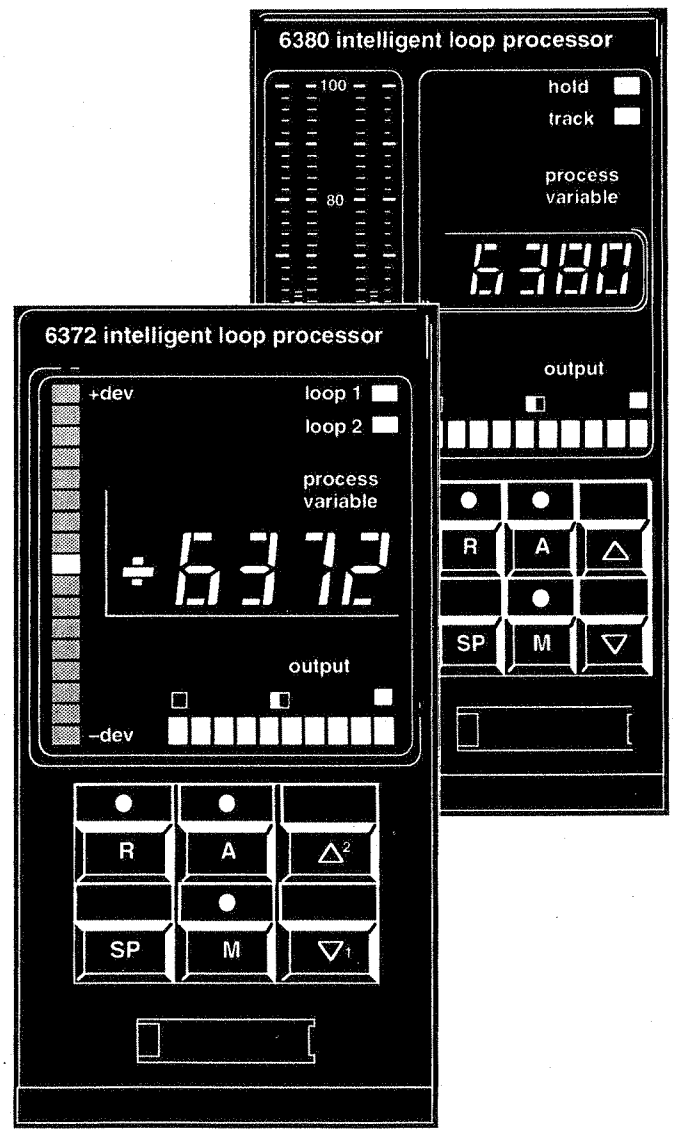
6000

NETWORK

EUROTHERM
PROCESS
AUTOMATION



6370/2
6380/2
Intelligent loop processor

Product specification

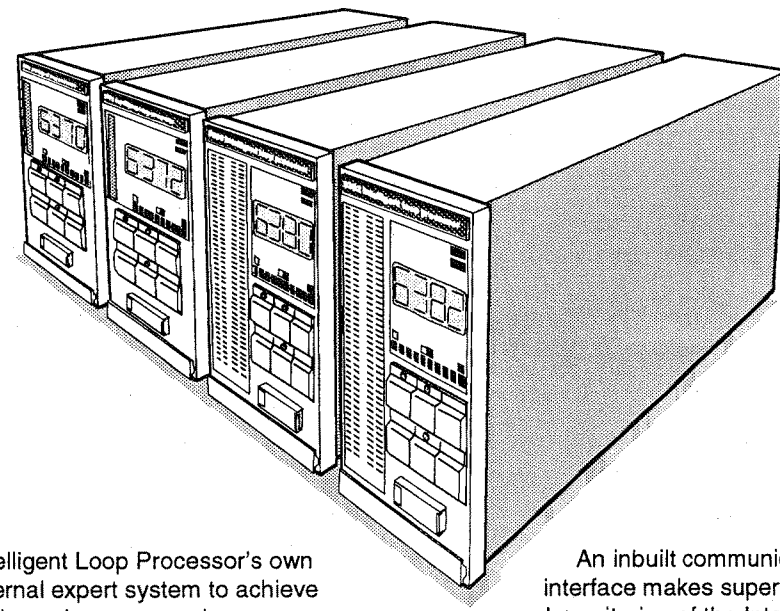
Intelligent Loop Processor: Features

* **Four units to handle all aspects of single and dual loop control strategies**
* **Choice of dual bargraph or deviation bargraph front panel displays**
* **Straightforward and friendly implementation at every level of capability**
* **Automatic setup of conventional loops or full block structuring for flexibility**
* **Compatible with the full range of Eurotherm Process Automation System 6000 Intelligent Instruments & Control Systems**
* **New single-board structure giving easier maintenance and higher reliability**
* **Expert block linking & scheduling procedures**
* **Comprehensive built-in diagnostics**
* **Remote monitoring and supervision via a simple serial link**
* **Field-proven concepts with a two-year hardware warranty**
* **Configurable via Hand-Held Terminal or by using the Eurotherm Process Automation IBM PC compatible driver**
* **Uses LoopDraw for Configuration Design**

Description

The 6370/80 family of single-board microprocessor based **Intelligent Loop Processors** incorporates the many years of experience gained by Eurotherm Process Automation in the implementation of advanced process control instrumentation.

The instruments exploit the very latest state-of-the-art technology, offering an unbeatable selection of process control facilities. On/off, 3-term PID, ratio, cascade, feedforward, lead-lag, and a broad range of control functions are easily configured using an 8263 LCD 32-character Hand-Held Terminal, or via the Eurotherm Process Automation IBM PC compatible driver.



You can set up control strategies for standard applications *automatically*, simply by calling a type number. Alternatively, highly complex strategies can be realized through an easy-to-follow *block structure*. Connections are made and then scheduled by the Intelligent Loop Processor's own internal expert system to achieve optimum loop processing.

LoopDraw from Eurotherm Process Automation offers the ultimate in CAD based configuration.

An inbuilt communications interface makes supervision and monitoring of the Intelligent Loop Processors particularly easy. The interface allows an intelligent device to monitor and/or update any of the parameters in a network of System 6000 instruments. This is done via an RS422 serial bus using a standard ANSI protocol.

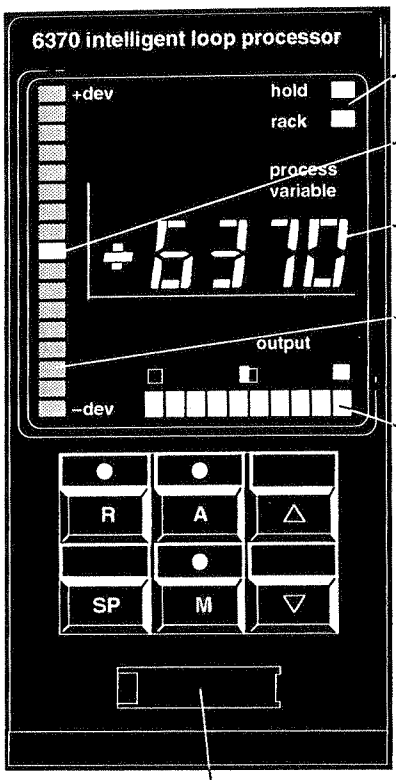
Solid state single-board technology at the heart of the 6370/80 family gives you high reliability levels, while self-diagnostic procedures built into each instrument further enhance integrity and simplify fault-finding.

The numbers and availability of block and function types that you can use to develop your control strategies are shown in the table, for each member of the 6370/80 family of Intelligent Loop Processors.

