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REVISIONS

| LTR | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| — | REL FOR PROD PER ERO 500613 | 9-19-75 | [illegible] |

APPLICATION

| NEXT ASSY | USED ON |
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# PRODUCTION RELEASE

| REV STATUS OF SHEETS | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | REV LTR | | | | | | | | | | | | | | | | | | | | | |
| | SHEET | | | | | | | | | | | | | | | | | | | | | |
| | REV LTR | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | | |
| | SHEET | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |

DO NOT SCALE DRAWING

SCREW THREADS PER HANDBOOK H-28

COUNTERBORE AND SPOTFACE FILLET RADII TO BE .010 MAXIMUM

REMOVE ALL BURRS AND BREAK SHARP EDGES EQUIVALENT TO .010R

ROUGHNESS OF MACHINED SURFACES 125 $\sqrt{}$ PER USAS B46.1

STANDARD HOLE TOLERANCE PER ANSI B4.2

TOLERANCES ON: .XX = ± .03 .XXX = ± .010 ANGLES = ± 0° 30'

INTERPRET DIMENSIONS AND TOLERANCES PER USAS Y14.5

DIMENSIONS ARE IN INCHES AND APPLY AFTER HEAT TREAT AND FINISH

UNLESS OTHERWISE SPECIFIED

CONTRACT NO.

| | | |
|---|---|---|
| DRAWN | T. Githens | 9/19/75 |
| CHECK | J. Boll | 9/19/75 |
| DESIGN | | |
| PROJ. ENGR. | R. Nakaya | 9/19/75 |
| OTHER APPROVALS | | |

**Plessey Memories Incorporated**
Santa Ana, California

DWG TITLE

PRODUCT PERFORMANCE SPECIFICATION
PM-DD/8 DUAL DISC DRIVE

| SIZE | CODE IDENT NO. | DWG NO. |
|---|---|---|
| A | 52648 | PS700695 |

SCALE:

SHEET 1 OF 16

FORM 000020

DISTR NO.

PRODUCT PERFORMANCE SPECIFICATION
FOR
PM-DD/8

## 1.0 FEATURES

The Plessey PM-DD/8 Dual Disc Drive is hardware, software, and media compatible with the DEC* RK 05 Disk Drive. Unique packaging permits double the storage capacity of the RK 05. This is accomplished by the use of one integral permanent disc and a DEC* compatible removable cartridge. The Plessey PM-DD/8 Disc Drive can be used in conjunction with or as a replacement for an existing DEC* RK 05 drive in a DEC RK 8-E system.

The Plessey PM-DD/8 Disc Drives incorporate advanced electronic and mechanical design features that contribute to their exceptional performance and reliable operation. Routine service requirements are minimal, and corrective maintenance, should it become necessary, is facilitated through the efficient layout and accessability of all components. Some of the notable design features are the following:

The disc spindle and the drive motor are combined in one integral assembly adding to the compactness of the disc drive.

The spindle motor is a D.C. unit, and its speed is held constant within $\pm 1\%$, regardless of line voltage and frequency fluctuations. The storage of data in any given sector can therefore be maximized.

The head positioning system uses a highly efficient electro-magnetic actuator which permits fast access times but also has low power dissipation and very low flux leakage.

Write protect circuitry, either by program control or selectable at the front panel controls, will protect previously recorded data on either disc.

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The clean-air system, which continuously purges the interior of the drive unit is highly efficient, forcing approximately 35 C.F.M. of clean air across the disc surfaces. Intake air is passed through a dual filter element, sweeps the discs and heads, and cools the electronic assemblies before it exits the unit.

Unit addressing is accomplished by means of a thumb-wheel module selection switch on the operator control panel located on the front of the disc drive. The switch is marked with four addresses: 0, 1, 2, 3; each of the address markings corresponds to two logical unit address. For example, setting "0" corresponds to logical addresses "0" and "1" respectively.

Internal flexible I/O signal and AC power cables interconnect the interface receptacles mounted on the rear panel of the drive unit itself. This feature permits permanent mounting of the rear panel in the cabinet, and makes it possible to slide the unit out, without the necessity of disconnecting or manipulating the external interface and power cables.

## 2.0 SYSTEM DESCRIPTION

The disc drive electronics system is comprised of the following main sections:

Start-up and safety sensing circuits.
A disc spindle motor servo system.
A read/write head positioner servo system.
Position address logic circuits.
Index and sector marks timing circuits.

The start-up and stop cycles, and Run/Load Mode selection are manually controlled with the switches on the operator control panel. The data read and write signals are initiated, monitored and terminated by the controller, via the interface input/output control lines.

