

CURRENCY NOTE VALIDATOR

The present invention relates to automated devices for validating currency.

In many commercial transactions involving automated equipment,
5 it is necessary to provide an apparatus for validating the authenticity of a currency note submitted by a patron. For example, in mass transit systems employing automatic fare collection equipment, it is necessary for the automatic ticket dispensing apparatus to validate paper currency inserted by patrons before dispensing tickets
10 having fares encoded thereon.

The applicant's co-pending applications Nos. 81 33482 - 81 33490 disclose modules which may be interconnected in various ways to provide ticket dispensing equipment, entrance gates, and exit gates for a mass transit system. The currency note validator disclosed
15 herein constitutes an additional module which may be utilized in conjunction with the foregoing modules. The apparatus described herein may also be utilized in conjunction with a wide variety of other automated systems which accept payment in the form of paper currency in return for goods or services.

20 It is an object of the present invention to provide a currency note validator apparatus which will accommodate large variations in the soiling of notes so that a high percentage of valid notes will be accepted while counterfeit notes will be rejected.

According to a first aspect of the invention, an apparatus
25 for validating a currency note comprises: transport means for propelling the note along a longitudinally extending path; means for separately illuminating each of a plurality of laterally spaced sample areas on the note in a repetitive sequence with radiation in a pre-selected spectral range as the note is propelled along the path, and
30 for separately taking a plurality of optical reflectance readings from each sample area along each of a plurality of longitudinally extending, laterally spaced tracks on the note as the sample areas are so illuminated; means for storing acceptance band data for the type of currency note to be validated; and means for comparing

selected ones of the optical reflectance readings corresponding to each track to the acceptance band data and for providing a validation signal if there is less than a predetermined maximum amount of non-conformity.

5 According to a second aspect of the invention, there is provided an apparatus for validating a currency note, comprising: transport means for propelling the note along a longitudinally extending path; means for separately illuminating each of a plurality of laterally spaced sample areas on the note in a repetitive sequence
10 with radiation in a preselected spectral range as the note is propelled along the path, and for separately taking a plurality of optical reflectance readings from each sample area along each of a plurality of longitudinally extending, laterally spaced tracks on the note as the sample areas are so illuminated; means for taking
15 a plurality of optical opacity readings along a longitudinally extending track on the note; means for measuring the length of the note; and controller means for providing a validation signal if the optical reflectance readings, optical opacity readings, and length of the note conform to a predetermined acceptance standard.

20 According to a third aspect, the invention includes an apparatus for validating a currency note, comprising: transport means for propelling the note along a longitudinally extending path; a plurality of emitter means positioned at laterally spaced locations along the path for separately illuminating a plurality of laterally
25 spaced sample areas on the note in a repetitive sequence with radiation in a preselected spectral range when pulsed with a drive signal; a plurality of detector means for each sensing radiation reflected from a sample area illuminated by a corresponding one of the emitter means and for generating a read signal whose amplitude
30 is proportional to the intensity of the reflected radiation sensed thereby; means for sequentially pulsing the emitter means with corresponding drive signals as the note is propelled by the transport means to cause each emitter means to illuminate a plurality of longitudinally spaced sample areas defining a corresponding track
35 on the note, and to cause the detector means to generate a plurality of read signals corresponding to each track; means for storing predetermined acceptance band data for the type of currency note to be

validated; and means for comparing selected ones of the read signals corresponding to each track to the acceptance band data and for providing a validation signal if there is less than a predetermined maximum amount of nonconformity.

5 According to a fourth aspect of the invention, an apparatus for validating a currency note comprises: transport means for propelling the note along a longitudinally extending path; means for taking a plurality of optical reflectance readings along a plurality of longitudinally extending, laterally spaced tracks on the note; means
10 for storing acceptance band data for the type of currency note to be validated; and means for comparing selected ones of the optical reflectance readings corresponding to each track to the acceptance band data, and for providing a validation signal if there is less than a predetermined maximum of non-conformity for the selected ones
15 of the optical reflectance readings, means for longitudinally shifting the locations of the selected ones of the read signals a predetermined number of positions to generate an alternate set of selected read signals corresponding to each track, means for comparing the alternate set of selected read signals to the acceptance band data,
20 and means for providing a validation signal if there is less than a predetermined maximum amount of nonconformity for the selected ones of the optical reflectance readings for the alternate set of selected read signals.

 In a preferred embodiment of the invention ageing and drift in
25 its electronic components is accommodated. The preferred embodiment is microprocessor controlled and accommodates variations in pattern registration in valid notes. It is capable of validating notes inserted in any one of four orientations, and also readily programmable to validate different types of currency notes. The apparatus may be
30 arranged to be capable of communicating with, and responding to, commands from the central controller of a larger system incorporating the validator apparatus, and can further be arranged to locate malfunctions therein and display an indication of the malfunctions.

The preferred embodiment of the present invention comprises a microprocessor controlled currency note validator which will accept valid currency notes for any type of currency for which it is configured and programmed. The apparatus includes a transport for propelling the note along a path beneath an optical scanning station where both infrared and visible color reflectance readings are taken along several tracks down the length of the note. Optical opacity readings are also taken along a track down the length of a note. The microprocessor normalizes the reflectance readings to accommodate variations in the soiling, discoloration, and damage in circulated currency notes. The microprocessor then compares selected reflectance readings and opacity readings against preprogrammed acceptance band data for the type of currency note to be validated, correcting for note-to-note pattern registration variations.

Because a large number of locations are tested on the note and acceptability is determined by a statistical criterion, a note with one or two discolored or damaged areas, as well as a note with a pattern registration variation can still be accepted. In addition to the optical testing, the apparatus also checks the length of each note. Invalid or counterfeit notes are returned to the patron through an entry slot.

During the idle cycle of the currency note validator apparatus, the microprocessor continuously monitors the various systems within the apparatus, checking for malfunctions. If a failure is discovered, the microprocessor places the validator apparatus out-of-service,

and a special panel of flashing indicators displays in code the reason for the out-of-service condition. During the idle cycle, the micro-processor also checks and re-adjusts drive currents in the optical subsystem. This self-calibration automatically compensates for the effects of component ageing and dirt buildup on optical surfaces.

The design of the currency note validator apparatus makes it readily adaptable to different types of currencies. The best reading locations and appropriate acceptance band data are determined in advance by collecting and analyzing optical data from large samples of currency notes. The acceptance band data and the best reading locations are stored in a program memory in the apparatus. The preferred embodiment of the present invention is capable of processing a currency note in less than two seconds while providing a valid note acceptance rate above ninety-five percent.

The invention will now be described by way of example with reference to the drawings, in which:-

Figure 1 is a simplified side elevation view of a preferred embodiment of the apparatus illustrating mechanical components of its note transport in phantom lines;

Figure 2 is a horizontal sectional view of the apparatus of Figure 1 taken along line 2-2 of Figure 1;

Figure 3 is an enlarged vertical sectional view of the optical scanning station of the apparatus of Figure 1 taken along line 3-3 of Figure 1;

Figure 4 is a vertical sectional view of the optical scanning station taken along line 4-4 of Figure 3;

Figure 5 is a vertical sectional view of the optical scanning station taken along line 5-5 of Figure 3;

Figure 6 is a diagrammatic view illustrating a plurality of longitudinally extending, laterally spaced tracks on a currency note, each consisting of a plurality of sample areas from which optical reflectance readings have been taken;

Figure 7 is a functional block diagram of the electronic control circuit of the apparatus of Figure 1;

Figure 8 is a schematic diagram of a portion of the optical driver and read circuitry of the control circuit of Figure 7;

Figure 9 is a schematic diagram of a portion of the circuit of Figure 8 illustrating the innerconnection of the LEDs and PIN diodes mounted in the optical scanning station; and

Figure 10 is a flow chart of an operational program of the apparatus.

The general mechanical construction of a preferred embodiment of the currency note validator apparatus of the present invention is illustrated in Figures 1-5. Referring to Figure 1, the apparatus 10 includes a rectangular housing 12 divided into an upper portion shown in phantom lines and a lower portion shown in solid lines. The apparatus 10 includes transport means for propelling the note along a longitudinally extending path past an optical scanning station.

Upper and lower horizontal, rectangular plates 14 and 16 (Figures 1-3) are mounted in the housing 12. The upper plate 14 is mounted to the bottom of the upper portion of the housing 12. The lower plate 16 is mounted in the top of the lower portion of the housing 12. The plates 14 and 16 are hinged on one side (not shown). The upper plate 14 and the upper portion of the housing 12 may be swung open from their closed positions illustrated in Figure 1 to allow direct access to the channel 18 defined between the plates. This permits easy maintenance and cleaning. The electronic circuitry of the apparatus which is hereafter described is carried by PC boards removably mounted in the upper portion of the housing 12.

The channel 18 (Figure 1) defines a longitudinally extending path through which a currency note is propelled. The currency note is inserted into a bezel 20 (Figure 1) which has converging upper and lower surfaces shown in phantom lines for feeding the note into the channel 18. The note is propelled through the channel by resiliently biased, opposing pairs of upper and lower rollers 22. The rollers extend into the channel 18 through slots formed in the plates 14 and 16 and are mounted on axles 24 (Figures 2 and 3). The axles each have pulleys such as 26 (Figure 3) mounted on the ends thereof. An endless belt 28 (Figures 1 and 2) engages each of the pulleys 26, one of which is mounted on the drive shaft of an electric motor 30. The motor 30 is energized to drive the rollers and propel the note longitudinally through the channel 18 from left to right in Figures 1 and 2.

A note 32 is shown in phantom lines in Figure 3 positioned within the channel 18 defined between the plates 14 and 16. By way of example, the motor 30 may be a normal-slip AC motor which generates a transport speed of approximately 21.6 centimeters per second at 60 Hz. The channel 18 may have a height of approximately one millimeter.

A small plastic hook 34 (Figure 1) extends downward into the rear portion of the channel 18 through a hole in the upper plate 14. This hook does not impede forward movement of the note 32 (left to right in Figure 1) but will prevent the note from being pulled rearwardly out of the apparatus (right to left in Figure 1) with a string after the note has been "cashed".

Preferrably, the transport means is capable of accommodating the various widths of currency notes used around the world. For example, one of the largest currency notes is the Hong Kong ten dollar note, which is 84 millimeters wide. The upper and lower plates 14 and 16 may be fabricated with a channel having this width. Lesser width notes can then be handled by mounting guide rails (not shown) at appropriate locations on either side of the channel, and by substituting a different entrance bezel having a throat with the appropriate width.

Figure 3 illustrates the optical scanning station 36 which is positioned intermediate the length of the channel 18. The optical scanning station includes an optical block 38 mounted in a transversely extending aperture 40 formed in the upper plate 14. The optical block 38 serves as a mounting platform for the emitter means and the detector

means utilized in making the optical reflectance and optical opacity measurements which are preformed by the apparatus. Preferably, the optical block is mounted so that it can be adjusted up and down by means of spring
5 loaded screws (not shown). This will enable the block to be lowered sufficiently to produce a smoothing and flatening effect on the note, without increasing the likelihood of a jam.

As the note 32 (Figure 3) is propelled beneath the
10 optical scanning station 36, optical reflectance readings are taken along three laterally spaced tracks 42, 44 and 46 (Figure 6) down the length of the note. As explained hereafter in greater detail, each of the tracks is formed of a plurality of circular sample areas 48 which are
15 momentarily illuminated by the pulsing of corresponding emitter means mounted in the optical block 38. The circular sample areas 48 in each track overlap each other since the pulse time is extremely short in comparison to the speed of movement of the note 32.

20 The construction of the optical block 36 is illustrated in Figures 3-5. Three laterally spaced vertical tunnels 50, 52 and 54 (Figure 3) extend through the optical block 38. Two inclined tunnels 56 and 58 (Figure 5) converge and intercept the lower end of the
25 center vertical tunnel 52. Two inclined tunnels 60 and 62 (Figure 4) converge and intercept the lower end of the end one of the vertical tunnels 50. Two inclined tunnels also converge and intercept the lower end of the other vertical

tunnel 54. In addition, inclined tunnels 64 and 66 (Figure 3) converge and intercept the lower ends of the vertical tunnels 50 and 54. respectively.

Three separate photodetectors 68, 70 and 72 (Figure 3) are each mounted in corresponding ones of the vertical tunnels 50, 52 and 54 in the optical block 38 and are oriented for receiving radiation reflected from the lower plate 16 or the note 32 beneath the optical block. Preferably, the photodetectors are PIN diodes operated in the photoconductive mode.

Light emitting diodes (LEDs) 74 (Figures 3-5) are mounted in each of the inclined tunnels which extend through the optical block 38. They illuminate the note 32 (Figure 6) along the three tracks 42, 44 and 46 as the note is propelled past the optical scanning station 36. Two LEDs 74 simultaneously illuminate the note along the center track 44. At a different time three LEDs 74 simultaneously illuminate the track 42. Thereafter three LEDs 74 simultaneously illuminate the track 46. Preferably, the LEDs 74 each illuminate the note at an angle of between approximately 25 degrees and 40 degrees. The LEDs on a given track preferably have their optical output intensities matched to within 25 percent. It will be understood that when the LEDs 74 for a particular track are pulsed with a suitable drive signal, they will illuminate a circular area 48 (Figure 6) on the note. At the same time, the particular pin diode associated with that track will receive radiation reflected from that circular area on the note and provide an output or read signal whose amplitude represents the intensity of the reflected radiation.

Special inks are used in the production of most currency notes, and their reflectances at a particular point in the spectrum are difficult to duplicate in printed counterfeit notes or photocopies. Preferably, the LEDs for a particular track illuminate the note in a preselected narrow spectral range. In addition, it is preferable for different tracks on the note to be illuminated with radiation in the visible and infrared ranges. By way of example, where the note validator apparatus is configured to validate a British one pound currency note, infrared LEDs with a peak wave length of approximately 940 nanometers may be used on the two outside tracks. "Green" LEDs with a peak spectral output at approximately 565 nanometers may be used on the center track 44.

Each of the LEDs emits radiation in a very narrow spectral range. When the LEDs for a track are pulsed with a suitable drive signal, the amplitude of the read signal generated by the associated pin diode represents a reflectance image of a particular circular sample area 48 on the note at a particular point in the spectrum. In order to achieve sufficient intensity of illumination, preferably all of the diodes associated with a particular track are pulsed simultaneously. The light is reflected upward from the surface of the note to the associated pin diode located directly above the sample area of illumination. In addition, the diodes for the respective tracks are pulsed sequentially so that the tracks are separately illuminated. Thus, for example, the center one of the pin diodes will receive only reflected radiation originating from the center ones of the LEDs 74 and not

from the LEDs mounted at either end of the optical block 38. Each one of the pin diodes generates read signals indicating the optical reflectance of a sample area on the note at a particular point in the spectrum. The design of the apparatus must be such that a minimum amount of stray light reaches the transport channel 18 at the optical scanning station 36 where the optical measurements are performed.

Tests have indicated that a circular sample area having a diameter of approximately five millimeters is sufficiently large to reduce scatter in the readings due to pattern registration variations, yet is small enough to provide sufficient optical resolution for gross pattern recognition. In the case of a British one pound note, a total of approximately 120 optical reflectance readings may be taken on each of the tracks 42, 44 and 46. The LED pulse time may be approximately 200 microseconds, for example. The distance travelled by the note during the 200 microsecond pulse time is negligible compared to the total sample area.

The currency note validator apparatus 10 is further provided with means for taking a plurality of opacity readings on the note. In the illustrated embodiment, optical transmission measurements are taken along the center track 44 only. This is done in addition to the optical reflectance readings which are taken along all three tracks. To facilitate the taking of opacity readings, a single infrared emitting diode 76 (Figure 3) is mounted in a cylindrical housing 78 formed on the underside of the lower plate 16. Infrared radiation emitted from the

diode 76 is transmitted through an aperture 80 in the center of the lower plate 16 and through the central hole of a plastic reference surface ring 82. This infrared radiation passes through the center track 44 on the note 32 and is received by the pin diode 70 mounted directly above the infrared emitting diode 76. The reference surface ring 82 is mounted in a circular recess formed in the lower plate 16 so that it is flush with the upper surface of that plate and does not impede forward movement of the currency note.

The infrared emitting diode or IRED 76 (Figure 3) and the pin diode 70 are initially used to detect the leading edge of the note at the scanning station 36. In addition, by pulsing the infrared emitting diode with a suitable drive signal in an appropriate sequence during the collection of the reflectance read signals generated by the pin diodes, transmission or opacity readings can be made along the center track of the note. When the infrared emitting diode 76 is pulsed, the amplitude of the signal generated by the pin diode 70 provides an indication of the amount of radiation transmitted through the note at that particular point.

Reference surface disks 84 and 86 (Figure 3) are also flushly mounted in the lower support plate 16 directly beneath the pin diodes 68 and 72. The location of the reference surface ring 82 and of the reference surface disks 84 and 86 is also illustrated in Figure 2. Preferably, they are made of a durable, white colored plastic material such as that sold under the trademark DELRIN. The reference surfaces are utilized in a self-

calibration procedure performed by the apparatus which is described hereafter in greater detail. When a note is not present at the optical scanning station 36, the LEDs for the tracks are sequentially pulsed and the radiation emitted thereby is reflected back to the pin diodes by corresponding ones of the white reference surfaces 82, 84 and 86. The reference signals generated by the pin diodes are then compared with stored data and the gain of certain amplifiers which generate the LED drive signals is adjusted.

The detailed reflectance spectrum of the reference surfaces is not critical since they are used only to adjust the LED drive currents. The reference surfaces are not directly involved in the analysis of the reflectance data from a note. The reflecting surfaces of the reference ring 82 and of the reference disks 84 and 86 are preferably bead blasted in order to provide non-specular reflection.

The currency note validator apparatus of the present invention is further provided with means for measuring the length of the note. The note length measurement is performed by timing the passage of the leading edge of the note from the scanning station to an exit sensor 88 (Figure 2), and by timing the complete passage of the full length of the note under the scanning station. The ratio of these two time periods, multiplied by the known distance from the scanning station to the exit sensor yields the length of the note. The result is compared with upper and lower limits stored in a program memory as hereafter described. The exit sensor 88 may consist of an infrared emitting diode (not shown in Figure 1-5) mounted in the lower plate

16 and transmitting radiation to a phototransistor (not shown in Figures 1-5) mounted directly above in the plate 16.

5 An entrance sensor 90 (Figure 2) may be mounted at the forward end of the transport means. It detects the leading edge of the note to indicate the insertion of a note. A sensor 92 (Figure 1) detects pivotal movement of the hook 34 to indicate that a note has passed the hook. The sensors 90 and 92 may also comprise IRED-phototransistor
10 pairs.

Figure 7 illustrates a functional block diagram of the electronic control of the currency note validator apparatus 10. It includes a microprocessor 100 which may be an INTEL 8039 microprocessor. The microprocessor is provided with
15 an external RAM 102 for optical data storage. The RAM 102 may comprise two P 2114-3 RAM chips providing 1K bytes of memory. The microprocessor 100 is also provided with a permanent memory in the form of an EPROM 1204 for storing the operational program of the apparatus hereafter
20 described. By way of example, the EPROM 104 may comprise two type B 2716-1 EPROM chips providing 4K bytes of program memory. A type 74LS273 latch chip (not shown) may be used as an interface between the microprocessor 100 and the memories 102 and 104.

25 LED driver and read circuitry 106 (Figure 7) is utilized by the microprocessor 100 for selecting and driving the LEDs, and for amplifying the PIN diode outputs. A digital to analog converter or DAC 108 is used by the microprocessor to adjust the amplitude of the LED drive
30 currents. A decoder 109 hereafter described in conjunction

with Figure 8 is utilized by the microprocessor to sequentially pulse the LEDs for each track. The outputs from the PIN diodes are amplified and then passed through an analog to digital converter or ADC 110 and a decoder 112 to the microprocessor. The microprocessor performs the analysis of the data hereafter described which is necessary to determine whether the note can pass the optical reflectance and optical opacity tests. The DAC 108 may be a type mc 1408 chip. The ADC 110 may be a type ADC 808 chip.

The microprocessor 100 may be provided with a system communications interface 114 (Figure 7) for enabling the currency note validator to communicate with and respond to commands from the central controller of a larger system incorporating the validator apparatus. For example, in an automatic ticket dispensing machine for a mass transit system, the currency note validator apparatus may be one module which operates with other modules in the ticket dispensing operation. All of the modules may be controlled by a central controller in the form of a microprocessor. By way of example, where the microprocessor 100 of the currency note validator apparatus 10 is an INTEL 8039 microprocessor, pins P14-P17 along with the interrupt pin are available for external communications. In simpler applications, separate high-low output signals on these pins may represent status conditions such as "note being checked", "note valid", "note cashed", and "out-of-service". Input signals may represent "cash note", "reject

note", or "block all notes" commands. In more sophisticated applications, a software USART with two-way communications capability can be provided.

5 The electronic circuitry of the illustrated embodiment of the currency note validator further includes motor control circuitry 116 (Figure 7) which enables the microprocessor 100 to operate the motor 30 (Figure 2) of the transport means as required to propel the note. By way of example, the motor control circuitry may include two
10 solid state relays (not shown) for activating the motor in either the forward or reverse direction. These relays may be controlled by the microprocessor. The motor is energized to propel the ticket forwardly past the optical scanning station in order to perform the optical and size
15 tests necessary to determine if the note is valid. If an invalid note is determined, the motor is driven in the reverse direction to eject the note out of the entry bezel
20.

Finally, the control circuit of the note validator
20 apparatus includes a plurality of malfunction indicators 118. As described hereafter in greater detail, during and idle cycle of the apparatus. i.e., when no note is present in the transport means, the microprocessor continuously checks for system malfunctions. Upon locating a system
25 malfunction, an indication of the particular malfunction is given on a display which may comprise a plurality of LEDs (not shown) mounted on a panel secured to the housing 12 of the apparatus. There may be four such LEDs. By flashing certain ones of these LEDs according to a code, a specific
30 malfunction may be indicated. If an INTEL 8039

microprocessor is used, a 75LS175 chip may provide the interface required between the microprocessor and the four indicator LEDs. When a system malfunction is located by the microprocessor, the microprocessor places the currency note validator apparatus out-of-service, indicating such a status condition through the systems communications interface 114. At the same time, the nature of the malfunction may be displayed by the malfunction indicators 118.

