CATHCART - NEILSTON REMOTE CONTROL SYSTEM

TECHNICAL DESCRIPTION AND

GUIDE TO MAINTENANCE/FAULTING

5112/4908m/1

DESIGN PHILOSOPHY

The design brief was for an inexpensive remote control system, simple in construction and maintenance and easily expanded in capacity.

The resultant system uses standard CCITT data modems for transmission and micro-computer controlled buses for data marshalling. Only three distinct card types are used and these are constructed of inexpensive, industry standard, multi-sourced components.

The system uses scanning to maintain integrity but is asynchronous, using direct addressing and a change of state driven interrupt system to give a considerable advantage in response time over conventional TDM systems.

The Scotchflex cable/connector system is used to simplify construction. Expansion is simply by the addition of input or output cards.

Maintenance is minimal and fault-finding is facilitated by the low spares requirement and the provision of a maximum of functional information on the card faceplates. No specialised test instruments are required.

SYSTEM ARCHITECTURE DRAWING NO.SES82/3-4&5

Office and Field are identical in concept. Each consists of two independent bus systems, one a group of input cards connected by address and data buses to a control card, the other a group of output cards connected by a second bus system to a second control card. Each bus system has its own DC power supply.

As a consequence of the use of simple modems, two pairs are required for transmission. Any possibility of crosstalk is countered by the use of opposite parity on each pair.

A conventional V24 interface is used between the modem and the control cards, the TX connection being with the input control card and the RX connection being with the output control card. The power supply for the modem and the V24 interface on both control cards is derived from a common $\pm$ 12V supply, powered from the input DC supply at Cathcart and from the output DC Supply at Neilston.

Card identity is established by backplane wiring, all cards of a given type being totally interchangeable.

THE CARDS

The cards from which the system is constructed are of three types. These are known as CONTROL CARD, INPUT CARD and OUTPUT CARD. The CONTROL CARD is dual purpose. It can either obtain information from Input Cards and present it to the modem for transmission, or, receive information from the modem and present it to Output Cards. Each INPUT CARD accepts fourteen inputs from the relay room and presents them in a noise free digital form to its Control Card. Each OUTPUT CARD accepts the information for fourteen outputs from its Control Card and presents it in the form of dedicated relay contacts to the relay room.

The cards are of ScR design and are at present unique to the system. They do however incorporate a measure of flexibiity with an eye to future applications.

Format is double eurocard with 2 x 64 way indirect edge connectors.

INPUT CARD SES82/3-1

Each INPUT CARD handles fourteen inputs organised as two blocks of seven (referred to as DATA WORDS).

The inputs are optically isolated from the logic supply.

A bit is set by completing a dedicated isolating circuit (e.g. via a closed relay contact). A light emitting diode (LED) in series with each isolating diode is mounted on the card faceplate such that the condition of any input can be seen at a glance.

Each Data Word is presented at the inputs of an octal latch the outputs of which are presented at the inputs of gated inverting bus buffers. The outputs of the bus buffers are connected to the DATA BUS. A bus comparator IC enables the card to accept a Read signal ($\overline{RD}$) when it detects its identity (five hardwired backplane inputs) on bits 1 to 5 of the ADDRESS BUS. Bit 0 of the address selects which Data Word is to be read.

When a card is addressed, $\overline{RD}$ clocks the current data for the selected word into the latch and enables the bus buffers, placing the Data Word onto the Data Bus.

Reading the word generates an ACKNOWLEDGE pulse ($\overline{AK}$) which the Control Card requires as verification before allowing transmission.

Two cascaded four bit magnitude comparators compare the word at the latch inputs with the word at the latch outputs. When an input changes the comparators will generate CHANGE OF STATE ($\overline{COS}$), triggering a rapid scan.

The comparator output is also presented to bit 8 of the latch. Thus, when the rapid scan reaches the word which generated $\overline{COS}$, the comparator output will be clocked through onto the bus identifying the Data Word for transmission. The latch output will now agree with the input and the $\overline{COS}$ interrupt will be removed.

