incremental controller

system 6000

6351

product specification

Incremental controller: Features

- No options.
- All controllers are identical and interchangeable.
- Single loop integrity.
- Built-in diagnostic routines.
- Velocity mode PID or ratio control.
- Microprocessor technology and solid state displays.
- Remote monitoring and supervision via a simple serial link.
- Field proven unit with a two-year warranty.
- Fully compatible with the TCS range of advanced instrumentation.

Description

The 6351 single loop incremental controller combines the flexibility of modern microprocessor technology with the integrity associated with conventional analogue instruments.

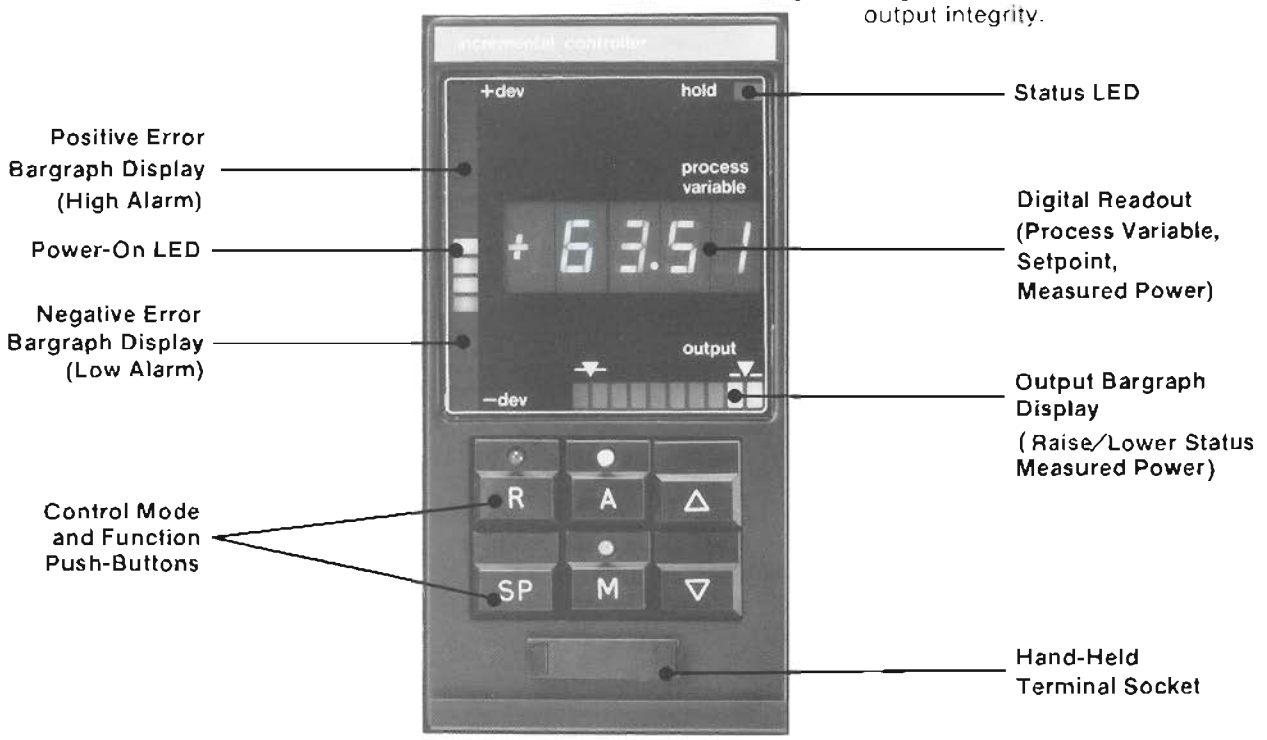
A microprocessor is incorporated in every 6351 enabling a user to characterise each device for the application using a simple plug in hand-held terminal. As the loop characteristics are defined by easily changed parameters all 6351 controllers are identical and interchangeable. One 6351 is a spare for all the others on a plant as its function is defined and changed by the technician via the hand-held terminal. Use of the terminal ensures security of the settings which are retained indefinitely when the device is powered and for at least five years if unpowered.