The decoder 109 (Figure 7) may include a type 74LS174 chip (not shown) and six AND gates 120 (Figure 8). The inputs of each AND gate are connected. The outputs of the AND gates are connected to the bases of corresponding NPN bipolar junction transistors 122. The AND gates 120 and the transistors 122 may be provided in the form of type 75452 chips. This provides a convenient two switch package. The gates 120 thus do not technically function as AND gates. The input leads 124 to the gates 120 may be connected to the respective Q pins of the aforementioned 74LS174 latch chip. The box in Figure 8 labelled LED/PIN diode circuitry in Figure 8 is shown schematically in Figure 9. The collectors of the bipolar transistors 122 (Figure 8) are each connected through resistors 126 to the emitters of corresponding NPN bipolar junction transistors 128a through 128f. The collectors of the transistors 128a, 128b and 128c are connected through leads 130, 132 and 134 to the LEDs 74 (Figure 9) which illuminate the tracks 42, 44 and 46 on the currency note, respectively. The lead 136 (Figure 9) is connected to a source of supply voltage $V+$ which in the illustrated embodiment is +12 volts. The

collector of the bipolar transistor 128e is connected to the infrared emitting diode 76 through a lead 138 (Figure 9).

5 The bases of the transistors 128a-f (Figure 8) are connected to the output of an op amp 140. The inverting input of this op amp is connected through a lead 142 to the output of the DAC 108. The microprocessor 100 controls the gain of the op amp 140 via the DAC 108 and thereby adjusts the amplitudes of the drive currents provided by the transistors 128a-f. The output of the op amp 140 is applied to the bases of each of the drive transistors 128a-f. These transistors are turned on in sequence by the microprocessor utilizing the decoder 109 (Figure 7) which includes the previously mentioned 74LS174 latch chip and the switches 120 and 122.

15 As previously mentioned, the sensors 88, 90 and 92 (Figures 1 and 2) detect the leading edge of note and the position of the hook 34. As illustrated in Figure 8, each of these sensors may consist of a separate infrared emitting diode (IRED) such as 88a and a phototransistor such as 88b. The collectors of the driver transistors 128d and 128f are connected to one side of the IREDs 90a and 88a respectively. The other sides of these IREDs are connected to a supply voltage V+. The third one of the IREDs 92a is connected between ground and V+. The emitters of each of the phototransistors 88b, 90b and 92b are connected to a supply voltage V- and the collectors of these phototransistors are connected to the inverting inputs of corresponding op amps 144, 146 and 148. The positive or non-inverting inputs of these op amps are connected to

ground. The output leads 150, 152 and 154 of the op amps 144, 146 and 148, respectively, are connected to the ADC 110 (Figure 7). The output from each of the phototransistors 88b, 90b and 92b is amplified and then
5 passed through a corresponding channel of the ADC to the microprocessor 100 for interpretation. Thus, for example, when the leading edge of the note reaches the location of the IRED-phototransistor pair 90 (Figure 2), this is detected by the microprocessor. The same is also true when
10 the leading edge of the note reaches the IRED-phototransistor pair 88 at the exit of the transport means. Also, when the hook 34 pivots up and backwardly, this breaks the beam of the IRED-phototransistor pair 92 (Figure 1) which is indicated to the microprocessor by signals
15 generated by the op amp 148 (Figure 8).

Details of the LED/PIN diode circuitry block of Figure 8 are illustrated in Figure 9. The PIN diodes 68, 70 and 72 detect the radiation reflected by the note by the reference surfaces. The PIN diodes are connected to the
20 inverting input of an op amp 158 whose output lead 160 is in turn connected to the inverting inputs of op amps 162 and 164 (Figure 8) through resistors 166 and 168. The output lead 160 (Figure 8) has successive signals generated thereon corresponding to read signals for the first, second
25 and third tracks. The output leads 170 and 172 of these op amps are connected to corresponding channels of the ADC 110 (Figure 7) which permits the microprocessor 100 to interpret the amplitudes of the read signals generated by the respective PIN diodes. A diode 174 (Figure 9) is
30 connected to the PIN diodes 68, 70 and 72 and to a voltage

source V- in order to compensate for dark current zero offset. The op amp 158 (Figure 9) may be a type TL 081 chip. The op amps illustrated in Figure 8 may be provided by TL 084 chips.

5 The resistor 168 may be 1K ohms and the resistor 166 may be 2K ohms, for example. This will make the op amp 164 a higher gain second stage amplifier with respect to the op amp 162. Thus, the op amp 164 will have sufficient gain for amplifying the outputs of the specific PIN diode which
10 receives reflected infrared radiation. The amplitudes of the output signals generated by the infrared detecting PIN diode are significantly smaller than those of the PIN diodes which receive radiation in the visible spectrum.

15 Having described the general mechanical construction and electronic control circuitry of the illustrated embodiment, its operation can now be described. As already indicated, the principal basis for testing the validity of a currency note with the apparatus involves a spectral imaging process which tests the color fidelity of the
20 note's printed design. After the note is inserted through the entry bezel into the transport, it is propelled beneath the optical scanning station where visible color and infrared reflectance readings are taken along the three tracks down the length of the note. The microprocessor
25 compares selected ones of these reflectance readings against preprogrammed acceptance band data stored in the program memory. The operational program of the apparatus automatically corrects for dirty or soiled notes, and to some extent, corrects for note-to-note pattern registration

variations. Because a large number of sample areas (for example 20 per track) are tested, a note with one or two discolored or damaged areas can still be accepted.

5 The microprocessor monitors the position detectors within the transport as the note is propelled therethrough in order to execute various portions of the operational program. For example, the position sensors are used to measure the length of the note, and to verify that the note has exited from the apparatus.

10 The use of a microprocessor in the apparatus enables the currency note validator to perform significant self-diagnostic operations during its idle cycle. The microprocessor continuously monitors the various systems within the apparatus, checking for malfunctions. If a
15 fault is discovered, the microprocessor places the apparatus out-of-service, and the nature of the fault is displayed in a code on an LED panel on the housing. Also, during the idle cycle, the microprocessor continuously checks and re-adjusts the outputs of the LEDs in the
20 optical scanning system. This self-calibration automatically compensates for the effects of component aging and dirt build up on the reference optical surfaces.

An example of an operational program for the apparatus which may be stored in the EPROM 104 (Figure 7) is set
25 forth hereafter in source listing form in Table I and is entitled "BILL VALIDATOR APPLICATIONS PROGRAM". Copyright in and to this program is claimed by the assignee of this application.

ASM48 :F1:NEWBV.SRC PRINT (:L1:) PAGEWIDTH(80) MACROFILE (:F1:) ARFF

TABLE I

CWO
PD 326

ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V3.0

PAGE 1

LOC	OBJ	LINE	SOURCE STATEMENT
		1	
		2	
		3	*****
		4	*****
		5	;
		6	BILL VALIDATOR
		7	;
		8	APPLICATIONS PROGRAM
		9	;
		10	NEWBV.SRC
		11	;
		12	MARCH 3, 1981
		13	;
		14	975-2200
		15	;
		16	*****
		17	
		18	
		19	*****
		20	;
		21	INTRODUCTION
		22	;
		23	THE SOFTWARE APPLICATIONS PROGRAM FOR THE BILL
		24	VALIDATOR MUST CONTROL ALL ASPECTS OF ITS
		25	OPERATION, INCLUDING NOTE ENTRY DETECTION,
		26	MECHANICAL TRANSPORT, OPTICAL DATA COLLECTION
		27	AND ANALYSIS, EXTERNAL COMMUNICATIONS, SELF-
		28	TESTING, AND SELF-CALIBRATION.
		29	THE MICROPROCESSOR USED IN THE BILL VALIDATOR
		30	IS THE 8239. UP TO 4K-BYTES OF ROM IS AVAILABLE
		31	FOR PROGRAM STORAGE, AND 1K-BYTES OF EXTERNAL RAM
		32	IS PROVIDED FOR STORING DATA. THE INSTRUCTION CYCLE
		33	TIME IS 1.5 MICROSECONDS.
		34	;
		35	*****
		36	\$EJECT

37

-24-

LOC	OBJ	LINE	SOURCE STATEMENT
		37	
		38	
		39	*****
		40	;
		41	RAM ASSIGNMENTS
		42	;
		43	;
		44	*****
		45	
		46	INTERNAL RAM REGISTERS:
		47	0 - 7 : WORKING REGISTERS, BANK 1
		48	8 - 23 : STACK
		49	24 - 31: WORKING REGISTERS, BANK 2
		50	32 : POS 1 ADJUSTED D/A SETTING
		51	33 : TRACK 1 ADJUSTED D/A SETTING
		52	34 : TRACK 2 ADJUSTED D/A SETTING
		53	35 : TRACK 3 ADJUSTED D/A SETTING
		54	36 : POS 4 ADJUSTED D/A SETTING
		55	37 : DIVIDE CONSTANT (=100)
		56	38 : REFERENCE READING, POSITION 1 (=30)
		57	39 : POSITION 4 REFERENCE READING (=165)
		58	40 : REFERENCE READING, POSITION 3
		59	41 : REFERENCE READING, POSITION 5
		60	42 : POS 5 ADJUSTED D/A SETTING
		61	43 : PARTIAL DATA COUNT FROM P4 TO P5 (=N; USED
		62	: FOR LENGTH CHECK AND FOR TRANSPORT SPEED
		63	: CORRECTION.)
		64	44: REMAINING DATA COUNT. ALSO, TOTAL NO OF
		65	READINGS INCLUDED IN DATA ANALYSIS
		66	(= 96% OF TOTAL DATA COUNT)
		67	45 : TOTAL DATA COUNT (=NT)
		68	46 - 47: SUBTOTAL OF READINGS, TRACK 1 (47=HIGH BYTE)
		69	ALSO, 46=AVERAGE READING, TRACK 1.
		70	48 - 49: SUBTOTAL OF READINGS, TRACK 2 (49=HIGH BYTE)
		71	ALSO, 48=AVERAGE READING, TRACK 2.
		72	50 - 51: SUBTOTAL OF READINGS, TRACK 3 (51=HIGH BYTE)
		73	ALSO, 50=AVERAGE READING, TRACK 3.
		74	52 - 53: SUBTOTAL OF READINGS, POS 4 (53=HIGH BYTE)
		75	ALSO, 52=AVERAGE READING, POS 4.
		76	54 : TRACK 1 OFFSET
		77	55 : TRACK 2 OFFSET
		78	56 : TRACK 3 OFFSET
		79	57 : POS 4 OFFSET
		80	58 : TEMPORARY STORAGE
		81	59 : POS 1 AND POS 5 OFFSET (=0)
		82	60 : TALLY OF NOTES WITH EXCESSIVE READINGS (>240)
		83	61 : TALLY OF TOTAL NUMBER OF NOTES (UP TO 100)
		84	62 : RUNNING ADDRESS WITHIN EACH PAGE
		85	63 : TEMPORARY DATA STORAGE, TRACK 1
		86	64 : TEMPORARY DATA STORAGE, TRACK 2
		87	65 : TEMPORARY DATA STORAGE, TRACK 3
		88	66 : TEMPORARY DATA STORAGE, POS 4
		89	ALSO, FLAG FOR CHANGING REVERSE ENTRY.
		90	67 - 127: TEMPORARY ACCEPTANCE BAND DATA STORAGE
		91	OBJECT

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PAGE 3

LOC	OBJ	LINE	SOURCE STATEMENT
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PAGE 4

LOC	OBJ	LINF	SOURCE STATEMENT
		92	
		93	; EXTERNAL RAM REGISTERS
		94	; 0 - 199: TRACK 1 DATA
		95	; 201 - 207: TRACK 1 ERRORS
		96	; 256 - 455: TRACK 2 DATA
		97	; 457 - 463: TRACK 2 ERRORS
		98	; 512 - 711: TRACK 3 DATA
		99	; 713 - 719: TRACK 3 ERRORS
		100	; 768 - 957: POSITION 4 DATA
		101	\$EJECT

LOC	OBJ	LINF	SOURCE STATEMENT
102			*****
103			;
104			ACCEPTANCE BAND TABLE FORMAT
105			;
106			*****
107			;
108			THE ACCEPTANCE BAND TABLES
109			REQUIRE A SEPARATE (DEDICATED) PAGE IN
110			PROGRAM MEMORY FOR EACH DIFFERENT NOTE
111			ORIENTATION CHECKED.
112			THE SUBROUTINES "ORIENX" AND "ACCBDX" FOR
113			ORIENTATION X MUST BE INCLUDED ON EACH
114			MEMORY PAGE CONTAINING AN ACCEPTANCE BAND TABLE
115			PROPER. FOR A GIVEN ORIENTATION, THE PAGE LINF
116			ASSIGNMENTS ARE AS FOLLOWS:
117			;
118			LINES:
119			;
120		6 - 38	: ORIENX SUBROUTINE (X=1,2,3,OR 4)
121			;
122		40 - 72	: ACCBDX SUBROUTINE (X=SAME AS ABOVE)
123			;
124		75	: FIRST READING LOCATION NUMBER, TRACK 1
125			;
126		76	: UPPER LIMIT FOR FIRST READING LOCATION
127			;
128		77	: LOWER LIMIT FOR FIRST READING LOCATION
129			;
130		78	: SECOND READING LOCATION NUMBER, TRACK 1
131			;
132		79	: UPPER LIMIT FOR SECOND READING LOCATION
133			;
134			.
135			.
136			.
137			;
138		135	: FIRST READING LOCATION NUMBER, TRACK 2
139			;
140			.
141			.
142			.
143			;
144		195	: FIRST READING LOCATION NUMBER, TRACK 3
145			.
146			.
147			.
148			;
149			\$FJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		150	*****
		151	;
		152	OUT-OF-SERVICE INDICATORS
		153	;
		154	*****
		155	;
		156	KEY: 1 = LED FLASHING
		157	2 = LED OFF
		158	;
		159	REASON FOR OUT-OF-SERVICE CONDITION: CODE
		160	;
		161	ENTRANCE BLOCKED, OR ENTRANCE SENSOR FAILED..1111
		162	;
		163	;
		164	POSITION SENSOR P3 FAILED... 0011
		165	;
		166	;
		167	POSITION SENSOR P5 FAILED... 0101
		168	;
		169	;
		170	REFERENCE SURFACES NEED CLEANING... 0110
		171	;(CODE IS FLASHED BUT UNIT REMAINS IN SERVICE)
		172	;
		173	;
		174	INHIBIT SIGNAL FROM HOST ELECTRONICS... 0111
		175	;
		176	;
		177	A/D CONVERTER FAILED... 1000
		178	;
		179	;
		180	RAM MALFUNCTION... 1001
		181	;
		182	;
		183	JAM (NOTE TRAPPED INSIDE UNIT)... 1010
		184	;
		185	;
		186	OPTICAL MEASUREMENTS SYSTEM FAILURE:
		187	;
		188	CHANNEL 1... 1110
		189	CHANNEL 2... 1101
		190	CHANNEL 3... 1100
		191	CHANNEL 4... 1011
		192	REJECT

LOC	OBJ	LINE	SOURCE STATEMENT	
		193	*****	
		194	;	
		195	NOTE REJECTION INDICATORS	
		196	;	
		197	*****	
		198	;	
		199	KEY: 1 = LED ON	
		200	0 = LED OFF	
		201	;	
		202	REASON FOR REJECTION	CODE
		203	;	
		204	NOTE VALID, BUT "CASH" INSTRUCTION FROM	
		205	HOST NOT RECEIVED WITHIN 6 SECONDS...	0110
		206	;	
		207	;	
		208	NOTE VALID, BUT "REJECT" INSTRUCTION WAS	
		209	RECEIVED FROM HOST...	0010
		210	;	
		211	;	
		212	SECOND NOTE ENTERED BEFORE FIRST NOTE WAS	
		213	CASHED...	0011
		214	;	
		215	;	
		216	EXIT BLOCKER NOT CLEAR AFTER CASH ATTEMPT...	1011
		217	;	
		218	;	
		219	VERY SHORT PAPER DETECTED...	0100
		220	;	
		221	;	
		222	POTENTIAL JAM DETECTED...	1010
		223	;	
		224	;	
		225	NOTE FAILED LENGTH TEST...	0111
		226	;	
		227	;	
		228	NOTE FAILED OPACITY TEST...	1000
		229	;	
		230	;	
		231	NOTE FAILED SPECTRAL REFLECTANCE TEST...	1001
		232	;	
		233	REJECT	

LOC	OBJ	LINE	SOURCE STATEMENT
		234	*****
		235	;
		236	NOTE IDENTIFICATION CODES
		237	;
		238	*****
		239	;
		240	DENOMINATION CODE
		241	;
		242	U.S. \$1... 0001
		243	;
		244	U.S. \$5... 0101
		245	;
		246	BANK OF ENGLAND #1... 1110
		247	;
		248	*****
		249	;
		250	EQUATES
		251	;
		252	;
		253	*****
		254	;
		255	;
0001		256	CHAN1 EQU 1 ;CHANNEL 1
		257	;
0002		258	CHAN2 EQU 2 ;CHANNEL 2
		259	;
0003		260	CHAN3 EQU 3 ;CHANNEL 3
		261	;
0004		262	CHAN4 EQU 4 ;CHANNEL 4 (POS 3 : EXIT FLOCKER)
		263	;
0005		264	CHAN5 EQU 5 ;CHANNEL 5
		265	;
0006		266	CHAN6 EQU 6 ;CHANNEL 6 (POS 1 : ENTRANCE)
		267	;
0007		268	CHAN7 EQU 7 ;CHANNEL 7 (POS 5 : EXIT)
		269	;
000A		270	BLOK EQU 10 ;BAD OPTICS REF
		271	;
003C		272	OPL01 EQU 60 ;CALIBRATE REF TRAK 2
		273	;
0040		274	OPL0 EQU 64 ;CALIBRATE PFF TRAK 1 S 3
		275	;
00C8		276	LIMIT EQU 200 ;CALIBRATE REF CHAN 4
		277	;
0090		278	NOLFD EQU 000H ;NO OPTICAL BLOCK LFD ON
		279	;
0023		280	FIRST EQU 43 ;ADDR OF 1ST DATA CNT
		281	;
002C		282	SECND EQU 44 ;ADDR OF 2ND DATA CNT
		283	;
0026		284	POS1 EQU 38 ;ADDR OF POS 1 REF RDNG
		285	;
		286	;
002E		287	POS3 EQU 40 ;ADDR OF POS 3 REF RDNG
		288	;

LOC	OBJ	LINE	SOURCE STATEMENT
0027		289 POS4 EQU 39	:ADDR OF POS 4 REF RDNG
		290	
0029		291 POS5 EQU 41	:ADDR OF POS 5 REF RDNG
		292	
003C		293 EXCLIM EQU 60	:ADDR OF >245 TALLY
		294	
003F		295 PAGADD EQU 62	:ADDR OF PAGE ADDR
		296	
002E		297 SBTOT1 EQU 46	:ADDR OF TRAK 1 TOTAL
		298	
0030		299 SBTOT2 EQU 48	:ADDR OF TRAK 2 TOTAL
		300	
0032		301 SBTOT3 EQU 50	:ADDR OF TRAK 3 TOTAL
		302	
0034		303 SBTOT EQU 52	:ADDR OF POS 4 TOTAL
		304	
0042		305 TEMP EQU 66	:ADDR OF TEMP POS 4
		306	
003F		307 TEMP1 EQU 63	:ADDR OF TEMP TRAK 1
		308	
0040		309 TEMP2 EQU 64	:ADDR OF TEMP TRAK 2
		310	
0041		311 TEMP3 EQU 65	:ADDR OF TEMP TRAK 3
		312	
00A0		313 JAM LIM EQU 160	:MAX NO OF READINGS BEFORE JAM
		314	:CALLED
		315	
003D		316 N0 EQU 61	: "NORMAL" NO. OF READING
		317	: CYCLES COMPLETED DURING
		318	: PASSAGE OF THE LEADING
		319	: EDGE OF A NOTE FROM P4
		320	: TO P5. (MUST BE DETERMINED
		321	: EMPIRICALLY)
		322	
0014		323 NCOLOR EQU 20	: NO. OF LOCATIONS CHECKED PER
		324	: TRACK (MAXIMUM = 20).
		325	
0003		326 FRRCT EQU 3	: MAXIMUM NUMBER OF COLOR ERRORS
		327	: ALLOWED PER TRACK.
		328	
0030		329 L2 EQU 176	: UPPER LIMIT FOR LENGTH CHECK
		330	
		331	
00A3		332 L1 EQU 163	: LOWER LIMIT FOR LENGTH CHECK
		333	
0043		334 OPLIM EQU 67	: LOWER LIMIT FOR TRACKEA
		335	
		336 \$EJECT	

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LOC	OBJ	LINE	SOURCE STATEMENT
		337	
		338	*****
		339	
		340	EXEC
		341	
		342	(MAIN PROGRAM FLOW)
		343	
		344	*****
		345	
		346	THIS ROUTINE CONTROLS THE SEQUENCE OF STEPS IN THE
		347	PROCESSING OF A NOTE. AT THE END OF EACH STEP
		348	SUCCESSFULLY COMPLETED, P0 IS SET, AND THE PROGRAM
		349	JUMPS TO THE NEXT STEP. IF A STEP IS NOT SUCCESSFULLY
		350	COMPLETED, P0 IS CLEARED, THE "JECT" SUBROUTINE IS
		351	CALLED, AND THE PROGRAM JUMPS BACK TO "START" AND
		352	RESETS THE UNIT FOR ANOTHER NOTE.
		353	THE PROGRAM THEN REMAINS IN THE "IDLE" CYCLE UNTIL
		354	A NOTE IS DETECTED AT THE ENTRANCE OF THE UNIT.
		355	
0000		356	ORG 0
		357	
0000 040A		358	JMP EXEC
0003		359	ORG 3
		360	
0003 15		361	DIS 1
0004 040A		362	JMP EXEC
		363	
0F0A		364	ORG 10
		365	
000A 548A		366	EXEC: CALL INIT ;INITIALIZE SYSTEM.
000C 7452		367	CALL RESET ;RESET POS SENSORS.
000E 7485		368	START: CALL RST ;RESET REQUIRED REGISTERS FOR
		369	NEXT NOTF.
0010 7499		370	CALL CKG245 ;CHKCK FOR HIGH READINGS
		371	RESULTING FROM DIRTY
		372	REFERENCE SURFACES. IF
		373	SURFACES NFFD CLEANING, GO
		374	OUT-OF-SERVICE.
0012 341D		375	CALL READY ;OUTPUT "READY" STATUS TO
		376	HOST ELECTRONICS.
0014 54C5		377	CALL IDLE ;CHECK RAM; CHECK POSITON
		378	SENSORS;
		379	CALIBRATE PFAD OPTICS; CHECK
		380	FOR
		381	"INHIBIT" SIGNAL FROM HOST. IF
		382	A FAULT IS DISCOVERED, GO OUT-
		383	OF-SERVICE
		384	CHKCK ENTRANCE. IF A NOTE IS
		385	DETECTED, EXIT ROUTINE;
		386	OTHERWISE
		387	REPEAT CYCLE.
0016 74C2		388	CALL JITDEL ;100 MS JITTER DELAY; THEN TURN
		389	ON MOTOR
0018 361C		390	JF0 GO1 ;IF NOTE STILL PRESENT.
001A 040E		391	JMP START