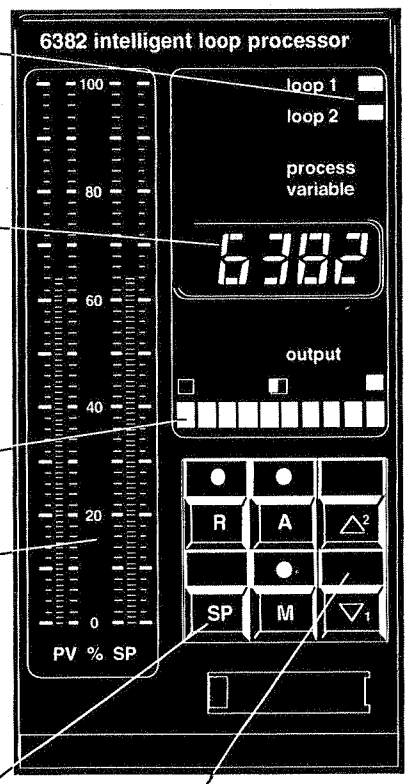
BLOCK or FUNCTION	6370/80	6372/82
ANALOGUE INPUT	4	8
ANALOGUE OUTPUT	4	4
DIGITAL INPUT (8-CHANNEL)	1	1
DIGITAL OUTPUT (8-CHANNEL)	1	1
CONTROL	1	2
MANUAL STATION	1	2
DEADTIME	-	2
LEAD/LAG	-	2
TOTALISATION	-	2
ALARM	1	2
CHARACTERISER	-	2
COMMS/PSEUDO I/O	-	18
DISPLAY	-	1
GENERAL PURPOSE	1	1
ASSIGNED	12	70
LIBRARY FUNCTIONS	12	50
STORED PROGRAMS	2	2
TIME SCHEDULED USER TASKS (LOOPS)	1	2
BACKGROUND USER TASKS	-	1

Operator Displays & Controls

6370/2



6380/2



Loop Select / Loop Mode Indicators
6372 & 6382: Two yellow LEDs indicating PID loops 1, 2, or Display Mode (both lit). 6370/80: LEDs show hold or track mode only.

Power-on & Zero Error Indication
Green LED in centre of deviation bargraph.

Digital Readout
4-digit orange LED display (PV, SP or OP) with sign and decimal point. Assignable to any variables in Display Mode.

Deviation Bargraphs
Two red 8-segment LED bargraphs for +ve and –ve error in 1% steps. Assignable to any variables in Display Mode.

Horizontal Output Display
Yellow 10-segment LED bargraph indicating 0 - 100% of the output. Assignable to any variables in Display Mode.

Vertical Bargraph
Two 101-segment bargraphs for PV and SP. Assignable to any variables in Display Mode.

Power-on Indication
Lowest segment of both bargraphs lit.

Alarm Indication
High or low alarms may be set to flash the bargraphs and/or set digital outputs.

Setpoint Display Selection
One non-illuminated pushbutton (**SP**) causes the digital readout to display the current setpoint while pressed.

Control Mode Selection
Three illuminated pushbuttons: Manual (**M**) with integral yellow LED. Local Auto (**A**) with integral green LED. Remote Auto or Ratio (**R**) with integral green LED. Press any one to display OP on Digital Readout

Hand-Held Terminal Socket
Accepts the 8263 Hand-Held Terminal, or computer/VDU terminal, for RS232 configuration of the instruments. Alternatively, the rear-panel RS422 data link can be used with a supervisory computer.

NOTE. Pushbuttons may be used as digital inputs to a control strategy to trigger other events.

Function Select
Two non-illuminated pushbuttons: Raise (Δ^2) *either* selects PID loop 2 if operated alone, *or* increments the output with (**M**) pressed, *or* increments the setpoint with (**SP**) pressed. Lower (∇_1) either selects PID loop 1 or *decrements* the output or setpoint as above. Press *both* to access Display Mode.

Communications

Every System 6000 microprocessor-based instrument is fitted with an RS232 port and an RS422 port for serial data communications. The RS232 port is accessed via a front-panel socket and is used for the 8263 Hand-held Programming Terminal. The RS422 port is available on the module rear connector pins and is bussed onto the supervisory data link common to all modules. All parameters that can be monitored via the 8263 terminal can also be accessed and updated via the supervisory data link.

Programming Terminals

With the 8275 Instrument Database Configurator, based on an IBM PC, you can create applications programs off-line, then document and store them on disk using a word-processing package. They may then be block down-loaded to the Intelligent Loop Processor. Existing configurations in the Intelligent Loop Processor can be uploaded into data files for backup purposes or they can be edited and the modified configuration downloaded.

The latest in CAD-based control design is now available from Eurotherm Process Automation in the form of LoopDraw. This powerful package lets you *graphically* design your control strategy on-screen, then document it and download it into an Intelligent Loop Processor. LoopDraw requires an IBM PC or compatible with EGA colour display and preferably a PC Systems mouse or compatible.

Datalink Specification

Transmission Standard Character Length

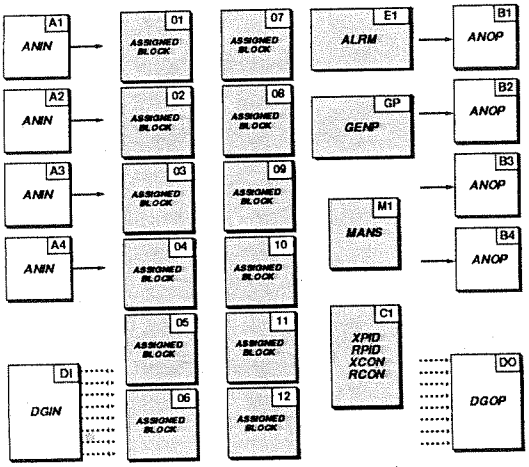
As for Hand-Held Terminal.

Data Rate

Selectable from 110, 300, 600, 1200, 2400, 3600, 4800, or 9600 baud.

6370 & 6380 Block Structure

The diagrams on this page show the functional blocks installed in the 6370 and 6380 family of Intelligent Loop Processors.



The set of *fixed blocks* in the 6370/80 instruments includes Analogue Input (***ANIN***) blocks, Analogue Output (***ANOP***) blocks, an 8-way Digital Input (***DGIN***) block, an 8-way Digital Output (***DGOP***) block, a Control (***XPID***, ***RPID***, ***XCON***, or ***RCON***) block, a Manual Station (***MANS***) block, and a General Purpose (***GENP***) block.

Fixed blocks have unique addresses, shown in the small boxes at the top right corner of each block. Each fixed block can be used only once in your control strategy.

