DESIGN PARAMETERS OF ON-LINE MEASURING EQUIPMENT OUTPUT

1. PURPOSE. The purpose of this paper is to outline the design parameters for developing a direct communication link between coordinate measuring equipment and a central computer on a real-time basis.

2. SCOPE. Transmission between the computer and the remote station is to be via two twisted pair of standard 18 or 20 gauge telephone quality lines. Adequate steps have been taken to insure minimum interference from outside sources. One pair of transmission lines, commencing at the central computer site, is to be connected to a page printer. The contractor, however, is to have no responsibility for the printer except for consideration of placement within the operator's immediate control.

STATINTL

The second pair of lines to the computer is to be connected to the measuring equipment digitizing system through a pair of [redacted] STATINTL [redacted] Data Phone subsets, model 202B lists 1, 3, A, and B. One Data Phone will be located at the computer room, and the contractor is to have no responsibility for this unit. The second Data Phone is to be mounted in the digitizing system, and the contractor is responsible for providing the necessary interface connection. In all cases, the customer will be responsible for providing the Data Phones and Printers. For the purpose of this paper, the measuring equipment and digitizers are understood to consist of (a measuring engine, pulse generators,)* pulse decoding system, digital accumulators, buffer storage as required,* and circuitry for generating special characters as later explained. There is to be no data connection between the printer and digitizer except through the computer link.

* SEE APPENDIX B PARAGRAPH 1

3. TRANSMISSION INTERFACE. The Data Phone interface is to meet the following requirements:

a. Electronic Industry Associates (EIA) specifications to which the Data Phone was built. It is currently EIA-RS 232, but should be checked prior to final design for any changes.

b. Data Phone to operate in the half duplex mode.

c. Transmission is asynchronous with the rate of transmission to be fixed at 1200 bits per second ± 1% tolerance, and is binary serial.

d. A voltage within -8 to -20 represents off or marking (1), a voltage within +8 to +20 represents on or spacing (0).

e. In addition to the information bits to be transmitted, two pulsing bits must be transmitted for each character. A start pulse is a space or (0) and is the same duration of the other bits. A stop pulse is a mark or (1) and is a minimum of 1.5 bits in length but may be longer.

4. CODE REQUIREMENTS. The code to be transmitted will meet the following requirements:

a. Code to be used will be Field Data Code, consisting of a 6-bit character plus one parity bit. Parity is to be odd.

b. The 2^0 or least significant information bit is the first bit to be transmitted from each character.

c. Parity is to be the 2^6 bit and is the last information bit of each character to be transmitted.

5. MESSAGE GENERATED. The message to be generated by the measuring equipment system shall consist of: (See appendix A for output sequence.)

a. Digital coordinate values for each axis of the system. This shall normally consist of six decades plus sign per axis.

b. A start of message character (SOM).

c. An end of transmission character (EOT). (This bit configuration would normally be a parity error).

d. A message parity count (MPC). This is the sum of bits of all characters transmitted (including SOM and EOT), and is non carry add. Lateral parity is odd. Longitudinal parity is even. The parity bit is to be the sum of the longitudinal parity bits.

e. Four special instruction characters, each generated by four operator controlled push on, push off back lit switches, two dummy bits (mark or 1), and a parity bit generated by the equipment based on the condition of the four switches. The fixed dummy bits will occupy the 2^4 and 2^5 bit positions.

f. A special readout character generated by five momentary contact push button switches and two fixed dummy bits occupying the 2^5 and 2^6 bit positions. The dummy bits are to be spaces or 0's. It is understood that the parity (2^6) is to be fixed at 0 so that if two of the five switches are pressed at the same time, a parity error will be detected. The five switches are to be understood as readout switches and will also control the request to send, SOM and text as later described.

g. Three rotary switches are to be provided for machine identification purposes. These switches are to have the capability to create 0 to 9 and are to be placed in the equipment so that only the maintenance engineers will have the capability to change them.

h. A minimum of 12, twelve position rotary switches. These switches are to have the capability of producing 0 to 9, minus (-), and EOT.

