ESCORT MEMORY SYSTEMS
A DATALOGIC GROUP COMPANY

Technical Specification for the LRP75 / LRP76

Equipment Name: Escort Memory Systems Long Range Passive Reader-Writer

Model Number: LRP75 / LRP76

Escort Memory Systems' FCC Registration Number: 0007627128

Escort Memory Systems' Grantee Code: E36

A schematic diagram of all circuitry and devices provided for determining and stabilizing frequency, for suppression of spurious radiation, for limiting modulation, and for limiting power is provided in the confidential documents listed below. These documents contain trade secret information and may not be shared with any party other than the intended recipients.

CONFIDENTIAL1411892C.pdf
CONFIDENTIAL1411882C.pdf
CONFIDENTIAL14119001.pdf
CONFIDENTIAL14120601.pdf

Circuitry and devices provided for determining and stabilizing frequency

The frequency reference for the RF Transmitter and the clock for the logic circuits are derived from a colpitts crystal oscillator. The crystal is of the AT cut type and varies in frequency no more that 50 ppm over the temperature range from –20 to +70 degrees centigrade. The oscillator comprises Y1, R67, R55, C81, C98, and U13B as seen on the analog schematic 14-1189.All buffers and amplifiers operating at the center frequency of 13.56 Megahertz are designed for stable operation under all operating conditions.

Circuitry and devices provided for suppression of spurious radiation.

The spurious spectral content of the LRP75 / LRP76 transmitter is reduced by a 5-pole passive Butterworth LC filter. A conductive shield between the antenna and the analog PCB reduces the mutual inductance between the antenna and board traces with harmonic content. The combination of the Transmitter output filter, the shield between the antenna and the analog PCB, and the use of a small, narrow bandwidth antenna suppress spurious radiation to compliance with Part 15. To prevent radiation from the LRP76 antenna cable, the cable is fitted with a ferrite clamp, Fairrite p/n 0431173951.

In order to prevent spurious radiation from the cabling, all data and power connections to the unit are filtered for suppression of spurious currents. The devices provided on the 24 Volts DC input to the unit are two EMI suppression inductors labeled L1 and R3, bypass capacitor C5 and filter capacitors designated C105 through C110. Each data line is provided with an EMI suppression inductor. These are: L4, L9, L8, L6, L7,L10. Additionally, the power and data cabling must be wrapped around an external ferrite toroid. In the operator's manual, Escort Memory Systems recommends FairRite part number 2643803802 or Amidon part number FT-240-43.

Circuitry and devices provided for limiting modulation.

Modulation depth is limited by the resistive network composed of R60, R61, and R62. This network takes a logic-level signal and converts it to an analog signal which determines the gain of the modulating amplifier, U15.
The gain of this amplifier is given by:

G = (VC / VFS) * (R56 / R57)

The gain of the modulating amplifier varies proportionally with the voltage VC. This provides a modulated input to the power amplifier. Since the dynamic range of VC is limited by the resistance values R60, R61, and R62, the modulation depth is inherently limited to be no more than the dynamic range of VC – approximately14%.
The frequency of the modulation signal is determined by the H8 DSP and is determined by the software to be 100 kilohertz.

Circuitry and devices provided for limiting power.

The power output of the transmitter is limited by the temperature-compensating bias scheme of the power devices, Q4 and Q3. A matched pair of transistors, Q1B and Q1C, is configured as a current mirror thermally coupled to the power devices. Output power is also limited by reference to the regulated power supply voltage through the use of a logic gate, U14.

Functional Description:

The Long Range Passive Reader Writer is composed of seven functional blocks.

1. Power supplies

2. Serial transceivers

3. 8051 Controller

4. H8 DSP

5. RF Transmitter

6. Antenna

7. Receiver

1. Power supplies:

The LRP75 contains a buck converter to convert the 24 Volts DC input to the unit to an intermediate pre-regulation voltage of 7 Volts DC. This intermediate pre-regulation voltage

supplies power to one linear regulator which supplies power to the serial transceivers, the 8051 controller and the H8 DSP. The intermediate voltage also supplies power to two separate linear regulators which supply power to the transmitter and receiver. A boost converter draws power from the intermediate supply in order to provide a higher voltage which is not affected by transients in the input voltage to the 24 Volts DC input to the unit. This higher voltage is then distributed to the transmitter by one linear regulator and to the H8 DSP through a logic-selectable linear regulator. This voltage is used to program the Flash memory in the H8 DSP.

2. Serial Transceivers:

The LRP75 communicates to its host by one of two communications protocols – EIA RS 232 and RS 422. The voltage levels are converted to logic-level signals by the serial transceivers. The desired protocol is selected through the use of an analog multiplexer controlled by the 8051 controller. The desired interface can be selected through software during configuration using only the default RS 232 interface.

3. 8051 Controller

The 8051 controller processes communications with the host. It boots its program from an external 4 megabit Flash memory array. The controller operates out of 128 kilobytes of external SRAM. Address latching and Glue functions are achieved through the use of a programmable gate array. The controller also stores configuration information in serial eeprom. This serial eeprom resides on a dedicated, synchronous serial port to the 8051. The Controller CPU interprets commands from RS232 or RS422. This controller then interacts with the H8 DSP to effect Tag communications and, upon completion, provides the response data in the appropriate format. An external watchdog timer provides system reset during power supply transient conditions and under errant state-machine conditions within the 8051 controller.