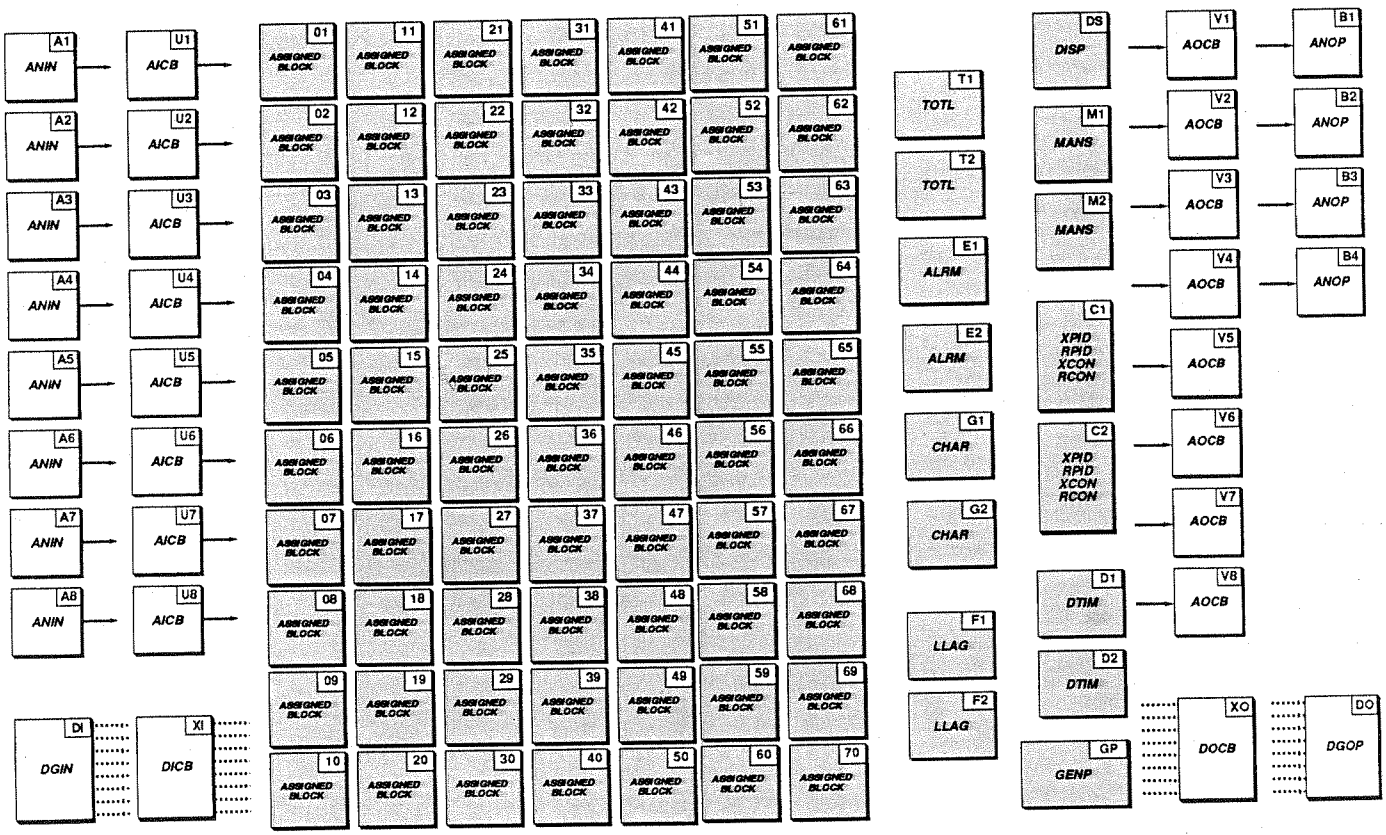
On the other hand, you can give the twelve *assigned blocks* installed in the 6370/80 instruments any function you like, chosen from the library of twelve functions available in this series.

Unlike fixed blocks, a given library function can be used as often as required, up to the maximum of twelve assigned blocks.

Assigned block functions include ADD2, SUBT, MPLY, DIVD, PGNT, AND4, OR4, LTCH, and selector blocks.

Configuring an Intelligent Loop Processor using the 8263 Hand-Held Terminal is easy. First you **install and parameterise** the blocks you will need, using easy-to-remember commands. Then you **interconnect** the blocks, again via straightforward 'intuitive' commands. You can connect up in any order you like, because, when you give the command, the instrument itself uses the logic of your strategy to sort out the **block execution order**, and then runs the program. At this stage you can review the configuration and make any changes you think fit.

6372 & 6382 Block Structure



The larger set of *fixed blocks* in the 6372 and 6382 series of instruments includes Analogue Input (***ANIN***) and Analogue Output (***ANOP***) blocks, an 8-way Digital Input (***DGIN***) block, an 8-way Digital Output (***DGOP***) block, Control (***XPID***, ***RPID***, ***XCON***, or ***RCON***) blocks, Manual Station (***MANS***) blocks, Deadtime (***DTIM***) blocks, Leadlag (***LLAG***) blocks, Totalisation (***TOTL***) blocks, Communications/ Pseudo I/O blocks (***AICB***, ***AOCB***, ***DICB***, and ***DOCB***), a Display (***DISP***) block, and a General Purpose (***GENP***) block.

There are 70 *assigned blocks* in these more powerful instruments, and you can install them with any combination of the up to 50 resident library functions available, or in preparation.

Applications

These simplified examples are for illustration purposes only and are not suitable for direct process plant use. Eurotherm Process Automation cannot accept any responsibility for their safe operation or functionality. For specific applications please refer to Eurotherm Process Automation or your local representative.

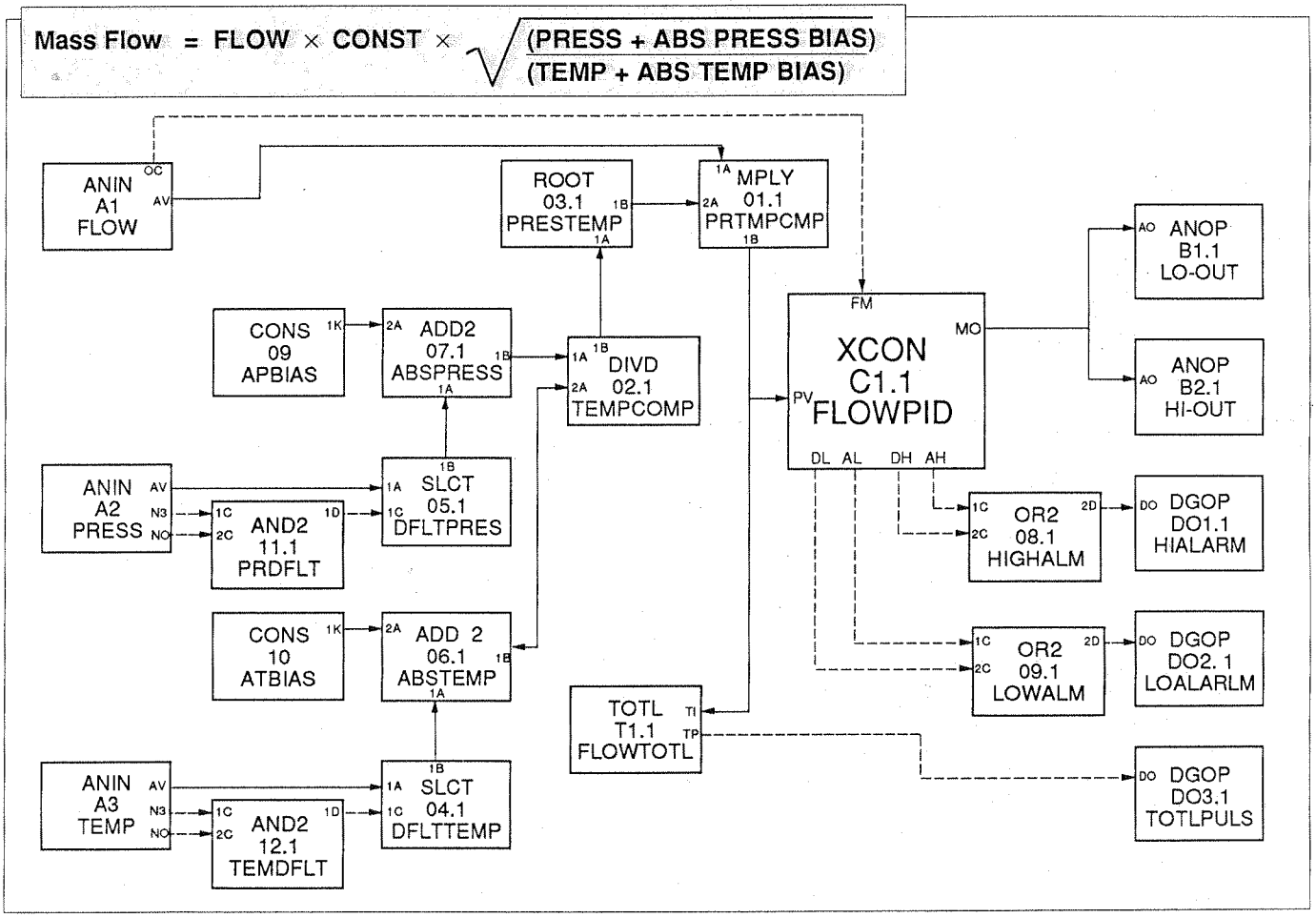
The 6370/80 series of Intelligent Loop Processors can tackle an enormously wide variety of applications from simple monitoring to sequence and sophisticated continuous control. Obviously it would be impossible to give examples of all types, but, as an indication of capability, here is a list of typical applications. Three are expanded to give a better insight into the structure of the Intelligent Loop Processor's facilities. The majority of the applications are run in the 6372/82 unit, although the 6370/80 units can handle many aspects of the examples put forward.