Functionally the module operates as a conventional incremental controller with raise/lower outputs typically used to change the position of a valve. It allows for the travel time of the valve and is not dependent on measured position feedback. Manual, Automatic, Remote or Ratio modes are selectable via front panel push-buttons. Raise/lower buttons allow manual operation and Setpoint changes.

Each controller has a suite of input linearisation routines and TCS will provide custom linearisation at an additional cost. As well as providing raise or lower control outputs the 6351 generates 0-10V signals as the linearised process variable control, control status and the setpoint or error deviation

Supervision and monitoring of the 6351 is made simple by the provision of a communications interface. This allows an intelligent device to monitor or update any of the control parameters of a network of 6351s via an RS422 serial bus using an ANSI protocol. The TCS 8245 Communications Buffer Unit enables RS232, TTL and fibre optic interfaces to be used

The solid state technology offers high reliability while the inbuilt diagnostic routines provide further output integrity.



Operator displays and controls

Operator displays

Digital Readout
(for process variable, setpoint and measured power indication) 4-digit, orange LED display with sign and decimal point.

Error Indication
Vertical red LED bargraphs with 8 segments for positive and negative error in 1% steps.

Alarm Indication
High or low alarms indicated by flashing positive or negative error bargraphs.

Zero Error and Power-on Indication
Green LED in centre of error bargraph.

Output Indication
Horizontal yellow LED bargraph with 10 segments to indicate raise or lower operation (2 bars illuminated each end) or valve position feedback in 10% steps.

Status Indicator
1 yellow rectangular LED to indicate HOLD status.

Operator controls

Control Mode Selection
3 illuminated push-buttons:
Manual (M) with integral yellow LED
Auto (A) with integral green LED
Remote Auto or Ratio (R) with integral green LED.

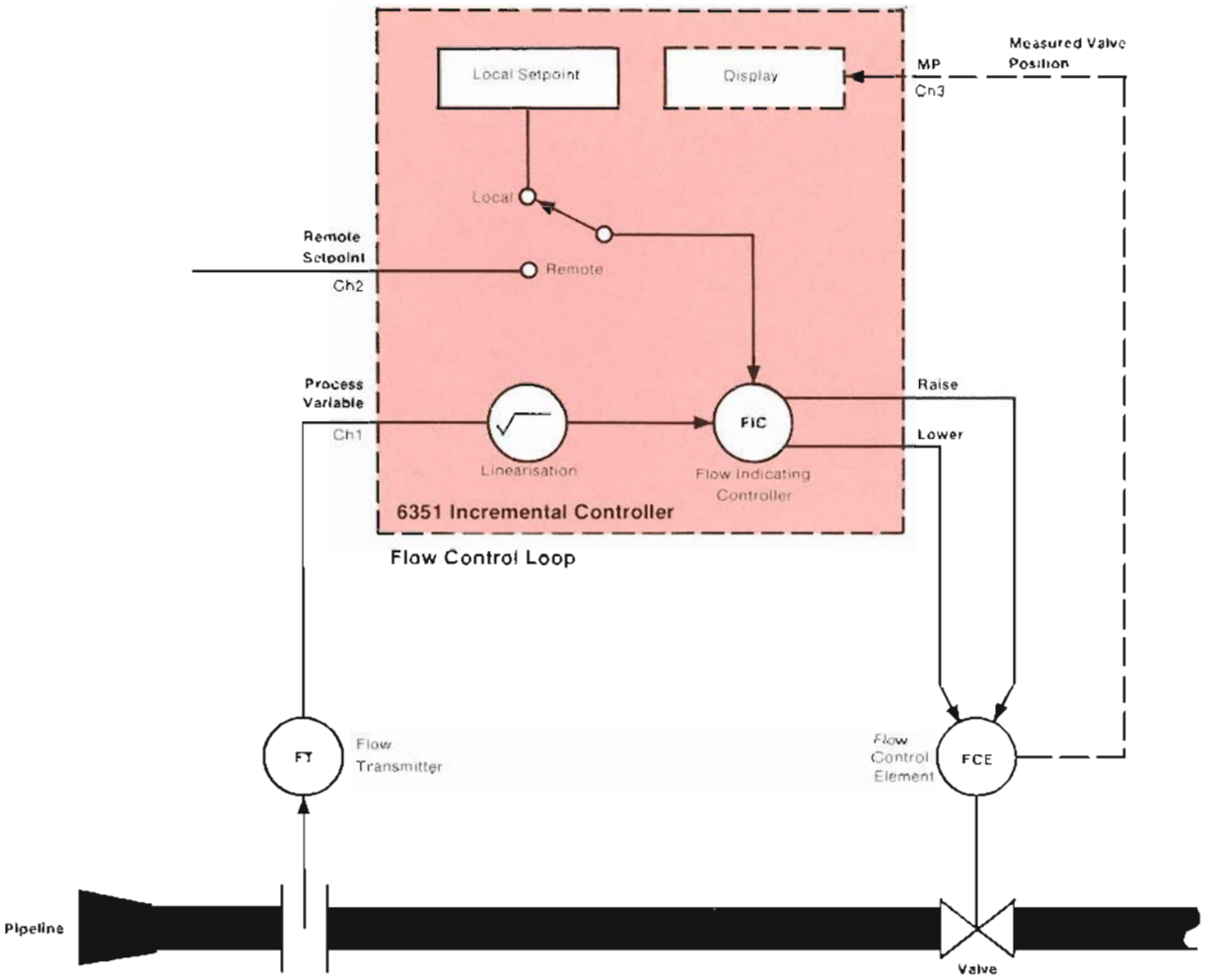
Function Selection
2 non-illuminated push-buttons:
Raise (▲) increments the output when (M) is pressed, or increments the setpoint when (SP) is pressed.
Lower (▼) decrements the output when (M) is pressed, or decrements the setpoint when (SP) is pressed

