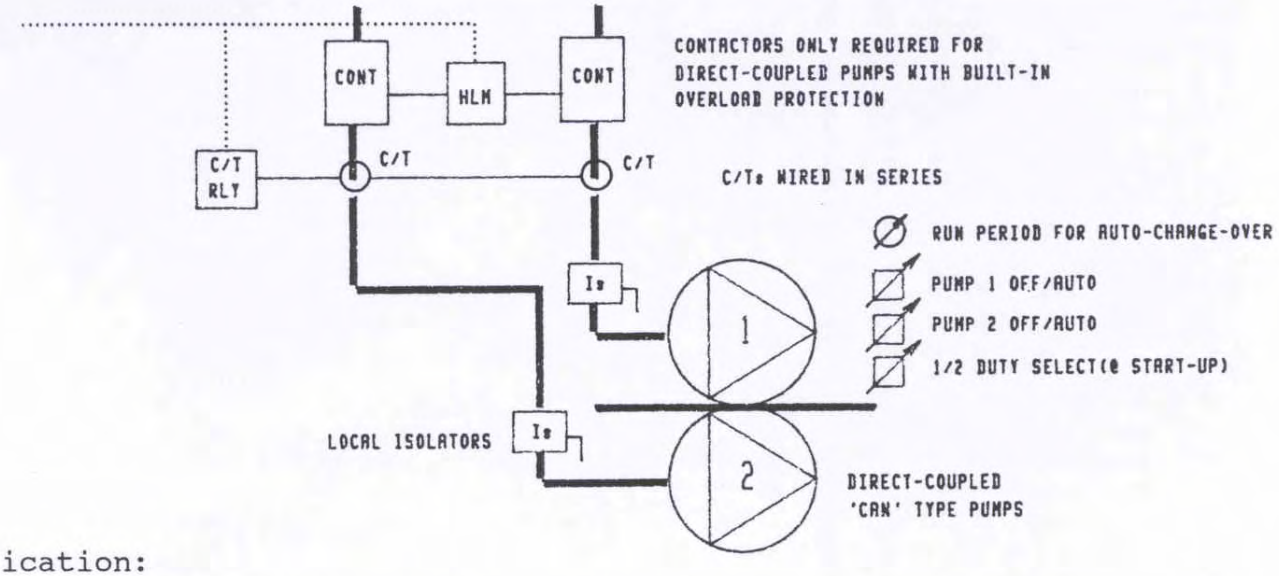
SOUTHAMPTON UNIVERSITY BMS	Applications MACRO

MAC/F1

DUTY/STAND-BY PUMP CONTROL



AUTO-CHANGEOVER PUMP CONTROL



Application:

Control of critical category pumps, which require continual exercising.

Typical operating parameters:

N/A

Notes:

1. Manual change-over is the preferred option as MACRO MAC/F1.
2. Use only on certain critical plant items that require continual exercising to ensure their availability for back-up.

AUTO-CHANGEOVER PUMP CONTROL

Features:

1. Use of one output for control of both pumps via HLM.
2. Automatic change-over on failure or specified run time.
3. Manual selection for OFF/AUTO via soft switch(s).
4. Read-backs via single digital input.

Standard components:

Pump enable relay:	Trend HLM
Read-back equipment:	
Direct coupled:	R.S. Components 349-800 C/T relay.
	R.S. Components 351-099 or 351-106 C/Ts. (2-OFF).
Belt-driven:	R.S. Components 347-696 Rotation relays.
	R.S. Components 256-332 Proxistors. (2-OFF each)

Notes:

1. Where soft switches are at a premium a single OFF/AUTO switch may be used for both pump sets.
2. Shaft-rotation relay outputs to be wired in parallel to single digital input.
3. Where insufficient current is available (on the smaller fractional HP motors) to switch the relay positively, motor-phase may be taken through the C/T several times to multiply its output level.
4. When using proxistors on belt-driven pumps, sensing target must be securely fixed to the PUMP pulley, inside the safety-

AUTO-CHANGEOVER PUMP CONTROL

Description:

Demand requirements from time-zone, master switches(W1 & W2) and stage-1 frost-protection are integrated by the two logic modules (G1 & G2). Final pump demand is derived from logic module(G2), whilst heat demand (if required) is sourced from logic module(G1) output. This is to stop a heat demand being generated when stage -1 frost-protection is called. Logic module(G11) provides a pump over-run to dissipate any excess temperature build up in the heat source, after the demand is removed.

In order for either pump to run, enable switches(W4 & W5) must be set to status 1 and module(G8) engaged to control function module (F2). When the (F2) control bit is 0 the module gates a value of 0 to the driver(D1), causing both relays of the HLM to be off. When the bit state is brought to status 1, a value of 40% or 100%, as determined by function module(F1), will gate through to run either pump 1(40%) or pump 2(100%).

Duty selection is normally performed on hours run, but on fault condition this is overridden. Hours run is determined from the run status of module(G6) and when this exceeds the value defined by soft knob(B1) the output from module(G6) will go status 1 for one complete sequence cycle. This causes module(G7) to change its output state. Module(G12) then uses this and the status from the pump enable switches(W4 & W5) to determine the pump selection via function module(F1).

Readback alarming is performed by modules(G4 & G5). The input status(DI1) is compared to the desired state as generated by module(G11). Output status is 1 when a demand is present with no input at (DI1). This will start 'on' timer(G5) to delay the discrepancy for 15secs. If during this period the input goes to status 1, the timer will be re-set, otherwise at the end of the period the timer output will be set status 1. This will be present for 1 sequence cycle, sufficient for the logic module(G8) to detect. This is to allow the appropriate grace-time for the stand-by pump action in the event of duty failure.

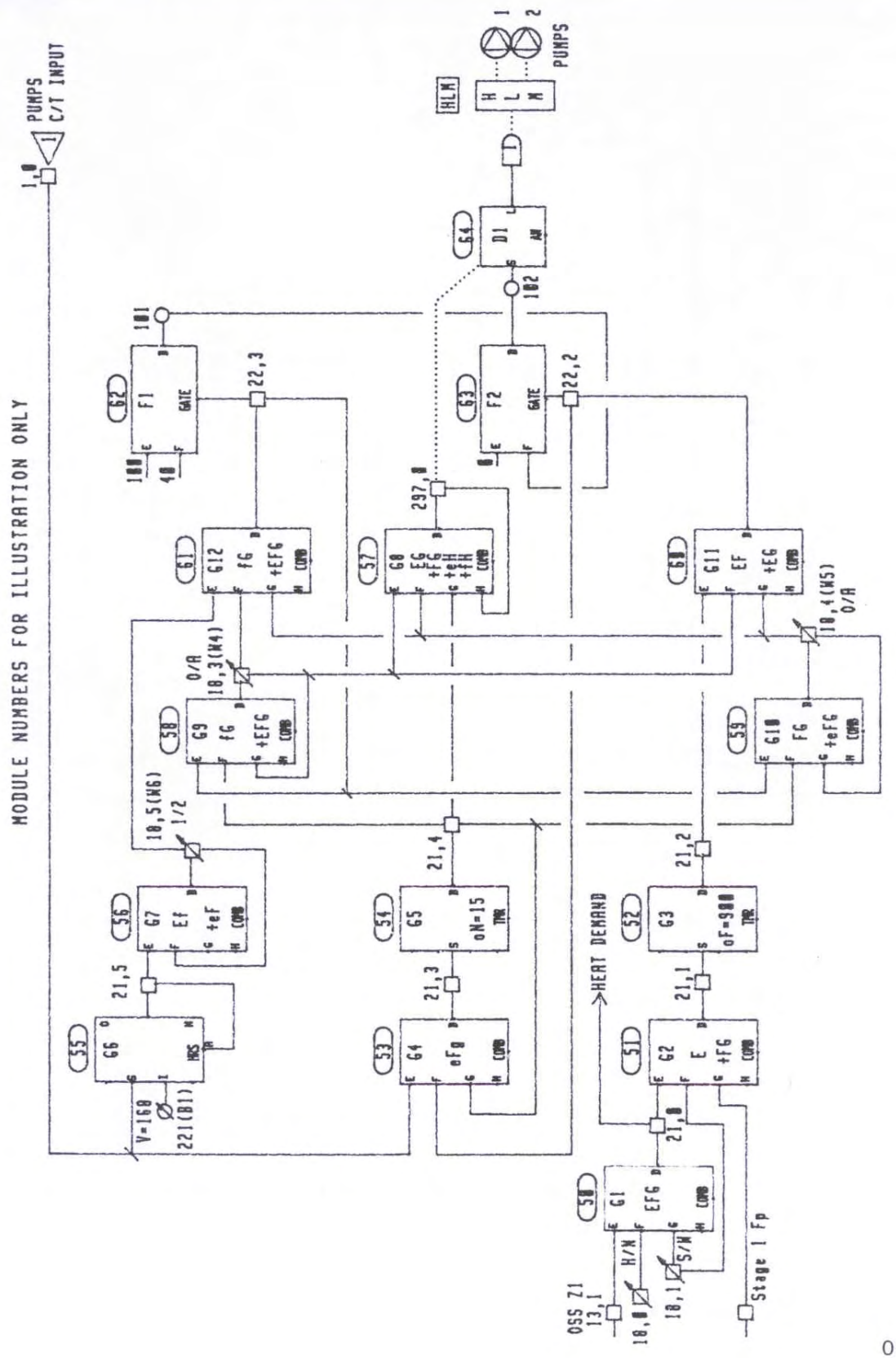
Modules(G9 & G10) disable their respective enable switches(W4/W5) when a read-back alarm occurs and once set to 0 has to be manually re-set to 1. This will cancel the read-back alarm associated with the particular pump although if there is an alarm associated with the other pump, this will cause the alarm to be generated.

Module(G8) latches on any alarm condition and drives the readback alarm associated with driver(D1).

Setting switches(W1 & W2) to 'on'(status 1) will clear any read-back alarm.

SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/F2

AUTO-CHANGEOVER PUMP CONTROL



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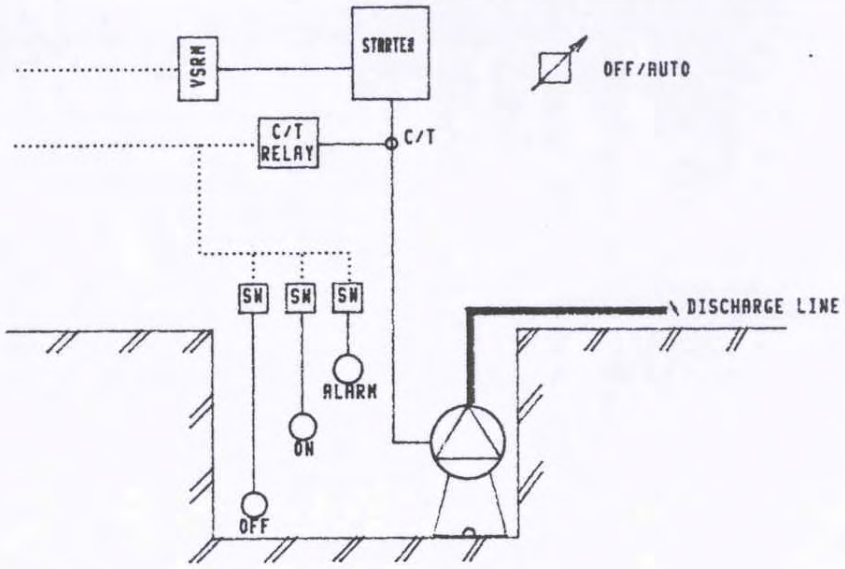
SUMP PUMP CONTROL



Application:

Critical area sumps, outside the scope of the small self-contained units.
Any liquid-level control requirement.

Typical operating parameters:

As specified for particular application.
ON level
OFF level
ALARM level

Notes:

Self-contained non-critical units require no control function, but must be furnished with an independent float-switch to generate an alarm input at high water levels.

SUMP PUMP CONTROL

Features:

1. Read-back alarm for pump failure.
2. High level alarm independent of control action.
3. Critical alarm option.

Standard components:

Pump enable relay:	Trend VSRM
Read-back equipment:	R.S.Components 349-800 C/T relay R.S.Components 351-099 or 351-106 C/T
Floats (3-OFF) ON OFF HIGH LEVEL	Flygt ENH10 float switches

Notes:

1. Where insufficient current is available to drive the current-sensing relay, using the smaller fractional HP motors, the motor phase may be taken through the C/T several times to multiply the output level.
2. Arrange float levels to give adequate on/off differential and early warning for high-level alarm.

SUMP PUMP CONTROL

Features:

1. Read-back alarm for pump failure.
2. High level alarm independent of control action.
3. Critical alarm option.

Standard components:

Pump enable relay:	Trend VSRM
Read-back equipment:	R.S.Components 349-800 C/T relay R.S.Components 351-099 or 351-106 C/T
Floats (3-OFF) ON OFF HIGH LEVEL	Flygt ENH10 float switches

Notes:

1. Where insufficient current is available to drive the current-sensing relay, using the smaller fractional HP motors, the motor phase may be taken through the C/T several times to multiply the output level.
2. Arrange float levels to give adequate on/off differential and early warning for high-level alarm.

SUMP PUMP CONTROL

Description:

A single logic module(G1) provides the master switching signal for the digital driver(D1) to run the sump-pump via the associated VSRM. Pump status is monitored for correct operation by readback module(G2) and the C/T relay signal presented at digital input (DI1).

Float-switch signals for pump(ON)(DI2) and pump(OFF)(DI3) are both applied directly to module(G1), together with the OFF/AUTO soft-switch(W4) and module(G1)'s own output (to provide a latch for differential switching action).

Assuming switch(W4) is in the AUTO mode, a full pump cycle would be as follows:-

Water in the sump is below the OFF float switch level so the logic presented to module(G1) as 'Efg' is untrue and the pump is OFF.

As water enters the sump the level rises and the OFF float is tilted, but no pump action is called as the logic presented is still untrue as 'EfG'. The water-level will continue to rise until the ON float is tilted, this presents logic to module(G1) as'EFGh' which is true, the (G1) output changes state and driver(D1) will run the pump via the associated VSRM. Whilst the pump is called, it is monitored for status via digital input(DI1) and readback module(G2), any failure causing a alarm to be sent.

Assume now that water stops entering the sump.

When the pump operates the water level in the sump drops returning the ON float to its normal position, but pump action continues due to the feed-back action of module(G1) by its own output being present at input 'H'. Logic presented at this point is 'EfGH' and still true.

As the level continues to drop the next action is the OFF float returns to its normal position and the logic presented to (G1) is 'EfgH', this is untrue and pump action is halted.

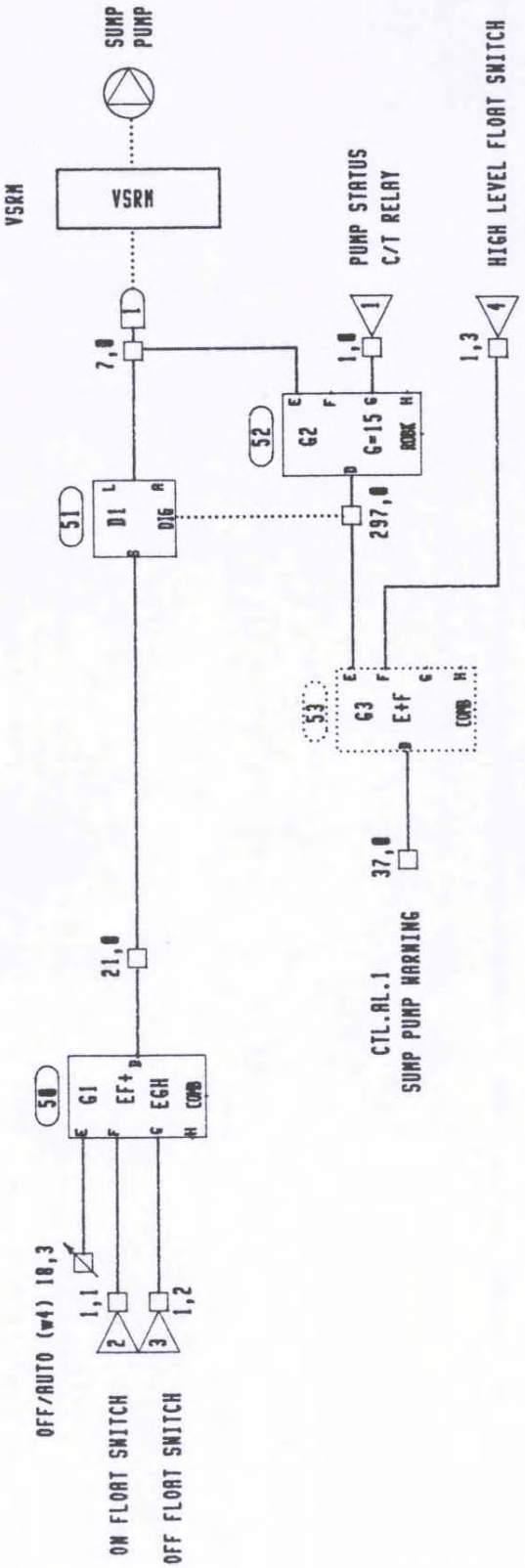
If at any time the water level rises above the ON float level with no pump action, not only is a readback alarm sent but if the water-level reaches the HIGH float, a second warning alarm is sent associated with the digital input(DI4).

Each application must be considered individually as certain cases will warrant critical alarms being generated, either by the action of the high-water level(DI4) alone, or high-water(DI4) and driver(D1) readback together.

Module(G3), shown dotted on the configuration drawing, is an option to initiate a single critical alarm should either a read-back or high water-level alarm occur.

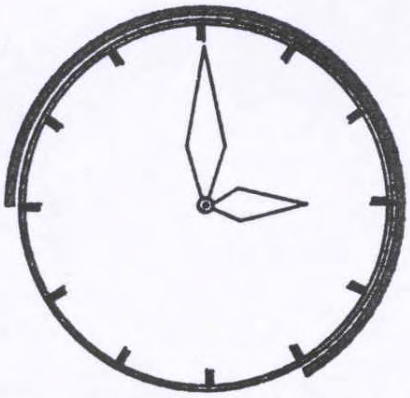
SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/F3

SUMP PUMP CONTROL



MODULE NUMBERS FOR ILLUSTRATION ONLY

OSS TIME ZONE INFORMATION



OSS CONTROLLED TIME ZONE INFORMATION FOR INCLUSION IN CONFIGURATION DRAWINGS

Application:

Presentation os OSS zone information within configuration.

Typical operating parameters:

Warm up limit:	240mins
Cool-down limit:	120mins
Start elevation:	-1
Stop elevation:	0

Notes:

1. Only zones using OSS facility need be shown.

OSS TIME ZONE INFORMATION

Features:

Information within configuration only.

Standard components:

Space sensors:	Trend T/320
Pipe sensor:	Trend T314/110
OAT sensor:	Trend T/PO

Notes:

1. Space sensors must be selected from each controlled zone, as indicative of the local conditions as possible.
2. OAT sensors for each zone aspect are preferred over single common unit.
3. Sensible gain and loss time constants to be used at set-up.
4. Medium address to be set as 0 and average value set in 'Medium temperature' where heat source is switched off or depressed at night.

OSS TIME ZONE INFORMATION

Description:

The purpose of this MACRO is to ensure that OSS information is included with the software configuration/strategy drawings.

Note.
Basic University occupation core times.