- **Reaction Vessel Control**
- **Wellhead Choke Valve Control**
- **Boiler Drum Level Control**
- **Headbox Pressure & Level Control**
- **Fluid Bed Drier Control**
- **Gain Scheduling**
- **pH Control**
- **Deadtime Control (Smith Predictor)**
- **Furnace/Kiln Profiling**
- **Forehearth Temperature Control**
- **Procedural/Sequence Control**
- **Distillation Control**
- **Mass Flow Control/Totalisation**
- **Lead/Lag Combustion Control**

Example 1

Gas Mass Flow Control & Totalisation

$$\text{Mass Flow} = \text{FLOW} \times \text{CONST} \times \sqrt{\frac{\text{(PRESS + ABS PRESS BIAS)}}{\text{(TEMP + ABS TEMP BIAS)}}}$$



The pressure and temperature compensation signals are fed in and referred to absolute terms. The resultant compensation is applied to the raw flow signal which is then used as the control function PV. If either the temperature or pressure signals go 'open circuit' default signals are automatically selected. If the flow signal goes 'open circuit' the controller enters 'forced manual' mode to give fail-safe operation.

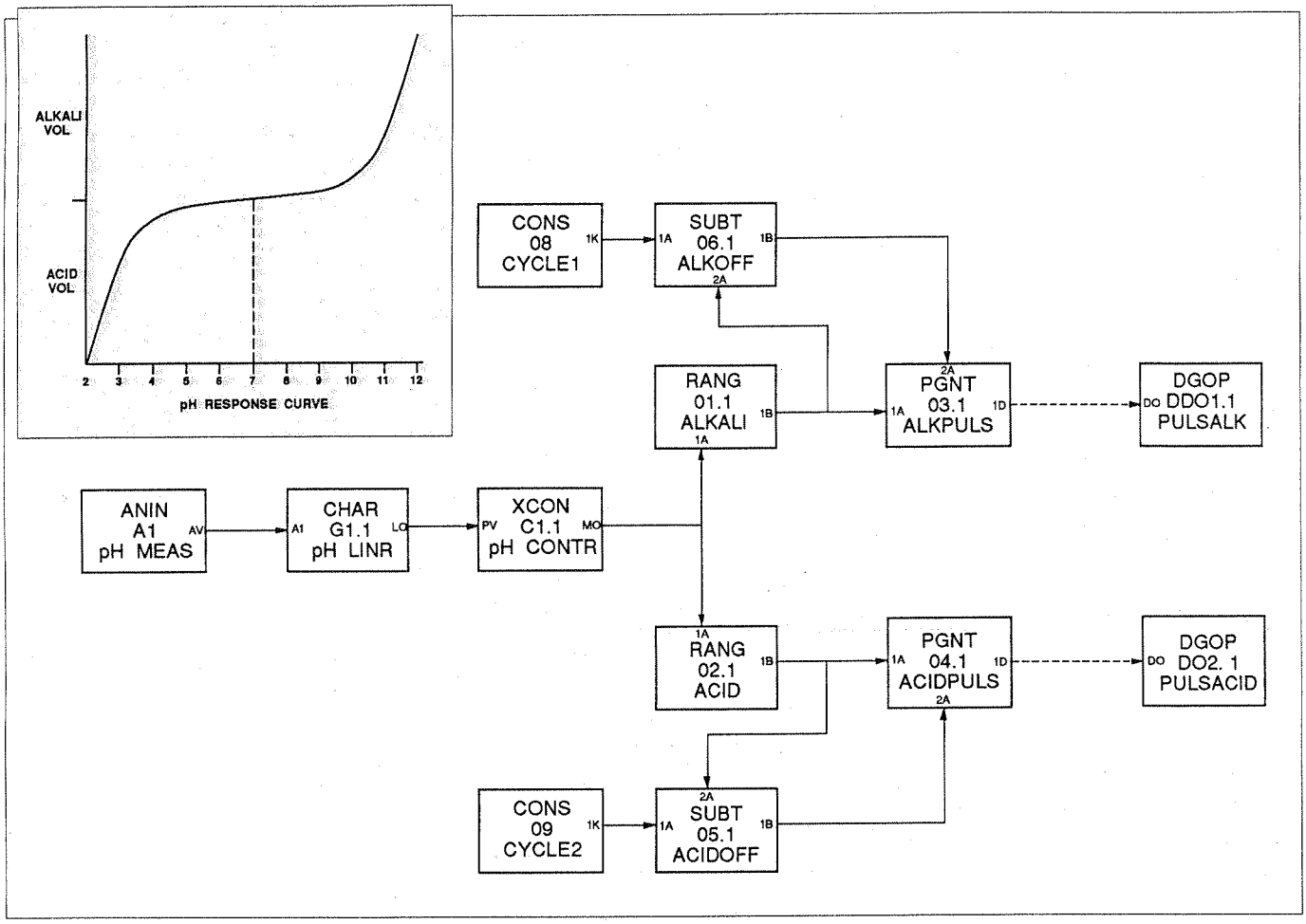
The controller output is fed to two analogue outputs. Here, ranged with suitable engineering units (e.g. 0 to 55 for output 1, and 50 to 100 for output 2), it provides split-range mode for the valves. This gives good control rangeability plus the option to configure crossover, as in the present example or in dead-band valve operation.

For the totalisation the compensated flow signal is fed into the totalisation block. This generates a pulsed digital output with pulse frequency dependent on a scaling factor. The pulsed output can be used to drive an external digital counter via the digital output block.

Applications

Example 2

Characterised pH Control with Modulated Pulse Output Dosing



The pH measurement is fed into a 16-breakpoint Characterisation (CHAR) block to condition the signal. This signal is then fed into the PV of the control block with the manual station output (MO) going to the acid and alkali range (RANG) blocks. These determine the requirement to dose either with acid or alkali to attain the required pH value. The pulse generator (PGNT) blocks operate on the magnitude of these signals to give a fixed cycle pulse duration modulated output, passed on to digital output blocks. These outputs drive the ON/OFF dosing valves, typically through external relays.

Minimum on and off times are configurable within the PGNT blocks to provide a threshold that avoids over-frequent operation of the dosing valves on small output demand changes. These settings also affect the control resolution — but this has to be balanced against dosing valve wear rates.