The discs are rotated, at a constant speed by the motor-spindle assembly, which is part of the speed control servo system. The read/write heads are positioned over the data tracks on the discs by the positioner unit,

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which is a component of the head positioning servo system; the position information (cylinder address) is supplied to the positioning servo system by the controller. Index and sector marks are generated by transducers, processed, and transmitted to the controller for data formatting. The read and write amplifier chains are coupled with write protect logic circuits to ensure that the data is written safely. The disc drive operation is continuously monitored by safety sensing circuits to protect vulnerable components, as well as recorded data, in the event of external power failure or incorrect operating conditions within the drive unit.

## 2.1 Disc Speed Control

The fixed and removable discs are rotated, at 1500 r.p.m. by the spindle assembly, which is driven by a D.C. motor. The speed of the motor and, therefore, of the spindle and discs is controlled by a digital servo circuit that supplies a correction current to the motor if the rotational speed deviates from the correct operating value. The servo operation is governed by a reference (crystal) oscillator, or clock, whose output is compared, once for each spindle revolution, against the time interval between index pulses derived from a magnetic transducer that is positioned in the proximity to a slotted hub or ring mounted on the cartridge disc. Turn-on and turn-off of the spindle motor drive is controlled with the RUN/LOAD switch, mounted on the operator control panel. This switch is interlocked with a micro switch that senses the presence or absence of the disc cartridge and prevents start-up of the spindle motor if a cartridge has not been inserted in the drive unit.

If the spindle speed deviates (high or low) by more than one percent from the correct operating value, the signal SP DET (Off Speed Detect) is generated and sent to the write inhibit circuits so that data cannot be written until the correct speed has been restored.

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## 2.2 Head Positioning Servo System

The read/write heads are positioned over the track of the addressed cylinder by a linear electro-magnetic actuator which is driven by a servo system. The control input to the servo is the set of binary address signals issued by the disc controller. The servo system includes a coarse servo loop, which positions the heads within one track of the addressed track.

The cylinder address signals (ADD 1 through ADD 128) and cylinder address (Seek) strobe received from the controller are fed into the New Address Register, which stores the cylinder address. The Current Address Register, an up-down counter, receives an input (the detent pulses) from the servo logic circuits which is a continuous representation of carriage position as the head carriage moves toward the addressed track. The outputs at the two registers are compared in a substractor which generates a binary difference address (DF 2 through DF 128).

The comparator output - the difference address - is fed into a velocity profile generator, comprised of a digital-to-analog converter and a shaping amplifier, than generates the various velocity profiles (as a function of the length at the address seek) which the servo must follow. For example, less power is applied to the positioner for a five-track seek than for a 100-track seek, and the respective velocity profiles are consequently different.

The velocity profile generator output is fed into the summing junction of the servo amplifier, together with the output of the velocity transducer circuit.

The velocity transducer, in conjunction with a gain scaling network, provides rate feedback that controls the positioner speed to minimize overshoot. In responce to the two input signals, the servo amplifier drives the positioner at the predetermined speed towards the addressed track. As the head approaches that track, the comparator output (the difference address) diminishes, as does the velocity transducer

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output, until the head is positioned within one track of the addressed track.

At this time, the new address register is sampled to determine whether the last address bit is even or odd, this information is used in the detenting process to lock on the proper track. The servo detents on the zero crossovers of the bipolar position transducer signal. If the last address bit is even, detenting takes place on the position slope of the signal, (tracks 2, 4, 6, etc.); if it is odd, detenting is on the negative slope. The selection is done with FET multiplexers, which are controlled by internal logic signals respectively designated ODD and EVEN DETENT ENABLE.

When the heads have been positioned to within one track of the addressed cylinder, the coarse servo loop output is essentially zero, and the detenting is performed mainly with the detent servo loop, which obtains its input signal from the position transducer. This transducer consists of a stationary variable reluctance transformer/detent rack assembly, with the rack attached to the positioner carriage.

The transformer is driven by a 100K Hz carrier oscillator; as the detent rack moves over the transformer pole pieces, the carrier signal is amplitude modulated. The output signal is demodulated and sent through a low pass filter. The filter output - a signal of approximately sinusoidal shape - is fed into the servo amplifier which drives the positioner to, and detents it on, the addressed track.

The position transducer signal is further utilized (a) to detect the "home position" at the head, which is the positioner reference point, and generate a corresponding logic signal (HOME PULSE); (b) to detect the rest position (i.e., setting over the addressed track) of the carriage and generate an internal signal designated OFF TRACK, which indicates correct centering of the head over the track; (c) to generate the detent pulses, which drive the current address register as described above.

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Normal retraction of the positioner carriage takes place if the RUN/LOAD switch is placed in the LOAD position. An internal logic signal (REVERSE) then activates a multiplex switch that applies a specific input to the servo amplifier to effect full retraction of the positioner.

## 2.3 Data Storage and Readout

### Disc and Head Selection

Before data can be written or read, selection of disc (fixed or removable) and head (top or bottom) must have been made. The fixed and removable discs are treated by the program as separate units and are selected by unit select control lines.