CONTROL CARD SES82/3-2

The CONTROL CARD is based on a 48 series micro-computer with support circuits for clock generation, bus control and serial TX/RX. Provision is made for I/O expansion. Ancillary circuits are V24/TTY interfaces, power up reset and systems alarms, with associated faceplate mounted indicators.

As programmed for Remote Control System use the Control Card can function in either input or output control mode. On power up the micro-computer tests the backplane wiring to determine its mode. Lc13 is tested, if looped to Lc12 the card functions in the input control mode, if looped to Lc14 it functions in the output control mode. Lc1 is tested to determine whether ODD or EVEN PARITY is valid. ODD PARITY is used for transmission from CATHCART to NEILSTON and EVEN from NEILSTON to CATHCART.

When functioning as an input Control Card the card scans sequentially through the Input Cards, reading one seven bit Data Word at a time and transmitting the data contained in this word preceded by its address, before moving onto the next word. This scan can be interrupted by a $\overline{\text{COS}}$ signal from an Input Card. On receipt of $\overline{\text{COS}}$ the Input Cards are scanned rapidly to determine its origin, and when located the associated Data Word (with address) is immediately transmitted. The Control Card then checks whether $\overline{\text{COS}}$ is still present, if so this further change is located, if not the scan continues from the point at which it was interrupted, re-transmitting the last address and word since an interrupt can occur between transmission of address and word. Eight bits are transmitted, the most significant bit determining whether the transmission is of address or data (LOW if data). The output Control Card can recognise when it has received address without data and take no action.

When functioning as an output Control Card, the card is not scanning but writes to the Output Card specified by the received address (after first checking the validity of both address and data).

OUTPUT CARD SES82/3-3

Like the INPUT CARD, the OUTPUT CARD is organised as two seven bit DATA WORDS. Card and word selection is achieved in similar manner.

The data is clocked into a latch by a WRITE signal ($\overline{WR}$). Output is over the front contact of one board mounted relay per data bit. Thus isolating the logic circuit from the relay room. The armatures of the seven contacts of each Data Word are commoned externally.

The relay coils are driven from the latch via a line driver IC. LED's in series with the relay coils are mounted on the card faceplate such that the conditions of any output can be seen at a glance. It should be noted that since a current limiting resistor parallels the relay coil, the LED indicates the driver not the relay.

The latches constitute stick circuits for the output relays and, should a fault occur which prevents scanning, the relays will remain in the position of the last correct transmission.

The output of wrong data at power up is avoided by preventing the 12V relay supply from being applied to the coils until a bit generated by a delay circuit is clocked through bit 8 of the WORD B latch. Since WORD A is written to first the relays are not energised until valid data is applied to all fourteen drivers.

The relays used are capable of driving a BR SPEC 930 relay directly.

POWER SUPPLIES

The power supplies are constructed from GRESHAM modules. There are two types of power supply.

(a) A 5V/12V supply containing two modules whose outputs are indicated on the front panel. Two of these supplies are used at each site. One supplies 5V to the cards on the input bus system and 12V to the opto isolators. The other supplies 5V to the cards on the output bus system and 12V to the output relay coils.

(b) A ± 12V supply containing a DC to DC converter. This supplies the modem and the V24 interface to both Control Cards. It is powered from the INPUT 5V at CATHCART and the OUTPUT 5V at NEILSTON.

All share a 110V AC supply, each 5V/12V supply being individually fused. This supply comes via a filter and a double pole master switch with neon indicator.

PROTECTION

Two additional boards are attached to the rear of the cabinet. One provides protection for the transmission equipment and consists of parallel 10V zener diodes, 63mA fuses in series, followed by a zenamic varistor (Z15L390) in parallel. The other protects against interference from the back EMF of BRB relays and consists of one suppressor for each output (RS 283-463).

MODEM

A modulator-demodulator (MODEM) is used to convert the data signals from the Control Card to voice frequency signals suitable for transmission over telecom cable. The modem used is an ITT type 2072 one-card modem.

The frequencies used are 1300 Hz (MARK) and 2100 Hz (SPACE). Line levels are - 12db at transmitter and -18db at receiver.