Applications

Example 3

Lead/Lag Combustion Control with Oxygen Trim

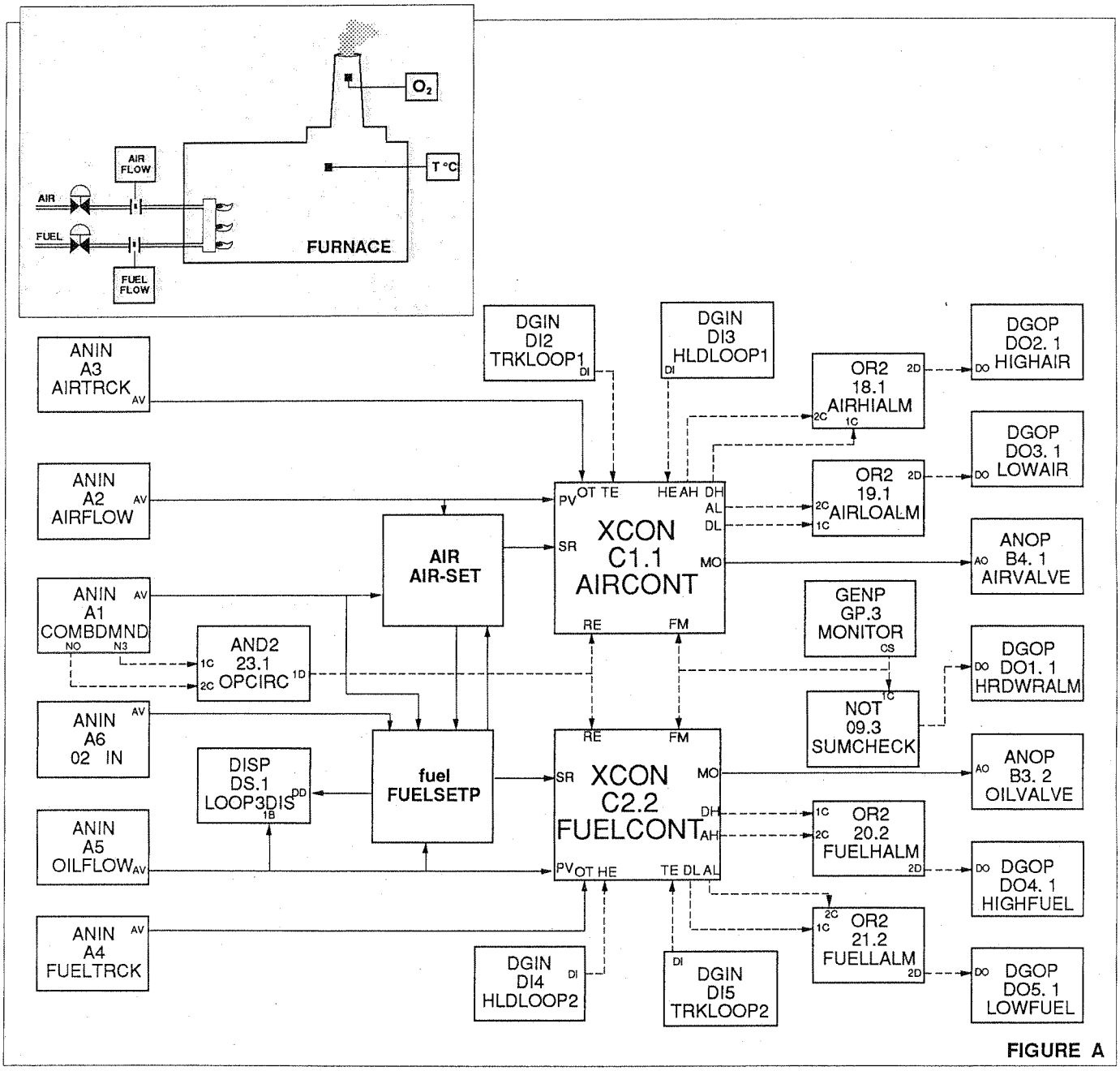


FIGURE A

FIGURE A The scheme illustrated is single fuel with fuel/air cross-limiting and oxygen trim.

This scheme would typically require two PID controllers and a number of computation and relay units. Using a 6372/82 Intelligent Loop Processor, however, the entire scheme can be implemented in a single unit.

The field signals coming into the unit can be characterised and then converted into engineering units.

Loop 1 and 2 displays serve as the operator interfaces. They present fully independent display information with identical functionality, making the equipment easy to use and promoting operator confidence. The display-only mode (or 'Loop 3' display) can provide information of more interest to the Engineer — particularly data associated with ratio settings and other critical information.

The control strategy is designed to offer a high degree of failsafe operation with further facilities readily implemented — for example, action on loss of the oxygen analysis signal. Each control loop, either air or fuel, can be put into a safe mode; in this case *track* is used, though *forced manual* or *hold* are also often adopted. As well as process alarms, software and hardware alarms can be generated very easily.

Applications

Example 3 (continued)

Lead/Lag Combustion Control with Oxygen Trim

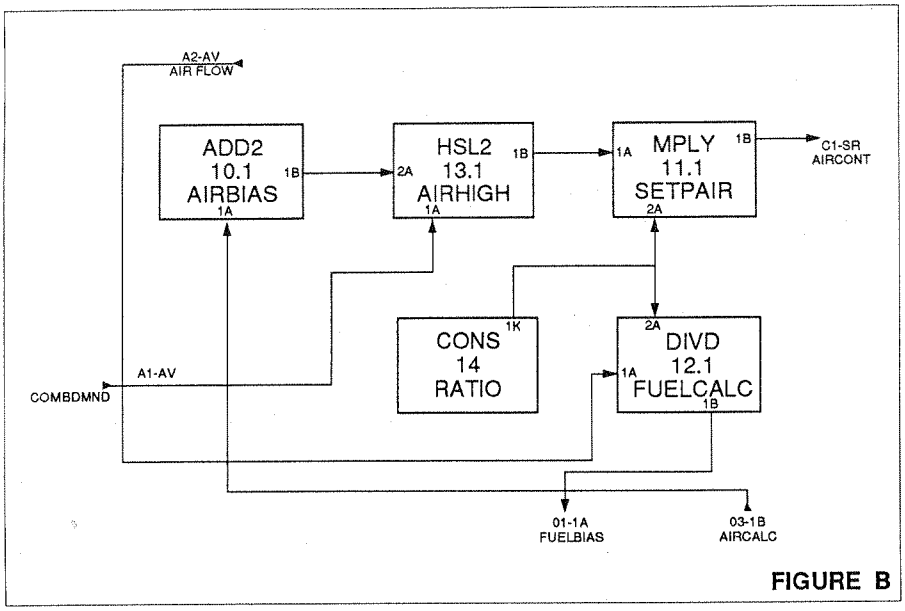


FIGURE B

FIGURE B The air relational control is run in a compound called AIR-SET in which the lead-lag, air bias, and air ratio functions are handled with respect to the combustion demand signal and the fuel rate. AIR-SET also calculates the fuel bias signal used to modify the fuel rate.

FIGURE C The fuel relational control is run in a compound called FUELSETP which handles the lead-lag, fuel bias and ratio functions with respect to the combustion demand signal and the air flow rate. FUELSETP also calculates the oxygen trim as well as the air bias signal, used to modify the air rate.