Teaching Areas

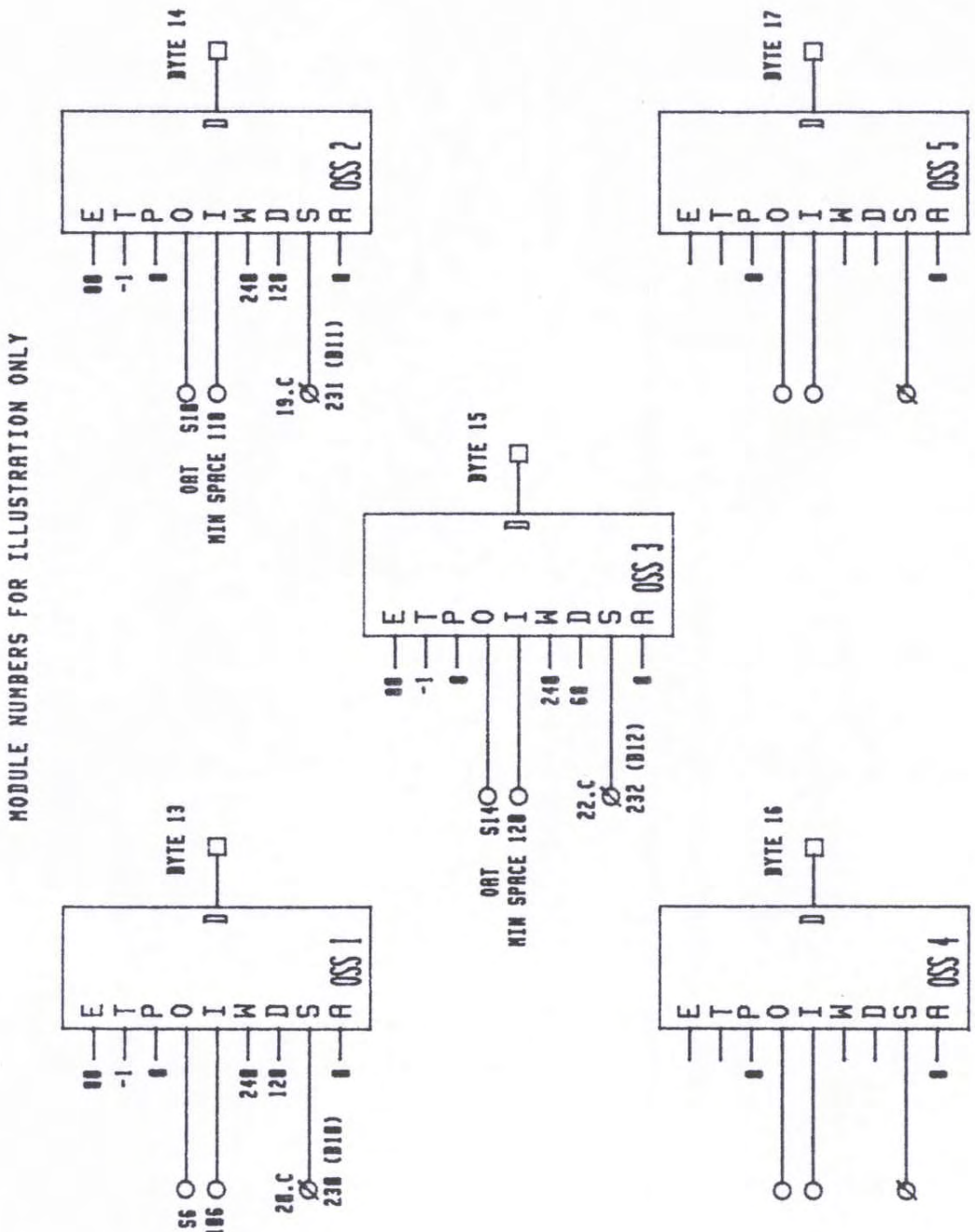
Mon-Fri.	ON 09:00	OFF 17:00		
Sat-Sun.	ON 00:00	OFF 00:00		

Residential Areas

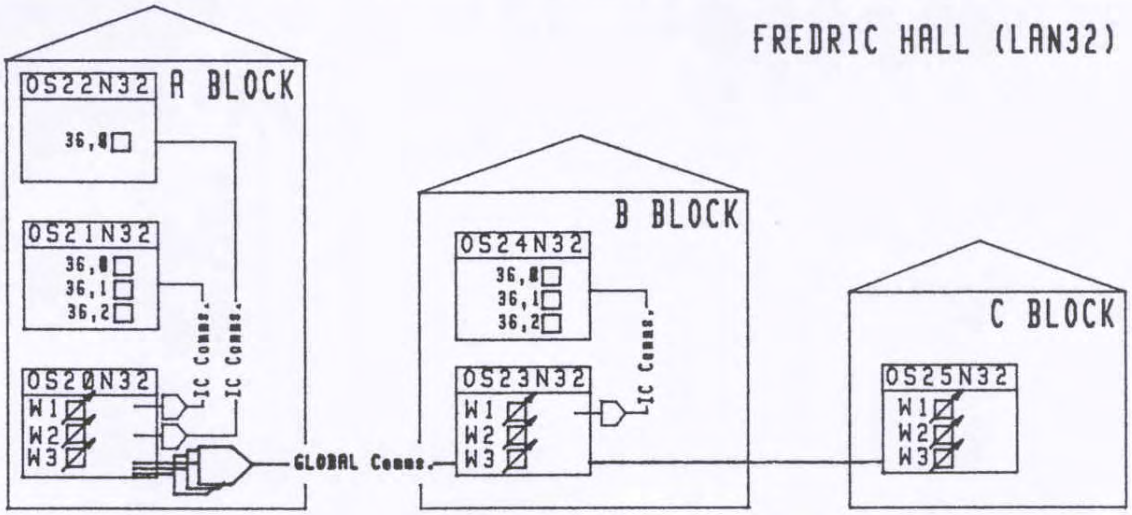
Mon-Fri.	ON 06:30	OFF 09:30	ON 16:30	OFF 23:00
Sat-Sun.	ON 06:30	OFF 23:00		

SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/G1

OSS TIME ZONE INFORMATION



MASTER SWITCH INFORMATION



Application:

Master switching for Holiday/Normal, Summer/Winter and Fireman's Smoke Vent. on all University buildings.

Typical operating parameters:

Holiday/Normal	set on switch (W1) 18,0	ON=Normal
Summer/Winter	set on switch (W2) 18,1	ON=Winter
Smoke Vent.	set on switch (W3) 18,2)	ON= All Ext.fans run.

Notes:

1. Where multiple fire zones exist on larger buildings, additional consecutive soft switches may be used to cater for the zones individually.
   (W3) 18,2 Zone 1 smoke vent.
   (W4) 18,3 Zone 2 smoke vent.
   (W5) 18,4 Zone 3 smoke vent.

MASTER SWITCH INFORMATION

Features:

Grand-master switching via IC.Comms. and Global Comms. for ease of plant mode operational requirements.

Standard components:

All internal software

Notes:

1. This must apply to all University properties.
2. Address module attributes have no specific University assignments to allow greater flexibility.

MASTER SWITCH INFORMATION

Description:

Each building, regardless of the number of outstations contained, will carry at least the three master soft switches within the lowest referenced outstation:-
W1 (18,0) Holiday/Normal
W2 (18,1) Summer/Winter
W3 (18,2) Fireman's smoke vent.
The lowest referenced outstation will send these master switch commands to all other outstations within the building requiring the information for interlock/operational purposes. This will be carried out using digital bit/byte (To)IC.Comms. to over-write free digital bits assigned within the local outstation software. Where practical all IC Comms. are to be set up in the outstation carrying the master switches, to allow local software bits in the receiving outstations to be over-written for testing etc., without the command being 'chained' to other outstations.
Where a group of buildings form a complex, the above will apply with the addition of Global Comms. also being set-up within the lowest referenced outstation to command all master switches within other blocks. Attribute #2 to be used for this purpose and the text set to be indicative of the group/complex name.
(e.g. Fredric Hall = FRED)
This will provide mastering for the whole complex, but still allow individual blocks to be over-written back again if there is an operational requirement.
Example:-
A complex containing a large number of individual blocks may, during a holiday period, require one or two of the blocks to be operational. Changing the grand-master soft switch, contained within the lowest referenced outstation of the complex, will trigger the Global Comms. to write all blocks to holiday mode. Specific blocks may then be over-written back to normal using their local soft-switches.

Example of system set-up requirements are given on the following page.

MASTER SWITCH INFORMATION

Description:

Set-up example.
Assume we have a complex known as Fredric Hall which is assigned the common building number B100. The complex consists of three individual buildings known as 'A block', 'B block' and 'C block'. A block contains three outstations, B block contains two outstations and C block a single outstation.
The assigned LAN is #32.
All outstations require the three grand-master switch information for interlocking, with the exception of OS22 which only requires switch(W1).

A block outstations	OS20N32	Boilerhouse
	OS21N32	Calorifier plantroom
	OS22N32	Roof plantroom
B block outstations	OS23N32	Boilerhouse
	OS24N32	Roof plantroom
C block outstation	OS25N32	Boilerhouse

Outstation set-up requirements would be as follows:-

OS20N32
1. GRAND MASTER switches W1-W3 set up.
2. Digital bit/byte IC(To) Comms. set to transfer switch information to outstations OS21N32 and OS23N32 as their software requirements dictate. To be received at these outstations on assigned free internal digital bits.
3. Digital bit Global Comms. set to transfer GRAND MASTER switch information to master switches in B & C block outstations OS23N32 and OS25N32 respectively.

OS21N32 and OS22N32
1. Assign free internal digital bits to receive incoming IC Comms. from OS20N32 as required.
   Note. a.Attribute #2 must NOT be set as =FRED.
   b.Soft switches W1-W3 are free for general plant use.

OS23N32
1. Master switches W1-W3 set up.
2. Digital byte IC(To) Comms. set up to transfer information to outstation OS24N32 as software requirements dictate. To be received at the outstation on assigned free internal digital byte. (Only first three bits used).
3. Address module attribute #2 set =FRED.

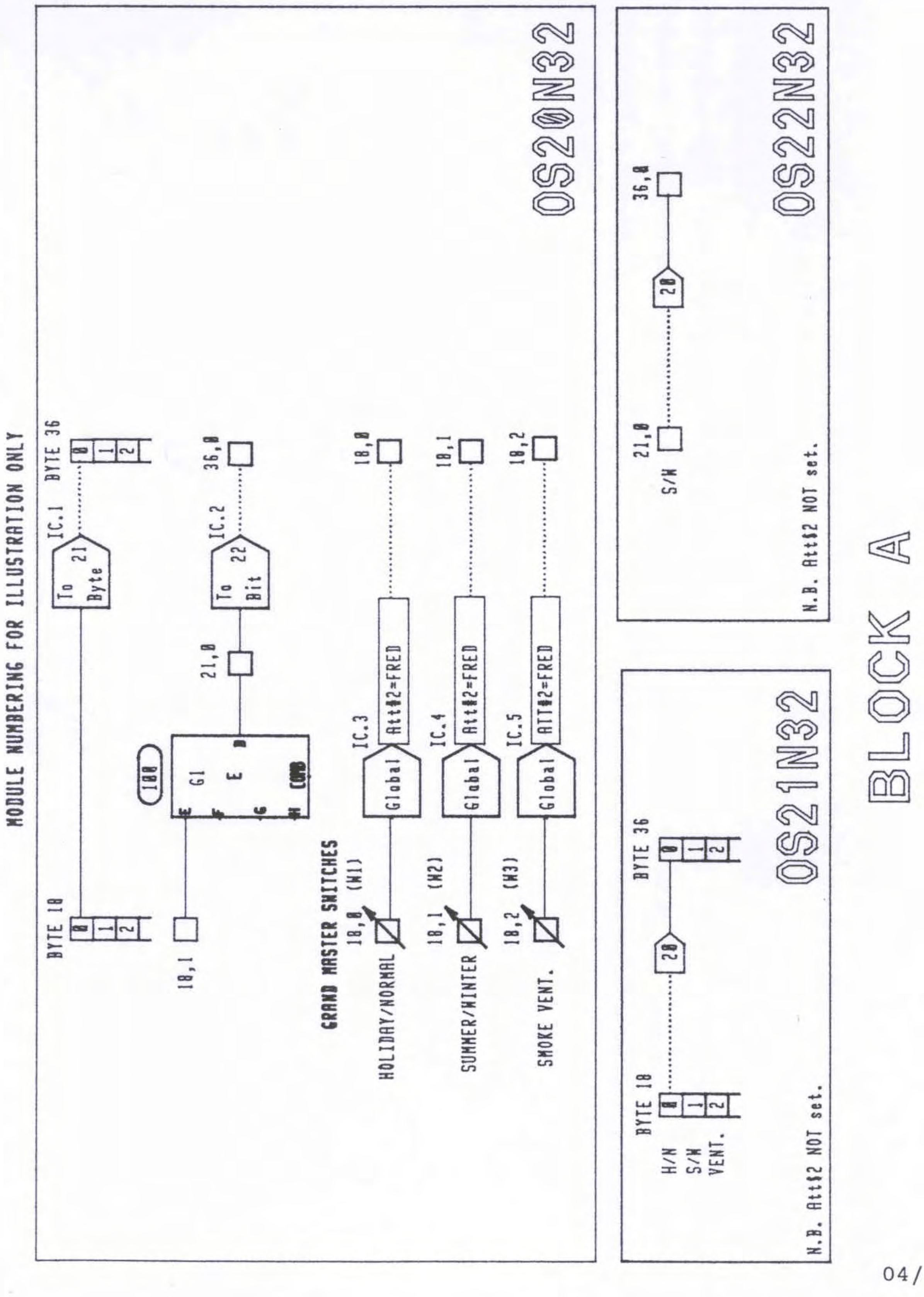
OS24N32
1. Assign free internal digital byte to receive incoming IC Comms. from OS23N32 as required.
   Note. a.Attribute #2 must NOT be set =FRED.
   b.Soft switches W1-W3 are free for general plant use.

OS25N32
1. Master switches W1-W3 set up.
2. Address module attribute #2 set =FRED.

NB. Where the plant/software in outstation OS22N32 does not require master switch information for interlocking, it is not provided.

SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/G2

MASTER SWITCH INFORMATION



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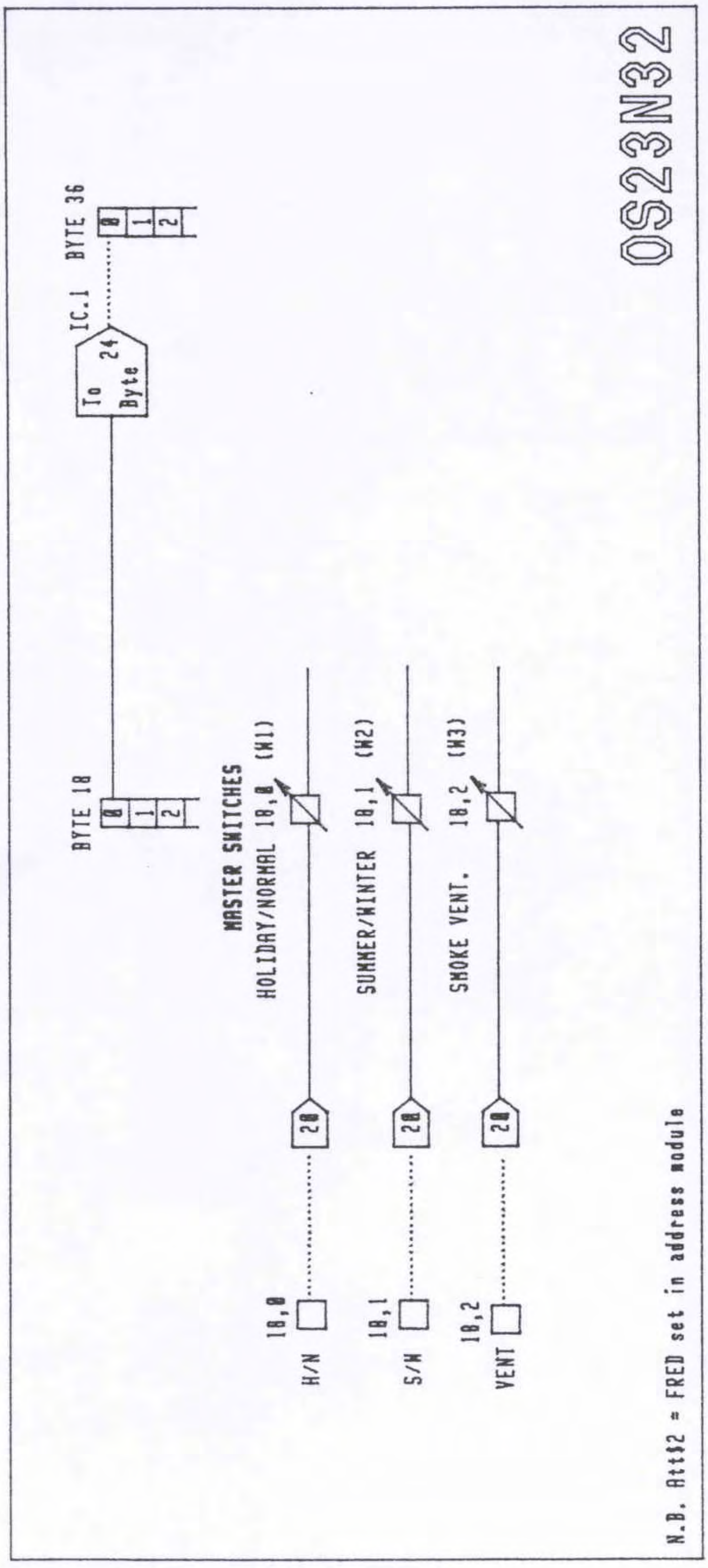
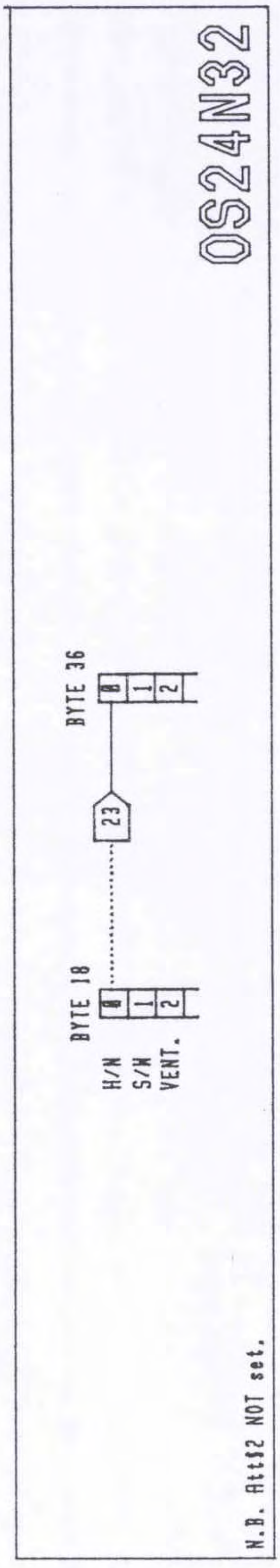
SOUTHAMPTON UNIVERSITY BMS	Applications MACRO

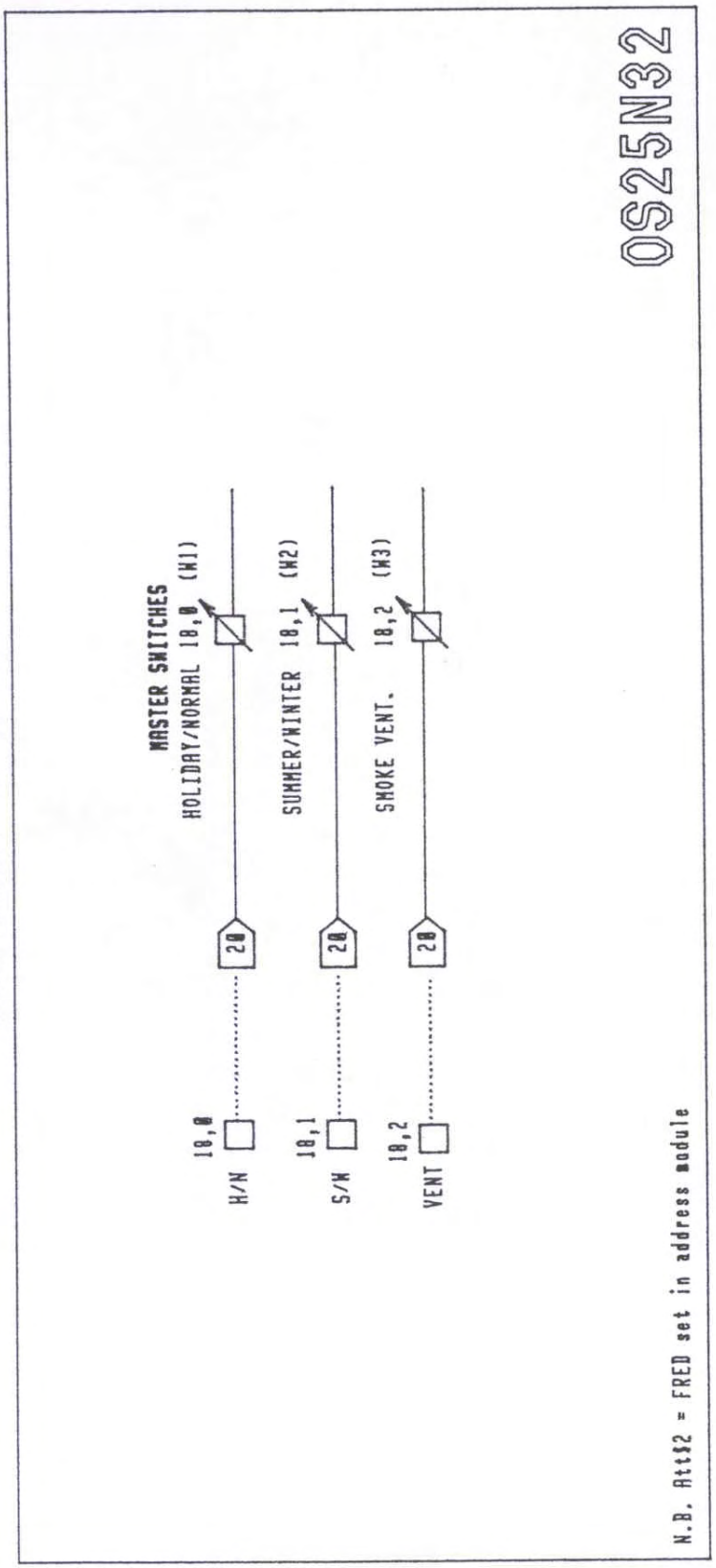
MAC/G2

MASTER SWITCH INFORMATION



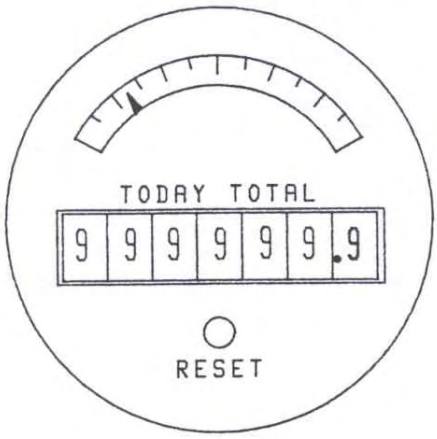


MASTER SWITCH INFORMATION



BLOCK C

METERING INFORMATION



Application:

Monitoring and logging of heat, gas, oil, water and electricity meters.

Typical operating parameters:

METER TYPE	RECORDING UNIT
HEAT	MWh
GAS	MWh
OIL	Ltrs.
WATER	Ltrs.
ELECTRICITY	KW & KVA

Notes:

1. Scale factors should be chosen where possible to obtain the preferred monitoring units. This may not be practical in the case of larger sites.
2. All HV electricity metering to utilise CALMU metering.
3. All electric consumption is monitored by a Stark system which uses the Trend network/Outstation devices.

METERING INFORMATION

Features:

1. Logging of rate and cumulative consumptions.
2. Simple digital pulse input requirement.
3. Alarm settings for high/low rates and cumulative totals.
4. Input re-scaling.

Standard components:

HEAT METERS	Samson(Spanner-Pollux) EZ
GAS METERS	PC Compters or Imac Systems Ltd.
OIL METERS*	Kent
WATER METERS	Samson(Spanner-Pollux) QN
ELECTRIC METERING	Calmu(HV)

* Line metering is not normally required, tankage to be fitted with static head transducer for contents monitoring. KDG, GEC or Bailey & Mackey.

Notes:

1. Exact requirements for each contract to be detailed in the 'Particular' specification.

2. Requirements for electricity consumption monitoring/logging to be detailed by Estates & Buildings Electrical Section.

METERING INFORMATION

Description:

Meter pulses are monitored via the digital inputs(DI1-DI7) and fed directly to their associated counter modules(G1-G7).
Within modules(G1-G7) the input pulses are counted and re-scaled for their correct engineering units by scale-factor(F) and at the end of each rate schedule time period(T), added to the module's cumulative output. Cumulative re-set is provided for modules G1-G5) by bit 493,4 every 24hrs at midnight.
Cumulative outputs from modules(G1-G5) are each logged by two internal dummy sensors, one with a sample period of 15mins the other set at 24hrs. Sensors(S33-S40).
On the counter module(G5) for the heating system's feed and expansion tank cold water make-up, an additional internal dummy sensor(S41) is provided to monitor the module rate output and provide a high level alarm facility. This will indicate a possible leakage. Notional setting would be 25Ltrs.(within the module rate re-schedule time(T) of 15mins.)
Note. Sensor(S41) does not require assignment for logging.