4. H8 DSP

The H8 DSP boots its program and data from a 128 Kbyte internal Flash memory array. It operates from 4 kbyte internal Sram. The H8 DSP and its software implement the Tag communications protocol through its two outputs to the RF Transmitter, the modulation signal and the enabling signal. The H8 transceives serial data to and from the 8051 controller through a dedicated UART operating at a fixed baud rate of 9600bps.

5. RF Transmitter

The RF Transmitter consists of three major functional subsystems, The 13.56 Megahertz master oscillator, the modulating amplifier, and the power amplifier. The master oscillator generates the frequency reference for radio communication and it provides the clock frequency for both the 8051 Controller and the H8 DSP. The clock signal is buffered between the oscillator and the logic subsystems.

The modulating amplifier takes two inputs, the frequency reference from the master oscillator and the logic-level modulation signal. The output of the modulating amplifier is 12 dBm into 50 ohms at 13.56 Megahertz with 14% index of modulation.
The power amplifier is a class AB push-pull linear. It takes the output of the modulating amplifier as its input and amplifies it by 10 dB for an output power of 150 mW into 50 ohms.

6. Antenna
The antenna of the LRP75 is a loop of approximately 4 square inches in effective area. Its conducting elements are etched copper on a printed circuit board. The antenna is a balanced, single resonance circuit with a manufacturing alignment range of 500 Kilohertz.
Frequency: 13.56 Megahertz +/- 250 kilohertz
Bandwidth: 200 kilohertz Maximum

The antenna of the LRP76 is a loop of approximately 16 square inches in effective area. Its conducting elements are etched copper on a printed circuit board. The antenna is an unbalanced, single resonance circuit with a manufacturing alignment range of 500 Kilohertz.
Frequency: 13.56 Megahertz +/- 250 kilohertz
Bandwidth: 200 kilohertz Maximum

7. Receiver
The receiver uses a bandpass input filter network coupled with a peak detector to demodulate sideband load modulation signals at 13.136 Megahertz. Peak detection demodulation in the presence of the 13.56 Megahertz carrier from the transmitter produces a 424 Kilohertz intermediate frequency. This demodulated signal is then bandpass filtered and amplified. The amplified signal is then rectified for baseband detection. The baseband data at 26.5 Kilohertz is processed through a fixed-reference comparator to produce a logic-level compatible signal for decoding by the H8 DSP.

Operational Description

The transceiver data is communicated in with characteristic similar to standard half- duplex on one 13.56 MHz ISM band frequency.

Internal frequencies are supplied by a standard Crystal Oscillator. The 8051 Controller interprets commands from RS232 or RS422. This controller then interacts with the H8 DSP to effect Tag communications and, upon completion, provides the response data in the appropriate format. The H8 DSP and its software implement the Tag communications protocol and support the timing and decoding of data from the receiver. The output power to the antenna is less than or equal to 150 milliwatts (22dBm). The transmitter output frequency is 13.56MHz and uses low level AM to encode the 100KHz BB data onto the transmitted carrier. The 13.56MHz reference frequency is used for RF carrier digital synchronization and is also supplied to the Transmitter circuitry. The Modulator also has two digital inputs from the H8 DSP. One to enable/disable the carrier, and another to provide the AM Modulation information. The modulated signal is lowpass filtered, and supplied to a temperature compensated Class ‘B’ output stage. This is followed by a lowpass output filter to attenuate transmitter harmonics and provide the correct impedance to the

antenna. The Impedance at this point is 50 Ohms, which is the characteristic impedance of the antenna.The receiver pre-selector filter, IF amplifier-filter, detector, and receiver Base Band (BB) comparator provide out of band rejection and selectivity to support the reception of tag data. The receiver uses an Amplitude Modulation (AM) detector to recover Base Band (BB) data. The received input frequency is at 13.136MHz with 26KHz data. The 423.8KHz signal is derived from the sub-carrier modulation of a "tag" on the 13.56MHz carrier. Only the lower side band at 13.13625 MHz is detected. The tag then modulates the sub-carrier with the 26KHz data signal. Analog to Digital conversion is achieved through the use of fixed-reference comparator at the output of the receiver.

FREQUENCIES
Receiver
The received frequency is product of the transmitted frequency and therefore controlled by the transmitter frequency stability.

Frequency, f_{in} (This is the lower side band)	13,136,750Hz
Bandwidth	200 ± 75KHz
Frequency, IF (sub-carrier)	423.75 ± 20KHz
Bandwidth	124 ± 50KHz
BASE BAND	
Data Rate, Manchester encoded	26.5KHz
Phase with respect to received signal	In phase plus delay
BASE BAND AMPLIFIER	
Gain BB	0 ± 1dB
Bandwidth	60KHz
Roll off	-18 dB/octave
SENSITIVITY	
IF	-55dBm @ 6dB SNR
FREQUENCY	
Carrier	13.56MHz ± 50PPM
RF BANDWIDTH	

Harmonics	-30dBc
Spurs at ≥20KHz <300KHz in 100Hz bandwidth (reference information only)	-60dBc
Noise at ≥300KHz to 1MHz in 100Hz bandwidth (reference information only)	-90dBc

POWER

Carrier	22dBm
Load without spectral breakup	∞ VSWR any angle
Impedance	50Ω nominal
Carrier disabled	-50dBc max
Response time	5.0msec Maximum

Modulation

Modulation Index (downward modulation)	14% fixed
Rise and Fall Time	0.25-1.5µsec
Data Pulse Width	5.31µsec
Start Pulse Width	17.11µsec