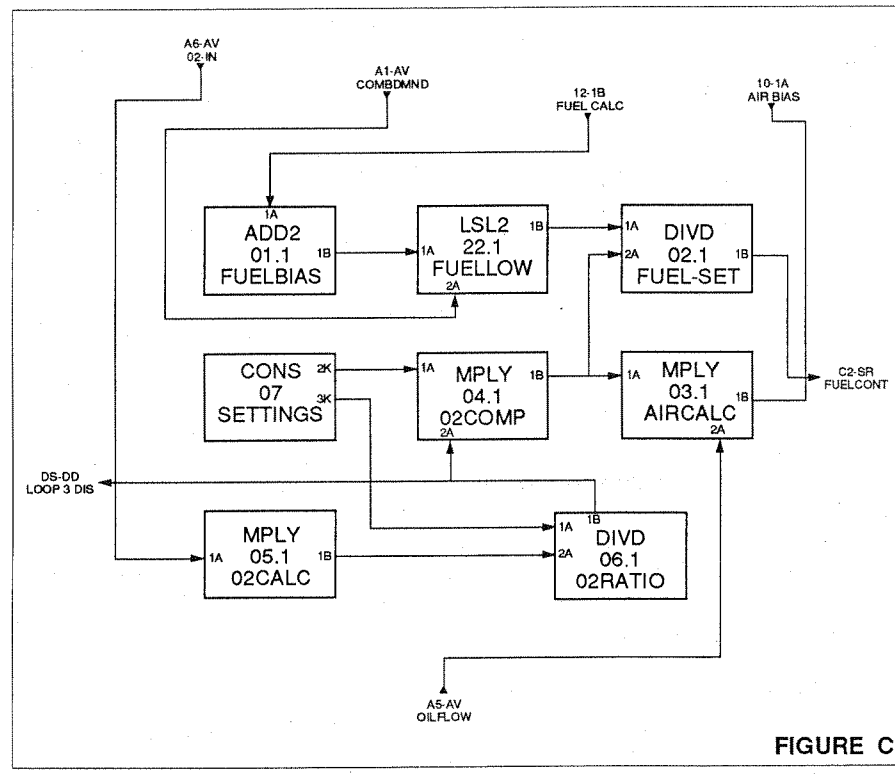


FIGURE C

Fixed Blocks

Analogue Input Blocks
First order digital filter on analogue inputs selectable in the range:
0.04 to 60.0 seconds.
Characterisation, Inversion, and Ranging.

Manual Station Block
Output range:
0 to 99.99% = 0 - 10V, or 4 - 20mA.
Limits — high, low, rate: 0 to 99.99%.
Polarity: inverse output mode (via Analogue Output block, software/ switch selectable).
Raise/lower rate in Manual:
0 - 99.99% in 10s, accelerating action.

Control Blocks
XPID block — basic PID control.
XCON block — as XPID, with built-in Manual Station.
RPID block — basic PID Ratio control.
RCON block — as RPID, with built-in Manual Station.

Range, Limits, Rate Limits —
low to high: –9999 to +9999.
Alarms
Absolute PV —
low to high: –9999 to +9999.
Deviation —
low to high: 0 to +9999.
Built-in hysteresis: 0.5% of SP span.
PID Algorithm Sampling Period:
100ms to 0.6s, set by instrument.
Proportional Band Range: 0 to 999.9%.
Integral & Derivative
Time Constants Ranges:
0.04 to 99.99 seconds
or 0.01 to 99.99 minutes.

General Purpose Block
Loops 1 & 2 repeat times, range:
0.1 to 999.9s

The following fixed blocks apply only to the 6372/82 instruments.

Deadtime Blocks
100ms to 2.7 hours, 80 segments.

Lead/Lag Blocks
Normal lead/lag, or filtered derivative.
Overall gain range: –99.99 to +99.99
Lead & lag time constants range:
0.04 to 99.99 seconds
or 0.01 to 99.99 minutes.

Totalisation Blocks
Range: 0 to 9999.

Display Block
Each of the front panel displays assignable to any analogue variable.

Assigned Blocks

The following is a selection of the assigned blocks presently available from Eurotherm Process Automation. New ones are being introduced on a continuing basis.

Maths Blocks
Scale factor range: 0 to ±9999
Analogue value range: 0 to $\pm 10^{38}$

ADD2 — Addition
SUBT — Subtraction
MPLY — Multiplication
DIVD — Division
AVG2 — Average

SIN — Sine
COS — Cosine
TAN — Tangent

ROOT — Square root
EXP — Exponential
ABS — Absolute value
NEGT — Inverse (negation)
NLOG — Natural logarithm
EXPN — Y^x
INT — Integer
RANG — Range & Limit

Constants Blocks
4 constants, ranges: –9999 to +9999.
CONS — read-only constants
SAMP — conditional read/write cons.

Logic Blocks
AND2, OR2, XOR2, NOT

AND4 — ANDs four inputs
OR4 — ORs four inputs
LTCH — 'Set/reset' or edge-triggered latch

GT — Greater than
LT — Less than
EU — Equal to

Selector Blocks
HSL2 — High Select
LSL2 — Low Select
MSL3 — Median Select

SLCT — Select. Digital input state outputs one of two analogue inputs.

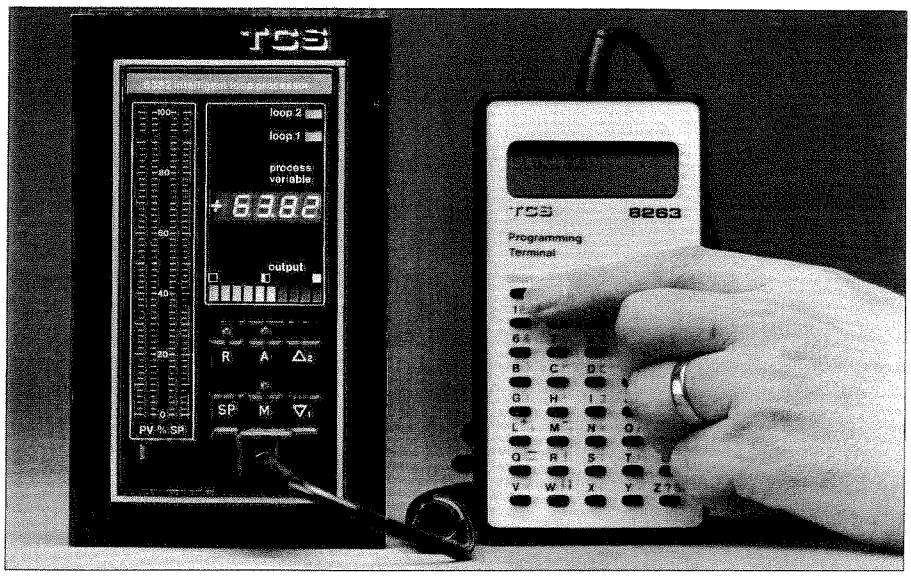
Time Blocks
PGNT — Pulse Generator
TIME — Timer
RATE — Rate Limit
RAMP — Ramp

Count Blocks
PCNT — Pulse Counter

Max/Min Blocks
PEAK — Peak Detect (Max/Min)

Hand-Held Terminal

System 6000 instruments can be set up using a plug-in 8263 Hand-Held Terminal. You access parameters using a simple two-character command mnemonic and enter data directly in engineering units. This technique ensures the accuracy and security of parameter settings.



Specification

Transmission Standard
2-wire RS232/V24 (±12V).

Data Rate
Self-setting to match instrument, from 300, 600, 1200, 2400, 3600, 4800, or 9600 baud.