MECHANICAL

The system consists of a 19" rack (VERO KM6) in a VERO wall mounted cabinet at each site. The cabinet has a transparent door, allowing the indications to be readily visible. The rack is hinge mounted in the cabinet, allowing easy access to terminations, fuses and backplane wiring. A lock on the rack accepts a 221 key.

Cards, power supplies and modems are mounted as modules in the rack and may be removed after first slackening the top and bottom retaining screws of the module.

Top and bottom rack cross members double as DC bus bars.

SPARES/.....

SPARES

Spares are allocated positions on the right-hand side of the Cathcart rack and consist of the following:-

1 INPUT CARD

1 OUTPUT CARD

1 CONTROL CARD

1 5V/12V POWER SUPPLY MODULE

1 ± 12V POWER SUPPLY MODULE

1 MODEM MODULE

MAINTENANCE

1. Clean and dust cubicles.

2. Check voltages on end of bus bars furthest from the hinge. These should be in the range 5V and 12V ± 0.25 Volts.

FAULT INDICATIONS SES82/3-1 THROUGH 4

Indications affected by fault conditions are SCAN 'OK' (Green LED) on both INPUT and OUTPUT CARDS, SD OK (Green LED), RxFAULT (Yellow LED) and FAULT (Red LED) on the CONTROL CARDS. FAULT operates in conjunction with the overall SYSTEM FAILURE indication which is given to the CATHCART signalman.

The SCAN 'OK' indications are maintained by monostables which are retriggered whenever the cards are successfully read from or written to. Should any of these monostables time out, SCAN 'OK' will be lost on that card indicating that the card is not being serviced, and the signal $\overline{SF}$ (scan fail) will be output to the alarm circuitry of the appropriate Control Card.

The micro-computer on the Control Card is continuously testing the status of the IC which handles the exchange of serial data between the Control Card and the modem (Universal Asynchronous Receiver Transmitter - UART). Should it detect a parity error or transmission format error it will take no action on that transmission other than to output a signal which lights RxFAULT. In addition, the UART maintains a monostable such that, should transmission or reception cease for a 10mS period, the SD OK (Serial Data OK) indication would be lost. If either of these errors occur or the Control Card receives $\overline{SF}$, a 5 second delay is triggered. Should the fault persist when the delay times out the FAULT indication would be given and ROK/TOFF would go low.

Associated with the FAULT indication on the CATHCART output Control Card is a normally energised relay external to the system. This is the SYSTEM ALARM relay. ROK/TOFF is one of three terminals accessing the Control Card alarm circuitry. The others are ROK and TOFF. ROK triggers FAULT when pulled low and TOFF disables the V24 interface thus preventing the card from transmitting. These terminals are interconnected such as to ensure that a FAULT condition on any of the four Control Cards triggers SYSTEM ALARM. The method is as follows:-

At Neilston, ROK/TOFF of the output Control Card is connected to ROK of the input Control Card. Thus a FAULT on the output Control Card will immediately trigger FAULT on the input Control Card, overriding any 5 second delay in progress. ROK/TOFF of the input Control Card is connected to TOFF on the same card. It follows that FAULT on either Control Card will prevent transmission from Neilston to Cathcart. This would lead to CATHCART output Cntrol Card losing SD OK and, after 5 sec, FAULT would trigger SYSTEM ALARM.

At Cathcart ROK/TOFF of the input Control Card is connected to ROK on the output Control Card and would immediately trigger SYSTEM ALARM via FAULT on the output Control Card.

For example, consider the case should the cable pair carrying transmission from Cathcart to Neilston be cut.

This would trigger FAULT on Neilston output Control Card which in turn would trigger FAULT on Neilston input Control Card stopping transmission to Cathcart. No transmissions to Cathcart would trigger FAULT on Cathcart output Control Card activating SYSTEM ALARM. Cathcart input Control Card would, in this case, not show FAULT and a continuous tone could be detected on the Neilston to Cathcart cable pair.

Any/.....

FAULT INDICATIONS (CONT'D)

Any system failure should be checked in the sequence Cathcart input/Neilston output/Neilston input/Cathcart output.

Any bit failure (control or indication function) should be checked at the appropriate Input Card and then at the corresponding Output Card using the Data Word indication LEDs as a guide.