Display Selection
1 non-illuminated push-button (SP) causes the digital readout to display the current setpoint while pressed.

Note: Pressing the (M) or (A) or (R) buttons causes the digital readout to blank or display the measured power.

Applications

The 6351 process controller has an incremental control algorithm which has been developed for those applications where it is essential that in the event of controller failure the final control element remains at its previous operating position. A typical example, as illustrated, is a fluid flow control loop with a split-phase motor-driven valve where the controller opens and closes the valve directly by 'Raise' and 'Lower' signals. The use of an explicit valve positioner utilising valve position feedback is avoided by modelling the valve within the controller as an integrator whose time constant is related to the end-to-end travel time of the motor. This method of control is an enhanced form of 'Velocity Mode' or 'Boundless Control' so known because the controller output sets the rate of change of position, i.e. speed and not its absolute position. A signal representing valve position may be displayed at the controller but is not used within the algorithm, thus eliminating problems caused by noisy or open circuit feedback potentiometers



The 6351 operates in a similar manner to the 6350 process controller, but control demand is varied by time-proportioning either the Raise or Lower logic output within the algorithm update period.

There are 3 unique parameters which define the operation of the Raise/Lower outputs.

TT End-to-End Travel Time of Control Element

In the case of a control valve this is the time taken for the valve to go from fully closed to fully open (or vice versa) under continuous drive.

TP Algorithm Update Period

This is used to allow the incremental PID output calculation to be updated at a faster rate than that determined by the travel time of the control element, thus allowing a relatively fast plant to be controlled using a slow output device.

TP will always be set less than TT and normally greater than about 5 times TM; increasing TP may be useful in minimising valve flutter. For good control performance TP might typically be set to about one fifth of the dominant lag in the plant.

TM Minimum Response Time

This is the minimum time for which either the Raise or Lower output must be asserted in order to cause the control element to move. Increasing TM beyond this value is equivalent to increasing the effective dead band on the control element; too high a value can cause hunting. Note that values of control demand implying a pulse width less than TM are accumulated by the algorithm. The ratio of TM to TP sets the minimum rate of travel. This rate is effective in Manual mode in response to the Raise or Lower buttons.

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 available via a front-panel socket and is used for the 8260 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 8260 terminal can also be accessed and updated via the supervisory data link.