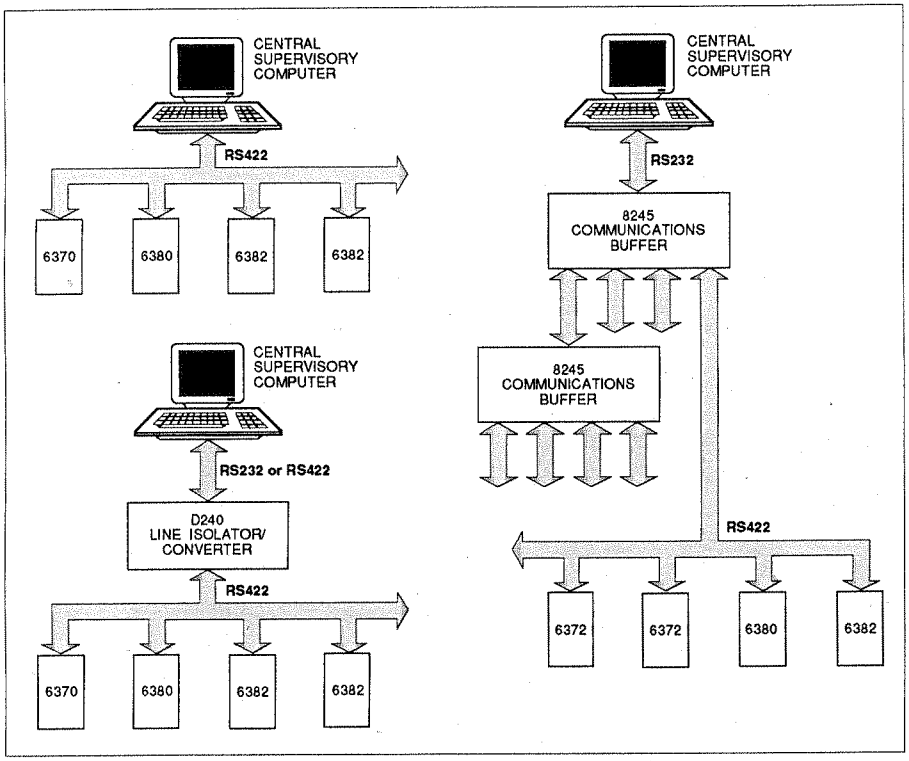
Character Length
10 bits made up of:
1 start + 7 data + 1 parity (even) + 1 stop.

Multi-Drop Supervisory Link

The RS422 communications port built into all System 6000 instruments enables them to send and receive command parameters over a simple four-wire link connected to other intelligent devices.

Using RS422 and transmitting information in ASCII or binary data format makes it particularly easy to communicate with the 6370/80 series of Intelligent Loop Processors. If you want to hook an instrument into a distributed control system, you don't have to modify it or spend any more on options. Simply connect up the four-wire link to make the instrument an integral part of the system.

The diagram (top left section) shows how you can connect an array of Intelligent Loop Processors directly to a supervisory computer having an RS422 serial port.



If the computer only has an RS232 serial port, you can use an 8245 Communications Buffer Unit to do the required RS232 to RS422 conversion, as illustrated. Buffering electrically isolates plant from computer, and by nesting the 8245s you can fan out the lines to cater for up to 128 instrument addresses.

Alternatively, as shown in the diagram, you can use a D240 Line Isolator/ Converter to provide an isolated line that can be bussed to a maximum of sixteen instruments, with a supervisory computer having either RS232 or RS422 ports.

Specification

Transmission Standard
4-wire RS422 (0 - 5V).

Line Impedance
120 - 240Ω twisted pair.

Line Length
4000 ft (1220m) max., at 9600 baud.

Number of Addresses per Line
16, but nesting of buffers provides maximum total of 128 addresses.

Data Rate
Selectable from 110, 300, 600, 1200, 2400, 3600, 4800, or 9600 baud.

Character/Length (ASCII/Binary)
10/11 bits — 300 to 9600 baud.
11/12 bits — 110 baud (2 stop).

Protocol

All microprocessor-based instruments in the System 6000 range employ a standard ANSI protocol known as BI–SYNCH. The exact form of BISYNCH implemented in System 6000 corresponds to the American National Standard specification:

ANSI-X3.28 - 2.5 - A4 Revision 1976.

Eurotherm Process Automation has implemented both an ASCII and a binary version of this protocol within each instrument. ASCII mode is simpler to use as all data is transmitted in easily-read ASCII characters.

However, binary mode offers a 4-to-1 increase in transmission speed by compressing data into a binary format. It also supports added features, such as Multi-parameter Polling and Enquiry Polling.

Power Supplies

Input Voltage
(May be unsmoothed full-wave rectified AC).
20 - 30V DC recommended range.
19 - 35V DC absolute max. input limits.

Input Current
At 24V DC typical:
330mA without Hand-Held Terminal;
335mA with Hand-Held Terminal.

Input Fuse Rating
1A.

Power Failure Detect Threshold
When input voltage < 16.5 ± 2V.

Remote Transmitter Supply
26V ± 1.5V at 4mA output.
30V ± 0.5V at 20mA output.
± 50V minimum isolation with respect to system ground.

Memory Standby Battery
Lithium type.
3.0V nominal output at 160mAh.
8 - 10 year shelf life typical.
5 year life typical on continuous standby.
20 minute holdup time minimum with battery board removed.

Input/Output Signals

Analogue Inputs

Number of Channels
4 (6370/80) or 8 (6372/82) direct non-isolated inputs.

Input Signal Levels
Inputs are 0 - 10V range or 1 - 5V range (4 - 20mA with burden resistor), with open-circuit detection.

Resolution
12 bit binary ADC (.025%) hardware applied to inputs. 15 bit binary representation obtained after digital input filtering and signal averaging, giving resolution of 1 digit in ±9999.

Accuracy
±1 LSB (typical) over 0 - 50°C range for hardware.
±1 digit of reading for 0 - 4000 range,
±2 digits of reading for 0 - 8000 range,
±3 digits of reading for 0 - 9999 range,
after input filtering.

Sampling Rate
ADC sampling rate is such that a given channel is sampled once every 72ms (all models).

Input Impedance
1 MΩ pull-down to –1.5V on all channels (0 - 10V or 1 - 5V).

Input Signal Processing
Linear (normal or inverse).
Normalised square root.
Type J, K, T, S, R, E, B thermocouples.
Platinum resistance thermometers.
Five user-specified linearisation functions.

Analogue Outputs

Number of Channels
4 direct non-isolated outputs with 1 available as an isolated output.

Output Signal Levels
Direct outputs are 0 - 10V range.
Isolated output is 4 - 20mA (or 0 - 20mA software selectable, channel 4 only).

Output Circuit Type
Medium-term analogue sample-and-hold circuits preceded by DAC.

Output Resolution
12 bit binary (.025%) giving minimum analogue voltage steps of 2.5mV.

0 - 10V Output Accuracy
±1 LSB (typical) over 0 - 50°C range.

Isolated Output Accuracy
±0.5% of full scale.

Sample & Hold
DAC update rate is such that a given channel is refreshed once every 72ms.

Output Drift Rate Under Watch-dog Failure Conditions
1/2mV/sec maximum, equivalent to 1% of full scale in 3 minutes.

Output Drive Capability
±5mA for direct voltage outputs.

Isolation Voltage
±50V minimum with respect to system ground.

Digital Inputs

Number of Inputs
8 external non-isolated inputs.

Input Voltage Levels
15V = logic 1; 0V = logic zero.

