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Foreword

Scope of this manual

This manual contains the specifications, functional description, operating instructions, schematic, parts locator and parts list for the 2016 mobile data terminal.

This manual is intended for use by qualified service technicians to aid them with installation, interfacing, alignment and trouble shooting of the 2016 when used with other land mobile radios.

Service manual revisions

Component changes, additions and deletions may occur in the circuit design to improve operation and will be reflected in future releases of this service manual. Specifications and circuit changes are subject to change without prior notice or obligation by Pyramid Communications.

Specifications

General:

Operation:	Auto respond console, self test, programming
Indicators:	5 high brightness LED's
Messaging:	16 characters (DTMF mode) or 64 characters (MSK mode)
Storage:	Non-volatile E²PROM with 100 year data retention.
Interface:	*Radio:* DB15M
	Dispatch Software: DB9F Bidirectional 9600 baud N81
	Billing software: DB9F Output only 9600 baud N81
Application:	Conventional and Trunking mobiles
Adjustments:	Rx Sensitivity, Tx Deviation, Squelch threshold.

Power   Requirements:

DC Supply	13.6VDC negative ground ±25%. 80 mA nominal

Physical:

Dimensions:	6.00"L x 5.275"W x 1.15"H.
Weight:	14 oz.
Case:	Extruded Aluminium.

Encoder:

Format:	Dual Mode: MPT-1317[1] and DTMF
Speed:	1200/2400 Baud MSK and 18.2 DPS DTMF 3:1 tone:space (41.33mS:13.66mS)
PTT Delay:	.1-.9 Sec in 100 mSec steps + smart trunking access
Tx Audio:	0-2.5 VRMS 2.2K Ohms, AC coupled

Decoder:

Format:	Dual Mode: MPT-1317[1] and DTMF
Speed:	1200/2400 Baud MSK and 18.2 DPS DTMF
Rx Audio:	Hi-Z (100k Ohm) AC coupled to discriminator
Level:	20mV - 10V RMS
DTMF twist:	12db
CTCSS Reject:	-36db @ 74 Hz

Outputs:

PTT:	Active Low 300 mA open collector
Audio Mute:	Active Low 100 mA open collector
Mic Mute:	Active Low 100 mA open collector
Aux1 Out:	Active Low 100 mA open collector
Aux2 Out:	Active Low 100 mA open collector
Aux3 Out:	Active Low 100 mA open collector

specifications subject to change without notice

Functional Description

The Pyramid Communications Model 2016 is a microprocessor controlled MPT-1317/DTMF intelligent modem that acts as the interface between the console computer equipment and a two way radio in order to provide the base operations of a dispatch system. The modem decodes and responds to the mobile status requests, and forwards the received information to the console computers via 2 serial communications ports. Port 1 will also accept commands from the PC for selective calls, horn honk sequences, mobile interrogation and over-the-air console reassignments. Port 2 is output only, for connection to a mini/main frame computer to be used in conjunction with many of the commercial software billing packages. The 2016 comes with PC software which works directly with the modem to provide a complete fleet dispatch system. The software may be used on any IBM PC or compatible; see page 18 of this manual for a complete software description. The 2016 may also be used with Street Smarts™ mapping software when GPS mobiles are used.

The model 2016 is PC programmable for all operating parameters through communications port #1 using the supplied dispatch software; see page 20 for programming details.

The model 2016 also has a built in self test mode for diagnostics and alignment which can be accessed through the supplied dispatch software. All internal adjustments are accessible by removing the front display panel. See pages 8-9 for alignment procedures.

Status Reporting: When a mobile user sends a status request, the 2016 will decode and forward the information to the console computers via com ports 1 and 2. The 2016 acknowledges the message received from the mobile automatically without interaction from the PC; all of the low level timing and verification of the received message is handled internally by the 2016.

The 2016 will monitor the channel for activity before responding and will not transmit on a busy channel. If unable to transmit within 6 seconds, the modem will abandon its attempt to respond, since the mobile will automatically retry after 6 seconds without receiving an acknowledgment.

If the channel is clear for transmission of the response, the model 2016 will key the radio for the PTT delay time (conventional operation) then send its message. On trunking systems, the model 2016 will key the radio while monitoring the radio's transmitter for an on-air condition. If it does not see the radio transmit at all (system is busy for instance) it will unkey and retry every 2 seconds until successful or time out (6 seconds). When it detects that the radio is transmitting, it will continue to monitor the on-air line until the transmitter has remained keyed long enough to ensure that the radio is not merely retrying. After successful acquisition of a voice channel, it will send it's message.