Hand-held terminal

Each System 6000 instrument can be set up using a plug-in 8260 Hand-held terminal. Every parameter is accessed by means of a simple 2 character command mnemonic and all data is entered directly in engineering units. This technique ensures the accuracy and security of parameter settings

Specification

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

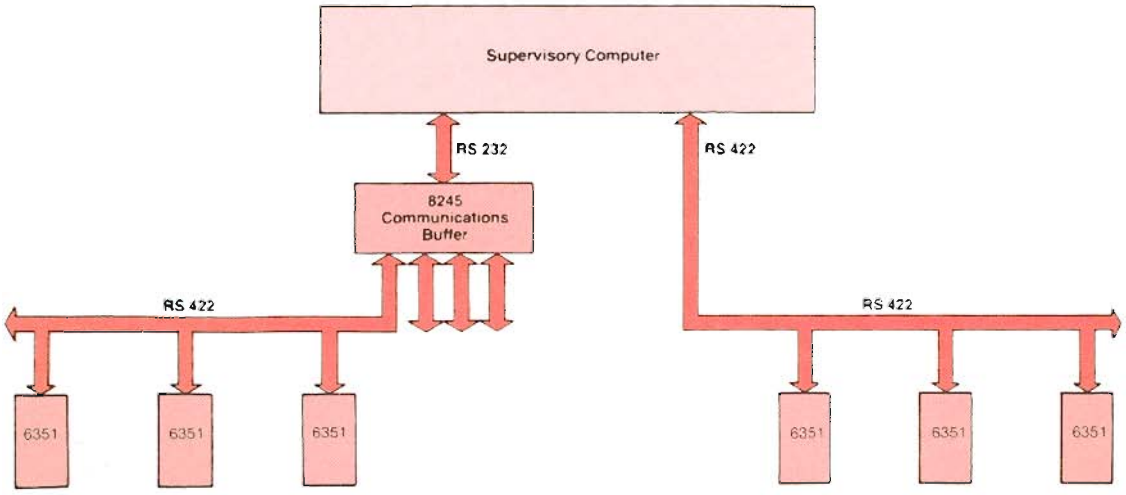
Data Rate
300 baud.

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

The photograph shows an 8260 terminal plugged into the front panel of a 6351 controller. A full list of the available command parameters is given in the 6351 Facts Card.

Multi-drop supervisory link

Every System 6000 instrument contains an RS422 communications port which enables it to send and receive command parameters over a simple four-wire link connected to other intelligent devices. The use of RS422 and the transmission of information in ASCII or Binary data format makes it particularly easy to communicate with the 6351 controller. To hook the 6351 into a distributed control system requires no modification to the instrument and no further expenditure on options. The four-wire link is simply connected up so that the 6351 becomes part of the distributed control system. The illustration shows how an array of 6351s can be directly connected to a supervisory computer which has an RS422 serial port. If the computer only has an RS232 serial port then an 8245 Communications Buffer Unit can be used to carry out the required RS232 to RS422 Conversion as shown.



Specification

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

Line Impedance
120-240Ω twisted pair.

Line Length
4000 ft max. (at 9600 baud).

Number of Units/Line
16.