LOC	OBJ	LINE	SOURCE STATEMENT
001C	5412	392	G01: CALL BILLIN ;ALLOW 3 SECONDS FOR NOTE TO
		393	;BE PULLED IN AND REACH P4.
		394	;OTHERWISE, CLEAR F0
		395	;AND TURN OFF MOTOR.
001E	B622	396	JF0 G02
0020	040E	397	JMP START
0022	B41A	398	G02: CALL BUSY ;OUTPUT "BUSY" SIGNAL TO HOST.
0024	347D	399	CALL READ ;COLLECT AND STORE OPTICAL DATA.
0026	B62C	400	JF0 G05
0028	944C	401	CALL EJECT ;IF JAM IS DETECTED DURING THE
		402	;READ
002A	040E	403	JMP START ;OPERATION
002C	3630	404	G05: JF0 G06 ;JUMP IF UNIT IS SET FOR "AUTO-
		405	;CASING" OF VALID NOTES.
002E	B906	406	ORL P1,#00EH;TURN OFF MOTOR.
0030	14D6	407	G06: CALL LNGTH ;CHECK NOTE LENGTH.
0032	B638	408	JF0 G07
0034	944C	409	CALL EJECT ;IF TEST IS FAILED.
0036	040E	410	JMP START
0038	D418	411	G07: CALL TRANRA ;CHECK OPACITY RATIO
		412	;ON CENTER TRACK.
003A	B640	413	JF0 G08
003C	944C	414	CALL EJECT ;IF TEST IS FAILED.
003E	040E	415	JMP START
0040	B46E	416	G08: CALL COLRCK ;CHECK COLOR REFLECTANCE ON
		417	;THREE TRACKS FOR ALL
		418	;ORIENTATIONS.
0042	B648	419	JF0 G09
0044	944C	420	CALL EJECT ;IF TEST IS FAILED
0046	040E	421	JMP START
0048	B481	422	G09: CALL VALID ;OUTPUT "NOTE_VALID" SIGNAL TO
		423	;HOST; AWAIT "CASH" INSTRUCTION
		424	;FROM HOST.
004A	B650	425	JF0 G010
004C	944C	426	CALL EJECT ;IF "CASH" INSTRUCTION NOT
		427	;RECEIVED.
004E	040E	428	JMP START
0050	B436	429	G010: CALL CASH ;TURN ON MOTOR AND CASH NOTE.
0052	B60F	430	JF0
0054	944C	431	CALL EJECT ;IF JAM OR SECOND NOTE DETECTED
0056	040E	432	JMP START ;DURING CASH.
		433	;EJECT



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LOC	OBJ	LINE	SOURCE STATEMENT
		434	*****
		435	;
		436	AVREAD
		437	;
		438	(COMPUTE AVERAGE READINGS)
		439	;
		440	*****
		441	;
		442	THIS ROUTINE COMPUTES THE AVERAGE READING FOR EACH
		443	OPTICAL CHANNEL AND STORES THE RESULTS IN INTERNAL
		444	RAM.
		445	;
		446	REGISTERS USED:
		447	;
		448	R0 = POINTER TO READING TOTALS R3 = MODIFIED
		449	R1 = POINTER TO DIVISOR R6 = CHANNEL COUNTER
		450	R2 = UPPER 8-BITS
		451	;
0058	34C5	452	AVREAD: CALL SUMTOT
005A	B92C	453	MOV R1,#44 ;SET R1 AS POINTER TO DIVISOR
005C	BE04	454	MOV R6,#4
005E	BE35	455	MOV R0,#53 ;START WITH CHANNEL 4
0060	F0	456	ALOOP: MOV A,R0 ;GET UPPER 8 BITS OF READING
		457	;
		458	MOV R2,A ;TOTAL
0061	AA	459	DEC R0
0062	C8	460	MOV A,R0 ;GET LOWER 8 BITS OF READING
0063	F0	461	;
		462	CALL DIVIDE
0064	149F	463	MOV R0,A ;STORE RESULT AS AVERAGE READING
0066	A0	464	DEC R0
0067	C8	465	DJNZ R6,ALOOP;NEXT CHANNEL ?
0068	EE60	466	RET
006A	93	467	\$EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		469	*****
		469	;
		470	MULPLY
		471	;
		472	(MULTIPLY)
		473	;
		474	*****
		475	;
		476	THIS ROUTINE PROVIDES AN UNSIGNED 8 BIT X 8 BIT
		477	MULTIPLICATION.
		478	;
		479	!AT ENTRY:
		480	;
		481	A = MULTIPLICAND
		482	R0 = POINTER TO MULTIPLIER AN INTERNAL RAM
		483	;
		484	!AT EXIT:
		485	;
		486	A = LOWER 8 BITS OF RFSUIT
		487	R2 = UPPER 8 BITS OF RESULT
		488	R3 = MODIFIED
		489	C = SET IF OVERFLOW
		490	;
0063	BA00	491	MULPLY: MOV R2,#00
006D	BB00	492	MOV R3,#5
		493	;
006F	1279	494	MPYSLP: JBO MPYSA
0071	2A	495	XCH A,R2
0072	97	496	CLR C
0073	67	497	RRC A
0074	2A	498	XCH A,R2
0075	67	499	RRC A
0076	EB6F	500	DJNZ R3,MPYSLP
0078	53	501	RET
		502	;
0079	2A	503	MPYSA: XCH A,R2
007A	60	504	ADD A,C#0
007B	57	505	RRC A
007C	2A	506	XCH A,R2
007D	67	507	RRC A
007E	EB6F	508	DJNZ R3,MPYSLP
0080	53	509	RET
		510	\$EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		511	*****
		512	;
		513	NORMDA
		514	;
		515	(NORMALIZE DATA)
		516	;
		517	*****
		518	;
		519	;
		520	; THIS ROUTINE NORMALIZES THE DATA READINGS FOR CHANNELS
		521	; 1-3, AND STORES THE NORMALIZED READINGS IN PLACE OF
		522	; THE RAW READINGS.
		523	;
		524	; REGISTERS USED:
		525	;
		526	R0 = POINTER TO INDIVIDUAL READINGS
		527	R1 = POINTER TO AVERAGE READING
		528	R6 = DATA COUNTER
		529	R5 = TRACK SELECTOR
		530	;
0081	B92C	531	NORMDA: MOV R1, #44
0093	F1	532	MOV A, R1
0084	AE	533	MOV R6, A
0095	BD03	534	MOV R5, #3
0057	B932	535	MOV R1, #50 ; START WITH CHANNEL 3
		536	;
0069	FF	537	LP1: MOV A, R6
008A	A8	538	MOV R0, A
005B	FD	539	MOV A, R5
009C	07	540	DEC A
009D	3A	541	OUTL P2, A ; SEND RAM PAGE NUMBER.
		542	;
008F	90	543	LP2: MOVL A, R0 ; GET READING.
009F	97	544	CLR C
0090	67	545	RRC A
0091	AA	546	MOV P2, A ; SET UP FOR DIVISION WITH
0092	27	547	CLR A ; READING MULTIPLIED BY 128.
0093	67	548	RRC A
0094	149F	549	CALL DIVIDE ; NORMALIZE READING.
0096	90	550	MOVL R0, A ; PUT NORMALIZED READING BACK
0097	F88E	551	DJNZ R0, LP2
0099	C9	552	DEC R1
009A	C9	553	DEC R1 ; GO TO NEXT CHANNEL.
009B	ED89	554	DJNZ R5, LP1
009D	33	555	RET
		556	*****
		557	;
		558	DIVIDE
		559	;
		560	;
		561	;
		562	*****
		563	;
		564	; THIS ROUTINE DIVIDES A 16-BIT DIVIDEND BY AN
		565	; 8 BIT DIVISOR TO OBTAIN AN 8-BIT RESULT

LOC	OBJ	LINE	SOURCE STATEMENT
		566	;PLUS 8 BIT REMAINDER.
		567	
		568	;AT ENTRY:
		569	
		570	; A = LOWER 8 BITS OF DIVIDEND
		571	; R2 = UPPER 8 BITS OF DIVIDEND
		572	; R1 = POINTER TO DIVISOR IN INTERNAL RAM
		573	
		574	;AT EXIT:
		575	
		576	; A = 8 BIT RESULT
		577	; R2 = 8 BIT REMAINDER
		578	; R3 = MODIFIED
		579	; C = SET IF OVERFLOW
		580	
009E	2A	581	DIVIDE: XCH A,R2
009F	BE08	582	MOV R3,#8
00A1	37	583	CPL A
00A2	61	584	ADD A,0P1
00A3	37	585	CPL A
00A4	F6A9	586	JC DIVIA
00A6	A7	587	CPL C
00A7	04C2	588	JMP DIVIB
		589	
00A9	51	590	DIVIA: ADD A,0R1
		591	
00AA	97	592	DIVILP: CLR C
00AB	2A	593	XCH A,R2
00AC	F7	594	RLC A
00AD	2A	595	XCH A,R2
00AE	F7	596	RLC A
00AF	ECB6	597	JNC DIVIF
00B1	37	598	CPL A
00B2	61	599	ADD A,0R1
00B3	37	600	CPL A
00B4	04BE	601	JMP DIVIC
		602	
00B6	37	603	DIVIE: CPL A
00B7	61	604	ADD A,0R1
00B9	37	605	CPL A
00B9	F6BF	606	JNC DIVIC
00BB	61	607	ADD A,0R1
00BC	04BF	608	JMP DIVID
		609	
00BE	1A	610	DIVIC: INC R2
		611	
00BF	EBAA	612	DIVID: DJNZ R3,DIVILP
00C1	97	613	CLR C
		614	
00C2	2A	615	DIVIB: XCH A,R2
00C3	53	616	RET
		617	SEJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		618	*****
		619	;
		620	SPCK
		621	;
		622	(SPEED CHECK)
		623	;
		624	*****
		625	;
		626	THIS ROUTINE COMPARES N WITH N0. IF N IS WITHIN 1 OF
		627	N0, THEN FLAG F1 IS SET, INDICATING THAT THE READING
		628	LOCATION NUMBERS DO NOT NEED TO BE CORRECTED FOR
		629	TRANSPORT SPEED VARIATION.
		630	;
		631	REGISTERS USED: R1
		632	;
00C4	A5	633	SPCK: CLR F1
00C5	B92B	634	MOV R1,#43 ;RAM ADDRESS OF N
00C7	233D	635	MOV A,#N0
00C9	97	636	CLR C
00CA	37	637	CPL A
00CB	07	638	DEC A
00CC	E1	639	ADD A,R1
00CD	F6D4	640	JC SPC
00CF	0303	641	ADD A,#003H
00D1	E6D4	642	JNC SPC
00D3	B5	643	CPL F1
00D4	E0	644	SPC: NOP
00D5	83	645	RET
		646	*****
		647	;
		648	LNGTCK
		649	;
		650	(LENGTH CHECK)
		651	;
		652	*****
		653	;
		654	THIS ROUTINE FIRST DETERMINES THE TOTAL DATA COUNT
		655	(OVER THE FULL LENGTH OF THE NOTE) AND STORES
		656	THE RESULT IN REG. 45. THE ROUTINE THEN
		657	MULTIPLIES THE TOTAL DATA COUNT BY A SCALING
		658	FACTOR OF 80, AND THEN DIVIDES THIS RESULT BY
		659	THE NUMBER OF READINGS TAKEN AS THE LEADING
		660	EDGE OF THE NOTE TRAVELS FROM P4 TO P5.
		661	THE FINAL RESULT IS TESTED AGAINST
		662	UPPER AND LOWER LIMITS TO DETERMINE LENGTH
		663	ACCEPTABILITY. IF THE NOTE PASSES THE TEST,
		664	F0 IS SET
		665	;
		666	REGISTERS USED:
		667	;
		668	R0 = POINTER TO N AND NT R3 = MODIFIED
		669	R1 = POINTER TO N R4 = MODIFIED
		670	R2 = UPPER 8-BITS OF PRODUCT R7 = LENGTH PARAMETER
		671	R45 = TOTAL NO. OF READINGS
		672	;

LOC	OBJ	LINE	SOURCE STATEMENT
00D6	B62B	673	LNCTCK: MOV R0,#43
00D8	F0	674	MOV A,GR0 ;GET PARTIAL DATA COUNT
00D9	18	675	INC R0
00DA	60	676	ADD A,GR0 ;ADD REMAINING DATA COUNT
00DB	18	677	INC R0
00DC	A0	678	MOV GR0,A ;STORE RESULT
00DD	85	679	CLR F0
00DE	2350	680	MOV A,#80
00E0	146B	681	CALL MULPLY ;MULTIPLY NT X 80
00E2	B92B	682	MOV R1,#43
00F4	149E	683	CALL DIVIDE ;DIVIDE NT Y 80 BY N
00E6	AF	684	MOV R7,A ;SAVE RESULT IN R7
00F7	23B0	685	MOV A,#L2 ;INPUT UPPER LIMIT FOR LENGTH
		686	;ACCEPTANCE
00E9	37	687	CLR C
00EA	37	688	CPL A
00EB	6F	689	ADD A,R7
00EC	16F7	690	JC LFAIL ;TEST AGAINST UPPER LIMIT
00EE	23A3	691	MOV A,#L1 ;INPUT LOWER LIMIT FOR LENGTH
		692	; ACCEPTANCE
00F0	2F	693	XCH A,R7
00F1	97	694	CLR C
00F2	37	695	CPL A
00F3	6F	696	ADD A,R7
00F4	16F7	697	JC LFAIL ;TEST AGAINST LOWER LIMIT
		698	
00F6	95	699	LPASS: CPL F0 ;SET F0 IS NOTF PASSES
		700	
00F7	BD70	701	LFAIL: MOV R5,#070H
00F9	8E2D	702	MOV R0,#45 ;CALCULATE
00FB	2360	703	MOV A,#96 ;94% OF NT . . .
00FD	146B	704	CALL MULPLY
00FF	B925	705	MOV R1,#37
0101	149E	706	CALL DIVIDE
0103	B92C	707	MOV R1,#44
0105	A1	708	MOV GR1,A
0106	83	709	RET
		710	\$EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		711	*****
		712	*****
		713	CP5
		714	*****
		715	*****
		716	*****
		717	THIS ROUTINE SETS F0 IF NOTE IS PRESENT AT P5.
		718	
0107	B701	719	CP5: MOV R7,#001H
0109	B807	720	MOV R0,#CHAN7
01CB	B92A	721	MOV R1,#42
010D	5440	722	CALL ADC1
0107	B829	723	MOV R0,#POS5
0111	B406	724	CALL BILSEN
0113	B3	725	RET
		726	
		727	\$EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		728	*****
		729	;
		730	CERCP
		731	;
		732	(COLOR ERROR SHIFT COMPARISONS)
		733	;
		734	*****
		735	;
		736	THIS ROUTINE CHECKS THE COLOR ERROR COUNTS FOR ALL
		737	THREE TRACKS, USING CONSECUTIVE DATA SHIFTS.
		738	IN ORDER FOR A NOTE TO PASS, THERE MUST BE A
		739	PARTICULAR SHIFT FOR WHICH THE ERROR COUNT IS NOT
		740	GREATER THAN ERRCT ON ANY OF THE THREE TRACKS.
		741	IF THE NOTE PASSES, F0 IS SET.
		742	;
		743	REGISTERS USED:
		744	;
		745	R1 = POINTER TO ERROR COUNT IN EXTERNAL RAM
		746	R2 = SHIFT INDEX
		747	R5 = TRACK PAGE ADDRESS IN EXTERNAL RAM
		748	;
0114	BA07	749	CERCP: MOV R2,#7 ;SET INITIAL SHIFT INDEX
0116	85	750	CLR F0
		751	;
0117	BD02	752	NSHIF: MOV R5,#2 ;NEW SHIFT. START OVER WITH
		753	TRACK 3
		754	;
0119	FD	755	NTRAK: MOV A,R5
011A	3A	756	OUTL P2,A ;LATCH PAGE ADDRESS
011B	23C8	757	MOV A,#200
011D	6A	758	ADD A,R2
011E	A9	759	MOV R1,A
011F	81	760	MOVI A,OR1 ;GET ERROR COUNT FROM EXTERNAL
		761	RAM
0120	97	762	CLR C
0121	37	763	CPL A
0122	BE03	764	MOV R6,#ERRCT
0124	1F	765	INC R6 ;CARRY IS SET IF ERRCT
0125	6F	766	ADD A,R6 ;IS NOT EXCEEDED.
0126	E62E	767	JNC TFAIL
0128	FD	768	MOV A,R5
0129	C632	769	JZ ORPASS ;PASSED ALL THREE TRACKS
012B	CD	770	DEC R5
012C	2419	771	JMP NTRAK
		772	;
012E	FA17	773	TFAIL: DJNZ R2,NSHIF
0130	2437	774	JMP ORFAIL ;FAILED FOR ALL SHIFTS.
		775	;
0132	95	776	OPPASS: CPL F0
0133	BE55	777	MOV R0,#05
0135	27	778	CLR A
0136	A0	779	MOV OR0,A ;CLEAR OOS COUNT.
0137	93	780	ORFAIL: RET
		781	;
		782	;

LOC	OBJ	LINE	SOURCE STATEMENT
		783	*****
		784	;
		785	TRAKCT
		786	;
		787	(INDIVIDUAL TRACK COLOR ERROR COUNT)
		788	;
		789	*****
		790	;
		791	; THIS ROUTINE CHECKS SELECTED DATA READINGS ON ANY
		792	; PARTICULAR TRACK AGAINST ACCEPTANCE BAND LIMITS
		793	; WHICH HAVE BEEN TRANSFERRED FROM PROGRAM MEMORY
		794	; INTO RAM ADDRESSES 66-127. IT TALLIES THE TOTAL
		795	; NUMBER OF ERRORS OCCURRING FOR EACH DATA SHIFT.
		796	; AND STORES THE RESULTS IN EXTERNAL RAM.
		797	;
		798	; AT ENTRY: R5 = PAGE ADDRESS OF TRACK DATA READINGS
		799	; IN EXTERNAL RAM
		800	;
		801	; REGISTERS USED:
		802	;
		803	; R0 = POINTER TO ACCEPTANCE BAND DATA IN RAM 66-127.
		804	; R1 = POINTER TO NOTF READINGS IN EXTERNAL RAM
		805	; R2 = DATA SHIFT + 4
		806	; R3 = ERROR COUNT
		807	; R5 = TRACK DATA PAGE ADDRESS
		808	; R6 = LOCATION COUNTER
		809	; R7 = TEMPORARY DATA STORAGE
		810	;
0138	RA07	811	TRAKCT: MOV R2,#7
013A	FD	812	MOV A,R5
013B	3A	813	OUTL P2,A ; LATCH EXTERNAL RAM PAGE ADDRESS
		814	;
013C	B843	815	SHIFT: MOV R0,#67 ; SET UP
013E	BB00	816	MOV R3,#0 ; FOR NEW CHECK
0140	BE14	817	MOV R6,#NCOLOR ; WITH NEW DATA SHIFT
		818	;
0142	18	819	LOCCK: INC R0
0143	F0	820	MOV A,R0 ; GET LOCATION NUMBER
0144	6A	821	ADD A,R2 ; SHIFT LOCATION NUMBER
0145	A9	822	MOV R1,A
0146	B1	823	MOVX A,R1 ; GET DATA READING AND
0147	AF	824	MOV R7,A ; PUT IN R7
0148	19	825	INC R0
0149	F0	826	MOV A,R0 ; GET UPPER ACCEPTANCE LIMIT
		827	;
014A	97	828	CLR C
014B	37	829	CPL A
014C	6F	830	ADD A,R7 ; TEST AGAINST
014D	F65A	831	JC OVERX ; UPPER LIMIT
014F	1E	832	INC R2
0150	F0	833	MOV A,R0 ; GET LOWER ACCEPTANCE LIMIT
0151	2F	834	XCH A,R7
0152	37	835	CPL A
0153	6F	836	ADD A,R7 ; TEST AGAINST
0154	F65B	837	JC BFYOND ; LOWER LIMIT