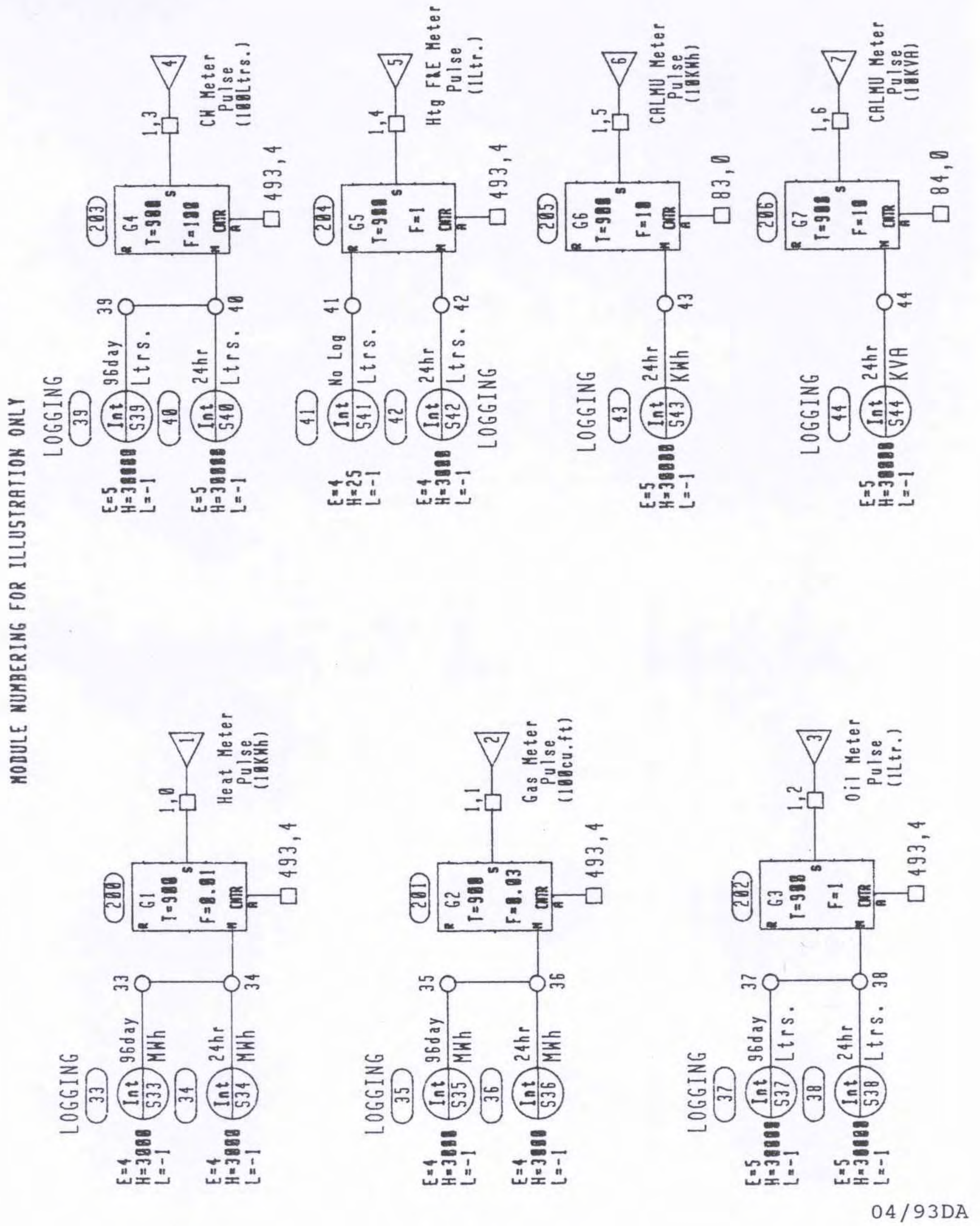
Configuration for electricity monitoring/logging via DI6/DI7, G6/G7 and internal sensorS(S43 & S44) are the recommended set-up by STARK SYSTEMS, used over the Trend network. Note the use of the associated sensor(S41 & S42) high alarm bits(81,0 & 82,0) to re-set the cumulative count of modules(G6 & G7).

SOUTHAMPTON UNIVERSITY BMS

Applications MACRO

MAC/G3

METERING INFORMATION



CRITICAL ALARM INFORMATION

Application:

All critical alarm handling requirements.

Typical operating parameters:

Refer to 'Configuration Standard Settings' sheets 1-5 for particular item parameters.

Notes:

1. All critical alarms report to PRN+ #14N4.
2. Access to LAN#4 from autodial is via MNC+ #8N4 0703-592107.
3. Off-campus requirements differ from those on-campus due to the presence of the Central Alarms System on-campus which handles Fire, Security and Special category alarms.
4. Alarm integration is normally required due to the limitations of the Outstation. (Only 4 CTL.ALs per outstation).

CRITICAL ALARM INFORMATION

Features:

1. Annunciation of all critical category alarms at secure-system printer. (PNC+ #14N4)
2. Autodial information received by dedicated MNC+ #8N4 (0703-592107).

Standard components:

All physical components will be provided, as required by the particular MACRO applications and associated control panel.

Notes:

1. Particular requirements to be agreed with the University BMS Engineer.

CRITICAL ALARM INFORMATION

Description:

General Critical alarms will be provided for the following main system elements:-
HIGH TEMPERATURE ALARM Associated with calorifiers.
ALTITUDE ALARM System pressures high and low.
BOILER FAULT ALARM Fault, lockout, and boiler high temperature.
GAS LEAK ALARM From Sieger gas-leak detection systems.
N.B. Off campus Fire, Security and Special category alarms may also be required.(These facilities being provided by the 'Central Alarm System' on campus).
Critical Alarm destination. PNC+ #14N4
Autodial access via MNC+ #8N4 (0703-592107)
All calorifiers provided with manual re-set high limit components are to be monitored by digital inputs, individually where sufficient outstation resources are practical, or combined where restricted. All high temperature devices will have their associated inputs enabled to provide discrimination via the main System Supervisor @ #1N1, but also be internally integrated by logic modules to provide a common critical alarm reporting to # 14N4. (Text: **HIGH TEMPERATURE ALARM**)
Example shown in configuration; High alarm bits associated with sensors(S1 & S2) are integrated by logic module(G1) for transfer to module(G2) input 'H' where further integration is provided with digital inputs(DI1-DI3). Module(G2) output is assigned to CTL.AL 1 bit(37,0) to initiate the common alarm.
N.B. Digital inputs(DI1-3) have their associated alarm bits enabled to provide discrimination.

All system altitude pressure sensors must have their high and low alarm levels set and enabled to provide discrimination via the main System Supervisor @ #1N1, but also be internally integrated by logic modules to provide a common critical alarm reporting to # 14N4. (Text: **ALTITUDE ALARM**)
Example shown in configuration; High and low alarm bits associated with sensors(S3 & S4) are integrated by logic module (G3) the output of which is assigned to CTL.AL 2 bit(38,0) to initiate the common alarm.
N.B. Discrimination will be automatically afforded at # 1N1.

Boiler fault alarms are a combination of high-temperature, lockout and/or other specific boiler fault conditions all of which must be integrated on each boiler to produce a single digital input. Where outstation resources are at a premium, ALL boiler fault contacts could form a single digital input.
Input(s) are processed by an internal logic module to provide a common critical alarm reporting to # 14N4. (Text; **BOILER FAULT**)
Example shown in configuration; Digital inputs(DI4 & DI5) are the individual fault signals from boilers 1 & 2 which are integrated by logic module(G4) the output of which is assigned to CTL.AL 3 bit(39,0) to initiate the common alarm.
N.B. Digital input alarm bits to be enabled for discrimination at # 1N1 only when more than one input is utilised.

CRITICAL ALARM INFORMATION

Description:

The gas leakage detection alarms are derived directly from the output contacts of the Seiger Gas Detection Unit.
Sieger Units provide three output connections for alarms:-
1. Fault
2. Low level gas detected. (1st Stage)
3. Alarm level gas detected.

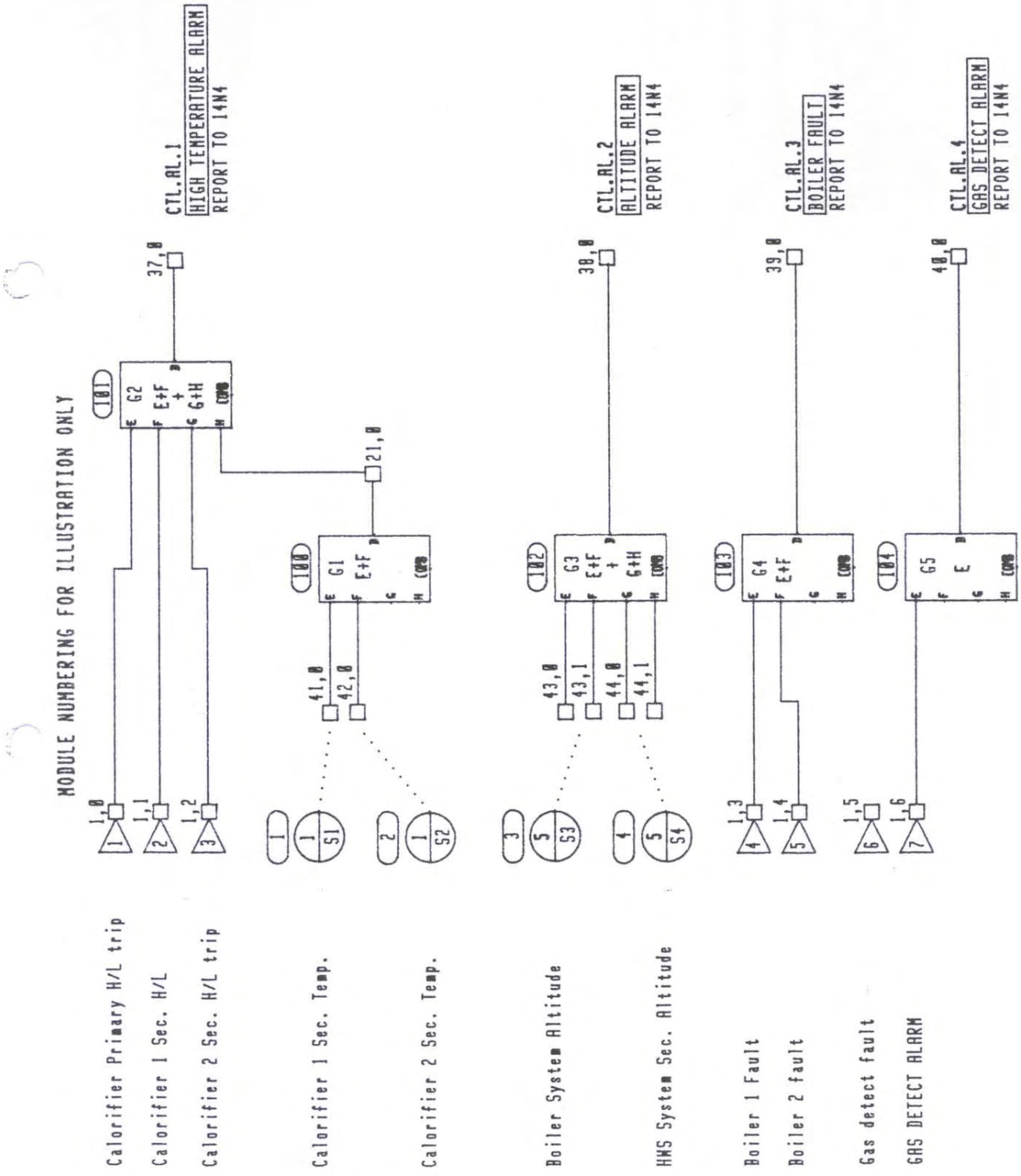
Outputs 1 and 2 are to be combined together to provide a single general digital input alarm. Output 3 is assigned an individual digital input which, via an internal logic module, will initiate a critical alarm (Text: **GAS DETECT ALARM**)
Example shown in configuration; Digital input(DI5) handles the fault/low gas combined signal to initiate its own general input alarm. (Text: **Gas Detect Fault**).
Digital input(DI6) receives the alarm-level gas signal from the Sieger Unit and via logic module(G5) activates the critical alarm bit(40,0) for CTL.AL 4.
N.B. The Sieger output for 'alarm level gas detected'(3) must also provide a hard-wired function which will interrupt the control circuit within the main control panel to afford full plant shut-down. An auxiliary relay may be necessary.
Any internal software interlocking is therefore precautionary, but still valid.

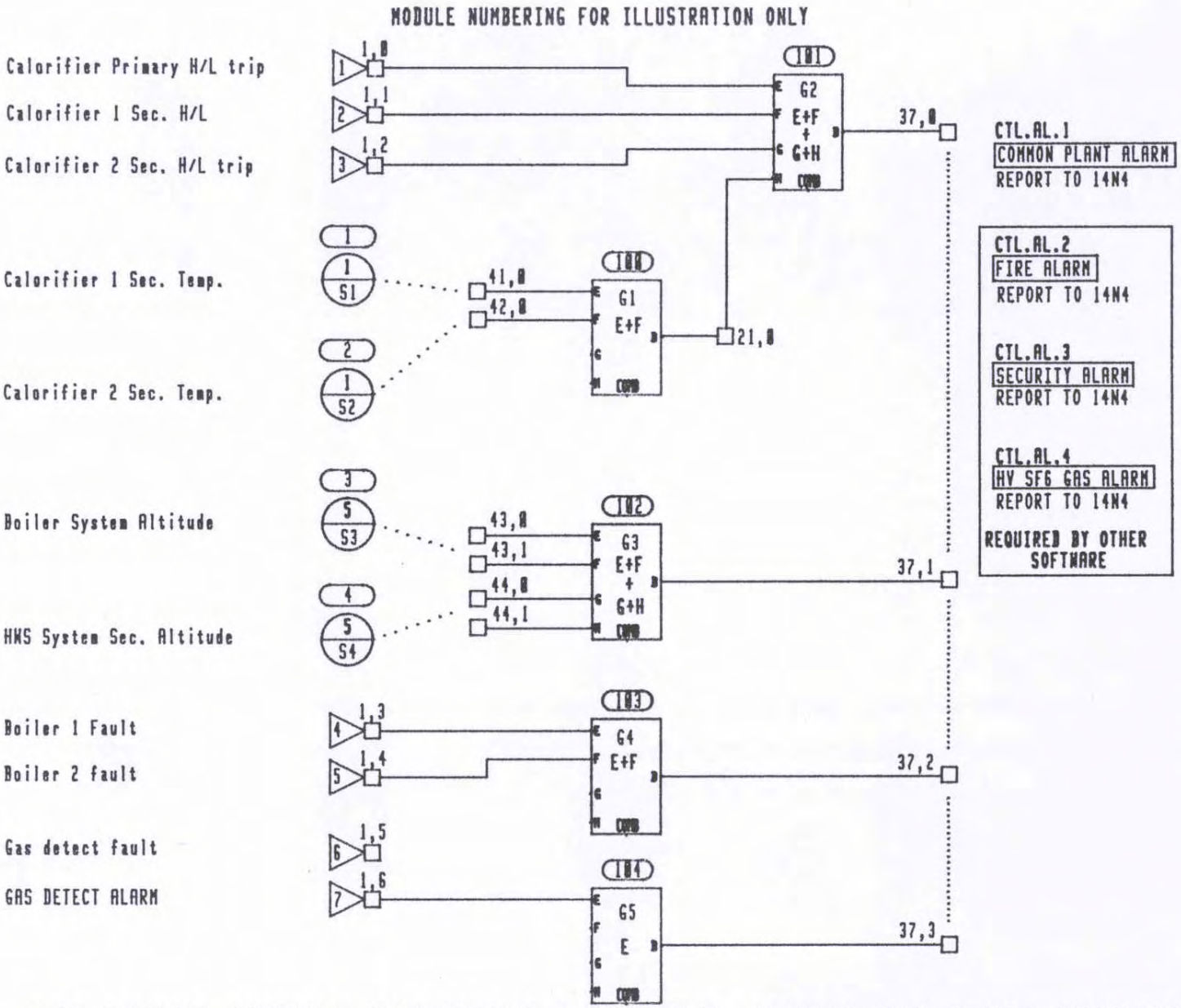
Notes:

Off-campus sites accessed via autodial links differ from the above in that Fire and Security alarms may also be required. This will cause a short-fall in the available critical alarms and where necessary all plant alarms must be integrated into one single common critical. (Text: **COMMON PLANT ALARM**).
On-campus Fire, Security and Special Category alarms are handled separately by the 'Central Alarms System'.

SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/G4

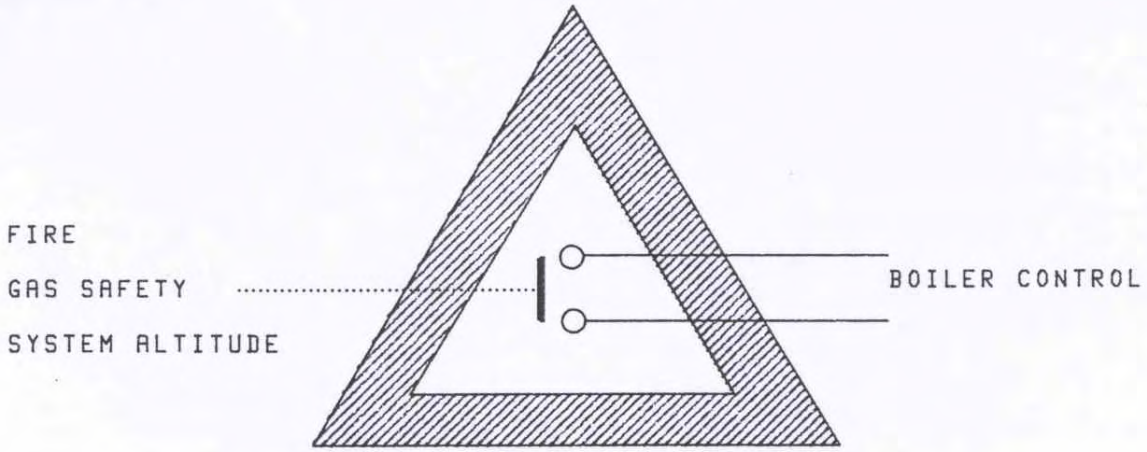
CRITICAL ALARM INFORMATION





OFF CAMPUS EXAMPLE REQUIRING 3 CRITICAL ALARMS FOR OTHER FUNCTIONS

GENERAL SAFETY INTERLOCK ARRANGEMENT FOR BOILERS



Application:

MACROs MAC/B1; MAC/B3 and MAC/B4

Typical operating parameters:

Refer to 'Configuration Standard Settings' sheets 1-5 for particular item parameters.

Notes:

1. Fire and Gas detection devices also take direct hard-wired action by interrupting the panel control-circuit. Software block is still valid.

GENERAL SAFETY INTERLOCK ARRANGEMENTS FOR BOILERS

Features:

Common interlock facility for all boiler modules.

Standard components:

As provided by the specified plant and control panel facilities.

Notes:

1. Read in conjunction with MACROs MAC/B1/B3/B4

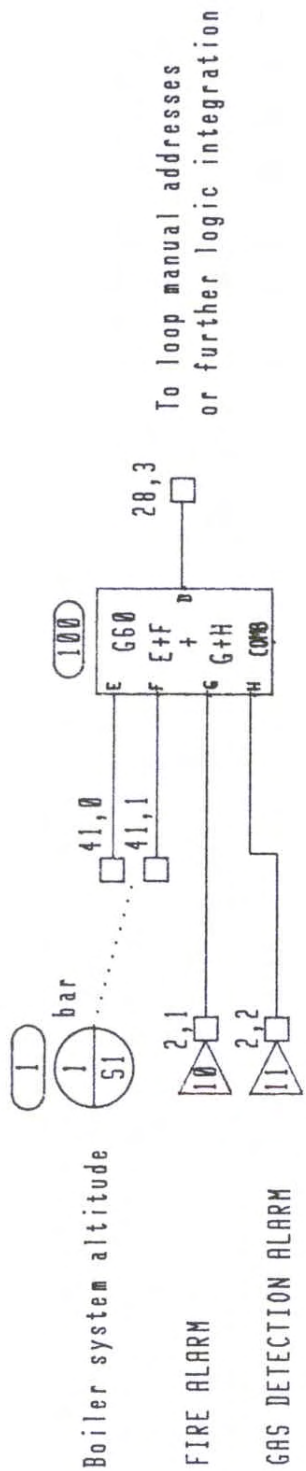
GENERAL SAFETY INTERLOCK ARRANGEMENTS FOR BOILERS

Description:

The desired safety interlocks from FIRE, ALTITUDE and GAS SAFETY are monitored by the single logic module(G60) and any off-normal condition will cause the associated output bit(28,3) to go high. Output bit(28,3) would usually form part of a further logic chain input, as MACRO MAC/B1, or be used directly to force the boiler control loop(s) into their manual mode condition which would be pre-set to 0%, as MACROs MAC/B3 and MAC/B4.