### 2.3.1 Read Operation

The read circuitry consists of the following main components: the read transformer, which matches the read/write head to the read/write amplifier; the read amplifier; a differentiator; a limiter; an edge differentiator; and a data discriminator.

The analog signal from the read/write head is passed through the read transformer, to the read amplifier. The amplifier output is differentiated and limited; it is then processed in an edge differentiator and, finally the read data and the data clock are separated in a data discriminator.

The clock signal is sent to the interface on the DATA CLOCK line. The read data is furnished to the interface in a (DEC* compatible) pulse format, with a single pulse for every "1" written, the pulses occurring half way between clock bits. The data is sent to the interface on the READ DATA line.

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### 2.3.2 Write Operation

The write circuitry consists of the following main components; the write amplifier; the write transformer which drives the read/write head; and gating circuits.

The double-frequency encoded write data from the controller interface is routed, via the Data Interface Board, to the write amplifier input. The write amplifier will drive the write head only if the following conditions prevail.

a) The WRITE GATE line (from the controller) is "true";

b) The PROT CART switch is in the "OFF" position, if the removable disc is selected, or

c) The PROT FIX switch is in the "OFF" position, if the fixed disc is selected.

d) The WRITE LOCK line from the controller is "false".

The write operation is unconditionally inhibited if the appropriate protective switch is in the "ON" position. Writing will also be inhibited if certain mandatory conditions within the drive are not met as described under WRITE INHIBITING in a later paragraph.

### 2.3.3 Erase Operation

Edge erasing of the data track is performed by means of an erase driver which directly drives the erase coil of the read/write head. The erase driver furnishes an output to the head if the WRITE GATE IS "true" and if writing is not inhibited.

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### 2.3.4 Write Inhibiting

The write inhibit circuits are a safety feature designed to inhibit the write operation if any of several improper conditions within the drive unit should occur, which if writing would take place, could result in unscheduled erasure of previously recorded data and/or incorrectly written data that would not be recoverable. If any of the following conditions are not met, the write operation will automatically be inhibited:

a) The disc speed must be within 1% of operating speed (1500 r.p.m.).

b) No two heads must be selected simultaneously (which could occur in the event of a malfunction of the head address decoding circuit);

c) The read/write head must be positioned within a specific tolerance over the center of the track (or the READY status signal will not be issued to the controller.

d) All internal voltages must be at a safe level.

If the write operation is inhibited, a signal is sent to the controller, via the line designated WRITE CHECK, which indicates the inhibiting condition. If the write operation is unconditionally inhibited through either of the disc write protect switches, or is inhibited via the WRITE LOCK signal from the controller, a status signal is sent to the controller via the line designated WRITE PROTECTED.

## 2.4 Index and Sector Timing

Data formatting, in which the disc area is divided into sectors, involves sector and index timing, the index mark being the reference for the sector timing. Index and sector marks are generated whenever the

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discs are revolving. These pulses are employed for timing purposes within the drive unit, and they are sent to the controller to be used in the processing of the read and write data.

The timing pulses are generated by the transducers that are closely positioned to the two sector rings, one on the removable cartridge and one located on the spindle area below the fixed disc. Each ring is divided into 16 sectors by machine slots. In the system run mode, when the spindle is revolving a sector pulse is generated each time that a slot passes the transducer. One additional slot produces a reference, or index, pulse.

The transducer output pulses are amplified and shaped into digital pulses and the index pulses are separated from sector pulses by way of the timing difference between the sector notches and the index notch on the sector ring. The separated pulses are sent to the interface on lines designated INDEX and SECTOR.

## 2.5 Protective Circuits

The safety sensing circuits are designed to protect the recording discs and the read/write heads against mechanical damage, as well as prevent incorrect writing and/or inadvertant erasing of data in the event that abnormal operating conditions should occur.

Damage to heads and disc can result from physical contact of these precision parts. For this reason:

a) The cartridge loading door remains locked except in the Load Mode, when the heads have been retracted, the spindle is at rest, and the cartridge can be safely removed or inserted.

b) The heads will be loaded onto the discs only after the discs have reached full operating speed and aerodynamic spacing between the heads and discs (the flying attitude) can occur.

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c) The heads will be fully retracted under conditions leading to excessive slow-down (greater than a 2% loss of speed) of the spindle.

## 3.0 INTERFACE CHARACTERISTICS

### 3.1 Line Receivers

All line receivers within the drive are of the high noise immunity type SP380. All incoming lines are terminated with 110 ohms to 3.5 volts.

### 3.2 Line Drivers

The line driver circuit used in the drive is of the open collector type. In a daisy chain configuration all output lines are terminated within the system at the last drive on the chain. The driver is capable of sinking 50ma from the user terminators.