LOC	OBJ	LINE	SOURCE STATEMENT
0156	EE42	838	DJNZ R6,LOCCK ;GO TO NEXT LOCATION
0158	245E	839	JMP ENDRUN
015A	18	840	OVERX: INC R0
015B	1B	841	BEYOND: INC R3 ;INCREASE ERROR COUNT
015C	EE42	842	DJNZ R6,LOCCK
		843	
015E	23C8	844	ENDRUN: MOV A,#200
0160	6A	845	ADD A,R2
0161	A9	846	MOV R1,A
0162	FB	847	MOV A,R3
0163	91	848	MOVX GR1,A ;STORE TOTAL ERROR COUNT
0164	EA3C	849	DJNZ R2,SHIFT ;GO TO NEXT DATA SHIFT
0166	83	850	RET
		851	*****
		852	;
		853	JAM
		854	;
		855	*****
		856	
		857	JAM CHECKS THE FIRST AND TOTAL DATA COUNTS. IF
		858	THE FIRST COUNT EXCEEDS 72, OR THE TOTAL COUNT
		859	EXCEEDS 160, F1 IS SET AND R5 IS LOADED WITH
		860	THE JAM CODE.
		861	
0167	A5	862	JAM: CLR F1
0168	B82E	863	MOV R0,#FIPST
016A	F0	864	MOV A,GR0
016B	37	865	CPL A
015C	0340	866	ADD A,#72
016E	F679	867	JNC FSTJAM
0170	F0	868	MOV A,GR0
0171	18	869	INC R0
0172	60	870	ADD A,GR0
0173	37	871	CPL A ;2'S COMP
0174	17	872	INC A
0175	03A0	873	ADD A,#JAMLIM ;LIMIT
0177	F67C	874	JC NOJAM ;IS JAM DETECTED
0179	B5	875	FSTJAM: CPL F1 ;YES, SET F1
017A	BDA0	876	MOV R5,#0A2H ;JAM CODE
017C	93	877	NOJAM: RET
		878	REJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		879	*****
		880	
		881	READ
		882	
		883	(READ OPTICAL DATA)
		884	
		885	*****
		886	
		887	;36MS DELAY TO GET BILL WELL UNDER OPTICAL BLOCK
		888	;READ MONITORS POS 4 AND POS 5 FOR BILL POS.. TOTAL
		889	;DATA SETS READ ARE IN TWO COUNTS, (1) BEFORE BILL
		890	;REACHES POS 5, AND (2) AFTER BILL EFACES POS 5.
		891	;(FOR BILL SPEED CK). READ GETS DATA FROM ALL TRACKS
		892	;AND POS 4 CONSECUTIVELY STOPES DATA TEMPORALLY.
		893	;DURING THE TIME BETWEEN READINGS THE SUBTOTALS ARE
		894	;DONE, DATA IS STORED IN EXT RAM, DATA COUNTS ARE
		895	;CHECKED FOR JAM DETECTION AND DATA TALLY REGISTER)
		896	
017D	74CE	897	READ: CALL DEL12
017F	74CE	898	CALL DEL12
0181	74CE	899	CALL DEL12
0183	74DF	900	READ1: CALL SETUP
0185	5440	901	CALL ADC1
0187	B627	902	MOV R0,#POS4
0189	B406	903	CALL BILSEN
018B	95	904	CPL F0
018C	B63E	905	JF0 ENDS
018E	B839	906	MOV R0,#57
0190	B4D4	907	CALL CFOS
0192	B842	908	MOV R0,#TEMP
0194	A0	909	MOV R0,A
0195	94DD	910	CALL COLLECT
0197	94A1	911	CALL STORE
		912	
0199	B92A	913	MOV R1,#42
019B	B807	914	MOV R0,#CHAN7
019D	BF01	915	MOV R7,#021F
019F	5440	916	CALL APC1
01A1	B829	917	MOV R0,#POS5
01A3	B406	918	CALL BILSEN
01A5	B6AF	919	JF0 PAR
01A7	B82B	920	MOV R0,#FIRST
01A9	F0	921	MOV A,R0
01AA	17	922	INC A
01AB	A0	923	MOV R0,A
01AC	24B5	924	JMP GET4
01AE	B82C	925	PAR: MOV R0,#SECND
01B0	10	926	MOV A,R0
01F1	17	927	INC A
01F2	A0	928	MOV R0,A
01E3	00	929	NOF
01B4	00	930	NOF
01E5	3467	931	GET4: CALL JAM
01B7	78ED	932	JF1 ENDIT
01E9	94B1	933	CALL RDEL

;LOAD REG'S FOR POS 4
 ;GET POS 4 DATA
 ;POS 4 REF
 ;CK FOR BILL SENSE
 ;BILL SENSED ?
 ;POS 4 DATA INTO ACC
 ;TEMP STORE POS 4
 ;GET TRAK 1,2,3 TFM ST
 ;ADDS SUBTOT, STORES
 ;AND CKS FOR >245
 ;D/A CHAN 7 (POS 5)
 ;GET POS 5 DATA
 ;POS 5 REF
 ;CK FOR BILL SENSE
 ;BILL AT POS 5 ?
 ;NO 1'ST CNT POINTER
 ;INC 1'ST DATA CNT
 ;YFS (2ND CNT POINTER)
 ;INC 2ND DATA CNT
 ;DISPLAY (BALANCE IF ELSE
 ;DELAY STRUCTURE)
 ;CK FOR JAM
 ;JAM DETECTED ?
 ;READ DELAY

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LOC	OBJ	LINE	SOURCE STATEMENT
01BB	2483	934	JMP READ1 ;GET ANOTHER DATA SFT
01BD	55	935	ENDIT: CLR F0
01BE	83	936	ENDS: RET
		937	
		938	*****
		939	;
		940	;
		941	;
		942	;
		943	;
		944	*****
		945	;
01BF	BB1B	946	T300: MOV R3,#27 ;27 X 11.5MS (300MS)
01C1	74CE	947	X27: CALL DEL12 ;11.5MS DELAY
01C3	EEC1	948	DJNZ R3,X27 ;300MS ELAPSED ?
01C5	83	949	RET ;YES
		950	*****
		951	;
		952	;
		953	;
		954	;
		955	;
		956	*****
		957	;
		958	;
		959	;
		960	;
		961	;
		962	;
		963	;
		964	;
		965	;
		966	;
		967	;
		968	;
		969	;
		970	;
01C6	BF04	971	SUMTOT: MOV R6,#4 ;INITIALIZE CHANNEL COUNTER.
01C8	2A00	972	MOV R2,#0 ;INITIALIZE FOR
01CA	B82E	973	MOV R0,#46 ;CHANNEL 1
01CC	FA	974	NCHAN: MOV A,R2 ;LATCH PAGE
01CD	3A	975	OUTL P7,A ;ADDRESS
01CE	27	976	CLR A ;CLEAR
01CF	A0	977	MOV GR0,A ;REGISTERS
01D0	16	978	INC R0 ;FOR
01D1	A0	979	MOV GR0,A ;SUBTOTALS.
01D2	B92C	980	MOV R1,#44
01D4	F1	981	MOV A,GR1
01D5	AC	982	MOV R4,A
01D6	AG	983	MOV R1,A
01D7	C0	984	NSUM: DEC R0 ;GO TO LOW BYTE
01D8	C0	985	DEC R1 ;GO TO NEXT LOCATION
01D9	81	986	MOVI A,GR1 ;GET READING
01DA	80	987	ADD A,GR0 ;ADD LOW BYTE
01DB	AC	988	MOV GR0,A ;STORE NEW LOW BYTE

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LOC	OBJ	LINE	SOURCE STATEMENT
01DC	18	989	INC R0
01DD	27	990	CLR A
01DE	70	991	ADDC A,CR0 ;ADD CARRY TO HIGH BYTE
01DF	A0	992	MOV CR0,A ;STORE NEW HIGH BYTE
01E0	ECD7	993	DJNZ R4,NSUM ;END OF CHANNEL?
01E2	16	994	INC R0 ;SET UP FOR
01E3	1A	995	INC R2 ;NEXT CHANNEL
01E4	EECC	996	DJNZ RC,NCHAN
01E5	83	997	RET
		998	*****
		999	;
		1000	FLASH
		1001	;
		1002	;
		1003	;
		1004	*****
		1005	;
		1006	FLASH IS A ROUTINE USED TO FLASH AN ERROR CODE
		1007	MESSAGE
		1008	;
01E7	FD	1009	FLASH: MOV A,R5 ;REFOR CODE INTO ACC
01E8	3A	1010	OUTL P2,A ;OUTPUT CODE TO LATCH
01E9	99FE	1011	ANL P1,#0FEH
01EB	8901	1012	ORL P1,#001H ;CLOCK LATCH
01ED	34BF	1013	CALL T300 ;300MS DELAY
01EF	27	1014	CLR A
01F0	3A	1015	OUTL P2,A ;OUTPUT ZERO TO LATCH
01F1	99FF	1016	ANL P1,#0FEH
01F3	8901	1017	ORL P1,#001E ;CLOCK LATCH (DISP OFF)
01F5	34BF	1018	CALL T300 ;300MS DELAY
01F7	83	1019	RET
		1020	\$EJECT

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LCC	OBJ	LINE	SOURCE STATEMENT
		1021	*****
		1022	;
		1023	CSPEED
		1024	;
		1025	(CORRECT FOR SPEED)
		1026	;
		1027	*****
		1028	;
		1029	;THIS ROUTINE CORRECTS THE READING LOCATION NUMBERS
		1030	;FOR TRANSPORT SPEED VARIATION.
		1031	;
		1032	;AT ENTRY: THIS ROUTINE ASSUMES THAT THE LOCATION
		1033	;NUMBER TO BE CORRECTED HAS BEEN PLACED IN A.
		1034	;
		1035	;NOTE: N = NO. OF READINGS TAKEN FROM P4 TO P5.
		1036	; N0 = "NORMAL" NO. OF READINGS TAKEN FROM
		1037	; P4 TO P5.
		1038	; P = READING LOCATION TO BE CORRECTED
		1039	;
01F8	A0	1040	CSPEED: MOV GR0,A
01F9	B92B	1041	MOV R1,#43
01FB	F1	1042	MOV A,GR1
01FC	146B	1043	CALL MULPLY ;CALCULATE N X P.
01FE	BF3D	1044	MOV R7,#N0
0200	B907	1045	MOV R1,#7 ;SET UP POINTFR TO N0.
0202	149E	1046	CALL DIVIDE ;CALCULATE N X P/N0 =
		1047	;CORRECTED P
0204	AB	1048	MOV R3,A
0205	97	1049	CLR C
0206	FF	1050	MOV A,R7
0207	57	1051	RRC A
0208	97	1052	CLR C
0209	37	1053	CPL A
020A	17	1054	INC A
020B	6A	1055	ADD A,R2 ;SETS CARRY IF REMAINDER > N0/2.
020C	FB	1056	MOV A,R3
022D	E610	1057	JNC NOINC
020F	17	1058	INC A ;ADDS 1 IF CARRY IS SET
		1059	;
0210	97	1060	NOINC: CLR C
0211	83	1061	RET
		1062	\$EJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		1063	*****
		1064	;
		1065	;
		1066	;
		1067	*****
		1068	;
		1069	; THIS ROUTINE EXECUTES A 3 SEC TIME-OUT WHILE
		1070	; MONITORING P1 AND P4. IF P4 GETS COVERED, F0 IS
		1071	; SET AND ROUTINE EXITED. IF P1 BECOMES UNCOVERED,
		1072	; THE MOTOR IS TURNED OFF AND THE ROUTINE IS EXITED
		1073	; WITH F0 CLEARED. IF 3 SEC ELAPSES WITH P1 STILL
		1074	; COVERED, THEN "EJECT" IS CALLED.
		1075	;
0212	BD10	1076	BILLIN: MOV R5, #16
0214	BBFA	1077	SEC6: MOV R3, #250
0216	FB	1078	ECHECK: MOV A, R3
0217	74DF	1079	CALL SETUP ; CK POS 4
0219	AR	1080	MOV R3, A
021A	5440	1081	CALL ADC1
021C	B827	1082	MOV R0, #POS4
021E	B406	1083	CALL BILSEN ; RFACHED POS 4 ?
0220	B632	1084	JF0 NJAM
0222	5433	1085	CALL CP1 ; NO, THEN CHECK P1
0224	95	1086	CPL F0
0225	B62F	1087	JF0 PULLED ; WAS BILL
		1088	;
		1089	DJNZ R3, ECHECK ; PULLED OUT ?
0227	EB16	1090	DJNZ R3, SEC6 ; NO; CONT LOOP
0229	ED14	1091	JAMMD: MOV R5, #0A2H ; UNLESS TIME EXP'T
022B	BDA0	1092	CALL EJECT ; JAM CODE; TRY TO
022D	944C	1093	PULLED: CLR F0 ; CLEAR ENTRANCE
022F	95	1094	ORL P1, #006H ; TURN OFF MOTOR
0230	5906	1095	NJAM: RET
0232	83	1096	*****
		1097	;
		1098	;
		1099	CP1
		1100	;
		1101	(CHECK POSITION 1)
		1102	*****
		1103	;
		1104	; THIS ROUTINE SETS F0 IF A NOTE IS PRESENT AT P1.
		1105	;
		1106	;
0233	BF04	1107	CP1: MOV R7, #204H
0235	BB06	1108	MOV R0, #CHANGE
0237	B920	1109	MOV R1, #32
0239	5440	1110	CALL ADC1
023B	B626	1111	MOV R0, #POS1
023D	B406	1112	CALL BILSEN
023F	83	1113	RET
		1114	;
		1115	EJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		1116	
		1117	*****
		1118	ADC
		1119	
		1120	A/D CONVERSION
		1121	
		1122	*****
		1123	
		1124	ADC SETS D/A TO TRACK CALIBRATE SETTING, TURNS ON
		1125	PROPER LFD'S THEN ALLOWS FOR AMP SFTTLING TIME BEFOF
		1126	A/D CONVERSION IS STARTED, GIVES A FIXED DELAY FOR
		1127	CONVERSION AND TESTS FOR EOC. IF EOC IS NOT COMPLETE
		1128	THE VALIDATOR IS PUT OUT OF SERVICE. ADC INPUTS THE
		1129	DATA AND SAVES, IT. THEN TURNS OFF THE LEDS
		1130	R0 = A/D CHANNEL R1 = D/A SETTING R2 = SAVE DATA
		1131	R6 = LOOP CTR R7 = LFD SELECTION
		1132	R4 = IS USED IN CALIB ROUTINE ONLY
		1133	
0240	A5	1134	ADC1: CLR F1
0241	B5	1135	CPL F1
0242	4445	1136	JMP ADC2
0244	A5	1137	ADC: CLR F1
0245	2330	1138	ADC2: MOV A,#030F
0247	3A	1139	OUTL P2,A
0248	F1	1140	MOV A,R1
0249	AC	1141	MOV R4,A
024A	90	1142	MOVX R0,A
024B	2320	1143	MOV A,#020F
024D	3A	1144	OUTL P2,A
024E	FF	1145	MOV A,R7
024F	90	1146	MOVX R0,A
0250	FF18	1147	MOV R6,#24
0252	EE52	1148	SETL: DJNZ R6,SETL
0254	2310	1149	MOV A,#010H
0256	3A	1150	OUTL P2,A
0257	FE	1151	MOV A,R0
0258	90	1152	MOVX R0,A
0259	FF42	1153	MOV R6,#66
025B	FF5B	1154	EOCD: DJNZ R6,EOCD
025D	7665	1155	JF1 EOC
025F	5665	1156	JT1 EOC
0261	BD80	1157	MOV R5,#0A0H
0263	D453	1158	CALL OOS
0265	2310	1159	EOC: MOV A,#010H
0267	3A	1160	OUTL P2,A
0268	FE	1161	MOV A,R0
0269	00	1162	MOVX A,R0
026A	AA	1163	MOV R2,A
026B	2320	1164	MOV A,#020F
026D	3A	1165	OUTL P2,A
026F	2320	1166	MOV A,#0E0H
0270	90	1167	MOVX R0,A
0271	97	1168	CLR C

;ADDR OF D/A LATCH
 ;GET D/A SETTING
 ;SAVE D/A (CALIBFATF)
 ;CLKS D/A LATCH R0 N/A
 ;ADDR OF LED SW LATCH
 ;LED SW SELECTED
 ;CLKS SW LATCH R0 N/A
 ;SET AMP SETTLING TIME
 ;END OF SETTING DELAY ?
 ;YES ADDR OF A/D WT
 ;START CONV ACC N/A
 ;SET CONVERT TIME
 ;SHOULD CONV BE COMP ?
 ;(YES) IS IT ?
 ;(NO) SET ERROR CODE
 ;GO OUT OF SERVICE
 ;ADDR OF A/D RT
 ;INPUT A/D DATA R0 N/A
 ;SAVE DATA
 ;ADDR OF LED SW LATCH
 ;TURN OFF LEDS
 ;(R2 N/A)
 ;CLEAR CARRY

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LOC	OBJ	LINF	SOURCE STATEMENT
0272	A5	1169	CLR F1
0273	93	1170	RET
		1171	\$EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		1172	*****
		1173	;
		1174	REJECT
		1175	;
		1176	(DISPLAYS CAUSE OF NOTF REJECT)
		1177	;
		1178	*****
		1179	;
		1180	;REJECT MAINTAINS DISPLAY FOR 2 SECONDS (OR LESS
		1181	;IF BILL IS REMOVED FROM ENTRANCE BEFORE THE 2 SECONDS
		1182	;HAS ELAPSED)
		1183	;R3 = LOOP CTR
		1184	;R2 = SAVE DATA REG (ADC1) & LOOP CTR
		1185	;
0274	BB04	1186	REJECT: MOV R3,#4 ;503MS X 4 = 2 SEC
0276	5433	1187	X10: CALL CP1
0278	95	1188	CPL P0
0279	B6B3	1189	JF0 ENDDIS ;IS BILL PRES ?
027R	BA2B	1190	MOV R2,#43 ;(YES) 11.7MS X 43 = 503
027D	74CE	1191	X43: CALL DEL12 ;11.7MS DELAY
027F	EA7D	1192	DJNZ R2,X43 ;503MS ELAPSED ?
0251	EB76	1193	DJNZ R3,X10 ;(YES) 2 SEC FLAPSED ?
0283	27	1194	ENDDIS: CLR A ;YES
0284	3A	1195	OUTL P2,A ;TURN OFF DISPLAY
0285	99FE	1196	ANL P1,#0FFH
0287	8901	1197	ORL P1,#021H
0289	53	1198	RET
		1199	REJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		1200	*****
		1201	;
		1202	INIT
		1203	;
		1204	(POWER-ON OR RSET INITIALIZATION
		1205	;
		1206	*****
		1207	;
		1208	INIT RESETS DISPLAY LATCH
		1209	PUTS INITIAL SETTING INTO D/A CALIBRATE REG'S
		1210	RESETS >240 AND BILL TALLY REG'S
		1211	ASSURES MOTOR IS OFF AND DISPLAY IS OFF
		1212	READY'S P16 FOR DATA INPUT
		1213	R0 POINTER REG
		1214	R6 LOOP CTR
		1215	;
026A	27	1216	INIT: CLR A
028B	3A	1217	OUTL P2,A ;ZEROS TO DISP LATCH
028C	23FE	1218	MOV A,#0FEF
028E	39	1219	OUTL P1,A ;LATCH CLK GOES LOW
029F	23FF	1220	MOV A,#0FFH
0291	39	1221	OUTL P1,A ;LATCH CLK GOES HI
0292	BF04	1222	MOV R6,#004H ;LOOP CTR
0294	B921	1223	MOV R0,#33 ;ADDF OF TRAK 1 D/A SFT
0296	23AF	1224	MOV A,#175 ;INITIAL D/A SETTING
0298	A0	1225	DTASET: MOV GR0,A ;PUT INITIAL SETTING
0299	16	1226	INC R0 ;INC ADDR
029A	EF98	1227	DJNZ R6,DTASET ;ALL TRAKS SFT ?
029C	B63C	1228	MOV R0,#EXCLIM ;PUT ADDR >240 IN R0
029E	27	1229	CLR A
029F	A0	1230	MOV GR0,A ;ZERO >240 REG
02A0	19	1231	INC R0 ;ADDR OF BILL TALLY
02A1	A0	1232	MOV GR0,A ;ZERO BILL TALLY
02A2	R825	1233	MOV R0,#37
02A4	2364	1234	MOV A,#100
02A6	A0	1235	MOV GR0,A ;SET DIVIDE CONST = 100
02A7	2320	1236	MOV A,#020E
02A9	3A	1237	OUTL P2,A ;ADDF OF LED SW LATCH
02AA	2380	1238	MOV A,#080H ;TURN OFF OP BLK LEDS
02AC	90	1239	MOVX GR0,A ;(R0 N/A)
02AD	B827	1240	MOV R0,#POS4 ;SET RFF FOR POS 4
02AF	23A5	1241	MOV A,#165
02B1	A0	1242	MOV GR0,A
02B2	B826	1243	MOV R0,#POS1 ;SET RFF
02B4	231E	1244	MOV A,#30 ;FOR
02B6	A0	1245	MOV GR0,A ;POS 1
02B7	15	1246	DIS I ;DISABLE INTERRUPT
02B8	74CE	1247	CALL DEL12
02BA	83	1248	RFT
		1249	\$FJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		1250	*****
		1251	;
		1252	CKPOS
		1253	;
		1254	(CHECK POSITION SENSORS)
		1255	;
		1256	*****
		1257	;
		1258	CKPCS TESTS ALL POS FOR BAD OPTICS
		1259	AND CHECKS POS1 FOR BILL BEING PRES & SETS F0
		1260	R0 = A/D CHANNEL AND BILL SFNSE REF.
		1261	R2 = SAVE DATA
		1262	R5 = ERROR CODE
		1263	R6 = LOOP CTR R7 = NO OPTICA BLOCK LIDS ON
		1264	;
02BB	85	1265	CKPOS: CLR F0 ;RESET F0
02BC	FA	1266	MOV A,R2
02BD	37	1267	CPL A
02BE	030A	1268	ADD A,#BLOC ;COMP WITH BAD OPTIC IM
02C0	2EC4	1269	JNC DATAOK ;OPTICS BAD ?
02C2	D453	1270	CALL OOS ;(YES) GO OUT OF SERVICE
02C4	83	1271	DATAOK: RET
		1272	*****
		1273	;
		1274	IDLE
		1275	;
		1276	;
		1277	;
		1278	*****
		1279	;
		1280	IDLE MONITORS POSITION SENSOR 5 FOR BAD
		1281	OPTICS. AND CHECKS PCS 1 FOR BILL PRESNT. IF BILL IS
		1282	DETECTED F0 IS SET. F0 IS CHECKED. IF SET AN ESCAPE
		1283	FROM IDLE IS MADE
		1284	IDLE CONTINUOUSLY CALIBRATES THE OPTICAL FLOCK
		1285	IDLE CONTINUOUSLY CHECKS THE INT & EXT RAMS
		1286	;
02C5	940F	1287	IDLE: CALL INTRAM ;TEST INT PAM
02C7	B432	1288	CALL OFFSET
02C9	2336	1289	MOV A,#54
02CB	B83A	1290	MOV R0,#58
02CD	A0	1291	MOV OR0,A
02CE	74EB	1292	CALL SETUP1 ;CALIBRATE TRACK 1
02E0	741A	1293	CALL CALIB
02D2	2337	1294	MOV A,#55
02D4	B83A	1295	MOV R0,#58
02D6	A0	1296	MOV OR0,A
02D7	7471	1297	CALL SETUP2 ;CALIBRATE TRACK 2
02D9	741A	1298	CALL CALIB
02DB	2338	1299	MOV A,#56
02DD	B83A	1300	MOV R0,#58
02DF	A0	1301	MOV OR0,A
02E0	74FA	1302	CALL SETUP3 ;CALIBRATE TRACK 3
02F2	741A	1303	CALL CALIB
02F4	2338	1304	MOV A,#57