GENERAL SAFETY INTERLOCK ARRANGEMENTS FOR BOILERS

MODULE NUMBERING FOR ILLUSTRATION ONLY



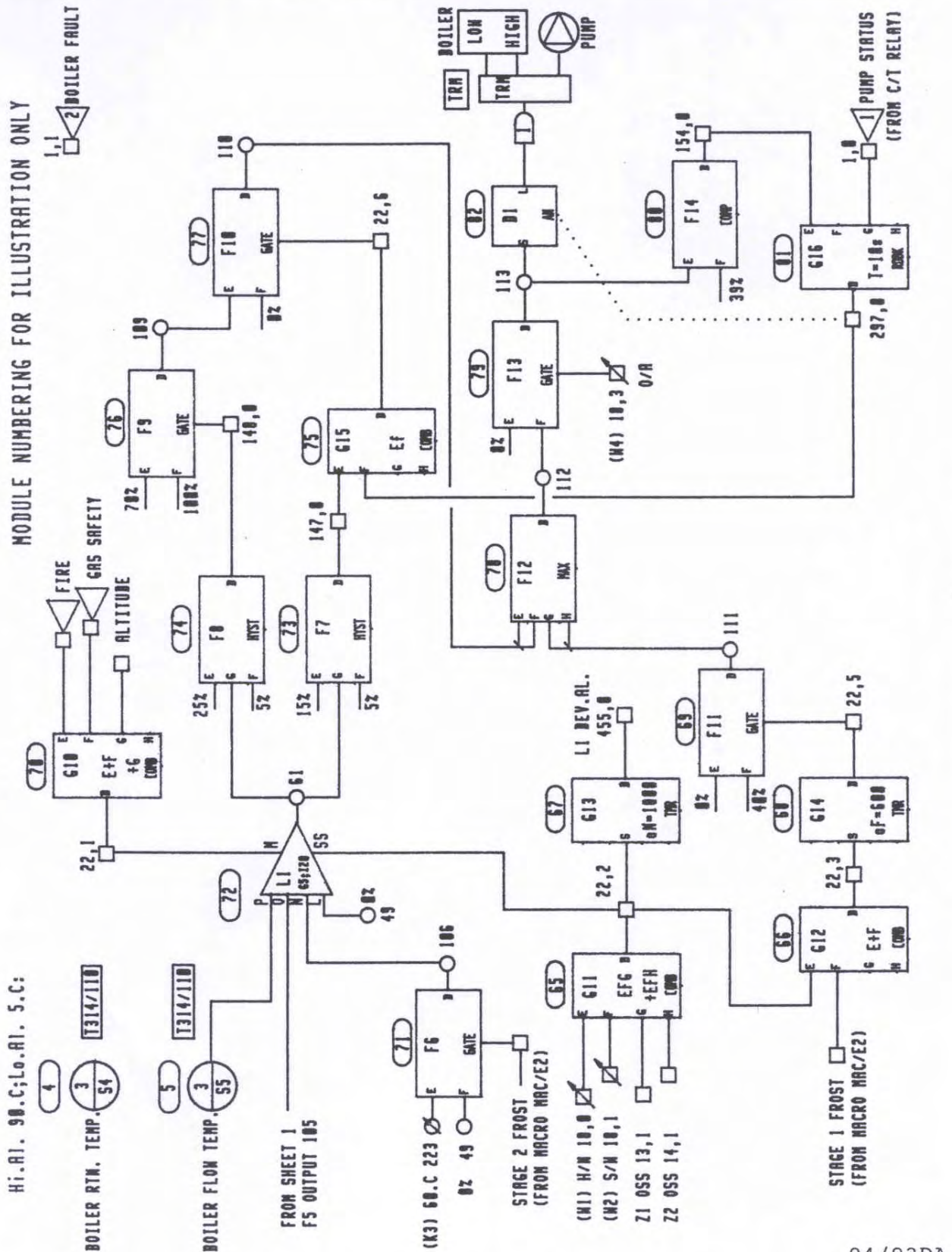
N.B. This logic may be integrated as part of MACRO MAC/G4 (Critical Alarm handling)

SOUTHAMPTON UNIVERSITY BMS

Applications MACRO

MAC/B7

2-STAGE CONDENSING BOILER/SHUNT PUMP CONTROL



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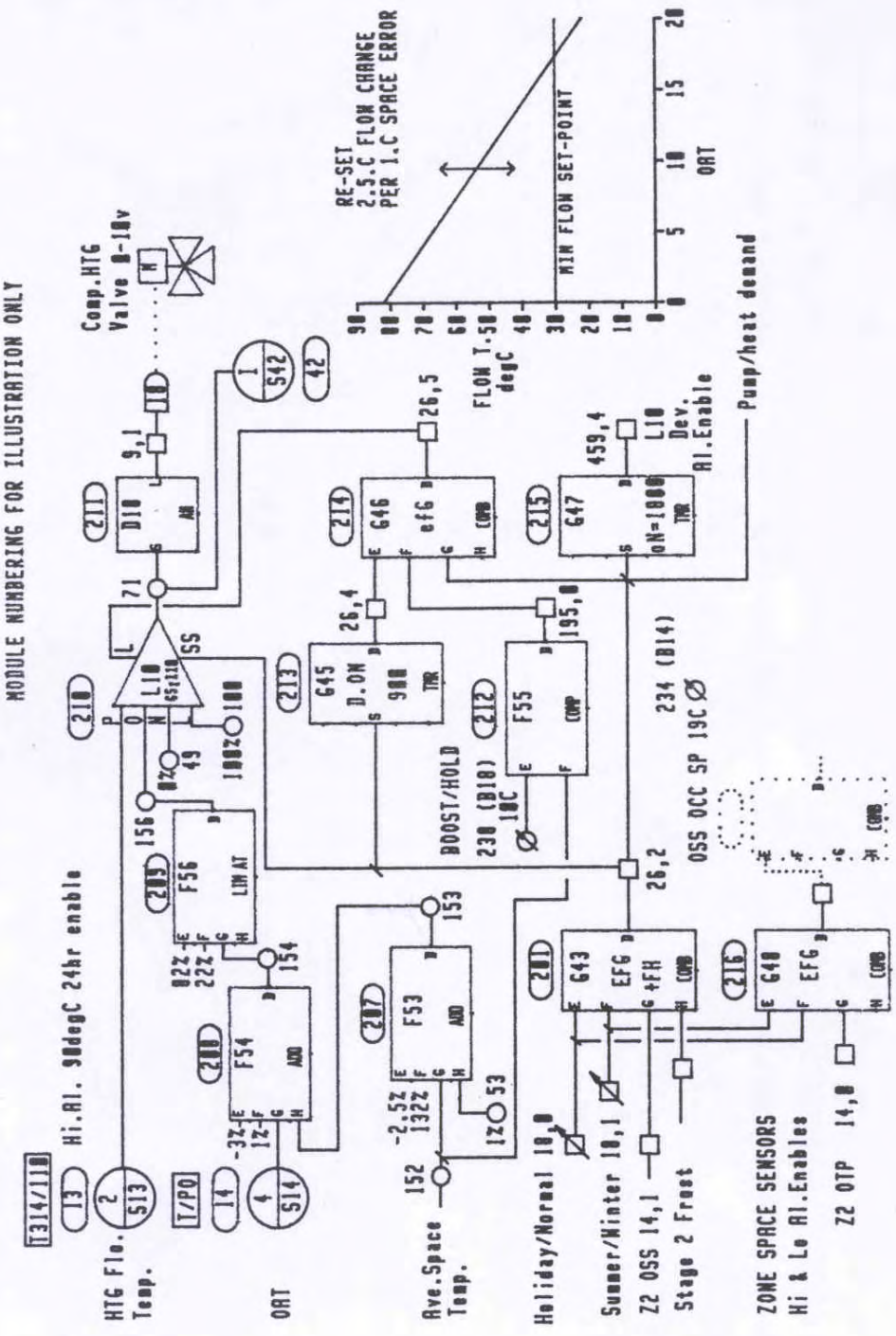
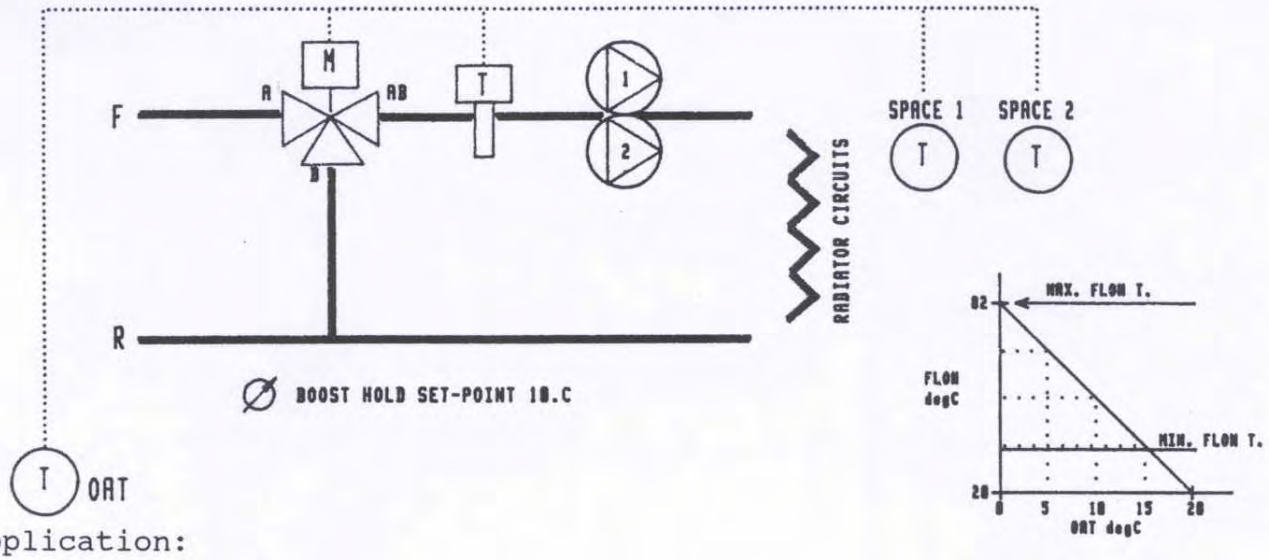
SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/C1

COMPENSATED HEATING CONTROL



COMPENSATED HEATING CONTROL



Application:

Control of heating water temperature for standard radiator zone. (Variable temperature circuits).

Typical operating parameters:

Flow temperature schedule:	82.C Flow @ 0.C OAT 22.C Flow @ 20.C OAT
Schedule Max. Flow:	82.C
Schedule Min. Flow:	30.C
OAT influence:	3.C Flow change per 1.C OAT change.
Space temp. influence:	Schedule elevate/depress 2.5.C per 1.C space error.
Desired space temperature:	20.C
Flow temp. alarms:	90.C High; 5.C Low.
Space temp. alarms:	25.C High; 17.C Low (OCC periods)
Altitude:	As provided by F&E tank (x bar)
Loop deviation alarm:	+/-5.C

Notes:

1. For details of pump control refer to MACRO MAC/F1.
2. For details of frost protection refer to MACRO MAC/E2.
3. Space sensor alarms enabled only during periods of OCC under 'winter' and 'normal' mode selections.

COMPENSATED HEATING CONTROL

Description:

At the start of the OSS period logic module(G43) will place loop(L10) in OCC mode if the soft switches (W1)Holiday/normal and (W2)Summer/winter are set as 'normal' and 'winter'. At the same time, if the average internal space temperature is less than the setting of knob(B10)(10.C) logic module(G46) will override this, placing loop(L10) in manual mode to facilitate a boost condition, for stabilisation of the flow temperature. This boost period is dictated by on-timer(G45) notionally set for 15mins and on time-out will make the logic at module(G46) untrue, thereby allowing loop(L10) to obey its OCC requirements.
Module(G43) also enables the loop(L10) deviation alarm after the timer(G47) period, set for 30mins.
During the OSS period when loop(L10) is in the OCC mode, the analogue output driver(D10) will modulate the heating valve to the preset weather schedule with space temperature re-set. This is achieved by Function modules(F53-F56) and loop(L10).
Add module(F53) elevates or depresses the OAT compensation schedule by +/- 2.5.C per 1.C error of the average space temperature from the desired 20.C. The constants for this module are:-

	E	2.5% (Flow change per 1.C space error)
	F	1% Unity
	H	132% (Max flow T + (desired int.T x E))
Input	G	average space temperature input signal.

Add module(F54) adjusts the flow temperature relative to the OAT with reference to the output of module(F53). The constants for this module are:-

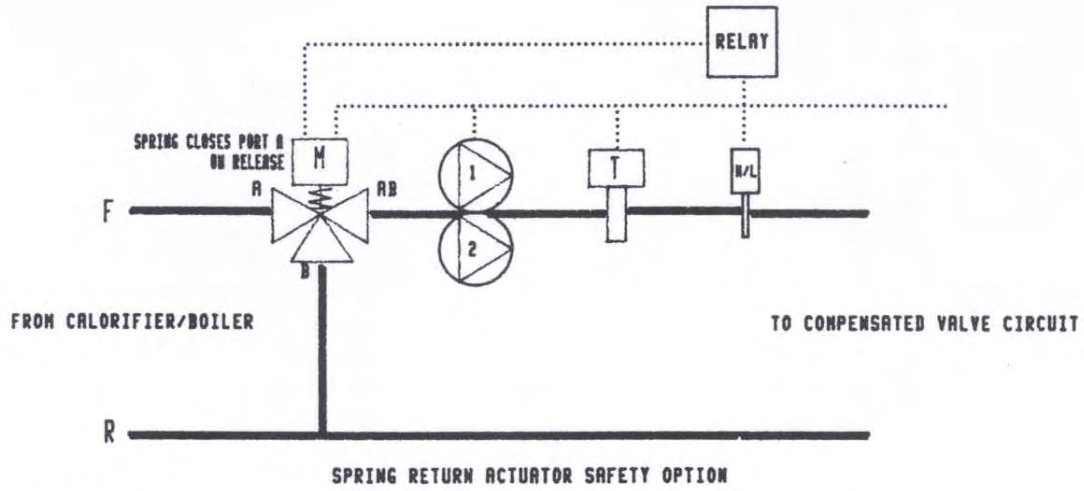
	E	3% (Flow change per 1.C OAT change)
	F	1% Unity
Input	G	actual OAT sensor
Input	H	Max flow as re-set by space T. error from (F53).

Limit at module(F56) allows the required calculated flow temp., from modules(F53/F54), to be passed to loop(L10) OCC set-point only within sensible bounds. viz. Min. 22.C; Max. 82.C:
Any error between actual flow temperature(S13) and the output of module(F56) is determined by the P+I action of loop(L10) and the resultant corrective output signal passed directly to the analogue driver(D10) for valve positioning.
Dummy internal sensor(S42) logs the loop output for system operation analysis, usually set for Daily(15min).

Logic module(G48) initiates the alarm enable logic modules for all associated space sensors,(not shown on this macro), only during OCC periods with soft switches (W1) and(W2) set as 'normal' and 'winter' respectively.

During winter mode(W2) stage-2 frost protection acts on module (G43) input 'H' to place loop(L10) into OCC demand to remove the valve enforced by-pass command.(NOC=0%). This will then allow heated water into the variable circuit where the pump is already in operation under stage-1 protection.(See pump MACRO MAC/F1).

CONTSANT (LOW) TEMPERATURE HEATING CONTROL (FLOOR/CEILING PANELS)



SPRING RETURN ACTUATOR SAFETY OPTION

Application:

Reduction of standard LTHW secondary temperature for use with embedded-panel heating.

Typical operating parameters:

LTHW standard flow temp.:	82.C
Max. panel flow temp.:	60.C (or as specified)
Panel flow high-limit T.:	65.C (manual re-set)
System altitude:	x bar (As provided by F&E tank)
Altitude alarms:	x+10% high; x-10% low:
Flow sensor alarms:	65.C High; 55.C Low:

S/S

Notes:

1. This is a safety control circuit only and the reduced flow temperature would be further controlled via compensation as MACRO MAC/C1 with a reduced temperature schedule.
2. High-limit control via spring-return actuator or additional direct-acting valve/controller.(See option on next page).

COMPENSATED HEATING CONTROL

Features:

1. Weather compensation of heating flow temperature with space temperature schedule re-set.
2. Full space sensor alarm blocking outside normal operation.
3. Valve boost when space temperature < 10.C at start of OSS.
4. Loop deviation alarm.
5. Second stage frost-protection valve signal.
6. Loop output logging via internal dummy sensor.
7. Summer/winter and Holiday/normal interlocking.
8. Pump run/heat demand signal for use with MACRO MAC/F1.

Standard components:

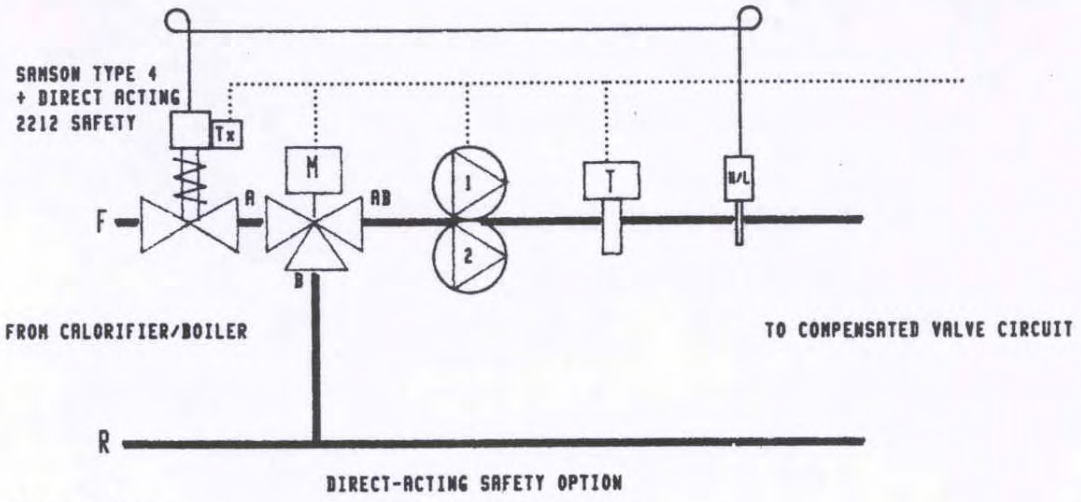
Flow sensor:	Trend T314/110 + S/S pocket
OAT sensor:	Trend T/PO
Space sensors:	Trend T320
Valve/actuator:	Samson 3260/5821(0-10v positioner) or Samson 243-2/3274-11(0-10v)

Notes:

1. System altitude monitoring and interlocking is detailed on the associated primary heat source. e.g. MACRO MAC/A1.
2. All real sensors to be set for logging on 15min(Daily) basis.
3. OSS and full time zone details as MACRO MAC/G1.

S/S

CONTSANT (LOW) TEMPERATURE HEATING CONTROL (FLOOR/CEILING PANELS)



DIRECT-ACTING SAFETY OPTION

Application:

Reduction of standard LTHW secondary temperature for use with embedded-panel heating.

********** DIRECT ACTING OPTION **********

Typical operating parameters:

LTHW standard flow temp.:	82.C
Max. panel flow temp.:	60.C (or as specified)
Panel flow high-limit T.:	65.C (manual re-set)
System altitude:	x bar (As provided by F&E tank)
Altitude alarms:	x+10% high; x-10% low:
Flow sensor alarms:	65.C High; 55.C Low:

Notes:

1. This is a safety control circuit only and the reduced flow temperature would be further controlled via compensation as MACRO MAC/C1 with a reduced temperature schedule.
2. High-limit control via additional 2-port direct-acting valve and controller.

CONSTANT (LOW) TEMPERATURE HEATING CONTROL (FLOOR/CEILING PANELS)

Features:

1. Close control of reduced constant temperature flow.
2. High-limit and power failure protection.
3. Sensor low alarm blocking.
4. Loop deviation alarm blocking.
5. Pump demand signal.

Standard components:

Flow sensor:	Trend T314/110 + S/S pocket
High-limit:	Satchwell/Sunvic TKR 3501 + pocket
Auxiliary relay:	R.S. 349-327(24v ac coil) DPCO
Control valve/actuator:	Samson 3260 + 5822(0-10v)
	or
	Samson 243-2 + 3274-22(0-10v)
Direct-acting High-limit option:	
	Samson Type 4 valve +
	2212 high-limit+ Aux. signal Tx.

N.B. If D/A option used, control valve actuators need not be spring return types. viz. 5821(0-10v) or 3274-11(0-10v).

Notes:

1. Direct-acting option requires an additional 2-port valve (Samson type 4).
2. This set-up only used where a separate low constant-temp. calorifier is not practical.
3. This 2 or 3 valve set-up may seem extravagant, but when considered against the damage that could be caused by excess temperature on the embedded panels the additional cost is insignificant.

CONSTANT (LOW) TEMPERATURE HEATING CONTROL (FLOOR/CEILING PANELS)

Description:

The flow temperature at (S12) is controlled to a constant level, as dictated by knob(B12), this being the maximum temperature available to the weather compensating zones (generally as MACRO MAC/C1) supplied to the embedded floor/ceiling panels circuits.
The set-point of knob(B12) will be dictated by the heating panel design criteria, but generally around 60degC.
The required constant flow temperature is controlled by the P+I action of loop(L9), which compares the actual flow on sensor(S12) with the required set-point, any negative error causing a corrective output signal to be passed to the analogue driver(D17) for valve action.
Set-point selection is not applied to the loop(L9) as the constant temperature is required at all times during winter mode selection at switch(W2) and during summer mode the heat source is removed so the valve position is irrelevant.
Summer/winter switch(W2) enables the low flow temperature alarm of sensor(S12) via timer(G42), which in turn enables the loop deviation alarm via logic module(G43) when winter mode is selected.
Pump demand is also taken directly from switch(W2) and control would generally as MACRO MAC/F1.
Digital input(DI3) monitors the high-limit device and on operation forces loop(L9) into manual mode, which being pre-set to 0% causes the driver(D17) to close. Input(DI3) has its associated alarm bit enabled to generate a general alarm on contact closure.

Electric spring-return actuator option.
With this option the high-limit thermostat is wired to operate an auxiliary relay (24v ac control circuit) which in turn will act to provide the direct digital input to (DI3) and to de-clutch the actuator to release the spring close mechanism. Note that this action is instantaneous and independent of the signal from loop(L9) in manual mode.