Dispatch Request: If the mobile user sends a Dispatcher Request, the model 2016 will send the request to the console computers, but is not required to respond to the mobile and will return to idle condition upon communication with the consoles.

Selective Call: The dispatcher may selectively call a vehicle in the system either in response to a dispatch request, or to alert a mobile user who has left his vehicle that he has been paged. The mobile will automatically respond with an acknowledgment to an individual call alert. The acknowledgment will be forwarded to the console computers and the model 2016 will return to idle condition.

Group Call: The dispatcher may alternately choose to alert a group of vehicles. In *DTMF* mode, the dispatcher may substitute the "#" wild card digit for any or all of the numbers in the vehicle code. *Example*: Sending "15#" would alert users 150-159. Sending "1##" would alert users 100-199. Sending "###" would alert all users in the system. The mobiles who are group called are not required to respond automatically. In *MSK* mode, the dispatcher enters the word "GROUP"; all users in the system will be called. The 2016 can group call units for the selective call function, horn honk function, Data message or Assign console (DTMF mode only).

Auto Interrogate: The dispatcher may selectively interrogate an individual mobile for it's current status. The mobile will respond, and the model 2016 will forward the message to the console computers as above.

Horn Honk: *(2012 Only)* If the dispatcher wishes to signal a user who is out of his vehicle, he may do so by sending a horn honk sequence. The mobile will automatically acknowledge and the model 2016 will forward the message, as above. The 2016 will accept a group horn honk sequence.

Assign Console (DTMF mode only):   The mobile message that is sent out contains a routing code which assigns it to one of 4 dispatch consoles. The current dispatcher may reassign the mobile to another dispatcher over the air by sending the proper sequence. The mobile will automatically respond and the 2016 will forward the message, as above. The 2016 will accept group reassignments.

Poll GPS (MSK mode only): The mobiles equipped with GPS will automatically send their position fix at a programmed interval. The dispatcher can interrogate an individual mobile to send its GPS position at anytime.

ANI: The mobiles may be configured to send an ANI sequence every time the radio operator presses the mic PTT button. The model 2016 will forward the message to the console computer, but is not required to respond to an ANI sequence.

Time Stamp: *(2012 Only)* If the mobile is out of range and cannot send it's status request when the button is pressed by the driver, the call is internally stored by the mobile unit and a time stamp is attached to the status that indicates when the driver actually pressed the button. When the mobile drives back into range, it will automatically   re-send any queued calls along with the time stamp information. The PC software will subtract the received time stamp from the computers clock to accurately display the time the driver changed each status. The 2016 will work with both mobile formats, time stamping and normal.

Data Message: The dispatcher can send an alpha numeric text message to any or all of the vehicles in the fleet. The driver is alerted that he has been paged and the data message is stored in the 2012 E²PROM and can be recalled even after power. In *DTMF* mode, the message length is 16 characters. In *MSK* mode, the message length is 64 characters, and the dispatch software can store up to 6 "canned messages" to send, each 64 characters in length.

Emergency: Mobiles can send an Emergency sequence that will alert the dispatcher continuously until reset. The emergency message is acknowledged by the 2016 modem, similar to the status requests. In the PC software, an emergency alert window will appear showing the vehicle number until cleared by the dispatcher.

Installation

The model 2016 can be configured for use with conventional or trunking systems. The minimum interface required is 5 wires for conventional operation and 6 wires for trunking. There are also a number of optional connections that allow for features such as microphone muting, and tone stripping (audio muting during the reception of messages) and busy channel lockout.

P1 (DB15-M) Radio Connector

Pin 1:
(Shield/Black)
Ground. Connect to the radio ground.

Pin 2:
(White)
Transmit Audio Out. This is the DTMF/MSK encode line to the radio. It is approximately 2.2K Ohms, AC coupled and should be connected to the input of the microphone bandpass filtering *before pre-emphasis and limiting. If* connected too close to the microphone input, it may reduce the amount of mic audio; if connected too far into the transmit audio circuitry, you may not be able to achieve enough modulation. *It is important that the transmitted signal does not get distorted.* Excessive distortion will affect the reliability of the received signal and may be responsible for retries and failed status requests. J2 selects the output adjustment range for RV2; if J2 is installed, RV2 adjusts the output between 0-200mV, if removed, RV2 adjusts the output between 0-5V.