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LOC	OBJ	LINE	SOURCE STATEMENT
0216	B83A	1305	MOV R0,#58
02E8	A0	1306	MOV GR0,A
02E9	74DF	1307	CALL SETUP
02EB	741A	1308	CALL CALIB
02ED	340F	1309	CALL BLKCK
02EF	BFC1	1310	MOV R7,#001H
02F1	B92A	1311	MOV R1,#42
02F3	B807	1312	MOV R0,#CHAN7
02F5	BD50	1313	MOV R5,#050H
02F7	5444	1314	CALL ADC
02F9	54BB	1315	CALL CKPOS
02FB	BF80	1316	MOV R7,#NOLED
02FD	B804	1317	MOV R0,#CHAN4
02FF	BD30	1318	MOV R5,#030H
0301	5444	1319	CALL ADC
0303	54BB	1320	CALL CKPOS
0305	BF04	1321	MOV R7,#004H
0307	B920	1322	MOV R1,#32
0309	B806	1323	MOV R0,#CHAN5
030B	5444	1324	CALL ADC
030D	B826	1325	MOV R0,#POS1
030F	B406	1326	CALL BILSEN
0311	B619	1327	JF0 PROCED
0313	9426	1328	CALL RAM
0315	D462	1329	CALL OPSUR
		1330	
0317	44C5	1331	JMP IDLE
0319	93	1332	PROCED: RET
		1333	\$EJECT

;CALIBRATE POS 4
 ;CHECK FOR INHIBIT
 ;TEST POSITION 5
 ;TEST POSITION 3
 ;TEST POSITION 1
 ;BILL INSERTED ?
 ;TEST EXT RAM
 ;FLASH DIRTY SURFACES
 ;COPE, IF NEEDED.
 ;NO DO IT AGAIN

LOC	OBJ	LINE	SOURCE STATEMENT
		1334	*****
		1335	*****
		1336	
		1337	CALIB
		1338	(CALIBRATE OPTICAL READ CHANNELS)
		1339	
		1340	*****
		1341	
		1342	CALIB TRIES 200 TIMES OR LESS TO ADJUST THE D/A WITHIN
		1343	A/D UPPER AND LOWER LIMITS
		1344	IF TRACK FAILS TO CALIBRATE IN 200 TRIES VALIDATOR
		1345	GOES OUT OF SERVICE
		1346	R4 = ADJUSTED D/A SETTING
		1347	R3 = LIMIT
		1348	R5 = LOOP CTR AND ERROR CODE
		1349	
		1350	
031A	BDC8	1351	CALIB: MOV R5, #200 ;SET ADJ LIMIT
031C	5444	1352	CALIB1: CALL ADC ;GET DATA
031F	F8	1353	MOV A, R0
031P	AF	1354	MOV R6, A
0320	B03A	1355	MOV R0, #58
0322	F0	1356	MOV A, GR0
0323	A0	1357	MOV R0, A
0324	B4D4	1358	CALL CFOS ;SUBTRACT OFFSET
0326	97	1359	CLR C
0327	37	1360	CPL A
0328	EB	1361	ADD A, R3 ;2'S COMP
0329	EE2F	1362	JNC TESTH1 ;COMPARE WITH LOW LIMIT
032B	1C	1363	INC R4 ;D/A SET TO LOW ?
032C	6436	1364	JMP NEW
032F	2304	1365	TESTH1: MOV A, #4 ;WINDOW
0330	EB	1366	ADD A, R3 ;ADD WINDOW
0331	37	1367	CPL A ;2'S COMP
0332	5A	1368	ADD A, R2 ;COMPAFF WITH E1 LIMIT
0333	E544	1369	JNC NEXT ;D/A SET TO H1 ?
0335	CC	1370	DEC R4 ;YES ADJUST D/A SETTING
0336	FC	1371	NEW: MOV A, R4 ;STORE NEW D/A SETTING
0337	A1	1372	MOV GR1, A
0338	FF	1373	MOV A, RE
0339	A0	1374	MOV R0, A
033A	ED1C	1375	DJNZ RS, CALIB1 ;TRY AGAIN ?
033C	F9	1376	MOV A, R1 ;NO WILL NOT CALIBRATE
033D	37	1377	CPL A ;CONV POINTER TO
033F	47	1378	SWAP A ;ERROR CODE
033P	53F0	1379	ANL A, #0F0H ;GET FID OF LOW NIPF
0341	AD	1380	MOV R5, A ;PUT IN ERROR CODE REG
0342	D453	1381	CALL OOS ;GO OUT OF SERVICE
0344	FC	1382	NEXT: MOV A, R4 ;STORE NEW D/A SETTING
0345	A1	1383	MOV GR1, A
0346	93	1384	RET
		1385	\$EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		1386	*****
		1387	;
		1388	;
		1389	CALC
		1389	;
		1390	(DETERMINE POSITION SENSOR THRESHOLDS)
		1391	;
		1392	*****
		1393	;
		1394	;CALCULATES BILL SENSE LIMITS
		1395	;50 X POSITION DATA/100
		1396	;
0347	FA	1397	CALC: MOV A,R2 ;GET DATA
0348	A0	1398	MOV GR0,A ;STORE DATA
0349	B925	1399	MOV R1,#37 ;ADDR OF DIVISOR
034B	2332	1400	MOV A,#50 ;MULTIPLIER
034D	146B	1401	CALL MULPLY ;DATA X 50
034F	149E	1402	CALL DIVIDE ;DIVIDE BY 100
0351	E3	1403	RET
		1404	*****
		1405	;
		1406	RESET
		1407	;
		1408	;
		1409	;
		1410	*****
		1411	;
		1412	; RESET CALIBRATES POSITIONS 1 AND 5 SO THAT EACH READS
			100 WHEN
		1413	; CLEAR. IT THEN STORES 40 AS THE REFERENCE READING FOR P
			OS5. ALSO,
		1414	; IT CALCULATES AND STORES THE REFERENCE READING FOR TFF
			EXIT
		1415	;BLOCKER (POS3).
		1416	;
0352	27	1417	RESET: CLR A ;STORE 0
0353	B83B	1418	MOV R0,#59 ;AS
0355	A0	1419	MOV GR0,A ;OFFSET.
0356	C8	1420	DEC R0 ;STORE
0357	233B	1421	MOV A,#59 ;OFFSET
0359	A0	1422	MOV GR0,A ;LOCATION.
035A	B920	1423	MOV R1,#32 ;STORE POS1
035C	23AF	1424	MOV A,#175 ;INITIAL
035E	A1	1425	MOV GR1,A ;D/A SETTING.
035F	B806	1426	MOV R0,#CHAN6 ;POS 1 A/D CHAN.
0361	BF04	1427	MOV R7,#024H ;POS1 LED SELECTION.
0363	B864	1428	MOV R3,#100 ;LOW LIMIT FOR CALIB.
0365	741A	1429	CALL CALIB ;CALIBRATE POS1.
0367	B92A	1430	MOV R1,#42 ;STORE POS 5
0369	23AF	1431	MOV A,#175 ;INITIAL
036B	A1	1432	MOV GR1,A ;D/A SETTING.
		1433	;
036C	B807	1434	MOV R0,#CHAN7 ;POS 5 A/D CHAN.
036E	FF01	1435	MOV R7,#001H ;POS5 LED SELECTION.
0370	BF64	1436	MOV R3,#100 ;LOW LIMIT FOR CALIB.
0372	741A	1437	CALL CALIB ;CALIBRATE POS 5.

LOC	OBJ	LINE	SOURCE STATEMENT	
0374	B829	1438	MOV R0,#POSS	
0376	2328	1439	MOV A,#40	;SET RFF READING
0378	A0	1440	MOV GR0,A	;FOR
0379	BF80	1441	MOV R7,#NOLED	;POSS.
037B	B804	1442	MOV R0,#CHAN4	;CALCULATE
037D	5444	1443	CALL ADC	;AND
		1444		;STORE
		1445		
037F	B828	1446	MOV R0,#POS3	;POS3
0381	7447	1447	CALL CALC	;REFERENCE
0383	A0	1448	MOV GR0,A	;READING.
0384	83	1449	RET	
		1450	\$EJECT	

LOC	OBJ	LINE	SOURCE STATEMENT
		1451	*****
		1452	;
		1453	REST
		1454	;
		1455	(RESET DATA COUNT REGISTERS)
		1456	;
		1457	*****
		1458	;
		1459	REST RESETS THE DATA CNT REG'S
		1460	RESETS PAGE ADDR. REG
		1461	RESETS SUBTOTAL REG
		1462	R0 POINTER REG
		1463	R6 LOOP CTR
		1464	;
0395	B62B	1465	REST: MOV R0,#FIRST ;RESETS DATA CNT REG'S
0387	27	1466	CLR A
0368	A0	1467	MOV GR0,A
0389	18	1468	INC R0
039A	A0	1469	MOV GR0,A
038B	B83E	1470	MOV R0,#PAGEADD ;RESETS PAGE ADDR
038D	A0	1471	MOV GR0,A
039E	B82E	1472	MOV R0,#SBTOT1 ;ADDR OF SUBTOTAL 1
0390	BF08	1473	MOV R6,#8 ;LOOP CTR
0392	A0	1474	SUBRES: MOV GR0,A ;RESET SUBTOTAL REG
0393	19	1475	INC R0 ;INC ADDR
0394	FF97	1476	DJNZ R6,SUBRES ;ALL SUBTOTAL REG'S ?
0396	9906	1477	ORL P1,#006H ;TURN OFF MOTOR.
0398	83	1478	RET
		1479	SEJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		1480	*****
		1481	;
		1482	;
		1483	CKG245
		1484	;(CHECK TALLY OF NOTES WITH READINGS EXCEEDING 245)
		1485	;
		1486	*****
		1487	;
		1488	; THIS ROUTINE INCREMENTS THE NOTE TALLY AND THE
		1489	; >245 TALLY IF REQUIRED. IF NOTF TALLY = 100, AND
		1490	; THE >245 TALLY IS LESS THAN 8, BOTH ARE RESET.
		1491	; IF >245 TALLY REACHES 8, BIT 7 OF RFG 61 WILL BE
		1492	; SET AS A FLAG INDICATING THAT THE OPTICAL
		1493	; SURFACES NEED CLEANING.
0399	B83C	1494	CKG245: MOV R0, #60 ;GET >245 TALLY...
039B	F0	1495	MOV A, GR0
039C	37	1496	CPL A
039D	F2B0	1497	JB7 BILTAL ;DATA >245?
039F	37	1498	CPL A ;YES, INC TALLY...
03A0	17	1499	INC A
03A1	537F	1500	ANL A, #07FH
03A3	A0	1501	MOV GR0, A ;RESTORE NEW TALLY.
03A4	37	1502	CPL A ;DOES NEW TALLY
03A5	97	1503	CLR C ;EXCEED 8?
03A6	0308	1504	ADD A, #8
03A8	F6B0	1505	JC BILTAL ;NO, THEN JUMP.
03AA	18	1506	INC R0 ;YES, SET FLAG...
03AB	F0	1507	MOV A, GR0
03AC	4380	1508	ORL A, #080H
03AE	A0	1509	MOV GR0, A
03AF	C8	1510	DEC R0
03B0	18	1511	BILTAL: INC R0 ;GET NOTE TALLY...
03B1	F0	1512	MOV A, GR0
03B2	17	1513	INC A
03B3	A0	1514	MOV GR0, A ;INC AND RESTORE.
03B4	97	1515	CLR C ;DOES TALLY EXCEED 100?
03B5	37	1516	CPL A
03B6	0364	1517	ADD A, #100
03B8	F6C1	1518	JC NT100 ;NO, THEN JUMP.
03BA	F0	1519	MOV A, GR0 ;YES, RESET BOTH TALLIES
03B8	5380	1520	ANL A, #080H
03BD	A0	1521	MOV GR0, A
03BE	C8	1522	DEC R0
03BF	27	1523	CLR A
03C0	A0	1524	MOV GR0, A
03C1	83	1525	NT100: RET
		1526	\$TJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		1527	*****
		1528	;
		1529	JITDEL
		1530	;
		1531	(JITTER DELAY)
		1532	;
		1533	*****
		1534	;
		1535	;100MS DELAY BEFORE MOTOR TURNS ON
		1536	;AFTER DELAY POS 1 IS CHECKED TO SEE IF IT IS STILL COVE RED
		1537	;IF IT IS THE MOTOR IS TURNED ON.
		1538	;
03C2	74D8	1539	JITDEL: CALL T100 ;100MS DELAY
03C4	5433	1540	CALL CP1
03C6	B6C8	1541	JF0 STPRS ;IS BILL PRES ?
03C8	85	1542	CLR P0 ;(NO) GO BACK STRT FLAG
03C9	64CD	1543	JMP NOTPR
03CB	99FD	1544	STPRS: ANL P1, #0F0H ;MOTOF ON FWD
03CD	83	1545	NOTPR: RET
		1546	*****
		1547	;
		1548	DEL12
		1549	;
		1550	*****
		1551	;
		1552	;DEL12 IS A 12MS DELAY
		1553	;
03CE	2306	1554	DEL12: MOV A, #6 ;SET INT TIMFR
03D0	52	1555	MOV T, A
03D1	55	1556	STRT T
03D2	16D6	1557	DELT: JTF STP ;11.7MS ELAPSED ?
03D4	64D2	1558	JMP DELT
03D6	65	1559	STP: STOP TCNT ;YES
03D7	83	1560	RET
		1561	*****
		1562	;
		1563	T100
		1564	;
		1565	(100MS DELAY)
		1566	;
		1567	*****
		1568	;
03DE	8808	1569	T100: MOV R3, #8
03DA	74CE	1570	X9: CALL DEL12 ;12MS DELAY
03DC	FFDA	1571	DJNZ R3, X9 ;HAS 100MS ELAPSED
03DE	83	1572	RFT
		1573	\$EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		1574	*****
		1575	;
		1576	SETUP, SETUP1, SETUP2, SETUP3
		1577	;
		1578	;
		1579	*****
		1580	;
		1581	;
		1582	LOADS REG'S FOR ADC & ADC1 SUBROUTINES
		1583	(OPTICAL BLOCK DATA)
		1584	R0 = A/D CHANNEL NO.
		1585	R1 = D/A SETTING
		1586	R3 = LOW LIMIT FOR CALIBRATION
		1587	R7 = LED SWITCH SEL
		1588	;
03DF	B924	1589	SETUP: MOV R1, #024H ; POINTER POS 4 D/A SET
03E1	B901	1590	MOV R0, #CHAN1 ; A/D CHANNEL 1
03E3	B102	1591	MOV R7, #002H ; LED SW FOR PCS 4
03E5	BBC8	1592	MOV R3, #LIMIT ; LOW LIMIT FOR CALIB
03E7	83	1593	RET
03E8	B921	1594	SETUP1: MOV R1, #021H ; POINTER TRAK 1 D/A SET
03EA	B901	1595	MOV R0, #CHAN1 ; A/D CHANNEL 1
03EC	BF08	1596	MOV R7, #009H ; LED SW FOR TRAK 1
03EE	BB40	1597	MOV R3, #OPL0 ; LOW LIMIT FOR CALIB
03F0	33	1598	RET
03F1	B922	1599	SETUP2: MOV R1, #022H ; POINTER TRAK 2 D/A SET
03F3	B902	1600	MOV R0, #CHAN2 ; A/D CHANNEL 2
03F5	BF10	1601	MOV R7, #010H ; LED SW FOR TRAK 2
03F7	BB3C	1602	MOV R3, #OPL01 ; LOW LIMIT FOR CALIB
03F9	33	1603	RET
03FA	B923	1604	SETUP3: MOV R1, #023H ; POINTER TRAK 3 D/A SET
03FC	B901	1605	MOV R0, #CHAN1 ; A/D CHANNEL 1
03FE	BF20	1606	MOV R7, #022H ; LED SW FOR TRAK 3
0400	BB40	1607	MOV R3, #OPL0 ; LOW LIMIT FOR CALIB
0402	53	1608	RET
		1609	*****
		1610	;
		1611	JAMCK
		1612	;
		1613	(JAM CHECK)
		1614	;
		1615	;
		1616	*****
		1617	;
		1618	JAMCK GETS DATA FROM ALL POSITION SENSORS
		1619	AND CHECKS TO SEE IF BILL IS PRESENT
		1620	(POSITION 1 IS EXCLUDED) IF ANY POSITION
		1621	HAS A BILL PRESENT FC WILL BE SET.
		1622	;
0403	95	1623	JAMCK: CLR FC
0404	3427	1624	CALL CP5
0406	74DF	1625	CALL SETUP ; REG LOADED FOR POS 4
0408	5440	1626	CALL ADC1 ; GET POS 4 DATA
040A	B827	1627	MOV R0, #POS4 ; POS 4 REF
040C	B407	1628	CALL SENBIL ; SETS FC ON BILL PRESENT

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ISIS-II MCS-4B/UPI-41 MACRO ASSEMBLER, V3.0