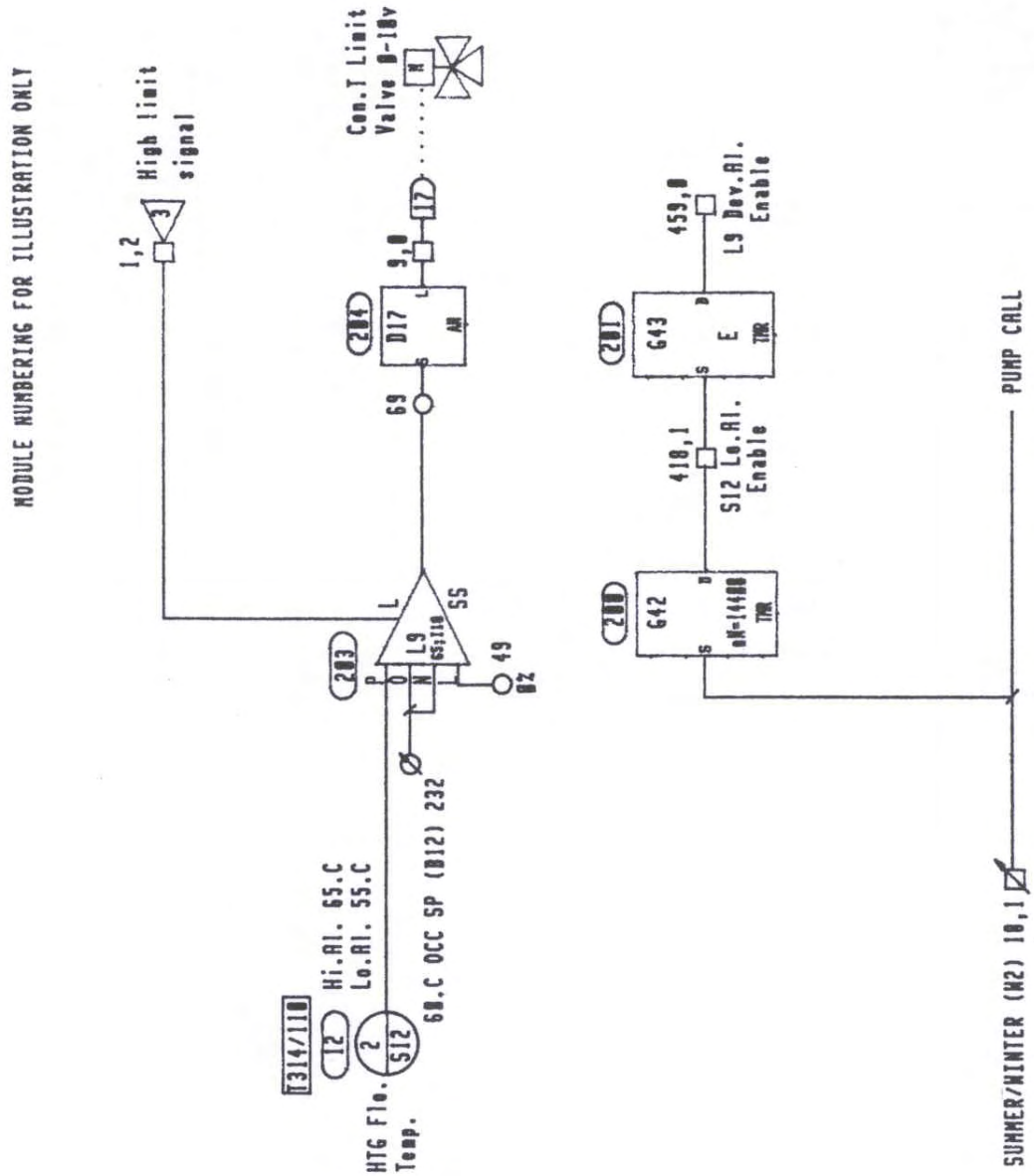
Direct-acting option.
With this option the high-limit device is of the capillary type acting directly onto the additional 2-port safety valve, when the sensing element is above set-point the trigger release is operated to allow the valve to close immediately under spring action. The Samson 2212 high-limit safety device is provided with and auxiliary Tx in the form of change-over contacts, the N.O. connections are wired directly to input(DI3) to provide the general alarm.

NOTE. Both safety devices are of the manual re-set type.

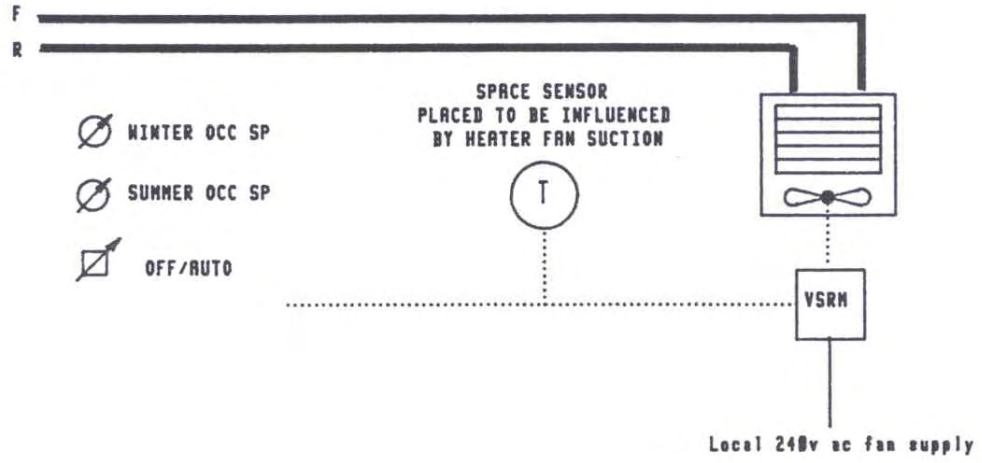
SOUTHAMPTON UNIVERSITY BMS	Applications MACRO

MAC/C2

CONSTANT (LOW) TEMPERATURE HEATING CONTROL (FLOOR/CEILING PANELS)



UNIT HEATER/FAN CONVECTOR CONTROL



Application:

Space temperature control using fan assisted heaters.

Typical operating parameters:

LTHW supply temperature:	82.C
LTHW altitude:	x bar As provided by F&E tank.
Fan:	240v ac.Fractional HP.
Desired space temp:	20.C Winter heating mode.
Space temperature alarms:	25.C High; 17.C Low: heating mode.
Summer fan run:	ON >23.C to provide air movement.
LTHW low-temp interlock:	Fan OFF if flow <50.C(heating mode)

Notes:

1. Heaters to be supplied from constant temperature heating circuit.
2. If a number of heaters are used to control the space temp. the VSRM is used to control auxiliary contactors.
   Note. By replacing the VRSM with a TRM and using an analogue output driver, pseudo modulation can be achieved.

UNIT HEATER/FAN CONVECTOR CONTROL

Features:

1. Close control of space temperature.
2. High and low temperature alarm blocking.
3. Summer/winter and holiday/normal interlocking.
4. Use of fan in summer mode to create air movement in times of high space temperature.
5. LTHW interlock in winter mode.
6. Fire alarm interlock.

Standard components:

Space sensor:	Trend T/320
Fan enable relay:	Trend VSRM

Notes:

1. VSRM is only capable of switching one fractional horsepower fan motor. If multiple fan units are used VSRM or TRM must operate coil circuits of auxiliary contactor/starters.
2. If area to be controlled is of intermittent occupancy, use of APD unit should be included for aditional efficiency.

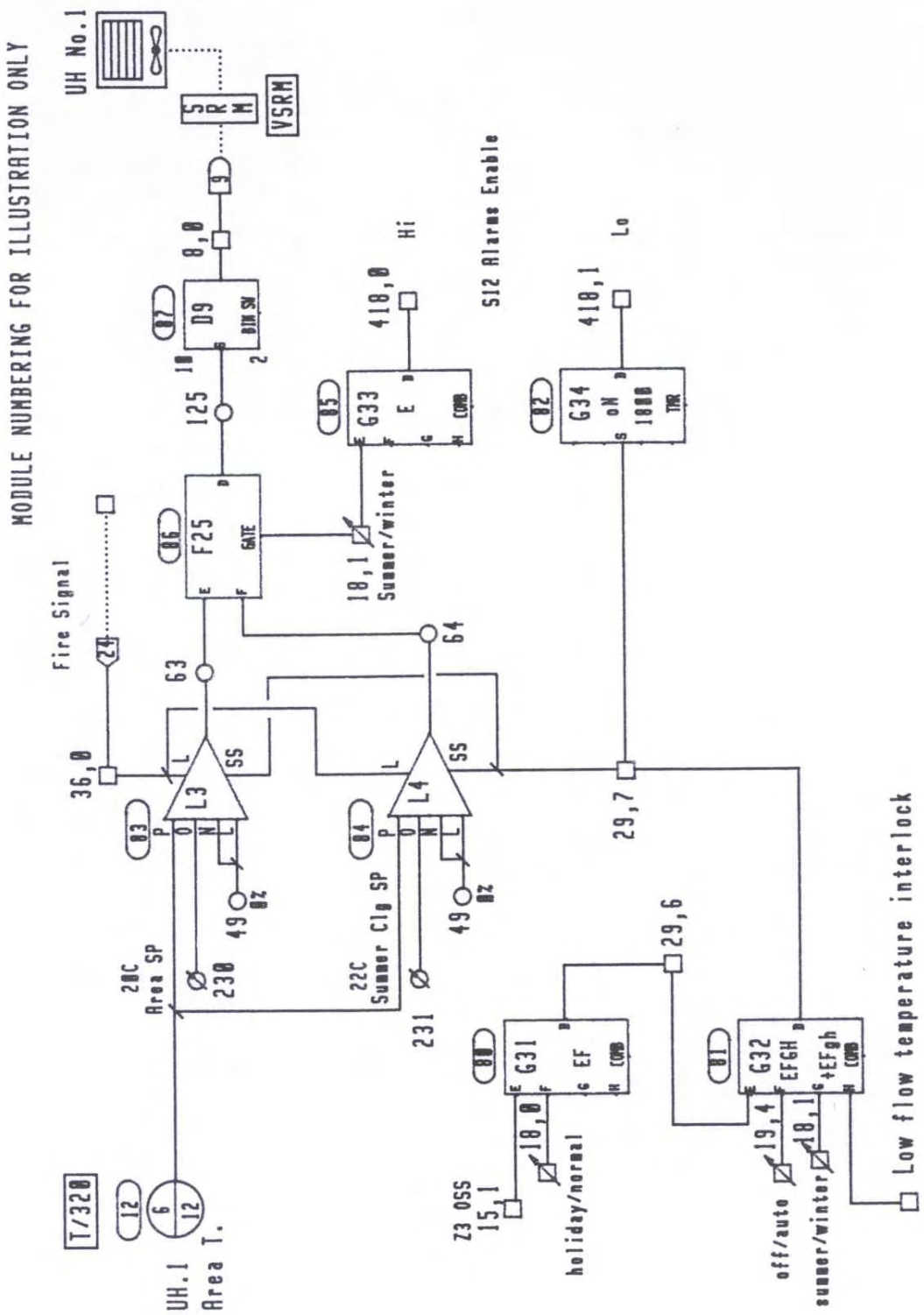
UNIT HEATER/FAN CONVECTOR CONTROL

Description:

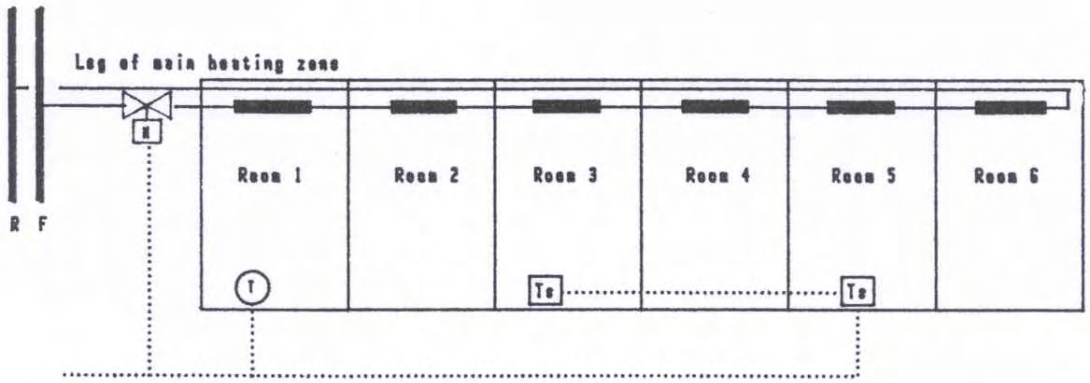
Logic modules(G31 & G32) provide the master switching for the set-point selections for loops(L3 & L4) and the warm-up period timer(G34) which will enable the associated low alarm bit for space sensor(S12).
The summer/winter switch(W2) provides the gate switching for function module(F25) which allows loop(L3) to control the binary switch driver(D9) in winter mode and loop(L4) to control in summer mode. Switch(W2) also enables the associated high alarm bit for space sensor(S12).
During OCC demand periods with switch(W2) in winter mode, loop(L3) compares the space temperature at sensor(S12) with the desired value set on knob(B10). Any negative error causes the P only action of loop(L3) to pass a corrective output, via gate (F25), to the binary switch driver(D9) to operate the unit heater fan circuit through the associated VSRM.
During OCC demand periods with switch(W2) in summer mode, loop(L4) compares the space temperature at sensor(S12) with the desired value set on knob(B11). Any positive error causes the P only action of loop(L4) to pass a corrective output, via gate(F25), to the binary switch driver(D9) to operate the unit heater fan circuit through the associated VSRM. Note that in summer mode the low-level flow temperature interlock at logic module(G32) is over-ridden, this allows fan operation in times of high space temperature to provide some air movement to minimise discomfort levels.
In the event of a fire signal being present on digital bit 36,0 , normally received IC Comms. from LAN4 alarm outstations, loops (L3 &L4) are forced into manual mode, which being pre-set to 0%, halt any fan operation.

SOUTHAMPTON UNIVERSITY BNS	Applications MACRO
	MAC/C3

UNIT HEATER/FAN-CONVECTOR CONTROL



LOCAL CONTROL OF MULTI-ROOM HEATING ZONE



Application:

Local temperature control of several rooms served by a common piped service.

Typical operating parameters:

LTHW flow temperature:	82.C Max. (Con.T or Compensated)
Altitude:	x bar As provided by F&E tank.
Desired space temperature:	20.C
Temperature alarms:	25.C High; 17.C Low:

Notes:

1. All auxiliary thermostats wired in parallel.
2. Heat emitters may be radiators or fin-convectors.
3. Location for the space sensor should be indicative of the area if possible.

LOCAL CONTROL OF MULTI-ROOM HEATING ZONE

Features:

1. Control of space temperature from single sensor with auxiliary thermostats.
2. High and low alarm blocking.
3. Low cost magnetic zone valve.

Standard components:

1.	Space sensor:	Trend T/320
2.	Space thermostats:	Sunvic TLX2358 (concealed scale)
3.	Valve enable relay:	Trend VSRM

Notes:

1. Auxiliary thermostats set for 18.C with a diff. of 2.C.
2. The number of auxiliary thermostats used should be approx. half the number of rooms controlled.
3. Space sensor/loop control has only equal authority with the auxiliary thermostats.

LOCAL CONTROL OF MULTI-ROOM HEATING ZONE

Description:

Logic module(G31) provides the master switching for zone heating when there is an OSS call from time-zone 3, with soft-switches (W1 & W2) in 'normal' and 'winter' modes respectively. Stage 1 frost protection signal can also activate the zone valve when soft-switch(W2) is in 'winter' mode. When module(G31) is called to provide heat, the set-point select line of loop(L3) is gated placing it in OCC mode, allowing sensor(S12) to control the binary-switch module(G9) via function module(F25). Control action of loop(L3) is proportional only.

The auxiliary thermostat input demand is passed to logic module (G32) and, if module(G31) is also demanding, will gate function module (F25) to 100%, over-riding any loop(L3) output to switch driver(D9) and open the zone valve.

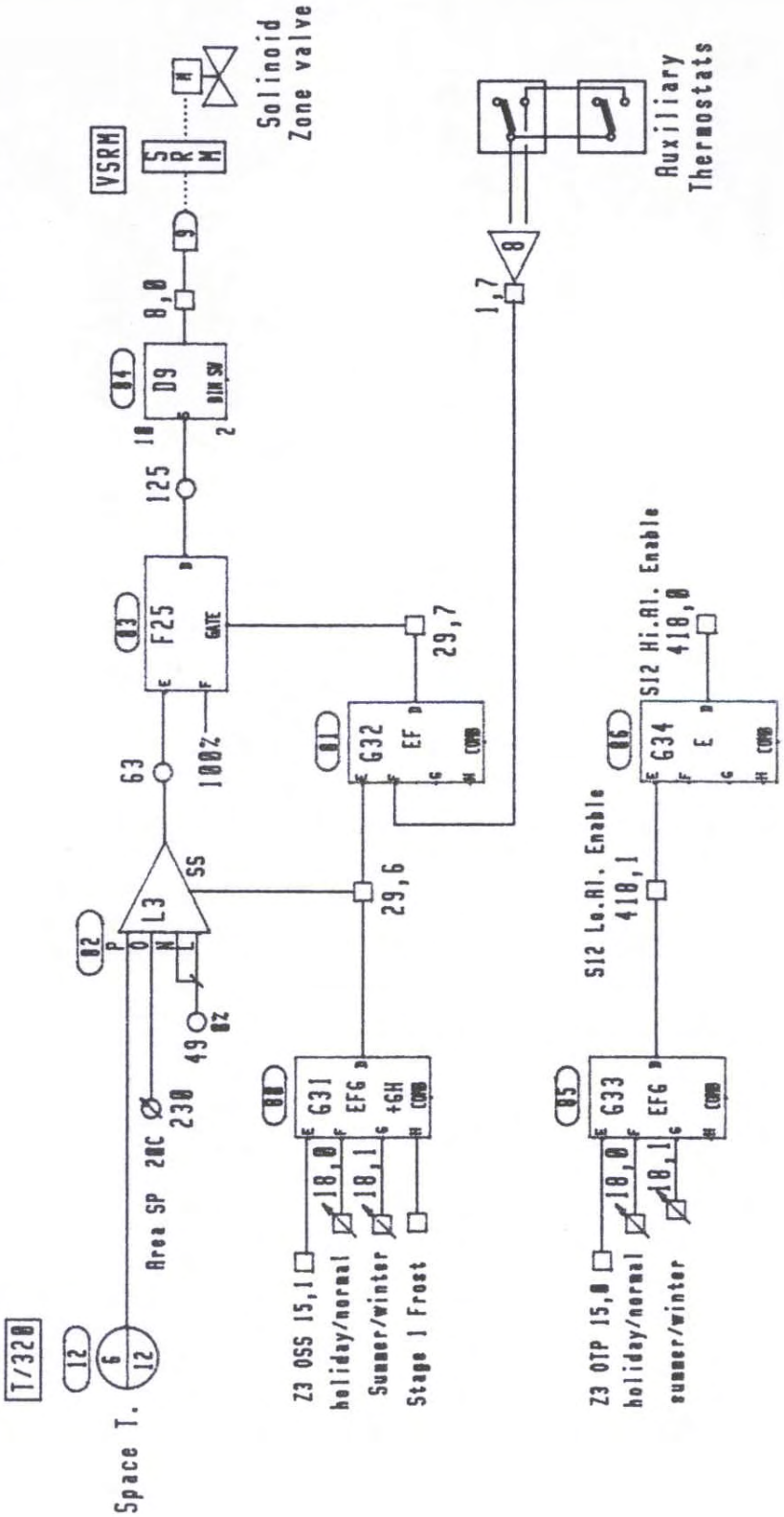
Note. Zone valve will be open if any auxiliary thermostat, or loop(L3) is demanding.

Space sensor(S12) high and low temperature alarms are only enabled during the OCC periods of time-zone 3 with soft-switches (W1 & W2) in 'normal' and 'winter' modes respectively.

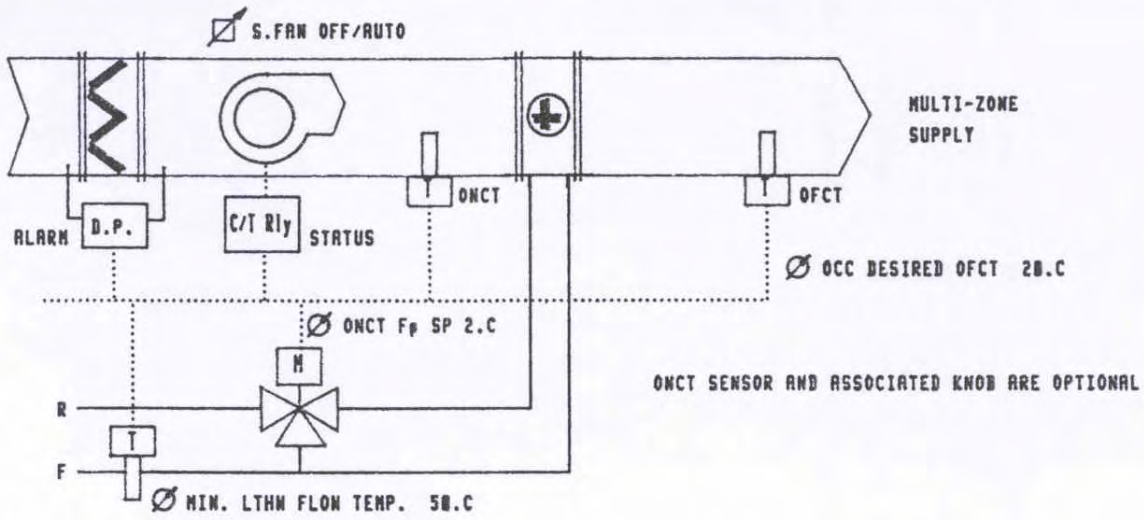
SOUTHAMPTON UNIVERSITY BMS	Applications MACRO

MAC/C4

LOCAL CONTROL OF MULTI-ROOM HEATING ZONE



AHU CONSTANT TEMPERATURE MULTI-ZONE DISCHARGE CONTROL



Application:

Multi-zone air-handling units with local or no extract units.

Typical operating parameters:

LTHW supply:	82.C
LTHW min.temp interlock:	50.C
Discharge temperature(OFCT):	20.C
OFCT sensor alarms:	25.C High; 17.C Low:
Min. valve position @ 2.C (ONCT):	8%

Notes:

1. ONCT sensor is optional as the control mode is constant temp. but it will provide additional frost protection to the heater-battery during NOC periods by lifting the valve to 8% when sensing <2.C. Common building two-stage frost protection is also active.

AHU CONSTANT TEMPERATURE MULTI-ZONE DISCHARGE CONTROL

Features:

1. Close control of discharge temperature from OFCT sensor.
2. Optional ONCT sensor shown for additional local heater-battery protection.
3. Sensor alarm blocking.
4. Summer/winter and Holiday/normal interlocked.
5. Control for associated supply fan and con.temp. pump call.
6. Supply fan status monitor.
7. LTHW low flow temperature interlocked.
8. AUH filter alarm status.
9. Standard 2-stage frost protection action.