6. SPECIAL CIRCUITS.* There is to be no character by character acknowledge signal received by the digitizer output circuit. However, there is to be a message acknowledge or error signal received on the basis of the total message transmitted. The reply will consist of SOM, A or E, EOT, and MPC. In addition, a timer is to be incorporated in the equipment to trigger an alarm if the reply is not received in a predetermined time to be specified by the customer. The output is to be held in the digitizer buffer until an acknowledge is received or the timer alarm is triggered. If an error signal is received due to a bad transmission, the timer is to be reset and another attempt at transmission is to be made. After a set number of attempts of retransmission (under computer control), an acknowledge or error signal will not be returned and the timer will time out. If a readout is initiated but never reaches the computer, the timer will also time out, warning the operator that the transmission is not taking place. Since the Data Phones are to be operated in the half duplex mode, the return acknowledge or error must pass over the same lines and will not be transmitted until the digitizer transmission is completed and the line phase relationship is reversed.

In addition, an indicator light is to be placed on the control panel in close proximity to the readout switches. On depressing any one of the five readout switches the light is to turn on and remain on for approximately one second or until an acknowledge signal is received, whichever is longer. This will indicate to the operator that a readout has been initiated within the digitizer.

* SEE APPENDIX B PARAGRAPH 2

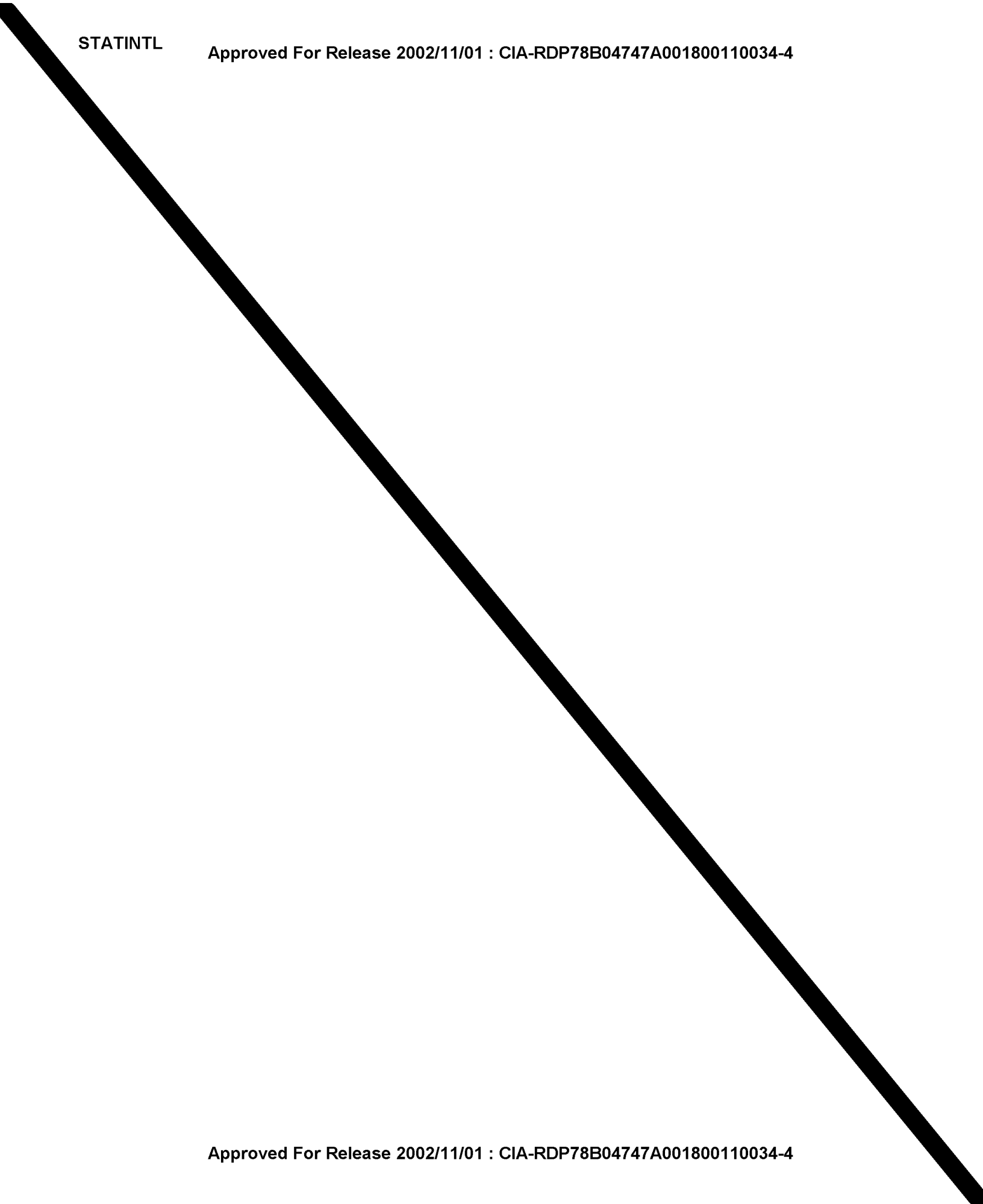
A numerical display of the coordinate system should be placed on the measuring engine within the operator's field of view. A reset button for each axis shall be placed on the control. It is also ~~desirable but~~ not mandatory that a master reset button be provided and a manual set feature for each decade of the counter to give the operator the ability to set the counter value to a predetermined value other than zero.*