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LOC	OBJ	LINE	SOURCE STATEMENT
040E	83	1629	RET
		1630	\$EJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		1631	*****
		1632	*****
		1633	INTRAM
		1634	
		1635	(INTERNAL RAM CHECK)
		1636	
		1637	*****
		1638	*****
		1639	;DOES NOT CHECK R0-R7
040F	BC77	1640	INTRAM: MOV R4,#077H ;LIMIT ADDR DEC TO 008H
0411	BS7F	1641	MOV R0,#07FH ;RAM ADDR
0413	F0	1642	ADDR1: MOV A,R0 ;INPUT DATA
0414	AA	1643	MOV R2,A ;SAVE DATA
0415	37	1644	CPL A ;COMP COPY
0416	A0	1645	MOV GR0,A ;WRITE INTO RAM
0417	F0	1646	MOV A,GR0 ;READ FROM RAM
0418	6A	1647	ADD A,R2 ;COMPARE
0419	17	1648	INC A
041A	C620	1649	JZ GOOD1
041C	BD90	1650	MOV R5,#090H ;ERPOF CODE FOR FAM EF
041E	D453	1651	CALL OOS ;GO OUT OF SERVICE
0420	FA	1652	GOOD1: MOV A,R2 ;RESTORE ORIGINAL DATA
0421	A0	1653	MOV GR0,A
0422	C6	1654	DEC R0
0423	EC13	1655	DJNZ R4,ADDE1 ;DEC ADDR
0425	93	1656	RET
		1657	\$EJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		1658	*****
		1659	;
		1660	RAM
		1661	;
		1662	(EXTERNAL RAM CHECK)
		1663	;
		1664	*****
		1665	;
		1666	RAM CHECKS THE EXTERNAL RAM BY ADDRESSING EACH
		1667	LOCATION IN MEMORY, INPUTS THE DATA, COMPLEMENTS THE
		1668	DATA, STORES IT, INPUTS IT AGAIN THEN COMPARES IT WITH
		1669	ORIGINAL DATA THE ORIGINAL DATA IS THEN RESTORED
		1670	R0 = PAGE ADDR R1 = PAGE R2 = SAVE DATA
		1671	R3 & R4 LOOP CTR'S R5 = ERROR REG
		1672	;
0426	B04	1673	RAM: MOV R3,#4 ;PAGE CTR
0428	B903	1674	MOV R1,#3 ;PAGE ADDR
042A	F9	1675	PAGE: MOV A,R1 ;OUTPUT PAGE ADDR
042B	3A	1676	OUTL P2,A
042C	BC00	1677	MOV R4,#0 ;SET LOOP CTR TO 256
042E	REFF	1678	MOV R0,#0FFH ;PAGE ADDR
0430	80	1679	ADDR: MOVX A,R0 ;INPUT DATA
0431	AA	1680	MOV R2,A ;SAVE DATA
0432	37	1681	CPL A ;COMP COPY
0433	90	1682	MOVX GR0,A ;WRITE INTO RAM
0434	90	1683	MOVX A,GR0 ;READ FROM RAM
0435	6A	1684	ADD A,R2 ;COMPARE
0436	17	1685	INC A
0437	CE3D	1686	JZ GOOD ;MEM CELL GOOD ?
0439	BD90	1687	MOV R5,#090H ;ERROR CODE FOR RAM FR
043A	D453	1688	CALL OOS ;GO OUT OF SERVICE
043D	FA	1689	GOOD: MOV A,R2 ;RESTORE ORIGINAL DATA
043E	90	1690	MOVX GR0,A
043F	C8	1691	DEC R0 ;DEC PAGE ADDR
0440	EC30	1692	DJNZ R4,ADDR ;DO NEXT CELL
0442	C9	1693	DEC R1 ;DEC PAGE
0443	FB2A	1694	DJNZ R3,PAGE ;DO NEXT PAGE
0445	83	1695	RET
		1696	*****
		1697	;
		1698	CKENT
		1699	;
		1700	- (CHECK ENTRANCE)
		1701	;
		1702	*****
		1703	;
		1704	CHECKS POSITION 1. SETS F0 WHEN PILL IS NOT PRESENT.
		1705	;
0446	PDF0	1706	CKENT: MOV R5,#0F7H ;POS 1 COVERED
044H	5433	1707	CALL CP1
044A	95	1708	CPL F0
044B	83	1709	RET
		1710	\$EJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		1711	*****
		1712	;
		1713	EJECT
		1714	;
		1715	;
		1716	*****
		1717	;
		1719	;EJECT IS A UNIVERSAL ROUTINE USED TO GET REJECTED
		1720	;BILL OR JAMMED BILL OUT OF VALIDATOR.
		1721	;THE MOTOR IS REVERSED FOR 2SEC THEN ALL POS SENSORS
		1722	;ARE CK'D FOR BILL PRES. (NOT POS 1) IF BILL IS
		1723	;DETECTED THE VALIDATOR GOES OOS
		1724	;BILL JAMMED CODE IS FLASHED.
		1725	;THE BILL AT ENTRANCE CODE IS FLASHED UNTIL BILL IS
		1726	;REMOVED FROM ENTRANCE
044C	8906	1727	EJECT: ORL P1,#006H ;TURN OFF MOTOR
044E	74CE	1728	CALL DEL12 ;12MS DELAY
0450	99FB	1729	ANL P1,#0FBH ;YES (FFV MOT)
0452	FD	1730	MOV A,R5 ;TURN
0453	3A	1731	OUTL P2,A ;ON
0454	99FE	1732	ANL P1,#0FFH ;RFJLCT
0456	8901	1733	ORL P1,#001H ;DISPLAY
0458	8BAB	1734	MOV R3,#171 ;171 X 11.7MS (2 SEC)
045A	74CF	1735	T171: CALL DEL12 ;11.5MS DELAY
045C	8B5A	1736	DJNZ R3,T171 ;2 SEC ELAPSED ?
045E	8906	1737	ORL P1,#006H ;TURN OFF MOTOR
0460	5474	1738	CALL RFJECT ;TURN OFF DISPLAY
0462	9403	1739	CALL JAMCK ;CK FOR BILL IN VAL.
0464	95	1740	CFL F0 ;
0465	866B	1741	JF0 ENTCK ;BILL JAMMED ?
0467	8DA0	1742	MOV R5,#0A2H ;YES (JAM ERROR CODE)
0469	842B	1743	CALL SDOOS ;GO OUT OF SERVICE
046B	8C32	1744	ENTCK: MOV R4,#50 ;LOOP CTR 50X600MS
046D	9446	1745	ATENT: CALL CKENT ;CK PCS 1
046F	867F	1746	JF0 NOTPRS ;IS BILL PRESENT ?
0471	34E7	1747	CALL FLASH ;(YES) FLASH BILL AT EN
0473	9CED	1748	DJNZ R4,ATENT ;HAS 30 SEC FLAPSET ?
0475	8431	1749	CALL SOOS ;(YES) SEND HOST MSG
0477	9446	1750	ENTRA: CALL CKENT ;CK PCS 1
0479	867F	1751	JF0 NOTPRS ;IS BILL PRESENT ?
047B	34E7	1752	CALL FLASH ;(YES) FLASH BILL AT EN
047D	8477	1753	JMP ENTRA ;LOOP BACK
047F	85	1754	NOTPRS: CLR F0 ;GO BACK TO STFT FLAG
0480	93	1755	AOK: RET
		1756	EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		1757	*****
		1758	;
		1759	;
		1760	;
		1761	;
		1762	;
		1763	*****
		1764	;
		1765	;
		1766	;
		1767	;
		1768	;
0481	B904	1769	RDEL: MOV R1,#4
0483	B0C8	1770	RDEL2: MOV R0,#200
0485	EP65	1771	RDEL1: DJNZ R0,RDEL1
0487	E983	1772	DJNZ R1,RDEL2
0489	B853	1773	MOV R0,#83
048B	E86B	1774	RDEL3: DJNZ R0,RDEL3
048D	B3	1775	RET
		1776	\$EJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		1777	*****
		1778	;
		1779	COMPAR
		1780	;
		1781	(COMPARE READINGS WITH 240)
		1782	;
		1783	*****
		1784	;
		1785	COMPAR CHECKS FOR DATA THAT EXCEEDS 240
		1786	IF DATA IS > 240 BIT 7 OF > 240 TALLY IS SET
		1787	;
049E	97	1788	COMPAR: CLR C
048F	R83C	1789	MOV R0, #EXCLIM ; POINTER FOR >240 TALLY
0491	23F0	1790	MOV A, #240 ; HI DATA LIMIT
0493	37	1791	CPL A ; 2'S COMP
0494	17	1792	INC A
0495	61	1793	ADD A, GR1 ; ADD TEMP DATA
0496	F69C	1794	JC EXCEED ; DOES DATA EXCEED 240 ?
0498	00	1795	NGP ; NO DELAY (RAL IS ELSE)
0499	00	1796	NOP ; DELAY
049A	84A0	1797	JMP BALDON
049C	2380	1798	EXCEED: MOV A, #000H ; YES SET BIT 7 >240 TLY
049E	40	1799	ORL A, GR0
049F	A0	1800	MOV GR0, A
04A0	93	1801	BALDON: RET
		1802	*****
		1803	;
		1804	STORE
		1805	;
		1806	*****
		1807	;
		1808	STORE STORES DATA IN EXT RAM,
		1809	ADDS DATA TO SUBTOTAL AND
		1810	CHECKS FOR > 240 READINGS
		1811	;
04A1	R93F	1812	STORE: MOV R1, #TEMP1 ; ADD TRAK 1 TEMP DATA
04A3	948E	1813	CALL CCMAP ; TEST FOR > 245 DATA
04A5	2300	1814	MOV A, #000H ; RAM PAGE 1
04A7	94D5	1815	CALL STRDAT ; STORE TRAK 1 DATA
04A9	362F	1816	MOV R0, #SBTOT1 ; ADD TRAK 1 SUBTOTAL
04AB	94FF	1817	CALL DADD ; ADD DATA TO SUBTOTAL
04AD	B940	1818	MOV R1, #TEMP2 ; ADD TRAK 1 TEMP DATA
04AF	948F	1819	CALL CCMAP ; TEST FOR > 245 DATA
04B1	2301	1820	MOV A, #001H ; RAM PAGE 2
04B3	94D5	1821	CALL STRDAT ; STORE TRAK 2 DATA
04B5	B930	1822	MOV R0, #SBTOT2 ; ADD TRAK 2 SUBTOTAL
04B7	94FF	1823	CALL DADD ; ADD DATA TO SUBTOTAL
04B9	B941	1824	MOV R1, #TEMP3 ; ADD TRAK 3 TEMP DATA
04BE	9465	1825	CALL CCMAP ; TEST FOR > 245 DATA
04BD	2302	1826	MOV A, #002H ; RAM PAGE 3
04BF	94D5	1827	CALL STRDAT ; STORE TRAK 3 DATA
04C1	B932	1828	MOV R0, #SBTOT3 ; ADD TRAK 3 SUBTOTAL
04C3	94FF	1829	CALL DADD ; ADD DATA TO SUBTOTAL
04C5	B942	1830	MOV R1, #TEMP
04C7	2303	1831	MOV A, #003H ; RAM PAGE 4

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LOC	OBJ	LINE	SOURCE STATEMENT
04C9	94D5	1832	CALL STRDAT
04CB	BE34	1833	MOV R0,#SBTOT
04CD	94FF	1834	CALL DADD
04CF	783E	1835	MOV R0,#PAGADD
04D1	F0	1836	MOV A,R0
04D2	17	1837	INC A
04D3	A0	1838	MOV R0,A
04D4	83	1839	RET
		1840	\$EJECT

;STORF POS 4 DATA
 ;ADDF OF POS 4 SUBTOTAL
 ;ADD DATA TO SUBTCTAL
 ;INC PAGE ADDR

```

;>2 >19          ;8=4          3>DA24 BC2C4<4=C

1841 ;*****
1842 ;
1843 ;          STRDAT
1844 ;
1845 ;          (STORE DATA)
1846 ;
1847 ;*****
1848 ;
1849 ;STREAT SIGRES DATA INTO EXTERNAL RAM
1850 ;SUBROUTINE STORE PUTS PAGE NO. INTO ACC. AND
1851 ;POINTER DATA INTO R1
1852 ;
04D5 R63E 1853 STRDAT: MOV      R0,#PAGADD      ;POINTER TO PAGE ADDR
04D7 3A   1854          OUTL      P2,A          ;OUTPUT PAGE NO.
04D8 F0   1855          MOV      A,R0          ;GET PAGE ADDR
04D9 26   1856          ICH      A,R0          ;PUT IT INTO R0
04DA F1   1857          MOV      A,R0          ;GFT DATA
04DB 90   1858          MOVX     GR0,A          ;STORE DATA
04DC 83   1859          RET
1850 $EJECT

```

LOC	OBJ	LINE	SOURCE STATEMENT
		1861	*****
		1862	*****
		1863	COLECT
		1864	
		1865	(COLLECT DATA)
		1866	
		1867	*****
		1868	
		1869	; COLLECTS DATA FROM ALL THREE TRACKS
		1870	; & STORES DATA TEMPORARLY
		1871	
04DD	74EB	1872	COLECT: CALL SETUP1 ; REG'S SET UP TRACK 1
04DF	5440	1873	CALL ADC1 ; GET TRACKS 1 DATA
04E1	B836	1874	MOV R0, #54 ; CORRECT
04E3	B4D4	1875	CALL CFOS ; POP OFFSET.
04E5	B93F	1876	MOV R0, #TEMP1 ; STORE DATA TEMPORARY
04E7	A0	1877	MOV GR0, A
04E8	74F1	1878	CALL SETUP2 ; REG'S SET UP TRACK 2
04EA	5440	1879	CALL ADC1 ; GET TRACK 2 DATA
04EC	B837	1880	MOV R0, #55
04EE	B4D4	1881	CALL CFOS
04F0	B840	1882	MOV R0, #TEMP2 ; STORE DATA TEMPORARY
04F2	A2	1883	MOV GR0, A
04F3	74FA	1884	CALL SETUP3 ; REG'S SET UP TRACK 3
04F5	5440	1885	CALL ADC1 ; GET TRACK 3 DATA
04F7	B838	1886	MOV R0, #56
04F9	B4D4	1887	CALL CFOS
04FB	B841	1888	MOV R0, #TEMP3 ; STORE DATA TEMPORARY
04FD	A0	1889	MOV GR0, A
04FE	B3	1890	RET
		1891	*****
		1892	*****
		1893	DADD
		1894	
		1895	(DOUBLE ADD)
		1896	
		1897	*****
		1898	
		1899	; DADD PERFORMS A DOUBLE ADD ON REG'S
		1900	; POINTED TO BY R0.
		1901	
04FF	50	1902	DADD: ADD A, GR2 ; ADD LOW BYTE
0500	A2	1903	MOV GR2, A ; STORE LOW BYTE
0501	16	1904	INC R0 ; HI BYTE ADD
0502	27	1905	CLR A ; ADD CARRY TO HI BYTE
0503	70	1906	ADDC A, GR2
0504	A0	1907	MOV GR0, A ; STORE HI BYTE
0505	B3	1908	RET
		1909	\$EJECT

```

LOC  OBJ      LINE      SOURCE STATEMENT
1910 ; *****
1911 ;
1912 ;      BILSEN
1913 ;
1914 ;      (BILL SENSE)
1915 ;
1916 ; *****
1917 ;
1918 ; BILSEN AND SENBIL TESTS FOR BILL PRESENT
1919 ; BILSEN CLRS F0 ON ENTRY SENBIL DOES NOT
1920 ; F0 IS SET IF BILL IS PRESENT
1921 ; DATA IS LOADED INTO REG'S BEFORE ENTRY
1922 ;
0506 85      1923 BILSEN: CLR      F0
0507 FA      1924 SENBIL: MOV     A,A2      ;PUT DATA INTO ACC
0508 37      1925         CPL      A      ;2'S COMP
0509 97      1926         CLR      C
052A 60      1927         ADD     A,0000    ;COMPARE WITH LIMIT
050B E60F    1928         JNC     NOBIL      ;IS BILL PRESENT ?
050D 95      1929         CPL      F0      ;YFS
050E 83      1930 NOBIL: RET
1931 ; *****
1932 ;
1933 ;      BLKCK
1934 ;
1935 ;      (CHECK FOR BLOCK SIGNAL FROM HOST)
1936 ;
1937 ; *****
1938 ;
1939 ; (BYPASSED IF T0 IS HIGH)
1940 ; THIS ROUTINE CHECKS FOR THE PRESENCE OF A BLOCK SIGNAL
1941 ; FROM THE HOST ELECTRONICS. IF THERE IS A BLOCK SIGNAL,
1942 ; THE TRANSPORT REMAINS INACTIVE, AND A MESSAGE IS FLASHED
1943 ; BY THE LED PANEL. WHEN THE BLOCK SIGNAL IS REMOVED,
1944 ; CONTROL RETURNS TO THE MAIN PROGRAM. A BLOCK SIGNAL IS
1945 ; NOT RECOGNIZED IF IT APPEARS DURING THE PROCESSING OF
1946 ; A NOTE.
1947 ;
050F 3619    1948 BLKCK: JTO      ATM
0511 BD70    1949         MOV     R5,#70H      ;LOAD OOS CODE
0513 A417    1950         JMP     CB
0515 3427    1951 PLP:   CALL     FLASH      ;FLASH OUT-OF-SERVICE CODE
0517 8615    1952 CB:    JNI      FLP      ;IF INHIBIT SIGNAL PRESENT,
1953         ;STAY IN FLASH LOOP
0519 83      1954 ATM:   RET
1955 $EJECT

```

LOC	OBJ	LINE	SOURCE STATEMENT
		1956 ;	*****
		1957 ;	
		1958 ;	BUSY
		1959 ;	
		1960 ;	(OUTPUT BUSY SIGNAL)
		1961 ;	
		1962 ;	*****
		1963 ;	
		1964 ;	THIS ROUTINE LATCHES OUT A "BUSY" SIGNAL TO THE HOST
		1965 ;	ELECTRONICS.
		1966 ;	
051A	99FF	1967	BUSY: ANL P1,#0EFH ;WRITE "0" TO P14.
051C	83	1968	RET
		1969 ;	*****
		1970 ;	
		1971 ;	READY
		1972 ;	
		1973 ;	(READY FOR NOTE)
		1974 ;	
		1975 ;	*****
		1976 ;	
		1977 ;	THIS ROUTINE CLEARS ALL COMMUNICATION LINES TO THE
		1978 ;	AUTELCA HOST ELECTRONICS, INDICATING THAT THE UNIT IS
		1979 ;	TO READY TO RECEIVE A NOTE.
		1980 ;	
051D	89F0	1981	READY: ORL P1,#0F0H ;WRITE "1" TO EACH
		1982	;COMMUNICATION
051F	83	1983	RET ;LINE.
		1984 ;	*****
		1985 ;	
		1986 ;	CASHED
		1987 ;	
		1988 ;	(OUTPUT "NOTE CASHED" SIGNAL)
		1989 ;	
		1990 ;	*****
		1991 ;	
		1992 ;	THIS ROUTINE LATCHES OUT A "NOTE CASHED" SIGNAL TO THE
		1993 ;	HOT ELECTRONICS. THE DURATION OF THE SIGNAL IS
		1994 ;	APPROXIMATELY 400 MSEC.
		1995 ;	
0520	8B23	1996	CASHED: MOV R3,#35 ;35X11.5 MS = 400 MS
0522	99BF	1997	ANL P1,#0EFH ;LATCH "NOTE CASHED"
		1998	;SIGNAL TO P1.
0524	74CE	1999	X35: CALL DEL12 ;11.5 MS DFLAY
0526	E324	2000	DJNZ R3,X35 ;400 MS FLAPSED ?
0528	8940	2001	ORL P1,#40H ;YES, REMOVE SIGNAL
052A	83	2002	RFT
		2003	SEJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		2004	*****
		2005	;
		2006	SDOOS
		2007	;
		2008	(OUT OF SERVICE)
		2009	;
		2010	*****
		2011	;
		2012	;THIS ROUTINE LATCHES OUT THE OUT-OF-SERVICE SIGNAL TO
		2013	;THE HOST ELECTRONICS. IT ALSO CONTINUOUSLY FLASHES THE
		2014	;OUT-OF-SERVICE CODE MESSAGE ON THE LED INDICATOR PANEL.
		2015	;THERE IS NO ESCAPE FROM THIS ROUTINE EXCEPT BY A RESET
		2016	;OPERATION.
		2017	;
052B	B431	2018	SDOOS: CALL SOOS ;LATCH OUT-OF-SERVICE
		2019	;COMMUNICATION SIGNAL.
052D	34E7	2020	OOS: CALL FLASH ;DISPLAY OUT-OF-SERVICE
052F	A42D	2021	JMP OOS ;LED CODE.
		2022	*****
		2023	;
		2024	SOOS
		2025	;
		2026	(SEND OUT-OF-SERVICE SIGNAL TO HOST)
		2027	;
		2028	*****
		2029	;
		2030	;THIS ROUTINE LATCHES OUT AN OUT-OF-SERVICE SIGNAL
		2031	;TO THE HOST ELECTRONICS (AUTFLCA).
		2032	;
F531	S990	2033	SOOS: ORL P1,#092H ;LATCH "1001" TO UPFF
F533	S99F	2034	ANL P1,#09FH ;HALF OF P1.
F535	83	2035	RET
		2036	SEJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		2037	*****
		2038	;
		2039	;
		2040	;
		2041	;
		2042	;
		2043	*****
		2044	;
		2045	THIS ROUTINE TURNS THE MOTOR ON FORWARD AND BEGINS A
		2046	0.7 SECOND TIME-OUT. IF
		2047	P5 CLEARS, THE EXIT IS CONFIRMED (VEXIT), AND THE
		2048	NOTE CASHED SIGNAL IS OUTPUT TO THE HOST.
		2049	THE MOTOR IS TURNED
		2050	OFF, AND P0 IS SET. IF 0.7 SECONDS ELAPSES OR IF P1
		2051	IS COVERED, P0 IS CLEARED.
		2052	(NOTE: IF P1 IS COVERED, THE NOTE IS CASHED ANYWAY, BUT
		2053	P0 IS CLEARED.) THE NOTE ID CODE IS DISPLAYED AFTER
		2054	NOTE IS CASHED.
		2055	;
0536	99FD	2056	CASH: ANL P1,#0FDH ;TURN MOTOR ON FORWARD.
0538	B942	2057	MOV R1,#66 ;STORE NOTE ID
053A	FD	2058	MOV A,R5
053B	A1	2059	MOV R51,A
053C	BB3C	2060	MOV R3,#60 ;BEGIN 0.7 SEC
		2061	TIME-CUT LOOP.
053E	3407	2062	TD1: CALL CFS
0540	95	2063	CPL P0
0541	74CE	2064	CALL DEL12 ;SFTS P0=1 IF P5
0543	B64B	2065	JF0 CL ;CLEARED
		2066	;
		2067	DJNZ R3,TD1 ;EXIT LOOP IF P5
		2068	;
		2069	MOV R5,#2A0H ;CLEARED
		2070	JMP OFF ;STAY IN LOOP UNTIL TIME
		2071	CL: CALL VEXIT ;EXPIRES.
		2072	JF1 OFF ;LOAD JAM CODE.
		2073	ORL P1,#006H ;VERIFY EXIT
		2074	MOV R1,#6E ;TURN OFF MOTOR
		2075	MOV A,R1 ;RETRIEVE NOTE ID CODE.
		2076	OUTL P2,A ;TURN ON DISPLAY
		2077	ANL P1,#0FFH
		2078	ORL P1,#001H
		2079	CALL BILL2 ;CHECK FOR 2ND NOTE.
		2080	CALL CASHED ;OUTPUT SIGNAL
		2081	;
055D	B906	2082	OFF: ORL P1,#006H ;TURN OFF MOTOR
055F	27	2083	CLR A ;TURN OFF DISPLAY.
0560	3A	2084	OUTL P2,A
0561	99FE	2085	ANL P1,#0FFH
0563	B901	2086	ORL P1,#001H
0565	53	2087	RET
		2088	\$EJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		2059	*****
		2090	;
		2091	COLRCK
		2092	;
		2093	(COLOR CHECK)
		2094	;
		2095	*****
		2096	;
		2097	;THIS ROUTINE TESTS THE NOTE'S REFLECTANCE READINGS
		2098	;AGAINST ACCEPTANCE BAND LIMITS STORED IN PROGRAM
		2099	;IF A MATCH IS FOUND, ;F0 IS SET. OTHERWISE,
		2100	;THE ROUTINE IS EXITED WITH F0 CLEARED.
		2101	;NOTE: INSTRUCTIONS PRECEDED BY A SEMICOLON ARE
		2102	;OPTIONAL, DEPENDING ON THE NO OF NOTE
		2103	;PATTERNS CHECKED.
		2104	;
0566	1481	2105	COLRCK: CALL NORMDA ;NORMALIZE DATA.
0568	85	2106	CLR F0
0569	D497	2107	CALL IMAGE1
056B	BDE0	2108	MOV R5,#0F0H ;LOAD NOTE ID CODE
056D	B671	2109	JF0 FPASS
		2110	;
		2111	SEL MB1
		2112	CALL IMAGE2
		2113	MCV R5,#1D
		2114	;
		2115	JF0 FPASS ;FOR
		2116	SEL ME0 ;REQUIRED.
056F	BD90	2117	MOV R5,#092H ;SET REJECTION CODE.
0571	93	2118	FPASS: RET
		2119	\$EJECT

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LOC	OBJ	LINE	SOURCE STATEMENT
		2120	;*****
		2121	;
		2122	; BILL2
		2123	;
		2124	;*****
		2125	
		2126	;BILL2 CKECKS FOR 2ND BILL IN UNIT
		2127	
0572	5433	2128	BILL2: CALL CP1
0574	BD30	2129	MOV R5,#030H
0576	B67F	2130	JF0 AN2
0578	9403	2131	CALL JAMCK
057A	B67F	2132	JF0 AN2
057C	95	2133	CPL F0
057D	A480	2134	JMP ACLEAR
057F	55	2135	AN2: CLR F0
0580	83	2136	ACLEAR: RET
		2137	\$EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		2139	*****
		2139	;
		2140	VALID
		2141	;
		2142	(OUTPUT "NOTE VALID" SIGNAL)
		2143	;
		2144	*****
		2145	;
		2146	; THIS ROUTINE FIRST CHECKS FOR AN AUTOMATIC CASH SETTING
		2147	; ON INPUT T0 (T0 = +5V FOR AUTO-CASH). IF THE UNIT IS
		2148	; SET FOR AUTO-CASH, A "NOTE VALID" SIGNAL IS OUTPUT FOR
		2149	; 42 MICROSECONDS. IF THE UNIT IS NOT SET FOR AUTO-CASH,
		2150	; THE "NOTE VALID" SIGNAL IS OUTPUT FOR 6 SECONDS OF
		2151	; UNTIL A "CASH" OR "RETURN" ORDER IS RECEIVED FROM THE
		2152	; HOST. IF THE "CASH" ORDER IS RECEIVED, P0 IS SET.
		2153	; OTHERWISE, IT IS CLEARED. THE "NOTE VALID" SIGNAL IS
		2154	; REMOVED BEFORE EXITING THE ROUTINE.
		2155	;
0581 85		2156	VALID: CLR P0
0582 369E		2157	JT0 AUTO ; JUMP TO AUTO-CASH IF
		2158	;
0584 15		2159	DIS 1 ; DIS-ABLE INTERRUPT.
0585 5960		2160	ORL P1, #60H ; WRITE "1" TO P17.
0587 99DF		2161	ANL P1, #0DFH ; LATCH "NOTE VALID"
		2162	; SIGNAL TO P1.
0589 BC07		2163	MOV R4, #7 ; INITIALIZE LOOP
		2164	; COUNTER.
058B BEFA		2165	LLA: MOV R6, #252 ; INITIALIZE LOOP
		2166	; COUNTER.
058D BFFA		2167	LLB: MOV R7, #252 ; INITIALIZE LOOP
		2168	; COUNTER.
058F 09		2169	LLC: IN A, P1 ; READ P1.
0590 5360		2170	ANL A, #080H ; MASK IN P17.
0592 C6AE		2171	JZ SNEXT ; JUMP IF "CASH ORDER"
		2172	; HAS BEEN RECEIVED
0594 B6AE		2173	JNI SEJEC2 ; JUMP IF "RETURN ORDER"
		2174	; HAS BEEN RECEIVED.
0596 FFBF		2175	DJNZ R7, LLC
0598 FFB0		2176	DJNZ R6, LLB
059A ECFB		2177	DJNZ R4, LLA
059C A4AA		2178	JMP SEJEC1
059E 99DF		2179	AUTO: ANL P1, #0DFH ; LATCH "NOTE VALID"
		2180	; SIGNAL TO P1.
05A0 BAWC		2181	MOV R2, #12 ; 36 MICROSECONDS
05A2 FAA2		2182	DD3: DJNZ R2, DD3 ; DELAY.
05A4 A4AE		2183	JMP SNEXT
05A6 BD20		2184	SFJEC2: MOV R5, #205 ; SET "FEJEC" CODE.
05A8 A4AF		2185	JMP DISCON
05AA BDE6		2186	SFJEC1: MOV R5, #60H ; SET "TIME EXPIRED"
		2187	; CODE.
05AC A4AF		2188	JMP DISCON
05AE 95		2189	SNEXT: CPL P0
05AF B920		2190	DISCON: ORL P1, #20H ; REMOVE "NOTE VALID"
		2191	; OUTPUT
		2192	; SIGNAL.