### 3.3 Logic Levels

Logic "0" is defined as a level between 2.5 and 5.0 volts. Logic "1" is defined as a level between 0 and 0.5 volts.

### 3.4 Input Lines

All input lines are defined as being true "1" = TRUE = 0 VOLTS.

#### 3.4.1 Cylinder Address

Eight lines which accept an absolute address from the controller. These are strobed into an address register by the cylinder address strobe line.

#### 3.4.2 Cylinder Address Strobe

One line, which strobes the CYLINDER ADDRESS lines into the internal address register.

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3.4.3 Restore

One line, which causes the drive to reposition the heads over cylinder "0".

3.4.4 Disc Select

One line, which selects the disc upon which the controller will operate. When true the fixed disc is selected.

3.4.5 Head Select

One line, which selects the disc surface to be operated upon.

3.4.6 Write Gate

One line, which turns on the write amplifier, and allows current to flow in the selected head.

3.4.7 Write Data

One line, which carries the double frequency encoded data from controller to drive. Each pulse on this line will cause a flux reversal to occur.

3.4.8 Read Gate

One line, which enables the read data and read clock lines.

3.4.9 Unit Select

Four lines used in conjunction with the unit select switch, which allows any drive to be given two of four logical address.

3.5 Output Lines

All output lines are defined as being true. "1" = TRUE = 0 volts.

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3.5.1 Ready

A signal on this line indicates that the drive is ready to accept external commands.

3.5.2 Seek Complete

When true, this line indicates that the drive has completed a seek operation.

3.5.3 Address Acknowledge

This line, when true, notifies the controller that a seek operation has commenced.

3.5.4 Seek Incomplete

One line, which indicates that a seek operation has not been completed in a predetermined time.

3.5.5 Illegal Address

A line which indicates that an address greater than 202 has been issued by the controller. The drive will not obey such a command, and the heads will not obey such a command, and the heads will remain positioned over the previously addressed location.

3.5.6 Attention

Four lines not gated with unit select which alert the controller that the corresponding drive has completed a seek operation.

3.5.7 Read Data

One line which transmits the read data to the controller.

3.5.8 Data Clock

This line transmits the read clock which has been separated form the data.

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3.5.9 Index Pulse

This line supplies one pulse for each disc revolution. The pulse is derived from the physical notch on the cartridge hub, or a similar notch on the fixed disc hub. This line is gated with disc select.

3.5.10 Sector Pulse

This line supplies one pulse for each notch on the cartridge hub, or the corresponding notch on the fixed disc hub. This line is gated with disk select.

3.5.11 Sector Address

Five lines which define, in binary form, the particular sector under the read/write head. The sector address is reset to zero by the first sector following the index mark.

3.5.12 Write Protect Status

One line which indicates to the controller that either the write inhibit switch is active on the front panel, or that the disc is write protected by program control.

3.5.13 Write Check

One line which indicates that a write operation may not take place, due to one of the following conditions:

a) Voltages below specified levels.

b) More than one head selected.

c) Disc Speed is out of tolerance.

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## 4.0 SPECIFICATIONS:

| | |
|---|---|
| Gross Capacity: | 2,457,600 (12 Bit) words |
| Transfer Rate: | 8.32 usec/word |
| Recording Density: | 2200 Bits/Inch, Max. |
| Track Density: | 100 tracks/inch |
| Disc Rotational Speed: | 1500 RPM |
| Speed Variation: | $\pm$ 1% Max. |
| Access Times: | |
| Track to Track | 15ms |
| Average | 50ms |
| Maximum | 90ms |
| Reliability: | |
| Recoverable errors (Max.) | 1 in 1 x $10^{10}$ bits transferred |
| Non-recoverable errors (Max.) | 1 in 1 x $10^{12}$ bits transferred |
| Mean time between failure (MTBF) | 5000 hrs. |
| Mean time to repair (MTTR) | Less than 1 hour |
| Surfaces/Drive: | 4 |
| Tracks/Surface: | 200 + 3 Spare |
| Sectors/Track: | 16 |
| Words/Sector: | 256 |
| Time for 1/2 revolution | 20ms |

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Recording Mode: Double frequency encoded

Cartridge Unload/Load Cycle: 60 seconds

Cartridge: IBM 2315 type (DEC compatible)

Power Requirements:

100, 110, 120, 130, 200,
220, 230, 240, 250, and
260 VAC ± 10% 47-63Hz
300 VA

Physical Dimensions:

| | |
|---|---|
| Height | 7.00 inches |
| Width | 17.60 inches |
| Length | 22.00 inches |
| Weight | 80 lbs. |

19 inch standard RETMA mounting

Environment (Operational):

| | |
|---|---|
| Temperature | 50 to 100 degrees F |
| Humidity (R.H.) | 5 to 95% non condensing |

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