Standard components:

ONCT sensor (Optional):	Trend T/PD40
OFCT sensor:	Trend T/PD40
Con.T flow sensor:	Trend T314/110
S.Fan enable relay:	Trend VSRM
S.Fan status relay:	Direct-drive R.S. C/T Relay 349-800 R.S. C/T 351-099 or 351-106 Belt-drive R.S. Shaft rotation relay 347-696 R.S. M18NPN Proxistor 256-332
Filter status:	Honeywell S830A hand-reset d.p. sw.
Control valve (typical):	Samson 3260/5821 (0-10v positioning)

Notes:

1. Select appropriate fan status components, depending on type used.
2. Samson control valve/actuator listed is typical only, the exact size and type would be found in the specification, but the actuator would be of the 0-10v positioning type.
3. LTHW flow sensor indicated would be common to all AHUs fed from the associated constant-temperature pump set.
4. Details of 2-stage frost protection would be as MACRO MAC/E2.
5. Con.T pump set would be generally as MACRO MAC/F1.

AHU CONSTANT TEMPERATURE MULTI-ZONE DISCHARGE CONTROL

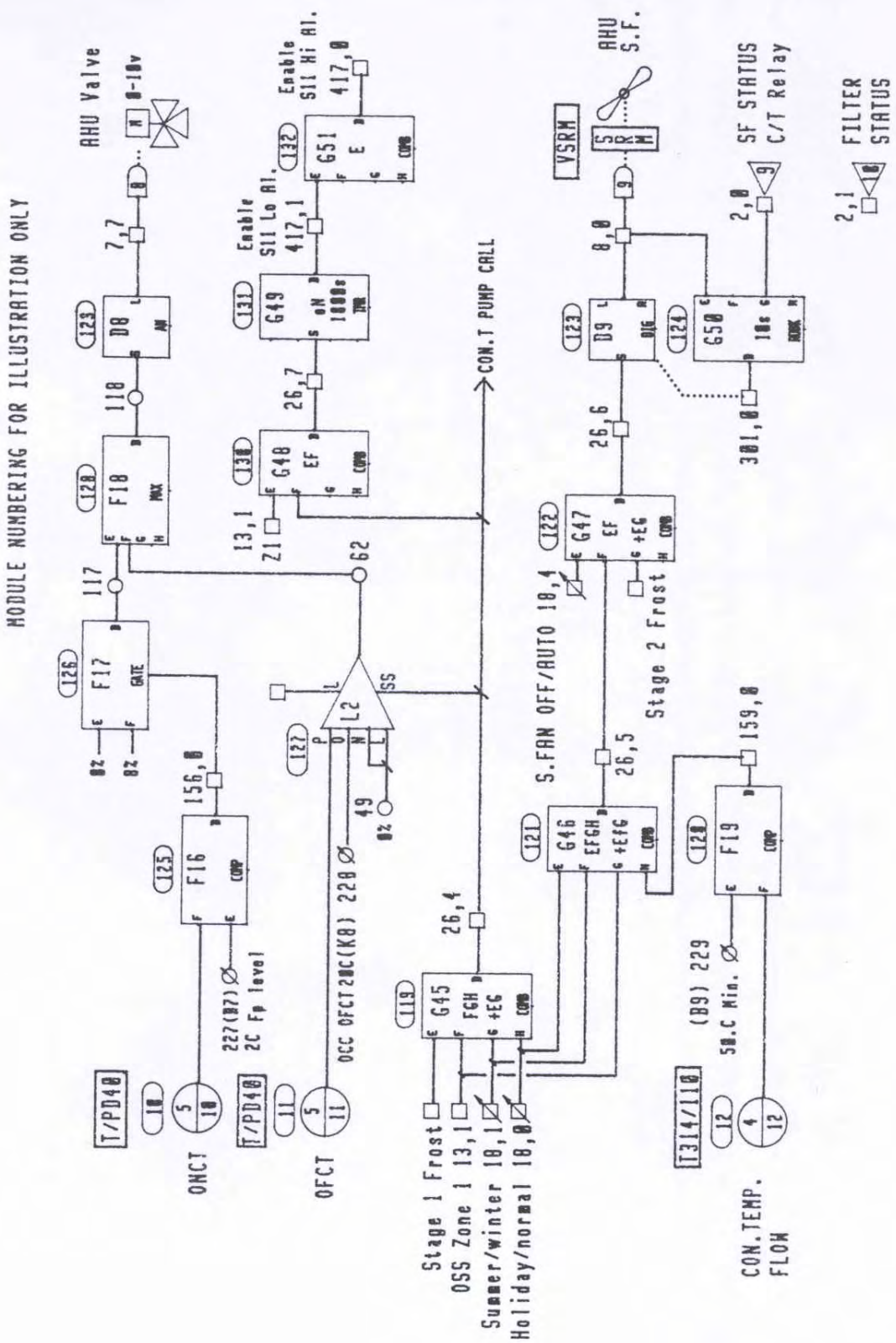
Description:

Heating is provided when logic module(G45) receives an OSS zone demand, with master switches(W1 and W2) set 'normal' and 'summer' respectively, by placing loop(L2) into OCC mode and calling for pump and fan operation. Only under these circumstances and, after pre-heat delay of (G49) are alarm bits for sensor(S11) enabled.
In OCC mode the P+I action of loop(L2) will maintain a constant temperature on sensor(S11), as set on knob(B8), by modulating the heater-battery control valve via the analogue driver(D8).
First-stage frost protection at logic module(G45) will open the control valve to line by placing loop(L2) in OCC mode and calling for pump operation to circulate water. Note sensor(S11) alarm bits are not enabled under these circumstances due to logic at module(G48) which requires the time-zone to be calling.
The optional on-coil sensor and associated function modules (F16-F18) provide additional battery anti-freeze protection by imposing a minimum of 8% on the control valve when ONCT <2.C, or as set on knob(B7).
Fan operation is determined by logic modules(G46 and G47) and allows operation under three circumstances only, and always with status monitoring via readback module(G50) and digital input(DI9).

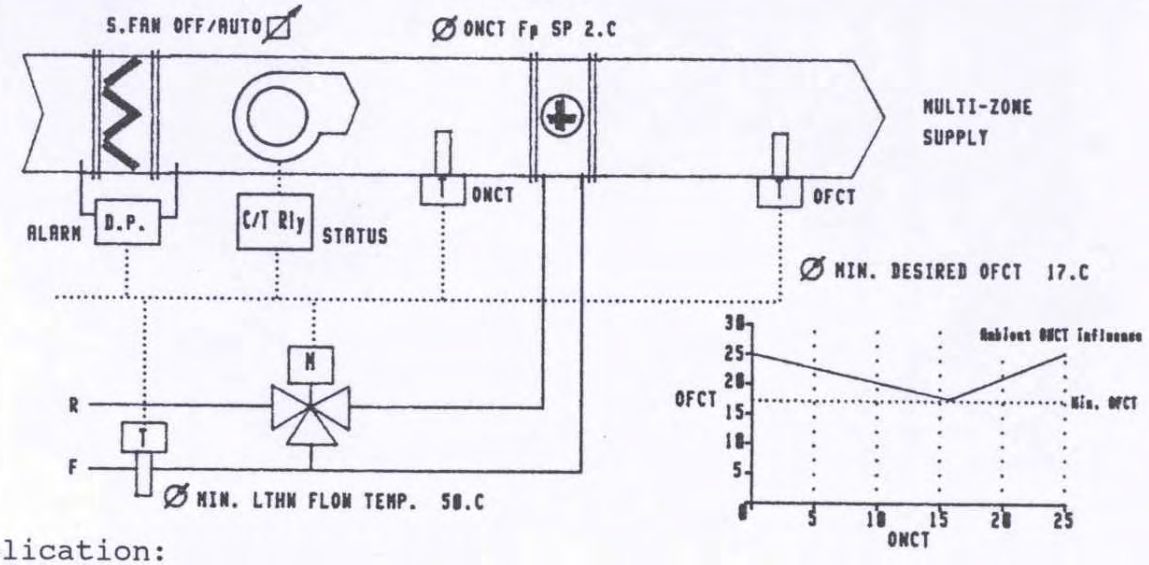
1. Normal/Winter mode during OCC demand periods when LTHW flow on sensor(S12) is above the level set on knob(B9).
2. Stage-2 Frost protection is called.
3. Normal/Summer mode during OCC demand periods, for ventilation.
   N.B. All above assume the OFF/AUTO switch(W5) to be in 'AUTO'.

The supply filter is permanently monitored by a differential-pressure switch which will generate an alarm on activation via digital input(DI10). No control action is required.

AHU CONSTANT TEMPERATURE MULTI-ZONE DISCHARGE CONTROL



AHU COMPENSATED TEMPERATURE MULTI-ZONE DISCHARGE CONTROL



Application:

Multi-zone air-handling units with local or no extract units.

Typical operating parameters:

LTHW supply:	82.C
LTHW min.temp interlock:	50.C
Discharge temperature(OFCT):	20.C
OFCT sensor alarms:	25.C High; 17.C Low:
Min. valve position @ 2.C (ONCT):	8%

Notes:

1. When the ONCT rises above the minimum OFCT set-point, the heating valve will be at 0%. Therefore, any increase in ONCT will be presented as OFCT on systems with no re-circulation or cooling facilities.

AHU COMPENSATED TEMPERATURE MULTI-ZONE DISCHARGE CONTROL

Features:

1. Compensated control of discharge temperature from ONCT.
2. OFCT low-limit action.
3. Sensor alarm blocking.
4. Summer/winter and Holiday/normal interlocked.
5. Control for associated supply fan and con.temp. pump call.
6. Supply fan status monitor.
7. LTHW low flow temperature interlocked.
8. AUH filter alarm status.
9. Standard 2-stage frost protection action.
10. Fire signal interlock to halt fan operation.

Standard components:

ONCT sensor:	Trend T/PD40
OFCT sensor:	Trend T/PD40
Con.T flow sensor:	Trend T314/110
S.Fan enable relay:	Trend VSRM
S.Fan status relay:	Direct-drive
	R.S. C/T Relay 349-800
	R.S. C/T 351-099 or 351-106
	Belt-drive
	R.S. Shaft rotation relay 347-696
	R.S. M18NPN Proxistor 256-332
Filter status:	Honeywell S830A hand-reset d.p. sw.
Control valve (typical):	Samson 3260/5821 (0-10v positioning)

Notes:

1. Select appropriate fan status components, depending on type used.
2. Samson control valve/actuator listed is typical only, the exact size and type would be found in the specification, but the actuator would be of the 0-10v positioning type.
3. LTHW flow sensor indicated would be common to all AHUs fed from the associated constant-temperature pump set.
4. Details of 2-stage frost protection would be as MACRO MAC/E2.
5. Con.T pump set would be generally as MACRO MAC/F1.

AHU COMPENSATED TEMPERATURE MULTI-ZONE DISCHARGE CONTROL

Description:

Heating is provided when logic module(G45) receives an OSS zone demand, with master switches(W1 and W2) set 'normal' and 'summer' respectively, by placing loop(L2) into OCC mode and calling for pump and fan operation. Only under these circumstances and, after pre-heat delay of (G49) are alarm bits for sensor(S11) enabled. In OCC mode the P+I action of loop(L2) will provide a modulated temperature on sensor(S11), to a preset schedule dictated by function modules (F16 & F17) relative to the ONCT of sensor(S10). This is achieved by modulating the heater-battery control valve via the analogue driver(D8). Note a minimum OFCT level is dictated by knob(B8).

First-stage frost protection at logic module(G45) will open the control valve to line by placing loop(L2) in OCC mode and calling for pump operation to circulate water. Note sensor(S11) alarm bits are not enabled under these circumstances due to the logic at (G48) which requires the time-zone to be calling.

The on-coil sensor(S10) and associated function modules(F18 & F19) provide additional battery anti-freeze protection by imposing a minimum of 8% on the control valve when ONCT <2.C. @ knob(B7).

Fan operation is determined by logic modules(G46 and G47) and allows operation under three circumstances only, and always with status monitoring via readback module(G50) and digital input(DI9).

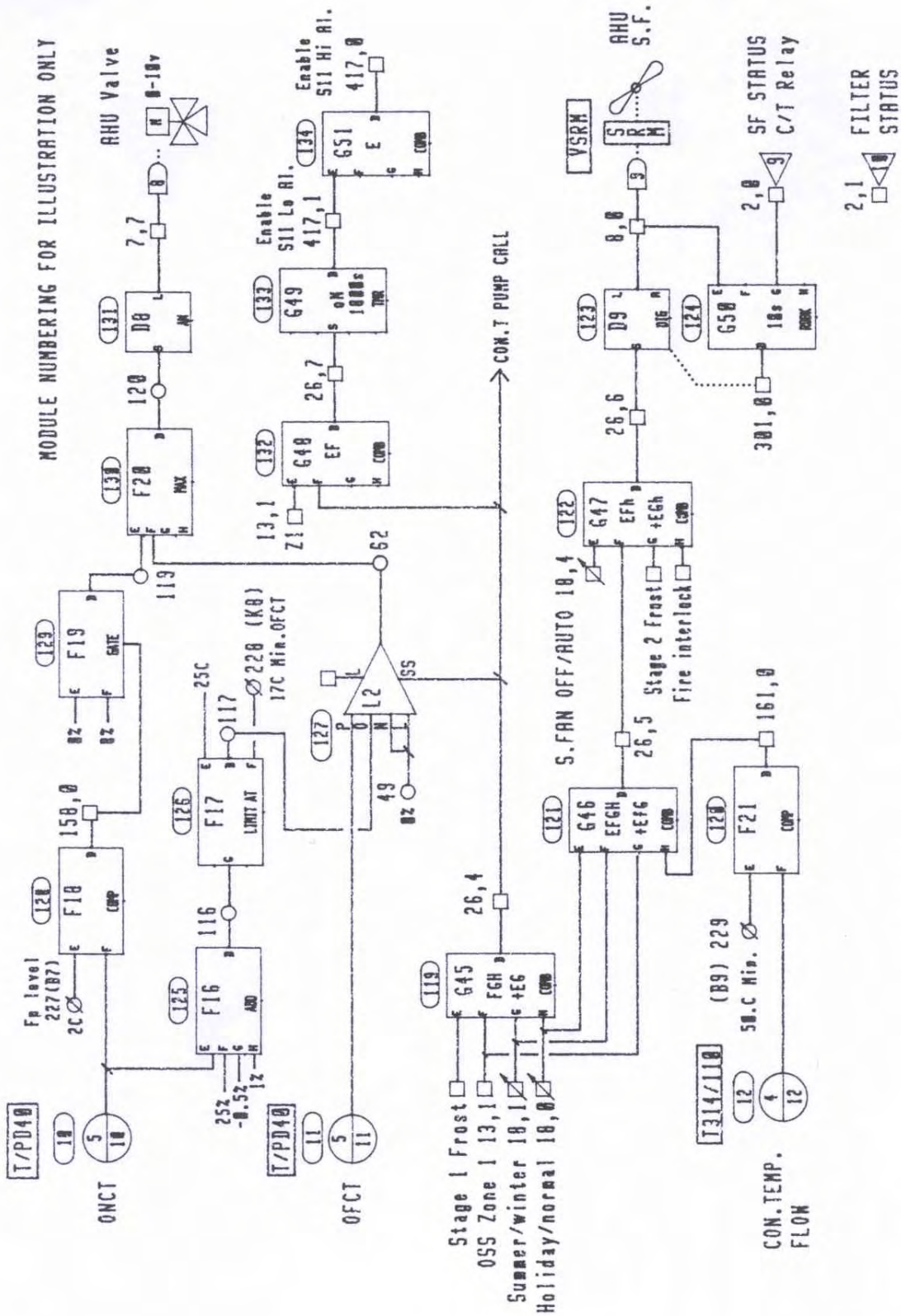
1. Normal+Winter mode during OCC demand periods when LTHW flow on sensor(S12) is above the level set on knob(B9).
2. Stage-2 Frost protection is called.
3. Normal+Summer mode during OCC demand periods, for ventilation.

   N.B. All above assume the OFF/AUTO switch(W5) to be in 'AUTO' and that no fire signal is present at module(G47).

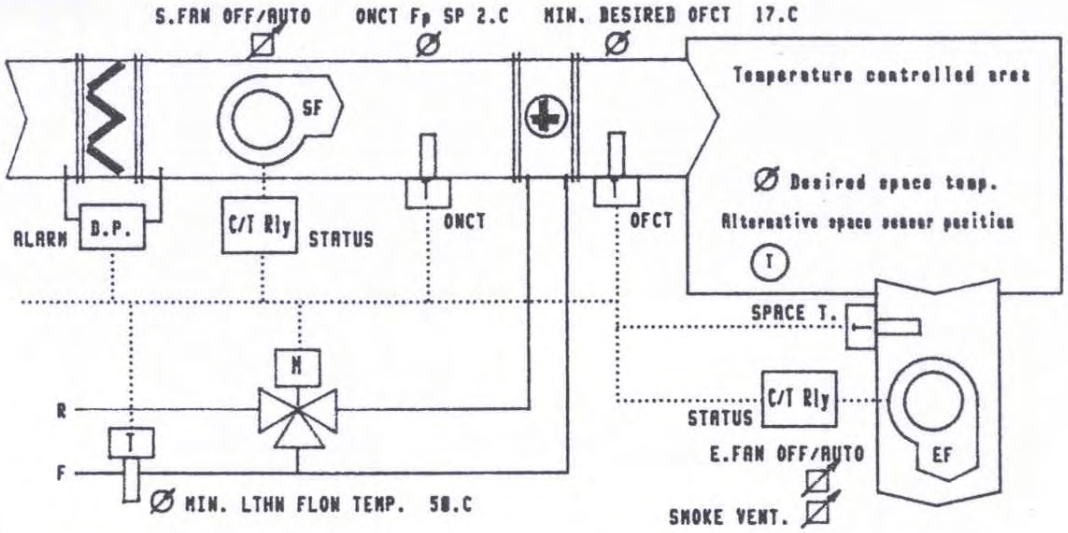
The supply filter is permanently monitored by a differential-pressure switch which will generate an alarm on activation via digital input(DI10). No control action is required.

SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/D2

AHU COMPENSATED TEMPERATURE MULTI-ZONE DISCHARGE CONTROL



AHU SPACE SET-POINT CONTROL (Cascade)



Application:

Control of space temperature with 100% fresh-air AHU.

Typical operating parameters:

LTHW supply:	82.C
LTHW min.temp interlock:	50.C
Discharge temperature(OFCT):	17.C - 35.C
OFCT sensor alarms:	40.C High; 15.C Low:
Min. valve position @ 2.C (ONCT):	8%
Min.OFCT limit:	17.C
Desired space temperature:	20.C - 22.C
Space sensor alarms:	25.C High; 17.C Low:

Notes:

1. This basic AHU space control MACRO, using 100% fresh-air, may be provided with various options as defined under MACROs - MAC/D4 - MAC/D8.

AHU SPACE SET-POINT CONTROL (cascade)

Features:

1. Space temperature control via cascade of OFCT.
2. OFCT low-limit action.
3. Sensor alarm blocking.
4. Summer/winter and Holiday/normal interlocked.
5. Control for associated supply fan and con.temp. pump call.
6. Supply and extract fan status monitoring.
7. LTHW low flow temperature interlocked.
8. AUH filter alarm status.
9. Standard 2-stage frost protection action.
10. Fire signal interlock to halt fan operation.
11. Extract fan smoke vent. interlock.

Standard components:

ONCT sensor:	Trend T/PD40
OFCT sensor:	Trend T/PD40
Space or return air sensor:	Trend T320 or T/PD40
Con.T flow sensor:	Trend T314/110
S.& E.Fan enable relays:	Trend VSRMs
S.& E.Fan status relays:	Direct-drive R.S. C/T Relay 349-800 R.S. C/T 351-099 or 351-106 Belt-drive R.S. Shaft rotation relay 347-696 R.S. M18NPN Proxistor 256-332
Filter status:	Honeywell S830A hand-reset d.p. sw.
Control valve (typical):	Samson 3260/5821 (0-10v positioning)

Notes:

1. Select appropriate fan status components, depending on type used.
2. Samson control valve/actuator listed is typical only, the exact size and type would be found in the specification, but the actuator would be of the 0-10v positioning type.
3. LTHW flow sensor indicated would be common to all AHUs fed from the associated constant-temperature pump set.
4. Details of 2-stage frost protection would be as MACRO MAC/E2.
5. Con.T pump set would be generally as MACRO MAC/F1.
6. Space temperature may be via return-air duct sensor or space mounted sensor. N.B. If APD option as MACRO MAC/D8 is included space mounted sensor must be used.

AHU SPACE SET-POINT CONTROL (Cascade)

Description:

Heating is provided when logic modules(G45 & G46) receive an OSS zone demand, with master switches(W1 & W2) set 'normal' and 'summer' respectively. Module(G45) places control loops(L1 & L2) into OCC mode, calls for pump operation and enables the alarm bits for sensors(S9 & S11). Note that sensor(S9) alarms are only active during OTP times, due to the logic at module(G54) which includes the associated 13,0 bit. Note also that sensor(S11) alarms are delayed at OSS start by the action of timer(G52) to allow a warm-up period. Module(G46) provides the call for fan operation and during 'winter' mode must have an input present from function module(F20) which ensures that a sensible flow temperature is available.

In OCC mode the space temperature on sensor(S9) is compared to that desired on knob(B7) and the P+I action of loop(L1) will output a 0-100% corrective signal. This signal is then re-scaled by function module(F16) for use as the OFCT set-point on loop(L2) to give a maximum of 35.C and a minimum as set on knob(B8), usually 17.C. Note this minimum level for OFCT ensures that no 'cold draught' is perceived within the space when at or near the space set-point. The OFCT on sensor (S11) is compared to the requirement dictated by the output of function module(F16) and the P+I action of loop(L2) will output to the control valve via function module(F19). ONCT sensor(S10) and the associated modules(F17-F19) provide heater-battery freeze protection by imposing a minimum of 8% on the control valve when ONCT <2.C, or as set on knob(B6).