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LOC	OBJ	LINE	SOURCE STATEMENT
05B1	93	2193	RET
		2194	\$EJECT

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LOC  OBJ      LINE      SOURCE STATEMENT
2195 ; *****
2196 ;
2197 ;
2198 ;           OFFSET
2199 ; *****
2200
2201 ; THIS ROUTINE MEASURES THE OFFSET READINGS (WITH
2202 ; THE LED'S OFF) FOR EACH OPTICAL CHANNEL AND STORES
2203 ; THE RESULTS IN INTERNAL RAM.
2204
05B2 BF80      2205 OFFSET: MOV      R7, #NOLED      ; LED'S WILL BE OFF.
05B4 B936      2206         MOV      R1, #54      ; SET POINTER TO FIRST
                                ; STORAGE LOC. IN RAM.
05B6 BF01      2207         MOV      R0, #CHAN1     ; TRACK 1 A/D CHAN.
05B8 5440      2208         CALL     ADC1      ; GET TRACK 1
05BA FA        2209         MOV      A, R2      ; READING.
05BB A1        2210         MOV      R1, A      ; STORE READING.
05BC 19        2211         INC      R1      ; SET UP FOR
05BD B802      2212         MOV      R2, #CHAN2    ; TRACK 2.
05BF 5440      2213         CALL     ADC1      ; GET TRACK 2 READING.
05C1 B4DA      2214         CALL     HIOFF     ; CHECK OFFSET TOO HIGH.
05C3 FA        2215         MOV      A, R2
05C4 A1        2216         MOV      R1, A      ; STORE READING.
05C5 19        2217         INC      R1      ; SET UP FOR
05C6 B801      2218         MOV      R0, #CHAN1    ; TRACK 3.
05C8 5440      2219         CALL     ADC1      ; GET TRACK 3
05CA FA        2220         MOV      A, R2      ; READING.
05CB A1        2221         MOV      R1, A      ; STORE READING.
05CC 19        2222         INC      R1      ; SET UP FOR
05CD B801      2223         MOV      R2, #CHAN1    ; POS. 4.
05CF 5440      2224         CALL     ADC1      ; GET POS. 4
05D1 FA        2225         MOV      A, R2      ; READING
05D2 A1        2226         MOV      R1, A      ; STORE READING.
05D3 93        2227         RET
2228 ; *****
2229 ;
2230 ;
2231 ;           CFOS
2232 ;
2233 ;           (CORRECT FOR OFFSET)
2234 ;
2235 ; *****
2236
2237 ; THIS ROUTINE SUBTRACTS APPROPRIATE OFFSET READING
2238 ; FROM OPTICAL DATA READING, LEAVING THE FINAL RESULT
2239 ; IN A AND R2.
2240
2241 ; AT ENTRY: R0 = POINTER TO OFFSET READING.
2242 ;           R2 = READING TO BE CORRECTED.
2243
05D4 F0      2244 CFOS: MOV      A, R0
05D5 37      2245         CPL      A
05D6 17      2246         INC      A
05D7 5A      2247         ADD      A, R2
05D8 AA      2248         MOV      R2, A
05D9 93      2249         RPT

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ISIS-11 PCS-48/UP1-41 MACRO ASSEMBLER, V3.0

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LOC	OBJ	LINE	SOURCE STATEMENT
		2250	\$EJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		2251	*****
		2252	;
		2253	HIOFF
		2254	;
		2255	(CHECK FOR HIGH OFFSET)
		2256	;
		2257	*****
		2258	;
		2259	AT ENTRY: R2 = OFFSET READING TO BE TESTED
		2260	;
05DA	97	2261	HIOFF: CLR C
05DB	2314	2262	MOV A, #20 ; INPUT HIGH LIMIT.
05DD	37	2263	CPL A ; TEST
05DE	17	2264	INC A ; AGAINST
05DF	6A	2265	ADD A, R2 ; LIMIT
05E0	EEEE	2266	JNC OFFOK ; JUMP IF OK.
05E2	BD40	2267	MOV R5, #040H ; OOS CODE
05E4	D453	2268	CALL OOS
05E6	83	2269	OFFOK: RET ; OFFSET OK
		2270	;
		2271	*****
		2272	;
		2273	VEXIT
		2274	;
		2275	(VERIFY EXIT)
		2276	;
		2277	*****
		2278	;
		2279	THIS ROUTINE EXECUTES A 300 MSEC TIMEOUT WHILE CHECKING
		2280	THE
		2280	EXIT BLOCKER (POS 3). IF THE EXIT CLEARS, F0 IS SET. IF
		2281	NOT,
		2281	F0 IS CLEARED, F1 IS SET, AND R5 IS LOADED WITH THE NOT
		2282	F
		2282	REJECTION CODE.
		2283	;
0600		2284	ORG 0600H
		2285	;
0600	BD1A	2286	VEXIT: MOV R5, #2E
0602	74CE	2287	CTIM: CALL DEL12 ; DFIAY
0604	A5	2288	CLR F1
0605	BF60	2289	MOV R7, #NOLED
0607	BE24	2290	MOV R0, #CHAN4 ; CHECK POSITION 3
0609	5440	2291	CALL ADC1
060B	BE28	2292	MOV R0, #POS3
060D	B406	2293	CALL BILSEN
060F	95	2294	CPL F0
0610	B617	2295	JF0 VFIED ; JMP IF CLEARED.
0612	ED02	2296	DJNZ R5, CTIM
0614	R5	2297	CPL F1 ; SET F1.
0615	BDEC	2298	MOV R5, #0B2H ; SET REJECT CODE
0617	83	2299	VFIED: RET
		2300	REJECT

LOC	OBJ	LINE	SOURCE STATEMENT
		2301	*****
		2302	;
		2303	;
		2304	TRANRA
		2305	(TRANMISSION RATIO)
		2306	;
		2307	*****
		2308	;
		2309	THIS ROUTINE CALCULATES THE RATIO, MULTIPLIFD BY
		2310	32, OF THE HIGHEST CENTER TRACK TRANMISSION
		2311	READING TO THE LOWEST CENTER TPACK TRANMISSION
		2312	READING. THE RESULT IS COMPARED WITH A LOWER
		2313	LIMIT STORED IN PROGRAM MEMORY. IF THE NOTE
		2314	PASSES, P0 IS SET.
		2315	;
		2316	;
		2317	;
0619	1456	2318	TRANRA: CALL AVREAD
061A	B82C	2319	MOV R0,#44 ;SET R0 AS
061C	F0	2320	MOV A,R0 ;POINTER TO
061D	A6	2321	MOV R0,A ;READINGS.
061E	2303	2322	MOV A,#003H ;LATCH EXTFRNAL
0620	3A	2323	OUTL P2,A ;RAM PAGE ADDRESS.
0621	8C	2324	MOVX A,R0 ;GET FIRST READING
0622	AD	2325	MOV R5,A
0623	AE	2326	MOV R6,A
0624	C8	2327	DEC R0
0625	80	2328	NEW1: MOVX A,R0
0626	AF	2329	MOV R7,A
0627	97	2330	CLR C ;COMPARE WITH
0628	37	2331	CPL A ;CURREAT
0629	17	2332	INC A ;LOWEST
062A	6D	2333	ADD A,R5 ;PPADING.
062B	E631	2334	JNC NEWH1 ;NEW LOWEST?
062D	FF	2335	MOV A,R7 ;YES,
062F	AD	2336	MOV R5,A ;STORE IN R5.
062F	C439	2337	JMP NREAD ;GO TO NEXT READING.
0631	FF	2338	NEWH1: MOV A,R6
0632	37	2339	CPL A
0633	17	2340	INC A
0634	6F	2341	ADD A,R7
0635	F639	2342	JNC NREAD
0637	FF	2343	MOV A,R7
0638	AE	2344	MOV R6,A
0639	FA25	2345	NREAD: DJNZ R0,NEW1
063B	2320	2346	MOV A,#32
063D	B806	2347	MOV R0,#6
063F	1403	2348	CALL MULPLY
0641	E905	2349	MOV R1,#5
0643	149F	2350	CALL DIVIDE
0645	AF	2351	MOV R7,A
0646	35	2352	CLR R0
0647	2343	2353	MOV A,#OPLIM
0649	2F	2354	XCH A,R7
064A	97	2355	CLR C

LOC	OBJ	LINE	SOURCE STATEMENT
064B	37	2356	CPL A
064C	6F	2357	ADD A,R7
064D	F650	2358	JC RFAIL
064F	95	2359	CPL F0
0650	BD80	2360	RFAIL: MOV R5,#060H
0652	93	2361	RET
		2362	*****
		2363	;
		2364	;
		2365	;
		2366	;
		2367	;
		2368	*****
		2369	;
		2370	;THIS ROUTINE OUTPUTS THE OOS SIGNALS. PUTS ZFCS
		2371	;IN THE STACK, AND EXECUTES A JUMP TO
		2372	;THE BEGINNING OF THE PROGRAM SO AS TO RECFCK
		2373	;THE OOS STATUS.
		2374	;
0653	F431	2375	OOS: CALL SOOS
0655	34E7	2376	CALL FLASH
0657	BF11	2377	MOV R7,#17
0659	R808	2378	MOV R0,#8
065B	27	2379	CLR A
065C	AF	2380	STAK0: MOV OR0,A ;PUT 0'S IN STACK.
065D	1S	2381	INC R0
065F	EF5C	2382	DJNZ R7,STAK0
0660	040A	2383	JMP EXEC
		2384	\$EJECT

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LOC	CBJ	LINE	SOURCE STATEMENT
		2385	*****
		2386	;
		2387	;
		2388	OPSUR
		2389	;
		2390	(FLASHES CODE FOR DIRTY OPTICAL SURFACES)
		2391	;
		2392	*****
		2393	TFIS ROUTINE CHECKS BIT 7 OF REG 61 TO DETERMINE
		2394	IF THE OPTICAL SURFACES NEED CLEANING. IF SO, IT
		2395	FLASHES THE APPROPRIATE CODE DURING THE IDLE CYCLE.
		2396	;
0662	B23D	2397	OPSUR: MOV R0,#61
0664	F0	2398	MOV A,GR0
0665	5380	2399	ANL A,#080H
0667	C684	2400	JZ SCLEAN
0669	18	2401	INC R0
066A	F0	2402	MOV A,GR0
066B	C67F	2403	JZ DARK
066D	2360	2404	MOV A,#060H
066F	3A	2405	OUTL P2,A
0670	99FE	2406	ANL P1,#2FEH
0672	8901	2407	ORL P1,#001H
0674	34BF	2408	CALL T300
0676	27	2409	CLR A
0677	A0	2410	MOV GR0,A
0678	3A	2411	OUTL P2,A
0679	99FE	2412	ANL P1,#0FEH
067B	8901	2413	ORL P1,#001H
067D	C4C4	2414	JMP SCLEAN
		2415	;
067F	34BF	2416	DARK: CALL T300
0681	2355	2417	MOV A,#055H
0683	A0	2418	MOV GR0,A
0684	83	2419	SCLEAN: RET
		2420	;
		2421	EXJECT

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LCC	OBJ	LINE	SOURCE STATEMENT
		2422	*****
		2423	;
		2424	REVLOC
		2425	;
		2426	(REVERSES ACCEPTANCE BAND LOCATION NUMBERS)
		2427	;
		2428	*****
		2429	;
		2430	;THIS ROUTINE REVERSES THE ACCEPTANCE BAND LOCATION
		2431	;NUMBERS IF AND ONLY IF REG 66 IS NON-ZERO.
		2432	;
		2433	;
0685	AD	2434	REVLOC: MOV R5,A
0686	B942	2435	MOV R1,#66
0688	F1	2436	MOV A,QR1
0689	968E	2437	JNZ YFEV
068B	FD	2438	MOV A,R5
068C	C49F	2439	JMP NFEV
068E	B92D	2440	YREV: MOV R1,#45
0690	F1	2441	MOV A,QR1
0691	37	2442	CPL A
0692	6D	2443	ADD A,R5
0693	0307	2444	ADD A,#7 ;ADD BORDER CORRECTION
0695	37	2445	CPL A
0696	93	2446	NREV: RET
		2447	;
		2448	*****
		2449	;
		2450	IMAGE1
		2451	;
		2452	(CHECKS FOR MATCH WITH ACCEPTANCE BAND 1)
		2453	;
		2454	*****
		2455	;
		2456	;THIS ROUTINE CHECKS A NOTE'S REFLECTANCE READINGS
		2457	;AGAINST ACCEPTANCE BAND 1 FOR ALL THREE TRACKS. IF
		2458	;THE NOTE PASSES, P0 IS SET. IF PIN 30 IS HIGH
		2459	;(VIA JUMPER J2), TWO POSSIBLE ENTRY ORIENTATIONS
		2460	;ARE TESTED ("NORMAL" AND "BACKWARDS"). OTHERWISE,
		2461	;ONLY THE NORMAL ENTRY ORIENTATION IS CHECKED...
		2462	;NOTE: INSTRUCTIONS PRECEDED BY A SEMICOLON ARE
		2463	;USED IF AND ONLY IF THE ACCEPTANCE BAND TABLE IS
		2464	;LOCATED IN THE UPPER 2K OF PROGRAM MEMORY.
		2465	;
0697	B942	2466	IMAGE1: MOV R0,#66 ;SET FLAG FOR
0699	27	2467	CLR A ;NORMAL ORIENTATION...
069A	A0	2468	MOV R0,A
069B	BC4B	2469	MOV R4,#75 ;SET POINTER FOR TRACK 1
		2470	;SEL MB1
069D	F425	2471	CALL ACCBD1 ;LOAD TRACK 1 ACCEPTANCE
		2472	;BAND INTO R4.
069F	3F00	2473	MOV R5,#0 ;PAGE ADDRESS FOR TRACK 1 DATA
06A1	F5	2474	SEL MRC
06A2	3435	2475	CALL TRACKT ;DETERMINE ERROR COUNT
		2476	;FOR TRACK 1.

LOC	OBJ	LINE	SOURCE STATEMENT
06A4	BC87	2477	MOV R4,#135
		2478	
		2479 ;	
06A6	F428	2480	SFL MB1
06A8	BD01	2481	CALL ACCBD1
06AA	F5	2482	MOV R5,#1
06AB	3438	2483	SFL MB0
06AD	BCC3	2484	CALL TRAKCT
		2485 ;	
06AF	F428	2486	MOV R4,#195
06B1	BD02	2487	SFL MB1
06B3	F5	2488	CALL ACCBD1
06B4	3438	2489	MOV R5,#2
06B6	3414	2490	SFL MB0
		2491	CALL TRAKCT
		2492	CALL CERCPC
06B8	BCF1	2493	JF0 TF
06BA	09	2494	IN A,P1
06BB	5308	2495	ANL A,#008H
06BD	C6E1	2496	JZ TF
06BF	B842	2497	MOV R0,#6E
06C1	2337	2498	MOV A,#55
		2499	
06C3	A0	2500	MOV GF0,A
06C4	BC4B	2501	MOV R4,#75
		2502 ;	
06C6	F428	2503	SFL MB1
06C8	BD02	2504	CALL ACCBD1
06CB	3438	2505	SFL R5C#2
06CD	BC87	2506	CALL TRAKCT
		2507	MOV R4,#135
		2508 ;	
06CF	F428	2509	SFL MB1
06D1	F5	2510	CALL ACCBD1
06D2	BD01	2511	SFL MB0
06D4	3438	2512	MOV R5,#1
06D6	BCC3	2513	CALL TRAKCT
		2514	MOV R4,#195
		2515 ;	
06D8	F428	2516	SFL MB1
06DA	F5	2517	CALL ACCBD1
06DB	BD00	2518	SFL MB0
06DD	3438	2519	MOV R5,#0
06DF	3414	2520	CALL TRAKCT
06F1	83	2521	CALL CERCPC
		2522	RET
		2523	TF: \$EJECT

;REPEAT FOR
 ;TRACKS 2 AND 3.

 ;CHECK ERROR TOTALS.
 ;SET F0 IF NOTE PASSES

 ;TEST PIN 30...

 ;SET FLAG FOR REVERSE
 ;ENTRY CHECK...

 ;REPEAT ACCEPTANCE
 ;FOR REVERSE ENTRY...

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ISIS-II MCS-46/UPI-41 MACRO ASSEMBLER, V3.0

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LOC	OBJ	LINE	SOURCE STATEMENT
2524			*****
2525			
2526			MOVLIM
2527			
2528			(MOVE ACCEPTANCE BAND LIMIT TO RAM)
2529			
2530			*****
2531			
2532			THIS MACRO TRANSFERS ACCEPTANCE BAND LIMITS FROM A
2533			PROGRAM MEMORY TABLE INTO RAM. IT IS INCORPORATED
2534			INTO THE ACCBDA SUBROUTINE.
2535			
2536			MOVLIM MACRO
2537			INC R4 ; INCREMENT ACCEPTANCE TABLE
2538			MOV A,R4 ; POINTFR.
2540			MOVP A,0A ; GET LIMIT FROM TABLE.
2541			INC R0 ; INCREMENT POINTER TO RAM.
2542			MOV GR0,A ; PUT LIMIT IN RAM.
2543			ENDM
2544			\$EJECT

LOC	CBJ	LINE	SOURCE STATEMENT
		2545	;;*****
		2546	;
		2547	;
		2548	ACCBD1
		2549	(TRANSFER ACCEPTANCE BAND1 TO RAM)
		2550	;
		2551	*****
		2552	;
		2553	THIS ROUTINE FIRST CHECKS WHETHER OR NOT A TRANSPORT
		2554	SPEED CORRECTION IS NEEDED. IT THEN TRANSFERS
		2555	ACCEPTANCE BAND DATA FOR A PARTICULAR TRACK FROM
		2556	PROGRAM MEMORY TO INTERNAL RAM LOCATION 68-127,
		2557	CORRECTING LOCATION NUMBERS FOR SPEED IF REQUIRED.
		2558	IT ALSO ADDS A PRE-SHIFT OF -4 TO EACH LOCATION NUMBER.
		2559	THIS ROUTINE MUST BE STORED ON THE SAME PAGE IN PROGRAM
		2560	MEMORY AS THE ACCEPTANCE BAND DATA WHICH IT PROCESSES.
		2561	;
		2562	REGISTERS USED:
		2563	;
		2564	R0 = BEGINNING OF ACCEPTANCE BANDS WHERE ACCEPTANCE
		2565	R1 = USED IN SPCK.
		2566	R4 = ACCEPTANCE BAND TABLE POINTER.
		2567	R5 = LOCATION COUNTER.
		2568	;
0728		2570	ORG 0728H
		2571	;
0728 BF14		2572	ACCBD1: MOV R6, #NCOLOR ;SET LOCATION COUNTER.
072A B844		2573	MOV R0, #68 ;SET POINTER TO RAM
072C E5		2574	SEL M30 ;ACCEPTANCE BAND TABLE.
072D 14C4		2575	CALL SPCK ;SET F1 IF SPEED OK.
072F FC		2576	L10: MOV A, R4 ;GET LOCATION NO.
0730 A3		2577	MOVP A, R0 ;FROM PROGRAM MEMORY
0731 7635		2578	JF1 SHIF3 ;JUMP IF SPEED
		2579	;
		2580	CORRECTION
			NOT REQUIRED.