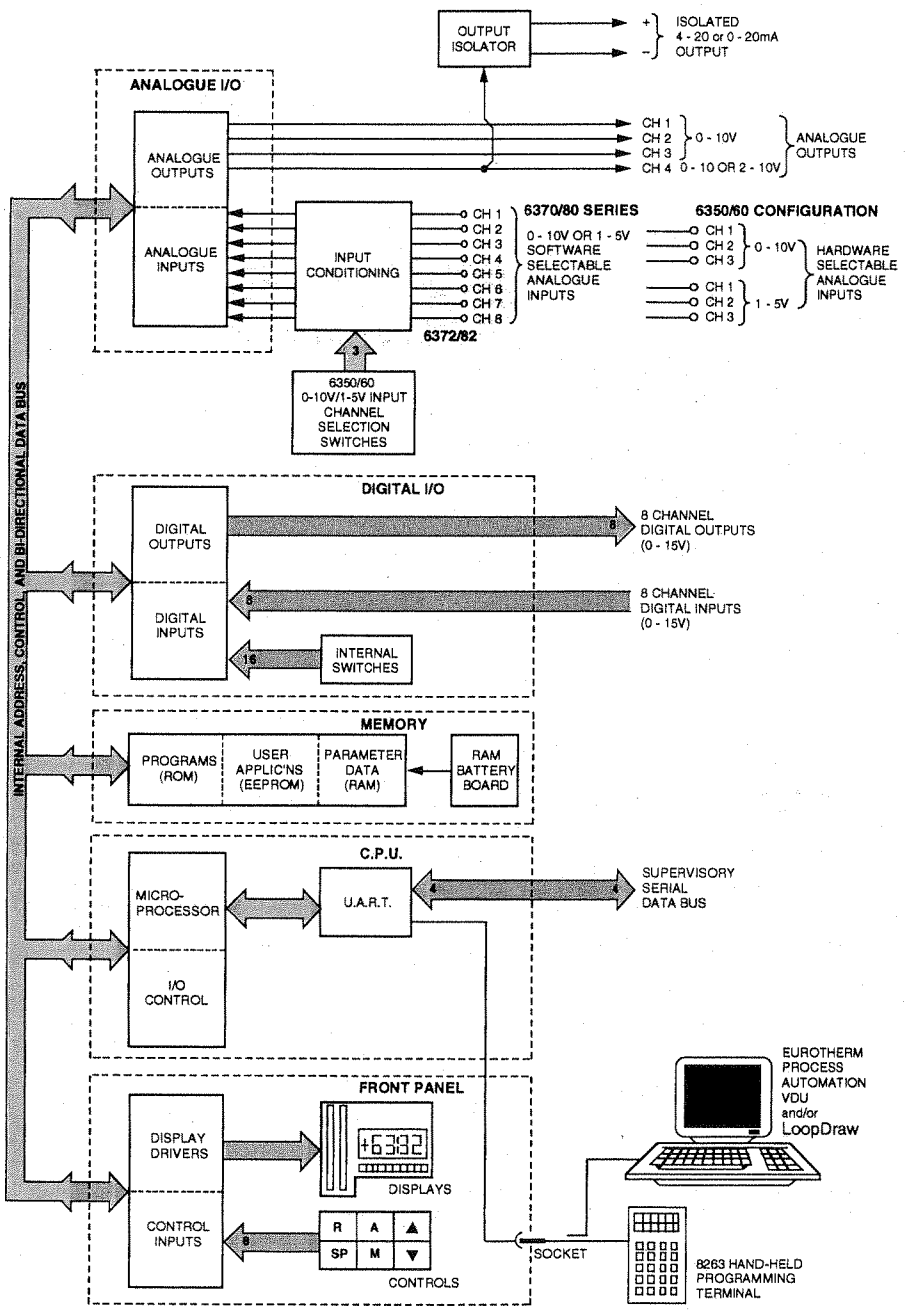
Min Input Impedance
100kΩ pull-down to 0V, giving 150µA logic 1 current.

Digital Outputs

Number of Outputs
8 external non-isolated outputs plus Watchdog.

Output Voltage Levels
15V = logic 1; 0V = logic zero.

Output Drive Capability
Logic 1: 2.2kΩ open-collector pull-up to +15V supply rail. Logic 0: Sinks up to 16mA from external load.



Ordering Information

Intelligent Loop Processors

6370 or **6380** — Basic instruments with deviation or dual bargraphs, respectively.

6372 or **6382** — 70 assigned blocks, 50 library functions, and deviation or dual bargraphs, respectively.

Hand-Held Terminal

8263 — LCD 32-character terminal.

Physical Specification

System 6000 instruments are supplied in 72mm wide metal housings fitted with front panel fascias and catch handles for module retention.

They can be mounted in 7930 DIN sleeves, or in the 7950 Universal Packaging System, which we particularly recommend. Alternatively, we can fit them into other suppliers' housings (on application).

Mechanical

Dimensions (mm): 72 W × 142 H × 300D
Weight: 1.16kg (without sleeve)

Environmental

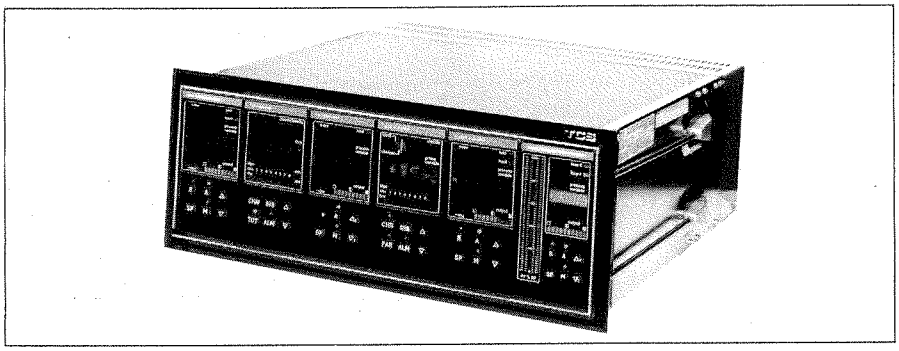
Operating Temperature:	0 to +50 °C
Storage Temperature:	–20 to +55 °C
Relative Humidity:	5 to 90 % non-condensing

7950 Universal Packaging System

The 7950 Universal Packaging System enables up to six Intelligent Loop Processors, or combinations of other System 6000 instruments, Matric modules, and Eurotherm Chessell recorders, to be fitted into a single 19 inch sleeve, which may be rack or panel mounted.

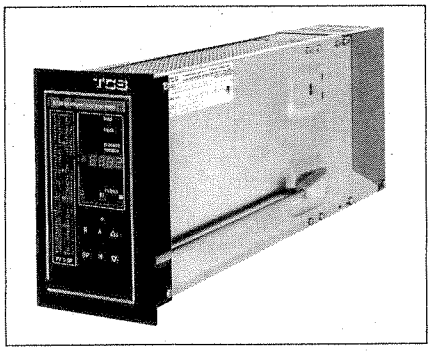
The 7950 system is also available with a panel mounting option in three other widths: 72mm, 144mm, and 216mm, for mounting 1, 2, or 3 instruments respectively.

Customer screw terminal blocks are protected by an optional hinge-down rear cover, which may itself have built-in (8750) mains power units, available in all width options.



7950 Sleeve. Overall dimensions of housings illustrated:

	6-way	1-way
width (mm):	482	105
height (mm):	177	177
depth (mm):	380	423
Panel cut-out dimensions:		
width (mm):	448.2	88.2
height (mm):	166.3	166.3



Further Details

For further details please refer to:

6370/80 Series Intelligent Loop Processors, Reference Manual.

6370/80 Series Facts Book

7950 Universal Packaging System, Product Specification.

8280 LoopDraw User Guide.

8275 Instrument Database Configurator, Product Specification.

TA637X/8X Termination Assembly Sheet.

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