MDR-8410 SPECIFICATIONS

GENERAL

Frequency:	173-174 MHz
Operating Range:	1000 feet typical ("power out" adjustable)
Temperature Range:	-20 degrees C to +55 degrees C
Battery Life:	8 hours typical (continuous operation) Nickel cadmium (1.2 Amp Hour) rechargeable batteries.
Environmental Conditioning: .	Transmitter and receiver both sealed against dust.
System Diagnostics:	Built-in with LED and numerical indicators.
System Address Capability: ...	15 addresses
Encoding/Decoding Method:	Microprocessor/software based

TRANSMITTER

Dimensions:	9" or 10 1/2" x 7 3/4 " x 4 1/2/"
Weight:	8 pounds (including battery)
Case:	Unit completely contained in a heavy gauge, aluminum housing.
Carrying Method:	Adjustable web belt/harness of strong, lightweight nylon fabric.
Switches:	Motor control switches are spring-return (deadman) lever type with five detented positions in each direction. Other switches are industrial grade and may be "lock-off" toggle, key operated, pushbutton or others as required.
Supply Voltage:	12 volts DC
Power Output:	100 milliwatts
Frequency Stability:	+/- 5 ppm 173-174 Mhz
Channel spacing.....	12.5KHz/20KHz/25KHz
Deviation @ 12.5KHz.....	+/-1.5KHz nom (+/- 2.5 KHz max)
Modulation Type:	FD1/F2D/F3D
Spurious emissions.....	In accordance with ETS/CEPT specifications
Duty Cycle:	100%
RF Output Impedance:	50 ohms

RECEIVER/DECODER

Enclosure:	24"Hx24"Wx10"D Nema 12 cabinet (standard)
Supply Voltage:	Customer supplied 120 VAC, Single Phase 60 Hz at 500 VA
Sensitivity:	1.2 microvolts
Frequency Stability:	+/- 2ppm
I.F. Selectivity:	6 db (bandwidth = +/- 7.5 khz minimum) 60 db (bandwidth = +/- 25 khz minimum)
Modulation:	+/- 5 khz
RF Input Impedance:	50 ohms
Output Relays:	Contact rating 110 VAC 10 amps resistive, 7.5 amps inductive: 220 VAC 7.5 amps resistive 5 amps inductive
Response Time:	78 - 136 milliseconds-system determinate

THEORY OF OPERATION

INTRODUCTION

The MDR-8410 is the expanded version of Control Chief's popular MDR-8400 series of Microprocessor Digital Radio Remote Controls. In addition to providing all the features of the 8400 series, the MDR-8410 provides proportional stepless control for overhead traveling cranes and other equipment requiring an analog input. Below is a chart comparing the maximum capabilities of each system.

	AUXILIARY FUNCTIONS	STEPPED MOTORS	STEPLESS MOTORS
MDR-8400	15	5	-
MDR-8410	15	4	8

BASIC SYSTEM THEORY

The MDR-8410 system consists of the radio remote control transmitter and the Receiver/Decoder/ Interface unit.

To encode and communicate the operator's commands to the crane, five transmitter sub-assemblies are involved: the control switches, the Stepless Interface Card, the Logic Card, the RF/Regulator Card and the transmitter antenna. (See simplified block diagram Firgure 3.1, Page 32)

To receive, decode and output the transmitted data to the crane controllers, five sub-assemblies within the Receiver/Decoder/Interface unit are utilized: The receiving antenna, the Receiver Card, the Processor Card, the Stepped I/O Relay Cards, and the Stepless Relay Cards. (See simplified block diagram Figure 3.2, Page 33)

The following information is provided to promote an understanding of the general circuit operation of each card and each circuit's role in the overall system. A detailed explanation of how each printed wiring board processes the information it receives is also presented. This information will be useful to people responsible for maintaining the system.

TRANSMITTER

The main circuitry of the transmitter unit consists of the Stepless Interface Card, Logic Card and the RF/Regulator Card. The Stepless Interface Card functions as an interface between the analog control switches and the Logic Card. The Logic Card is pre-programmed to encode control switch information into a binary coded serial data stream. The RF/Regulator Card modulates the serial data by providing tones to the 173 Mhz Radio Frequency Card.

STEPLESS CARD

The Transmitter Stepless Card formats the stepless switch speed and directional information into its 8-bit digital equivalent. Through the use of control lines the card sequentially sends the digital information from each stepless switch to the microprocessor on the Logic Card. A block diagram is shown in figure 3.3, Page 34.