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

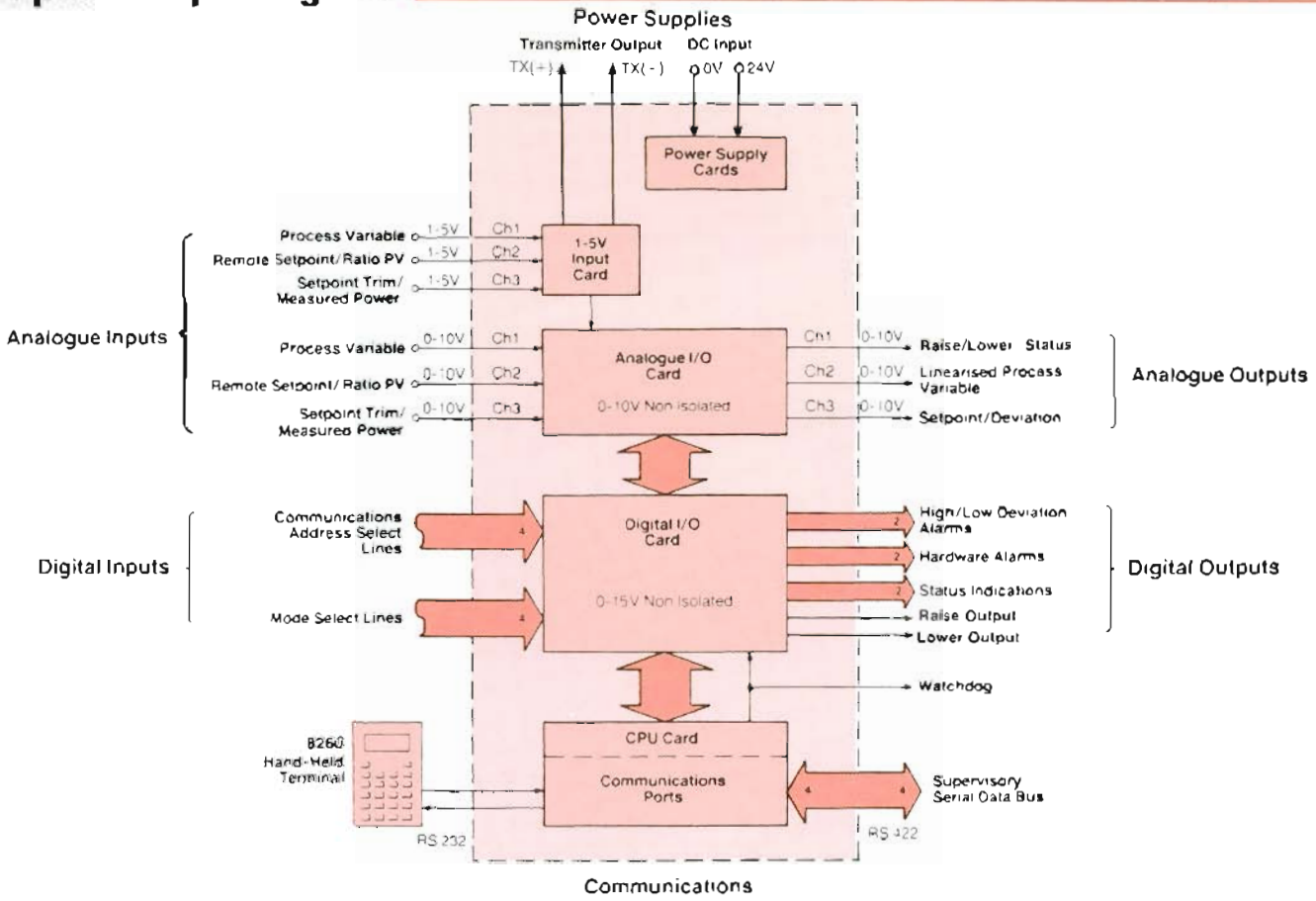
All microprocessor based instruments in the System 6000 range employ a standard ANSI protocol known as BI-SYNCH. The exact form of BI-SYNCH implemented within System 6000 corresponds with the American National Standard specification:

ANSI – X3 28 – 2.5 – A4 Revision 1976

TCS have implemented both an ASCII and Binary version of this protocol within each instrument.

The ASCII mode is simplest to use as all data is transmitted in ASCII characters. The Binary mode offers a 4 to 1 increase in transmission speed by compressing the data into a binary format, and also supports additional features like Multi-Parameter and Enquiry Polling.

Input/Output signals



Analogue inputs

Number of Channels
3 direct non-isolated inputs or 3 conditioned non-isolated inputs.

Channel Functions
Channel 1 = Process Variable input.
Channel 2 = Remote Setpoint/Ratio Process Variable input
Channel 3 = Setpoint or Ratio Trim/ Measured Power input.

Input Signal Levels
Direct inputs are 0-10V range.
Conditioned inputs are 1-5V or 4-20mA range with external sense resistors.

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.

Samping Rate
ADC samples 1 channel every 12ms, i.e. any one channel is sampled once every 36ms.