7. SEQUENCE OF OPERATIONS. Having properly set up the measuring equipment as instructed, the operator will procede to take measurements and thus transmit data. Prior to actuating the readout mechanism he will set up the necessary computation instructions on the 16 push on, push off switches comprising the four instruction characters. Then, on alining the reference mark with the image he will depress one of the five readout switches comprising the readout character.

On actuating one of the five readout switches, the digitizing system will set the timer, energize the readout indicator light, and apply the request to send signal to the Data Phone. On receipt of the clear to send, the bit by bit message will be fed to the Data Phone as indicated in Appendix A.

After sending the message, the digitizing system will await the acknowledge or error signal. If an acknowledge signal is received, the buffer storege will be released and ready to accept the next readout. If an error signal is received, the above procedure is repeated (including reseting the timer and readout light) sending the identical message. After a set numer of tries under computer control, neither an acknowledge or error signal will be sent to the digitizing system from the computer and the timer will time out, energizing an audible alarm indicating that transmission had not been successful. Also if the Data Phone lines fail to set up, the timer is to time out giving an alarm. When an alarm occurs, the operator is to reset the alarm circuits by controls to be provided and attempt retransmitting or call maintenance.

* See Appendix A, Paragraph 3



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APPENDIX B

1. When only the electronics are under consideration the design for the pulse decoding system should include individual plug-in printed circuit boards for a variety of pulse generators. Specific requirements exist for input cards for [redacted] systems. STAT However, final design should not preclude additional future inputs.

2. In addition to the readout mode described in paragraphs 5 and 6, a requirement also exists for a second readout mode on an optional basis. The second mode shall consist of sufficient circuitry to receive parallel information from a binary data block reader and transmit same to dataphone. The message shall consist of SOM, up to 150 binary bits, the 3 machine identifier characters, EOT, and MPC.

3. An operator controlled set of switches shall be available for each decade and sign for introducing an automatic preset value. They shall consist of 10 position switches for each decade and 2 position switches for the sign. Two position direction of count, and axis selection switches shall also be included. The above switches shall be under operator control but should not be placed on the main control panel.

4. Required performance and critical output timing demand maximum reliability and rapid maintenance. Where possible, all circuitry should be on plug-in printed circuit cards with a minimum number of types used. While mil specs are not specified, design should be of the highest possible commercial standards to insure maximum performance.

APPENDIX C

SPECIFICATIONS

Maximum Count Rate:		100 KC, 50 KC for readout on the fly.
Maximum Storage	:	± 999999 counts each axis.
Number of Axis	:	Two
Numerical Display	:	In line (Nixie or 1" projection type) Negative numbers are to be displayed as true numbers (not 9s complement).
Circuitry	:	Completely solid state.
Output	:	Binary serial 1200 bit per second ± 1%.
Identification Capacity	:	SOM, Readout character, 4 instruction characters, 3 machine identifier characters, 12 twelve position rotaries. (see text)
Resolution	:	Dependent on input.
Preset Feature	:	Operator controlled switches to allow any value within range of counters to be set in counter by depressing reset button.
Special Features	:	Direction of count toggle switches and axis interchange toggle switches.
Special Output	:	Mode 2 output available as optional feature.
Control Placement	:	The numerical display, identification capacity, and reset buttons are to be designed for remote placement. The preset controls and special features switches are to be mounted in an accessible manner on the main chassis.
Power Requirement	:	100 - 125 volts, VO cycle.