The hardware on the Stepless Interface Card includes two eight-channel data selectors (U1 and U2) and an eight-channel A/D converter (U3). The voltage converter (U4) provides the minus (-) 5 volt reference required by the eight-channel A/D converter. The microprocessor communicates with the Stepless Interface Card through the "Motor 5" connector on the Transmitter Logic Card and via additional free port lines on the microprocessor.

When the diode matrix scan line for motor five is toggles low, the Steples Interface Card hardware is enabled. Control lines determine which of the eight inputs are sent to the output. The outputs (digital representations of the motor speed and directionals) are sent to the microprocessor diode matrix via the "Motor 5" connector.

The following sequence of events occurs once the hardware is enables:

1. "One of eight" control line information is sent to U1, U2 and U3.

2. The microprocessor reads the stepless information from the motor switch designated by the control lines.

3. The microprocessor stores this information and advances the control line to the next motor.

LOGIC CARD

The main function of the Logic Card is to format the address switch and stepped-stepless control switch information into a binary coded serial data stream. This card's output data is fed to the RF/Regulator Card Modulator for conversion to a format suitable for sending through the atmosphere. The main circuits of the Logic Card are:

1. Address Switch

2. Diode Matrix

3. Microprocessor

4. Cutoff Enable/Watchdog

A simplified block diagram is shown in Figure 3.4, Page 35.

The address switch is a four (4) pole DIP (Dual In-Line Package). Positioning of each of the switches, 1 thru 4, sets the four bit transmitter address code. This code must match the setting of the Receiver/ Decoder/Interface unit Processor Card. A switch in the "on" position result in a binary one; the "off" position, a binary zero (See Figure 3.5, Page 36). A total of fifteen address codes are useable. Note: address code 0000 is not considered a valid address.

The diode matrix (see figure 3.6, Page 37) feeds switch position information to U1 (Microprocessor) via the Scan and Read Lines. U1 reads the switch position status by sequentially pulling low and then releasing each of the scan lines. When a scan line is pulled low, all switches in the open position which are connected to that particular scan line will be read via the read lines as a logic one or "high". All switches in the closed position will be read as logic zero or "low". When the motor 5 scan line is pulled low this enables the hardware on the Stepless Interface Card. The microprocessor then addresses each of the 8 stepless motor switch data by addressing the control line, reading information, addressing the next control line and so on until all the stepless motor information is read into the microprocessor.

The microprocessor (U1) format the serial data stream and outputs the information through an inverting buffer (U2A) to the RF/Regulator Card. An external clock frequency of 6 MHz is supplied to U1 by means of the crystal oscillator (X1). U1 divides the external crystal frequency and outputs a 400 KHz clock frequency to a Divide-By-Three Counter (U4). The output of U4 provides a toggle signal to U1 for program loop timing.

A monostable multivibrator (U3) performs a "watchdog"function of the microprocessor (U1). When the internal program of U1 is running properly, a watchdog toggle pulse will be sent to U3. Providing U3 receives this toggle pulse on a timely basis, it will output 5 volts to one of the inputs of the Cutoff Enable NAND Gate (U2B). When the battery voltage level is acceptable, 5 volts is suppled to the second input of NAND Gate (U2B) via the Battery Cutoff circuit located on the RF/Regulator Card. The output of U2B is normally low (0 volts) and is connected to the cutoff circuit on the RF/Regulator Card. Should the output of U2B go high (5 volts), such as during a low battery voltage condition or software runtime fault (watchdog), the RF circuit will be disabled by means of the cutoff Circuit.

LOGIC CARD – SERIAL DATA MESSAGE FORMAT

The serial data message format changes dynamically with activating command switches. If no command switches are engaged the serial stream contains primarily data synchronization pulses. The synchronization pulses cue the receiver microprocessor to the start of the serial data stream and keep the receiver microprocessor in synchronization with the data stream.

Each stepless motor word is made up of 8 bits and with a maximum 8 stepless motors, this would add 64 bits to the serial data stream (plus the synchronization pulse bits). For most users this would result in an unnecessarily extended response time. To optimize the response time, the number of stepless motors sent varies with the users needs. Below is a table to reference the serial data stream length in milliseconds with the number of stepless motors in system and the stepless serial data message format is shown in figure 3.7, Page 38.