Supply fan operation is dictated by logic module(G47) which will allow driver(D9) to engage only when master module(G46) requests or stage-2 frost protection is called. Both cases require no fire fire signal to be present and switch(W5) to be in "auto" mode.

Extract fan operation is dictated by logic module(G48) which will allow driver(D10) to engage only when master module(G46) requests or the fire smoke-vent switch(W3) is activated. Both cases require the switch(W6) to be in 'auto' mode, but the fire signal will block operation only during normal requests from module(G48).

During operation both supply and extract fans are monitored by their digital status inputs(DI9 & DI10) and associated read-back modules(G49 & G50).

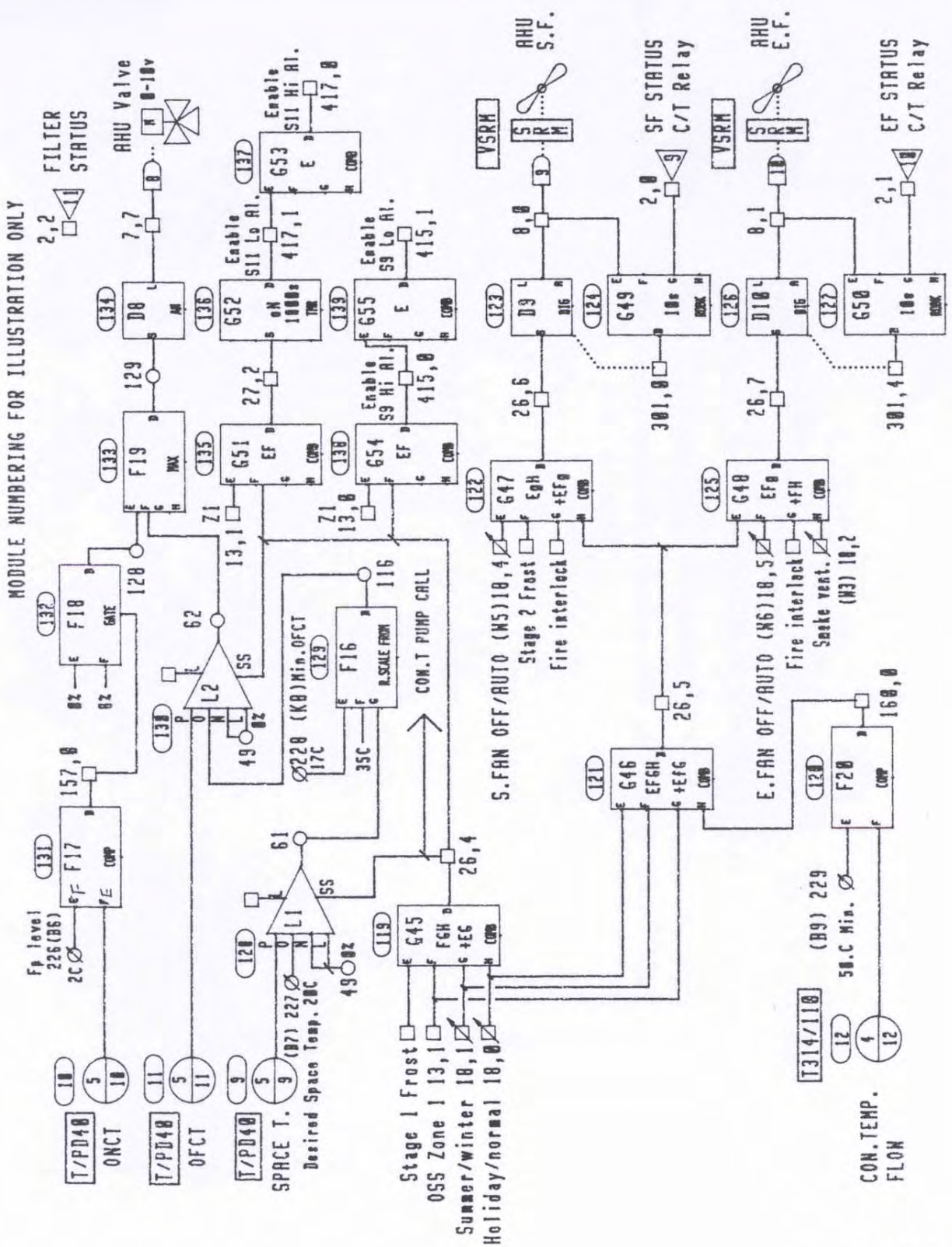
The supply filter is permanently monitored by a differential-pressure switch which will generate an alarm on activation via digital input(DI11). No control action is required.

SOUTHAMPTON UNIVERSITY BMS

Applications MACRO

MAC/D3

AHU SPACE SET-POINT CONTROL (Cascade)



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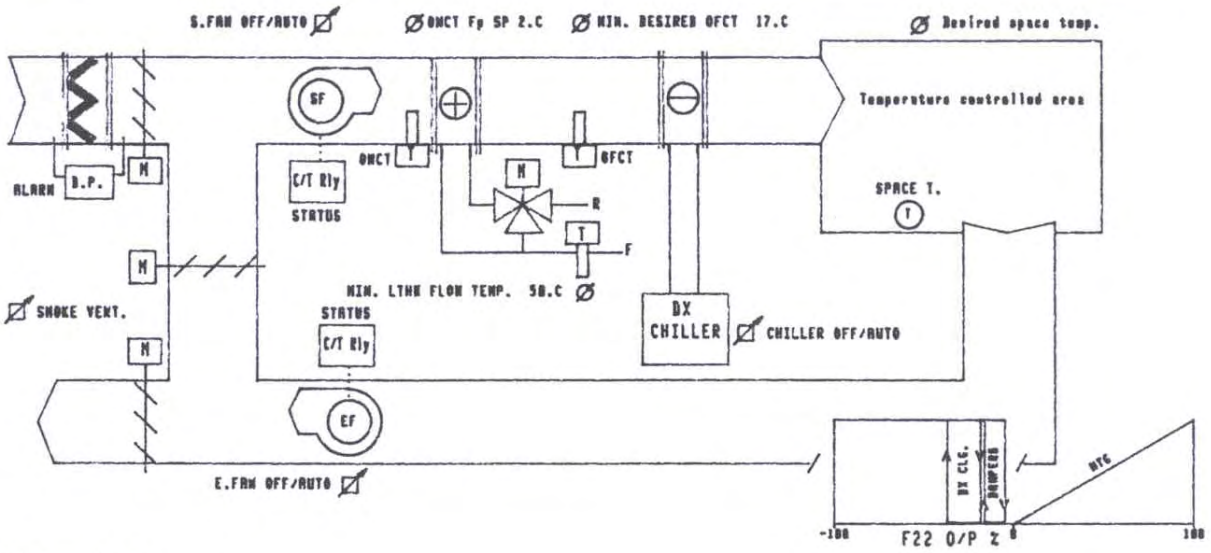
SENSIBLE DX COOLING OPTION FOR MACRO MAC/D3



Application:

Addition of sensible DX cooling to basic AHU set-point control as defined under MACRO MAC/D3.

Typical operating parameters:

LTHW supply:	82.C
LTHW min.temp interlock:	50.C
Discharge temperature(OFCT):	15.C - 35.C
OFCT sensor alarms:	40.C High; 13.C Low:
Min. valve position @ 2.C (ONCT):	5%
Min.OFCT limit:	15.C
Desired space temperature:	20.C - 22.C
Space sensor alarms:	26.C High; 17.C Low:
Fixed htg/clg dead-band:	2.C

Notes:

1. DX unit may be duct mounted as shown above or space mounted.
2. Option shown for automatic raising of minimum OFCT when ONCT < 15.C. (To minimise cold draught effect at lower outside air temperatures).

SENSIBLE DX COOLING OPTION FOR MACRO MAC/D3

Features:

1. Space temperature control via cascade HTG and DX cooling.
2. OFCT low-limit action with S.P change option via ONCT level.
3. Damper position over-ride for fire and smoke vent. actions.
4. Two position damper control for 100% fresh air (heating mode) and 95% re-circulation (cooling mode).
5. Heating valve 0% position interlock with damper control.
6. Damper Re-circulation position interlock with DX unit control.
7. Chiller fault interlock and alarm.

Standard components:

Damper actuators:		Samson 5801-4/24v 50Hz/limit switches
	or	Belimo SM240+S1-1
		(Both typical examples only)
Damper drive ralay:		Trend VSRM
DX enable relay:		Trend VSRM

Notes:

1. Damper actuators listed are typical only, exact requirements will depend on the dampers fitted.
2. Damper actuators to be provided with auxiliary limit switches for interlocking with DX enable signal. (Wire in series).
3. Heater battery control valve actuator to be provided with auxiliary limit switch for 0% position interlock.

SENSIBLE DX COOLING OPTION FOR MACRO MAC/D3

Description:

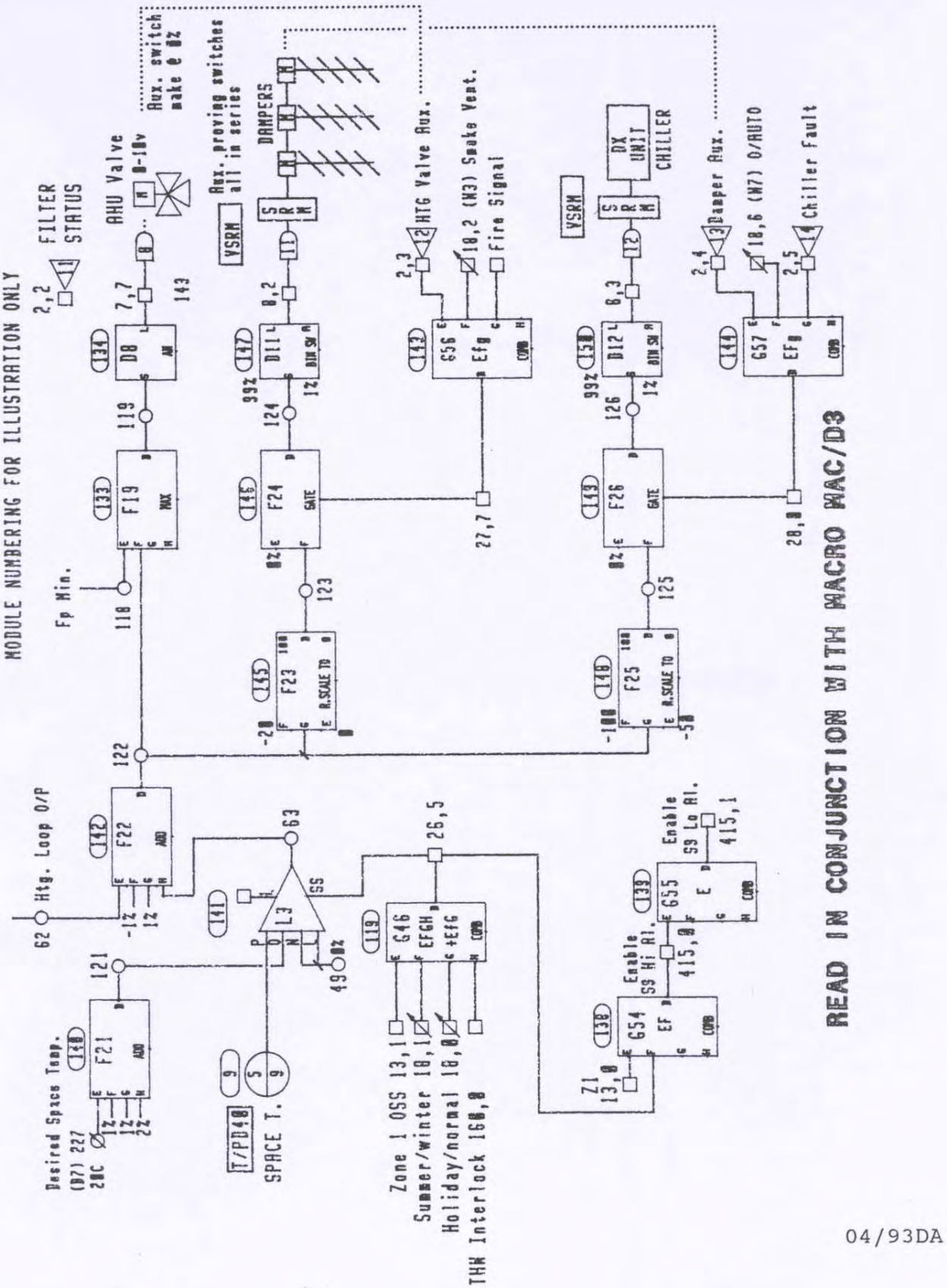
The strategy is designed to provide sensible cooling of the space temperature with air dampers in their 95% re-circulation position. At all other times, except for the damper transitional period, 100% fresh-air is utilised by the system.
Note, the heating coil is positioned up-stream of the cooling to provide frost protection, although under normal circumstances this function should not be required.
The following modules have been duplicated from MACRO MAC/D3 to provide a more complete picture of the cooling strategy:-
G46, G54, G55, F19 & D8.
The output demands from loop(L2)HTG and loop(L3)CLG are integrated by the add module(F22) to provide a range of +100%(Full HTG) to -100%(Full CLG) for use by the final output devices.
Function(F22) output is used directly by the heating-valve driver(D8) via (F19), with no re-scale, due to the unity constants of (F22). Module(F19) provides anti-freeze protection, see MACRO MAC/D3 for full details.
Function(F23) re-scales the (F22) output from an input range of 0% to -20% for control of the damper driver(D11) via function module(F24). Driver(D11) is set as a binary switch type to control the associated SRM providing the required 2-position control of the damper actuators. Gate(F24) will over-ride the (F23) output and force the dampers into the 100% fresh-air position should the logic at module(G56) dictate by:-

a Htg. valve not being sensed in a 0% position by the auxiliary switch input at (DI12).
b Smoke-vent switch(W3) being engaged.
c Fire signal present.

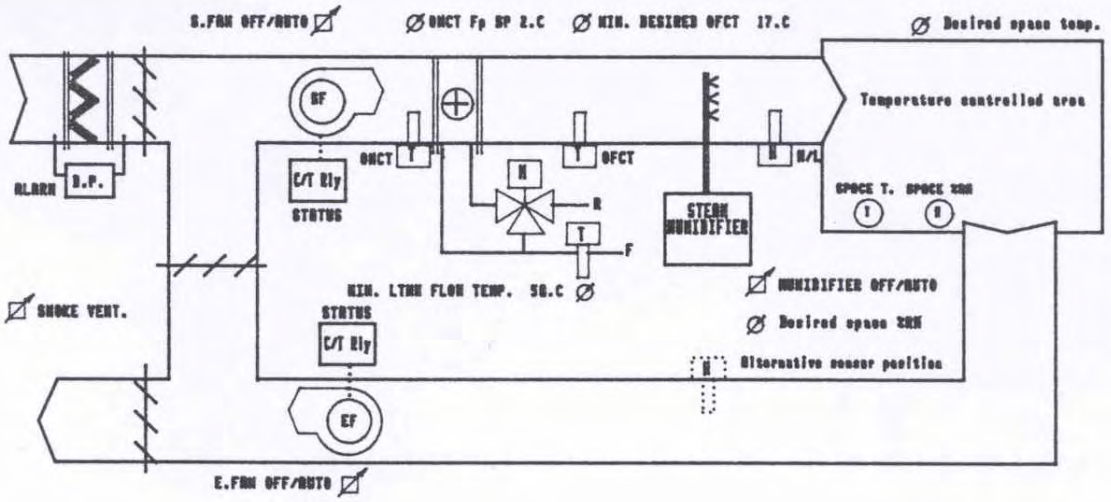
Function(F25) re-scales the (F22) output from an input range of -20% to -100% for control of the DX cooling unit driver(D12) via function module(F26). Driver(D12) is set as a binary switch type to control the associated SRM providing the ON/OFF control of the DX unit. On larger systems driver(D12) may be set as an analogue driver to master an associated CRM to provide multi-step DX unit control. Gate(F26) will over-ride the (F25) output to halt DX cooling should the logic at module(G57) dictate by:-

a Dampers not being sensed in their re-circulation position by the auxiliary switch input at (DI13).
b OFF/AUTO switch(W7) in OFF mode.
c Chiller fault is present at input(DI14).

SENSIBLE DX COOLING OPTION FOR MACRO MAC/D3



MINIMUM %RH CONTROL OPTION FOR MACRO MAC/D3



Application:

Addition of minimum %RH control via packaged steam humidifier to basic AHU MACRO MAC/D3. (NO DEHUM.)

Typical operating parameters:

LTHW supply:	82.C
LTHW min.temp interlock:	50.C
Discharge temperature(OFCT):	15.C - 35.C
OFCT sensor alarms:	40.C High; 13.C Low:
Min. valve position @ 2.C (ONCT):	5%
Min.OFCT limit:	15.C
Desired space temperature:	20.C
Space sensor alarms:	26.C High; 17.C Low:
Min. %RH set-point:	55%
Space %RH alarms:	65% High; 50% Low:
Supply %RH alarms:	75% High; 40% Low:

Notes:

1. Basic system usually fitted to fixed %Fresh-air make up systems with non-motorised dampers.
2. See MACRO MAC/D7 for full %RH control with de-hum.

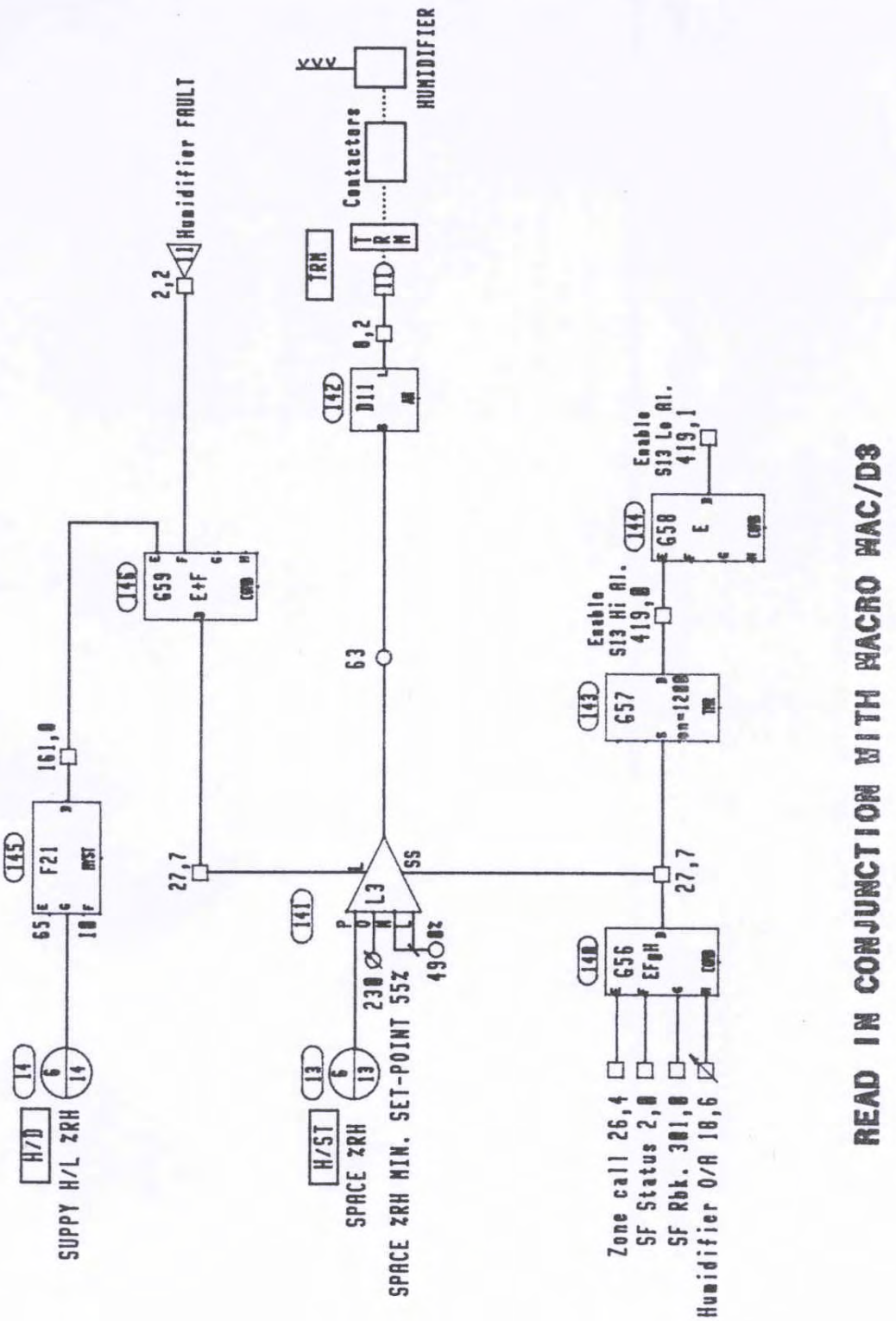
MINIMUM %RH CONTROL OPTION FOR MACRO MAC/D3

Description:

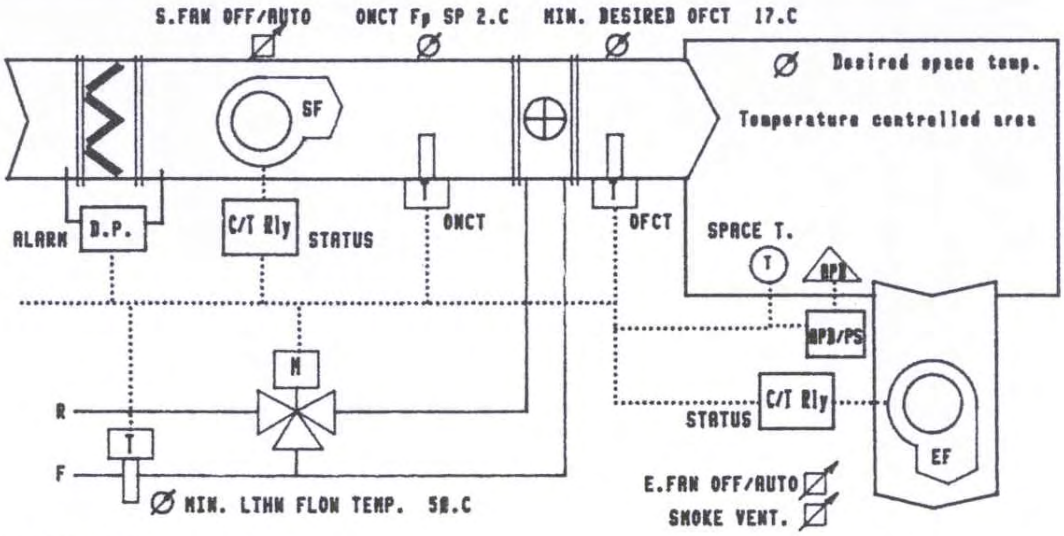
The strategy is designed to maintain a minimum %RH set-point within the controlled space on systems with a fixed percentage air re-circulation.
Logic module(G56) places loop(L3) into OCC mode for humidifier control only when the following criteria are met:-
1. There is a zone demand from bit(26,4) of MACRO MAC/D3.
2. The supply fan is operating(bit 2,0).
3. The supply fan has no driver read-back alarm present(301,0).
4. The soft switch(W7) 18,6 is in the 'AUTO' mode.
With loop(L3) in OCC the space sensor(S13) will control the analogue output driver(D11) under P+I action. Driver(D11) then dictates the required load steps via the cascade output relay which may be HLM TRM CRM depending on humidifier specification.
Logic module(G56) output also enables the high and low alarm bits associated with the space sensor(S13).
At all times the high-limit %RH sensor(S14), in the supply air duct, monitors discharge conditions and will halt humidifier operation on reaching the 75%RH set-point. This is achieved by hysteresis module(F21) forcing loop(L3) into manual mode which is pre-set to 0. The 10%RH hysteresis band on(F21) also provides a suitable humidifier re-start delay after high-limit action.
The direct digital input(I11), for humidifier fault condition, takes the same action as the high-limit. The two signals are integrated by logic module(G59) for forcing loop(L3) into manual mode. Sensor(S14) high and low alarm bits are permanently enabled.
The control function will maintain a minimum %RH level within the space as dictated by soft knob(B10) 230 normally set as 55%RH.
No de-humidification is possible with this plant set-up and for more sophistication MACRO MAC/D7 should be used.