ISIS-II MCS-48/UP1-41 MACRO ASSEMBLER, V3.0 ;*****

S S UP M RO SS M L R V P
 I I I C 48 -41 AC A E B E 3.0
 S M I AGE 58

LOC	OBJ	LINE	SOURCE STATEMENT
074B		2614	ORG 74BH
		2615	*****
		2616	;
		2617	BAND1
		2618	;
		2619	(ACCEPTANCE BAND FOR ORIENTATION1)
		2620	*****
		2621	FOR THAT LOCATION.
		2622	;
		2623	LOC. UPPER LOWER

	2630 ;	NO.	LIMIT	LIMIT	
	2631				
	2632 ;				
	2633				
	2634	DB	4,	111,	81
074B 04					
074C 6F					
074D 51					
074E 0F	2635	DB	14,	149,	103
074F 95					
0750 57					
0751 16	2636	DB	22,	104,	56
0752 68					
0753 42					
0754 23	2637	DB	35,	115,	56
0755 73					
0756 42					
0757 24	2638	DB	36,	105,	54
0758 6A					
0759 40					
075A 30	2639	DB	48,	193,	134
075B B7					
075C 95					
075D 31	2640	DB	49,	183,	148
075E B7					
075F 94					
0760 32	2641	DB	50,	195,	141
0761 R9					
IS07771 MCS-48/UPI-264 MACRO ASSEMBLER, SYMMENT 108,					
0777 4B					
0778 5F	2649	DB	95,	159,	139
0779 4B					
IS07811 MCS-48/UPI-264 MACRO ASSEMBLER, SYMMENT 109,					
0781 4B					
IS07811 MCS-48/UPI-41 MACRO ASSEMBLER, V3.0					
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LOC	OBJ	LINE	SOURCE STATEMENT		
07D6	9D				
07D7	6E				
07D8	32	2687	DB	50,	164, 135
07D9	A4				
07DA	87				
07DB	35	2688	DB	53,	164, 133
07DC	A4				
07DD	85				
07DE	37	2689	DB	55,	165, 133
07DF	A5				
07E0	85				
07E1	38	2690	DB	56,	166, 137
07E2	A6				
07E3	89				
07E4	39	2691	DB	57,	167, 139
07E5	A7				
07E6	8B				
07E7	46	2692	DB	72,	175, 120
07E8	AF				
07E9	78				
07EA	51	2693	DB	81,	143, 106
07EB	5F				
07EC	6A				
07ED	59	2694	DB	85,	147, 108
07EE	93				
07EF	6C				
07F0	A3	2695	DB	97,	163, 138

03

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0712 8A
07F3 6F 2696 - DB 110, 137, 90
07F4 39
07F5 5A
07F6 83 2697 DB 111, 131, 92
07F8 5C
07F9 70 2698 DB 112, 124, 98
07FA 7C
07FB 5E

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DISCON 05AF	DIVIA 00A9	DIVIB 00C2	DIVIC 00BE	DIVID 00FF
DIVIDE 009E	DIVIE 00B6	DIVILP 00AA	DTASET 0298	ECHECK 0216
EJECT 044C	ENDDIS 0283	ENDIT 01BD	ENDFUN 015F	ENDS 01BF
ENTCK 046B	ENTRA 0477	EOC 0265	ECCD 025B	ERRCT 0003
EXCFED 049C	EXCLIM 003C	EXEC 000A	FIRST 002F	FLASH 01E7
FPASS 0571	FSTJAM 0179	GET4 0135	G01 001C	G010 0050
G02 0022	G05 002C	G06 0030	G07 0038	G08 0040
G09 0048	GOOD 043D	GOOD1 0420	HIOFF 05DA	IDLE 02C5
IMAGE1 0697	INIT 02FA	INTRAM 040F	JAM 0167	JAMCK 0403
JAMLIM 00A0	JAMMD 022B	JITDEL 03C2	L1 00A3	L10 072F
L2 00B0	LFAIL 00F7	LIMIT 00C8	LLA 0588	L13 058D

(105)

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ISIS-II ASSEMBLER SYMBOL CROSS REFERENCE, V2.1

PAGE 2

DISCON	2185	2188	2190#					
DIVIA	586	590#						
DIVIB	589	615#						
DIVIC	601	606	610#					
DIVID	608	612#						
DIVIDE	462	549	581#	693	706	1046	1402	2350
DIVIE	597	603#						
DIVILP	592#	612						
DTASET	1225#	1227						
ECHECK	1078#	1089						
EJFCT	401	409	414	420	426	431	1092	1727#
ENDDIS	1189	1194#						
ENDIT	932	935#						
ENDRUN	839	844#						
ENDS	905	936#						
ENTCK	1741	1744#						
ENTRA	1750#	1753						
EOC	1155	1156	1159#					
EOCD	1154#	1154						
ERRCT	326#	764						
EXCEED	1794	1798#						
EXCLIM	293#	1228	1789					
EXEC	358	362	366#	2383				
FIRST	280#	863	920	1465				
FLASH	1009#	1747	1752	1951	2020	2376		
FPASS	2109	2118#						
FSTJAM	867	875#						
GFT4	924	931#						
G01	390	392#						
G010	425	429#						
G02	396	398#						
G05	400	404#						
G06	404	407#						
G07	408	411#						
G08	413	416#						
G09	419	422#						
GOOD	1686	1689#						
GOOD1	1649	1652#						
HIOFF	2215	2261#						
IDLE	377	1287#	1331					
IMAGE1	2107	2466#						
INIT	365	1215#						
INTLAM	1287	1640#						
JAM	862#	931						
JAMCK	1623#	1739	2131					
JAMLIM	313#	873						
JAMMD	1091#							
JITDEL	389	1530#						
L1	332#	691						
L10	2576#	2610						
L2	329#	655						
LFAIL	690	697	701#					
LLKIT	2286#	2592						
LLP	2167#	2176						
LLC	2169#	2175						
LNCTCK	437	673#						

ISIS-II ASSEMBLER SYMBOL CROSS REFERENCE. V2.1

PAGE 3

LOCCK	819#	838	842				
LP1	537#	554					
LP2	543#	551					
LPASS	699#						
MOVLIM	2536#	2592	2600				
MPY8A	494	503#					
MPY8LP	494#	500	508				
MULPLY	491#	681	704	1043	1401	2348	
N0	316#	635	1044				
NCHAN	974#	996					
KCOLOR	323#	817	2572				
NEW	1364	1371#					
NFW1	2328#	2345					
NEWFI	2334	2338#					
NEXT	1369	1382#					
NJAM	1084	1095#					
NOBIL	1928	1930#					
NOINC	1057	1060#					
NOJAM	874	877#					
NOLED	278#	1316	1441	2205	2289		
NORMDA	531#	2105					
NOTPR	1543	1545#					
NOTPRS	1746	1751	1754#				
NREAD	2337	2342	2345#				
SEXTET	2858#	2858#	2082#	1651	1688	2266	2375#
OPL0	274#	1597	1607				
OPL01	272#	1602					
OPLIM	334#	2353					
OPSUR	1329	2397#					
ORFAIL	774	780#					
OKPASS	769	776#					
OVERX	631	840#					
PBB1FD	1898#	1922#	1235	1825			
POS3	287#	1446	2292				
PCS4	289#	902	1092	1240	1627		
REDED	1388#	1802#	917	1438			

ISIS-II ASSEMBLER SYMBOL CROSS REFERENCE. V2.1

PAGE 4

READ1	900#	934							
READY	375	1981#							
REJECT	1185#	1738							
RESET	367	1417#							
RFTST	368	1465#							
REVLOC	2434#	2354							
RFAIL	2358	2360#							
SBTOT	303#	1633							
SBTCT1	297#	1472	1816						
SBTCT2	299#	1822							
SBTOT3	301#	1828							
SEXTET	2858#	2858#	2858#	2858#	2858#	2915	2529	428	430 432

*4*4N** "446.#-63 4:..#0- 53044 36'636/56M'750E

1"(K V

X0 1570# 1571
YEFV 2437 2440#

CROSS REFERENCE COMPLETE

The microprocessor uses the operational program to control all aspects of operation of the apparatus, including note entry detection and note position monitoring, mechanical transport control, optical data collection and analysis, external communications, self-testing and self-calibration. The program set forth in Table I is specifically adapted for determining the validity of a British one pound note. As already mentioned, the apparatus can be modified to accept currency notes from various countries and in various denominations. The operational program of Table I has a modular structure, with each major sub routine comprising a self-contained unit. Each subroutine is headed by a list of all the variables and all memory space used by the routine. Where an INTEL 8039 microprocessor is utilized, the input/output specifications set forth hereafter in Table II may be utilized:

Table II

Port HexAddress Select

20	Motor forward	P1	X2
	Motor reverse	P1	X4
	Motor off	P1	X6
	D/A converter	P2	3X
	A/D converter	P2	1X
25	LED switch select	P2	2X
	External PAM	P2	0X
	LED indicator panel	P1	X1

Tables III and IV set forth the main routines and utility subroutines of the program of Table I.

TABLE III

1. Idle, Test and Calibration Routine
 - 5 A. Check Ram
 - B. Check Position Sensors
 - C. Perform Optical Calibration
 - D. Check for Note Entry
 - E. Check for Inhibit Signal from Host Electronics
 - 10 F. Idle
2. Note Entry Routine
 - A. Turn on Motor
 - B. Recheck Entrance Sensor
 - C. Check for Note Arrival at Optical Block
 - 15 D. Check Width
3. Optical Data Collection
 - A. Sequentially Pulse LED's, Read and Store Data, and Update Data Subtotals for Each Track
 - B. Increment Data Count
 - 20 C. Check Position Sensor 4; Store Length Count
 - D. Check for Automatic Cash: otherwise, Turn Off Motor

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4. Data Analysis
 - A. Compute and Check Length
 - B. Check Average Opacity
 - C. Normalize Reflection Data (Correct for Dirt)
 - 5 D. Correct for Speed
 - E. Test Selected Readings against Acceptance Band, using Successive Data Shifts
5. Note Cashing
 - A. Turn Motor On
 - 10 B. Verify Note Exit into Escrow
 - C. Time Out Motor
6. Note Rejection
 - A. Turn on Motor in Reverse
 - B. Display Reason for Note Rejection
 - 15 C. Verify Note Exit
 - D. Time Out Motor
7. Out-of-Service
 - A. Display Reason for Out-of-Service Condition

Table IV

- 20 1. A/D Conversion
2. Multiply
3. Divide
4. Display

25 A flow chart of the operational program set forth in Table I is illustrated in Figure 10.

When the note is being propelled under the optical scanning station, the microprocessor sequentially pulses the LEDs for each track in cyclical fashion. The PIN diodes

thus generate a plurality of read signals corresponding to each track, the amplitudes of the read signals representing the intensity of the color or infrared spectral reflectance of a particular circular sample area on the note. These read signals are converted into digital information which is stored in the RAM 102.

The analysis of the optical data is based on comparing the readings from a particular note with acceptance band data stored in the EPROM 104 as part of the operational program. The acceptance band data, which represents a "standard profile" of the type of currency note which is to be validated, is determined in advance by collecting data from a large sample of valid notes. The acceptance band data consists of upper and lower limits for the reflectance readings at a predetermined number of locations on each track, for example at twenty circular sample areas 48 (Figure 6) for each track. Generally, the locations in each track are selected to be those which show the least scatter in the readings. Also, the locations which are to be tested are selected to be those which provide the best discrimination against photocopies.

The infrared emitting diode 76 (Figure 3) which is underneath the note is also pulsed in sequence with the LEDs above the note so that at the same time the optical reflectance readings are being generated, the optical opacity readings are also being generated. For example, during one cycle, first all of the LEDs above a particular track on the note would be pulsed, thereafter all the LEDs above the next track would be pulsed, thereafter all the LEDs above the remaining track would be pulsed, and finally

the infrared emitting diode beneath the note would be pulsed. Thereafter, the cycle would repeat itself. The signals generated by the PIN diode above the infrared emitting diode 76 are also converted into digital information representative of their intensity and are stored in the RAM 102. The actual reflectance and opacity readings collected for a note represent the raw data which much be processed before it can be compared to the acceptance band data. The reflectance readings and the opacity readings are processed differently.

The processing of the reflectance readings is as follows. First, each reflectance reading on a particular track is divided by the average of all the readings for that track. This normalization of the readings brings the readings from a dirty note up to the same average level as those for a new note. Tests have indicated that this significantly reduces the scatter found in the readings from a large sample of notes. The normalized reflectance readings are then corrected for transport speed. As the optical reflectance readings are taken, the time required for the leading edge of the note to travel from the scanning block 38 to the sensor pair 88 (Figure 2) is measured. A transport speed correction factor is computed from this measured time and known distance of travel, and is used to adjust data locations on the note. Finally, preselected normalized reflectance readings are compared with their corresponding upper and lower limits in the stored acceptance band data. Successive data shifts of up to two locations are made in each direction along the length of a track in order to compensate for note-to-note

pattern registration variations. In order for a note to pass as valid under the optical reflectance test, there must be a particular longitudinal data shift for which there are no more than two locations per track at which the note's preselected normalized reflectance readings fall outside the acceptance band limits.

Where it is required that a note be accepted when entered reverse and/or upside-down, then separate tables containing different acceptance band data for each different orientation in which the note can be entered are stored. The microprocessor must then execute the above analysis with respect to each orientation until a "match" is found. Accordingly, the note will pass the optical reflectance test if there is a predetermined maximum amount of non-conformity between the selected normalized read signals and the corresponding acceptance band data.

Tests have indicated that there is too much scatter and too little dynamic range in the optical transmission readings to perform a reliable acceptance band test by comparing a plurality of the opacity readings against a plurality of corresponding upper and lower acceptance band limits. However, the opacity readings along the length of the note can be averaged, and the resulting average opacity can be compared with further acceptance band data in the form of upper and lower limits for the opacity which are stored in the program memory. Thus, the opacity test is also passed if there is a predetermined maximum amount of non-conformity. This provides discrimination against one-sided copies and against copies using paper of the wrong type or thickness.

When there is no note present beneath the optical scanning station, i.e., during the idle cycle, the LED drive current for each track is adjusted by monitoring the light reflected from the optical reference surfaces 82, 84 and 86 (Figure 3) mounted below the optical block 38. When the LEDs for a particular track are pulsed on, the radiation is reflected from the reference surfaces to the corresponding PIN diode. The output of this PIN diode is compared against limits stored in the program memory. If the reading falls outside these limits, the microprocessor re-adjusts the LED drive current and the process is repeated. This self-calibration procedure automatically adjusts the optical outputs to correct for differences amount individual optical components and for dirt build-up on the optical surfaces. If the proper adjustment cannot be achieved, such as when one of the components has failed, then the microprocessor places the unit out-of-service.

Eventually, as dirt builds up on the optical reference surfaces, increasingly larger LED drive currents will be required to maintain the calibration. This means that the largest readings from the newer notes will begin to exceed the upper conversion limit of the ADC 110 (Figure 7). If this occurs on any predetermined proportion of processed notes, for example twenty out of one-hundred consecutive notes, the microprocessor is programmed to place the bill validator apparatus out-of-service, and to provide an indication of this malfunction so that maintenance personnel will know that the reference surfaces need cleaning or replacing.

In an actual commercial embodiment of the present invention, the apparatus was capable of accepting greater than ninety-five percent of all valid notes while rejecting forgeries. The time
5 required to process an individual note in the commercial embodiment did not exceed 2.0 seconds. The apparatus can be readily configured to validate various types of currency note by developing the required acceptance band data and inserting it into
10 the operational program.



CLAIMS

1. An apparatus for validating a currency note, comprising:
transport means for propelling the note along a longitudinally
extending path;
5 means for separately illuminating each of a plurality of
laterally spaced sample areas on the note in a repetitive sequence
with radiation in a preselected spectral range as the note is
propelled along the path, and for separately taking a plurality of
optical reflectance readings from each sample area along each of a
10 plurality of longitudinally extending, laterally spaced tracks on
the note as the sample areas are so illuminated;
means for storing acceptance band data for the type of currency
note to be validated; and
means for comparing selected ones of the optical reflectance
15 readings corresponding to each track to the acceptance band data and
for providing a validation signal if there is less than a predeter-
mined maximum amount of nonconformity.
2. An apparatus according to claim 1 and further comprising:
means for taking a plurality of optical opacity readings along
20 a longitudinally extending track on the note;
means for storing acceptance data for the opacity of the type
of currency note to be validated; and
means for comparing the optical opacity readings to the
acceptance data for the opacity and for providing a validation signal
25 if there is less than a predetermined maximum amount of nonconformity.
3. An apparatus according to claim 1 and further comprising:
means for measuring the length of the note; and
means for providing a validation signal if the length of the
note is acceptable.



4. An apparatus according to claim 1 and further comprising:
means for determining a malfunction in the apparatus; and
means for displaying the malfunction.
5. An apparatus for validating a currency note, comprising:
5 transport means for propelling the note along a longitudinally
extending path;
means for separately illuminating each of a plurality of
laterally spaced sample areas on the note in a repetitive sequence
with radiation in a preselected spectral range as the note is
10 propelled along the path, and for separately taking a plurality of
optical reflectance readings from each sample area along each of a
plurality of longitudinally extending, laterally spaced tracks on
the note as the sample areas are so illuminated;
means for taking a plurality of optical opacity readings along
15 a longitudinally extending track on the note;
means for measuring the length of the note; and
controller means for providing a validation signal if the
optical reflectance readings, optical opacity readings, and length
of the note conform to a predetermined acceptance standard.
- 20 6. An apparatus for validating a currency note, comprising:
transport means for propelling the note along a longitudinally
extending path;
a plurality of emitter means positioned at laterally spaced
locations along the path for separately illuminating a plurality of
25 laterally spaced sample areas on the note in a repetitive sequence
with radiation in a preselected spectral range when pulsed with a
drive signal;
a plurality of detector means for each sensing radiation
reflected from a sample area illuminated by a corresponding one of
30 the emitter means and for generating a read signal whose amplitude
is proportional to the intensity of the reflected radiation sensed
thereby;



means for sequentially pulsing the emitter means with corresponding drive signals as the note is propelled by the transport means to cause each emitter means to illuminate a plurality of longitudinally spaced sample areas defining a corresponding track on the note,
5 and to cause the detector means to generate a plurality of read signals corresponding to each track;

means for storing predetermined acceptance band data for the type of currency note to be validated; and

means for comparing selected ones of the read signals corresponding to each track to the acceptance band data and for providing
10 a validation signal if there is less than a predetermined maximum amount of nonconformity.

7. An apparatus according to claim 6 wherein:

the comparing means includes means for dividing each read
15 signal by the average of the read signals for its track to generate a plurality of normalized read signals corresponding to each track;

the predetermined acceptance band data consists of upper and lower limits for the normalized read signals corresponding to preselected sample areas for each of the tracks; and

20 the comparing means determines if the normalized read signal corresponding to each preselected sample areas falls within the upper and lower limits for that sample area and provides a validation signal if less than a predetermined number of the normalized read signals fall outside their corresponding upper and lower limits.

25 8. An apparatus according to claim 6 and further comprising:

means for taking a plurality of optical opacity readings along a longitudinally extending track on the note;

means for storing upper and lower acceptance limits for the opacity of the type of currency note to be validated; and

30 means for comparing the average opacity reading to the upper and lower acceptance limits for the opacity and for providing a validation signal if the average opacity falls within the upper and lower limits for the opacity.

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9. An apparatus according to claim 6 and further comprising:
a plurality of reference surfaces each positioned along the
path for illumination by corresponding ones of the emitter means;
means for sequentially pulsing the emitter means with the
5 drive signals when a note is not present in the transport means to
cause the detector means to generate reference read signals;
means for storing predetermined reference signal ranges; and
means for comparing the reference read signals to the reference
signal ranges and for adjusting the amplitudes of the drive signals
10 so that the reference read signals fall within the reference signal
ranges.
10. An apparatus according to claim 6 and further comprising:
means responsive to the comparing means not providing a
validation signal for longitudinally shifting the locations of the
15 selected ones of the read signals a predetermined number of positions
to generate an alternate set of selected read signals corresponding to
each track and for causing the comparing means to compare the alternate
set of selected read signals to the acceptance band data and provide a
valid signal if there is less than a predetermined maximum amount of
20 conformity.
11. An apparatus for validating a currency note, comprising:
transport means for propelling the note along a longitudinally
extending path;
means for taking a plurality of optical reflectance readings
25 along a plurality of longitudinally extending, laterally spaced tracks
on the note;
means for storing acceptance band data for the type of currency
note to be validated;
means for comparing selected ones of the optical reflectance
30 readings corresponding to each track to the acceptance band data and for
providing a validation signal if there is less than a predetermined
maximum of non-conformity for the selected ones of the optical reflectance
readings, means for longitudinally shifting the locations of the
selected ones of the read signals a predetermined number of positions to
35 generate an alternate set of selected read signals corresponding to each
track,



means for comparing the alternate set of selected read signals to the acceptance band data, and means for providing a validation signal if there is less than a predetermined maximum amount of nonconformity for the selected ones of the optical reflectance readings for the alternate set of selected read signals.

12. An apparatus according to claim 11, further comprising:

means for taking a plurality of optical opacity readings along a longitudinally extending track on the note;

means for storing acceptance data for the opacity of the type of currency note to be validated; and

means for comparing the optical opacity readings to the acceptance data for the opacity and for providing a validation signal if there is less than a predetermined maximum amount of nonconformity.

13. An apparatus according to claim 11, further comprising:

means for measuring the length of the note; and

means for providing a validation signal if the length of the note is acceptable.

14. An apparatus according to claim 11, further comprising:

means for determining a malfunction in the apparatus; and

means for displaying an indication of the malfunction.

15. An apparatus according to claim 11, wherein:

the comparing means includes means for dividing each read signal by the average of the read signals for its track to generate a plurality of normalized read signals corresponding to each track;

the predetermined acceptance band data consists of upper and lower limits for the normalized read signals corresponding to pre-selected sample areas for each of the tracks; and

the comparing means determines if the normalized read signal corresponding to each preselected sample areas falls within the upper and lower limits for that sample area and provides a validation signal if less than a predetermined number of the normalised read signals fall outside their corresponding upper and lower limits.



16. An apparatus according to claim 11, further comprising:

means for taking a plurality of optical opacity readings along a longitudinally extending track on the note;

means for storing upper and lower acceptance limits for the opacity of the type of currency note to be validated; and

means for comparing the average opacity reading to the upper and lower acceptance limits for the opacity and for providing a validation signal if the average opacity falls within the upper and lower limits for the opacity.

17. An apparatus according to claim 11, further comprising:

a plurality of reference surfaces each positioned along the path for illumination by corresponding ones of the emitter means;

means for sequentially pulsing the emitter means with the drive signals when a note is not present in the transport means to cause the detector means to generate reference read signals;

means for sorting predetermined reference signal ranges; and

means for comparing the reference read signals to the reference signal ranges and for adjusting the amplitudes of the drive signals so that the reference read signals fall within the reference signal ranges.

18. An apparatus according to claim 11, and further comprising:

means for comparing a first set of reflectance readings taken from one area of the note with a second set of reflectance readings taken from another area of the note and for providing a self comparison validation signal if there is less than a predetermined maximum amount of nonconformity between the first and the second set of readings.

19. Apparatus for validating a currency note, the apparatus being substantially as herein described and shown in the drawings.