Input Impedance
1MΩ pull-down to -5V on channel 1.
1MΩ pull-down to 0V on channels 2 and 3

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

Analogue outputs

Number of Channels
3 direct non-isolated outputs

Channel Functions
Channel 1 = Raise/lower status.
Channel 2 = Process Variable output
Channel 3 = Setpoint output or amplified deviation (error)

Output Signal Levels
Direct outputs are 0-10V range.
Channel 1 takes up one of three values: 10V, 0V or 5V for Raise, Lower and Off respectively

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.

Sample and Hold
DAC updates 1 channel every 12ms, i.e. any one channel is refreshed once every 36ms.

Output Drift Rate Under Watchdog Failure Conditions
½mV/sec maximum (equivalent to 1% of full scale in 3 minutes).

Output Drive Capability
± 5mA for direct voltage outputs.

Digital inputs

Number of Inputs
7 external non-isolated inputs.

Input Functions
4 communications unit address select lines.
3 mode select lines.

Input Voltage Levels
15V = logic one.
0V = logic zero

Input Impedance
100kΩ pull-down to 0V (gives 150μA logic one current)

Digital outputs

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

Output Functions
2 deviation alarms.
2 hardware alarms.
2 status indications.
2 raise/lower logic bits.

Output Voltage Levels
15V = logic one.
0V = logic zero.

Output Drive Capability
2k2 open-collector pull-up to +15V supply, maximum logic zero sink current = 16mA.

3-term control characteristics

Algorithm Sampling Period
36ms to 99.99s.

Setpoint
Range — low, high -9999 to +9999.
Limits — low, high -9999 to +9999.

Setpoint Trim
Range — low, high -9999 to +9999 in engineering units.

Alarm Limits (on deviation)
Low, high 0 to 9999 with hysterisis of ½% of setpoint span.

Input Filter Range (all inputs)
0 to 99.99 sec (first order).

Control Outputs
Time proportioning Raise and Lower logic outputs with 20ms delay between transitions.
Control status also available on a single analogue output.

Control Element Characteristics
Travel time — 0.01 to 327.7s
Minimum response time — 0.01 to 99.99s.
Raise/lower rate in manual — constant rate dependant on parameters.

Proportional Band Range
0 to 999.9%.

Integral Time Constant Range
0.04 to 99.99 sec. or 0.01 to 99.99 min. 0 = off.

Derivative Time Constant Range
0.04 to 99.99 sec. or 0.01 to 40.00 min. 0 = off

Power supplies

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

Input Fuse Rating
2A.

Input Current
550mA without hand-held terminal.
650mA with hand-held terminal.

Power Failure Detect Threshold
When input voltage falls below 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
3.0V Lithium type.
160mAh rating.
8-10 year shelf life.
5 year life typical on continuous standby.

Mechanical details

All System 6000 microprocessor based instruments are supplied in 72mm wide metal housings fitted with front-panel fascias and catch handles for module retention. These may be used with a wide variety of rack and panel mounting hardware as illustrated in the examples below.

7000 series racks

Up to six 6351 controllers may be fitted into a 7000 series 19 inch rack as shown. Interconnections between instruments are made by wire wrapping while external connections may be brought out to 2 rows of 64 way screw terminal blocks fitted to the hinge down rear door. The 7000 series rack is also available with a panel mounting option, and a 10 inch half rack version for mounting up to three 6351s can also be supplied.

7900 powered sleeves

The powered sleeve allows a 6351 to be mounted with a mains power unit. This is incorporated in the associated 7351 Rear Termination Assembly which is also fitted with alarm relays and gives access to all module connections via screw terminals. The 7900 assembly is available in single, 3 way or 6 way versions for mounting in panels from 1.5mm to 6.5mm thick. A 6 way 19 inch rack mounting version can also be supplied.

Overall dimensions in mm of housings illustrated:

	7000 rack	7900 sleeve
width:	482	105
height:	177	177
depth:	380	423

Panel cut-out dimensions in mm:

	7000 rack	7900 sleeve
width:	448.2	88.2
height:	166.3	166.3

Details

For further details refer to:

6351 Single loop microprocessor based incremental controller technical manual.

6351 Facts Card.

7351 Incremental Controller rear termination assembly.

7900 Single or multi-way sleeve assembly for microprocessor based instrumentation.

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Advanced Instrumentation

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