Pin 3:
(Blue)
On-Air detect input. In trunking applications, this line should be connected to radio logic level that indicates that the radio is transmitting. *This is not the same as mic PTT*. On trunking logic boards, this line would be radio PTT, or connect directly to the Tx LED. The line can be either active high or active low. Program "On Air Polarity" to "Low" if the line goes to ground during transmit, to "High" if the line goes positive during transmit. ***Do not install J1 for trunking applications.***

In conventional applications, this line is used for busy transmit lockout.

Pin 4:
(Green)
PTT output. This is an open collector output to the radio and should be connected to the mic PTT line.

Pin 5:
(Red)
Switched 13.6VDC from the radio. This line *must* go off when the radio is switched off, since the 2016 does not have a power switch. It should be capable of supplying at least 200mA.

Pin 6:
(Yellow)
Receive audio input. Connect this line *directly to the output of the radio's discriminator*. Do *not* connect to any point after filtering or de-emphasis. It is a high impedance input (100KOhms) and AC coupled.

Pin 7:
(Violet)
Busy Channel Input. This line is connected to the logic level output that indicates that the radio is receiving and audio is unmuted. The COR polarity can be programmed to be active high or active low. Adjust RV1 for a DC voltage at TP2 that is midway between the muted and unmuted levels on the violet wire. Example: If the violet wire goes from 0 volts (muted) to 5V (unmuted) adjust RV1 (TP2) for 2.5VDC and program mobile COR as active high. If the violet wire goes from 3.5V (muted) to 0.7V (unmuted), adjust RV1 (TP2) for 2.1 VDC and program mobile COR as active low.

Pin 8:   Audio mute output. Whenever the 2016 is receiving a signal, this line will pull to ground
(Brown)   to mute the receiver audio. When not receiving, it is open collector. If you wish to use tone stripping,
connect this line to an *active low* audio mute input to the radio, or more generally, to the high side
of the volume control.

Pin 9:   *Mic mute:* This line goes active *low* every time the 2016 sends it's message and may be used
(Grey)   to mute the microphone audio to prevent interference with the tone signal. If pin 11 is grounded,
the 2016 will pull this line to ground to affect a channel change request to the radio.

Pin 10:   Aux input 3. Ground to change P2 output to Alkon CMS format.
(Blk/Wht)

Pin 11:   Aux input 2. Ground to activate channel change capability.
(Turquoise)

Pin 12:   Aux input 1. Ground to double PTT delay time.
(Pink)

Pin 13:   Aux output 3. Not currently supported.
(Red/Wht)

Pin 14:   Aux output 2. Not currently supported.
(Brn/Wht)

Pin 15:   Aux output 1. Not currently supported.
(Org)

P2 (DB9-F) Connector: Billing Software
Output Only

Configured as DCE: 9600 baud, No Parity, 8 data bits, 1 stop bit

Pin 1:   Protective Ground

Pin 2:   Tx Data to PC

Pin 5:   Signal Ground

Refer to page 15 for billing software output.

P3 (DB9-F) Connector: PC Dispatch Software / Street Smarts™ Mapping Software.
Bi-directional

Configured as DCE: 9600 baud, No Parity, 8 data bits, 1 stop bit

Pin 1:   Protective Ground

Pin 2:   Tx Data to PC

Pin 3:   Rx Data from PC

Pin 5:   Signal Ground

Refer to pages 14-17 for data formats to and from the PC.

Alignment

Before aligning the 2016, ensure that the base radio is aligned per the manufacturer's service procedure; Ensure that the 2016 is properly programmed. In order to properly align the 2016, you will need a service monitor and the base radio that the 2016 will be installed with.

Dis-assemble the modem by removing the two cap screws on the rear panel. Carefully slide the entire assembly out of the housing. Connect the service monitor to the base radio antenna jack. Connect the cable from the base radio to the 2016.