SOUTHAMPTON UNIVERSITY BMS	Applications MACRO
	MAC/D5

MINIMUM %RH CONTROL OPTION FOR MACRO MAC/D3



AHU SPACE SET-POINT CONTROL (Cascade) WITH APD OPTION



Application:

Control of space temperature, where occupation during OTP is intermittent, from AHU with 100% fresh-air.

Typical operating parameters:

LTHW supply:	82.C
LTHW min.temp interlock:	50.C
Discharge temperature(OFCT):	17.C - 35.C
OFCT sensor alarms:	40.C High; 15.C Low:
Min. valve position @ 2.C (ONCT):	8%
Min.OFCT limit:	17.C
Desired space temperature:	20.C - 22.C (APD active)
	17.C - 19.C (APD quiescent)
Space sensor alarms:	25.C High; 15.C Low:

Notes:

1. Derived from basic MACRO MAC/D3

AHU SPACE SET-POINT CONTROL (cascade) WITH APD OPTION

Features:

1. Space temperature control via cascade of OFCT.
2. OFCT low-limit action.
3. Sensor alarm blocking.
4. Summer/winter and Holiday/normal interlocked.
5. Control for associated supply fan and con.temp. pump call.
6. Supply and extract fan status monitoring.
7. LTHW low flow temperature interlocked.
8. AUH filter alarm status.
9. Standard 2-stage frost protection action.
10. Fire signal interlock to halt fan operation.
11. Extract fan smoke vent. interlock.
12. Space set-point switching via APD unit.
13. Auto plant operation during NOC via APD unit.
14. Time delay for APD signal and minimum run time on activation.

Standard components:

ONCT sensor:	Trend T/PD40
OFCT sensor:	Trend T/PD40
Space or return air sensor:	Trend T320 or T/PD40
Con.T flow sensor:	Trend T314/110
S.& E.Fan enable relays:	Trend VSRMs
S.& E.Fan status relays:	Direct-drive R.S. C/T Relay 349-800 R.S. C/T 351-099 or 356-106 Belt-drive R.S. Shaft rotation relay 347-696 R.S. M18NPN Proxistor 256-332
Filter status:	Honeywell S830A hand-reset d.p. sw.
Control valve (typical):	Samson 3260/5821 (0-10v positioning)
APD:	Allen-Martin ADP/S/PS or TREND OCC/UP

Notes:

1. Select appropriate fan status components, depending on type used.
2. Samson control valve/actuator listed is typical only, the exact size and type would be found in the specification, but the actuator would be of the 0-10v positioning type.
3. LTHW flow sensor indicated would be common to all AHUs fed from the associated constant-temperature pump set.
4. Details of 2-stage frost protection would be as MACRO MAC/E2.
5. Con.T pump set would be generally as MACRO MAC/F1.
6. Space temperature must be sensed within the space for APD application due to set-point switching if extract system is held off during OCC quiescent periods.

AHU SPACE SET-POINT CONTROL (Cascade) WITH APD OPTION

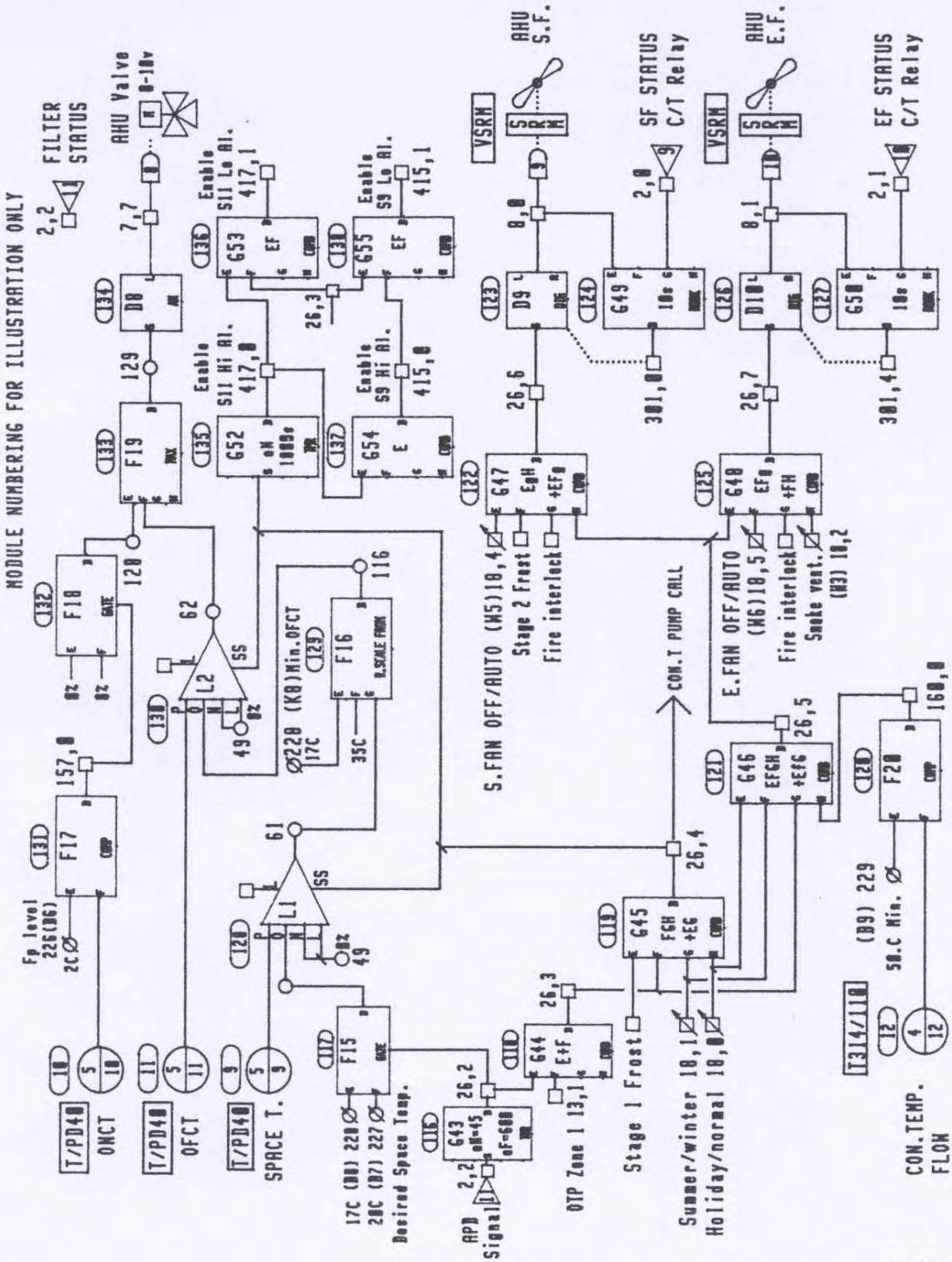
Description:

Heating is provided when logic modules(G45 & G46) receive an OSS zone or APD demand from logic modules(G43 & G44) with master switches(W1 & W2) set 'normal' and 'summer' respectively.
Module(G45) places control loops(L1 & L2) into OCC mode, calls for pump operation and enables the alarm bits for sensors(S9 & S11) via the delay timer(G52). Note that the input bit 26,3 is imposed on modules(G53 & G55) to block low alarm enables during operation under frost protection.
Module(G46) provides the call for fan operation and during 'winter' mode must have an input present from function module(F20) which ensures that a sensible flow temperature is available.
The space set-point level switching is controlled directly from the APD input at (DI11) through on/off timer module(G43). The 45sec on delay filters short term activation whilst the 600sec off delay provides a minimum run time to prevent short term cycling of the plant.
During OSS zone demands only (no APD signal present) space set-point on knob(B8) is obeyed, keeping the system at a minimum level to allow rapid warm-up when called to operate as normal.
On the APD becoming active,by sensing occupation of the space, the space set-point is elevated to normal level as set on knob(B7).
During APD operation the space temperature on sensor(S9) is compared to knob(B7) and the P+I action of loop(L1) will output a 0-100% corrective signal. This signal is then re-scaled by function module(F16) for use as the OFCT set-point on loop(L2) to give a maximum of 35.C and a minimum as set on knob(B8), usually 17.C. Note this minimum level for OFCT ensures that no 'cold draught' is perceived within the space when at or near the space set-point. The OFCT on sensor (S11) is compared to the requirement dictated by the output of function module(F16) and the P+I action of loop(L2) will output to the control valve via function module(F19). ONCT sensor(S10) and the associated modules(F17-F19) provide heater-battery freeze protection by imposing a minimum of 8% on the control valve when ONCT <2.C, or as set on knob(B6).
Supply fan operation is dictated by logic module(G47) which will allow driver(D9) to engage only when master module(G46) requests or stage-2 frost protection is called. Both cases require no fire fire signal to be present and switch(W5) to be in "auto" mode.
Extract fan operation is dictated by logic module(G48) which will allow driver(D10) to engage only when master module(G46) requests or the fire smoke-vent switch(W3) is activated. Both cases require the switch(W6) to be in 'auto' mode, but the fire signal will block operation only during normal requests from module(G48).
During operation both supply and extract fans are monitored by their digital status inputs(DI9 & DI10) and associated read-back modules(G49 & G50).
The supply filter is permanently monitored by a differential-pressure switch which will generate an alarm on activation via digital input(DI11). No control action is required.

SOUTHAMPTON UNIVERSITY BMS	Applications MACRO

MAC/D6

AHU SPACE SET-POINT CONTROL (Cascade) WITH APD OPTION



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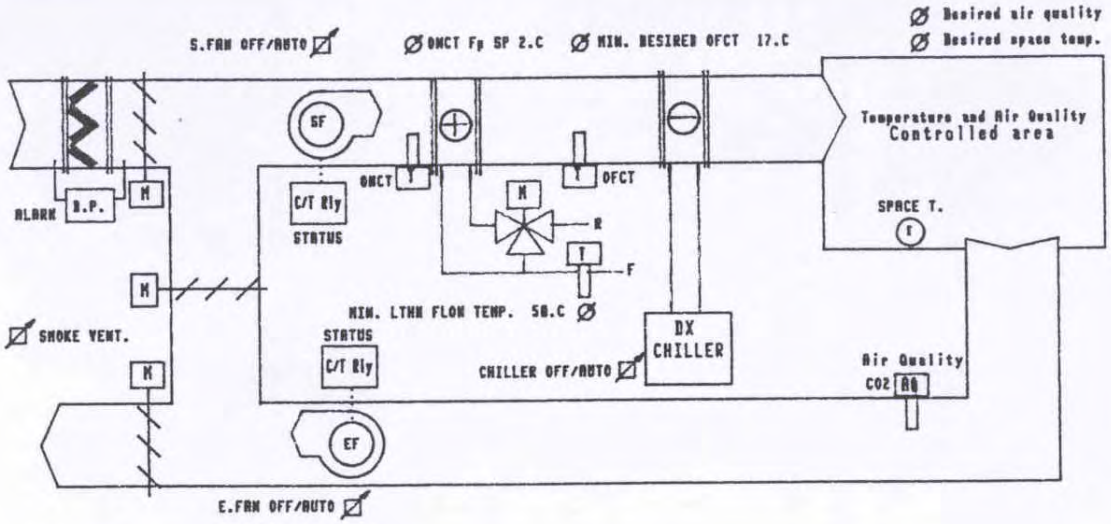
AIR QUALITY(CO2) CONTROL OPTION FOR MACROs MAC/D3/D4/D6



Application:

All ventilation systems where re-circulation is practical.

Typical operating parameters:

LTHW supply:	82.C
LTHW min.temp interlock:	50.C
Discharge temperature(OFCT):	15.C - 35.C
OFCT sensor alarms:	40.C High; 13.C Low:
Min. valve position @ 2.C (ONCT):	5%
Min.OFCT limit:	15.C
Desired space temperature:	20.C - 22.C
Space sensor alarms:	26.C High; 17.C Low:
Fixed htg/clg dead-band:	2.C
Damper range:	0-100% re-circulation. or Specified Min.- 100%
Air quality(CO2) S.P.	0.4% (CO2)

(Max. allowable concentration for 8hr period =0.5%) CIBSE.

Notes:

1. DX unit may be duct mounted as shown above or space mounted.
2. Option shown for automatic raising of minimum OFCT when ONCT < 15.C. (To minimise cold draught effect at lower outside air temperatures).
3. Read in conjunction with MACROs MAC/D3/D4/D6

AIR QUALITY(CO2) CONTROL OPTION FOR MACROs MAC/D3/D4/D6

Features:

1. Damper position over-ride for fire and smoke vent. actions.
2. Summer mode 100% fresh-air over-ride for systems without DX cooling.
3. Heating valve 0% position interlock with DX unit control.
4. Damper Re-circulation position interlock with DX unit control.
5. Chiller fault interlock and alarm.

Standard components:

Damper actuators:		Satchwell ARES7301 or ARE1301/1302
	or	Belimo SM24SR+S1-1
		(Both typical examples only)
Air quality sensor:		Trend AQ/D
DX enable relay:		Trend VSRM

Notes:

1. Damper actuators listed are typical only, exact requirements will depend on the dampers fitted.
2. Damper actuators to be provided with auxiliary limit switches for interlocking with DX enable signal. (Wire in series).
3. Heater battery control valve actuator to be provided with auxiliary limit switch for 0% position interlock.

AIR QUALITY(CO2) CONTROL OPTION FOR MACROs MAC/D3/D4/D6

Description:

The second configuration sheet whilst essentially identical to the first, for use where no cooling plant is installed, adds the provision to hold modulating re-circulation under loop(L4) CO2 control until the space temperature is greater than the OAT. This is achieved by function module(F28) comparing the two temperatures and, via logic module(G61) which ensures that soft switch(W2) is in the summer mode, forces loop(L4) into its manual mode. Manual mode is pre-set for 100% to drive dampers to their 100% fresh-air positions.

The third configuration sheet is for use where cooling plant is installed. Note loop(L4) has no manual mode initiation and NOC and M are both tied to 0% by analogue 49 for convention. Digital input(DI13) is derived from the damper(s) auxiliary contacts which are set to inhibit cooling operation when the fresh-air requirement, by the CO2 modulation, is greater than 50% when cooling becomes impractical and un-economic.
See MACRO MAC/D4 for DX unit interlocking.

Notes:

AIR QUALITY(CO2) CONTROL OPTION FOR MACROs MAC/D3/D4/D6

Description:

Basic requirements:

Winter mode	System OFF	Dampers in FIRE mode as below.
	System ON	Dampers Modulate
Summer mode	System OFF	Dampers in FIRE mode as below.
	System ON	Dampers 100% Fresh-air (No CLG.)
		Dampers Modulate (CLG. fitted)
FIRE MODE		Supply & Re-circ. dampers CLOSED
		Extract damper OPEN
Smoke Vent. mode		Supply & Re-circ. dampers CLOSED
		Extract damper OPEN
		Extract fan run

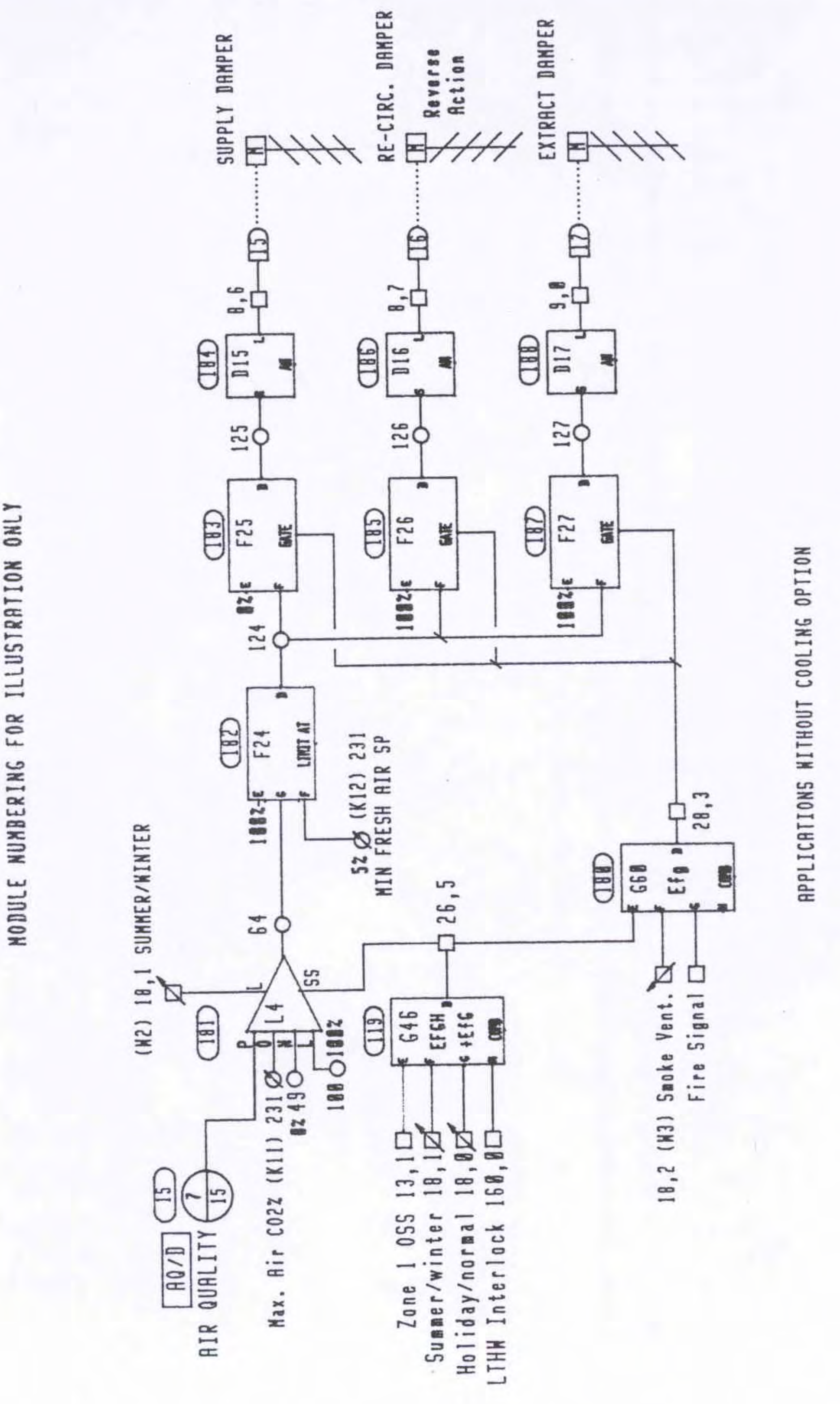
During all unoccupied periods, as dictated by logic module(G60), function modules(F25-F27) hold the damper drivers(D15-D17) in fixed positions. Supply-CLOSED;Re-circ.-CLOSED and Extract-OPEN. Fire and Smoke Vent. command signals require the same damper action as the unoccupied condition and therefore they act directly on logic module(G60) as inputs 'F' and 'G'.
When the system is called to operate in summer mode, if no cooling is fitted, the dampers will assume their 100% fresh-air positions. If cooling is fitted, then the dampers will modulate at the dictates of loop(L4) output to maintain the air-quality OCC set-point.
Modulation is achieved by comparing the air-quality sensor(S15) value with the desired set-point on knob(K11,231), any error is then calculated by the 'P' only action of loop(L4) and output to the drivers(D15-D17) via the function modules(F24-F27).
Module (F24) makes a provision for a minimum fresh-air position to be imposed by knob(K12). Modules(F25-F27) provide the signal switching to change from normal OCC control to NOC/SAFETY fixed positions.
Note. If cooling option is not fitted summer/winter switch(W2) is assigned to the loop(L4) manual selection bit to provide 100% Fresh-air damper positions during OCC periods.
Loop input NOC set as analogue 49 pre-set for 0%.
Loop input Manual Level set as analogue 100 pre-set for 100%.

If cooling option is fitted, Manual Level switching by the summer/winter switch is not required and both NOC and Manual Level inputs are assigned to analogue 49, pre-set for 0%.

NOC values are fixed for convention, they play no active part in the sequence due to the action of the function gates(F25-F27).

Under normal modulating conditions the re-circulation air damper must work inversely to the supply and extract dampers, this is achieved via its physical actuator linkage. Note the override CLOSE signal from function gate(F26) is 100% (INVERSE).

AIR QUALITY(CO2) CONTROL OPTION FOR MACROs MAC/D3/D4/D6



READ IN CONJUNCTION WITH MACROs MAC/D3/D4/D6