Transmit Deviation: Using the PC dispatch software, select the ***Configure Menu, Test Mode.***

MSK mode: Select ***Send MSK***; the 2016 will send alternating 1's and 0's until the <Esc> key is pressed. Adjust **RV2** for 60% of rated system deviation. Compare the service monitor display with the waveforms on page 9; the transmitted signal should resemble the sine waves as shown. If excessive distortion is occurring, you may need to find a different tx audio input to the radio.
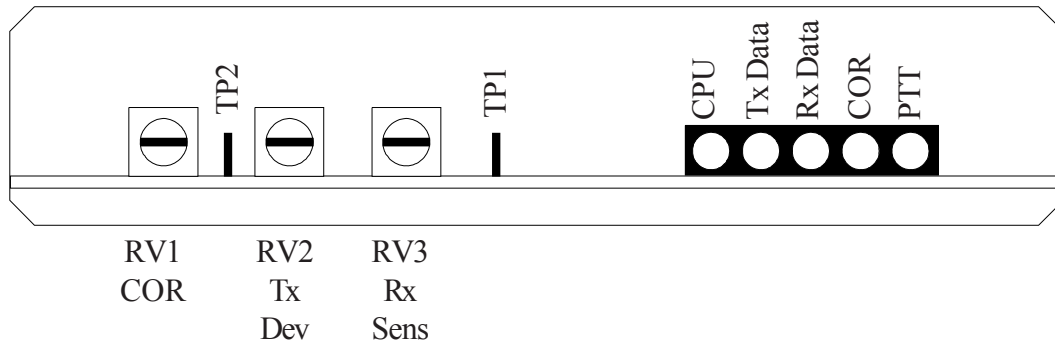
DTMF mode: Select ***Send DTMF***; a DTMF key pad appears on screen. Press the "*" key with the mouse (or press the keyboard "*") and adjust RV2 for 60% of system deviation. Press <Esc> to cancel DTMF test.

Receive Sensitivity: Set the service monitor signal generator for the mobile's receive frequency, with 60% deviation of a 1kHz tone. Connect an oscilloscope or AC voltmeter to **TP1** and adjust **RV3** for 1VPP as read on the scope, or 375mVrms on the meter.

If in DTMF mode, select ***Decode DTMF*** from the test mode menu, turn off the 1kHz tone and enable the DTMF encoder. Any DTMF digits sent to the 2016 should be displayed on the PC screen. Ensure all DTMF digits are decoded.

The DTMF decoder works at full speed and can be used to receive and display status requests and acknowledgments from other mobiles and the base. If a 2012 is not handshaking properly with the base, set a 2016 in test mode and monitor the signalling to determine what is being sent and received.

Squelch Threshold: Measure and record the voltage on the violet wire when the mobile is receiving and when it is squelched. Adjust RV1 for the mid-way point between the two voltages just recorded, with a voltmeter on TP2. The yellow LED (COR) will light to indicate a busy channel. If the COR LED is on when the channel is idle and off when busy, the COR polarity is programmed backwards. If the COR LED is always on or always off, RV1 is improperly set or the violet wire is not connected to a point that indicates receive unmute.

1200 Baud Test Waveform

| 1 cycle 1200 Hz | 1½ cycles 1800 Hz | 1 cycle 1200 Hz |

| ½ cycle 1200 Hz | 1 cycle 2400 Hz | ½ cycle 1200 Hz |
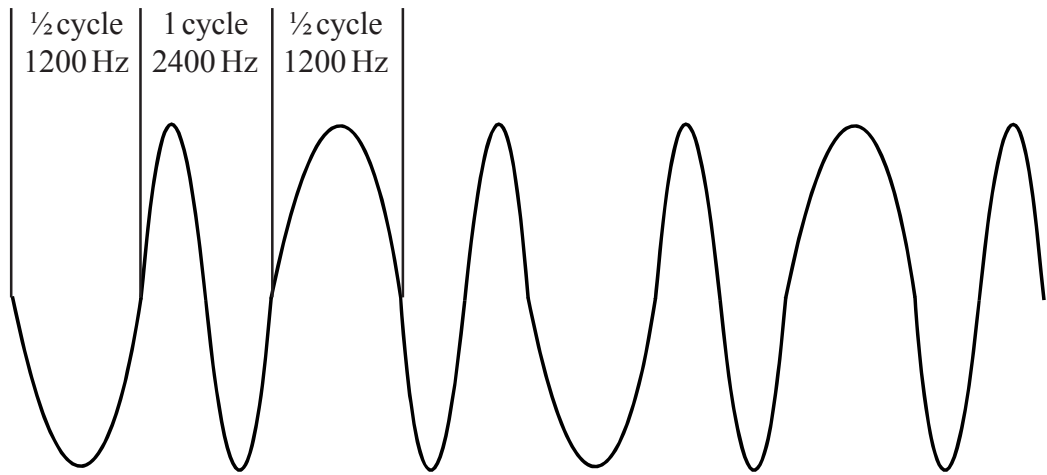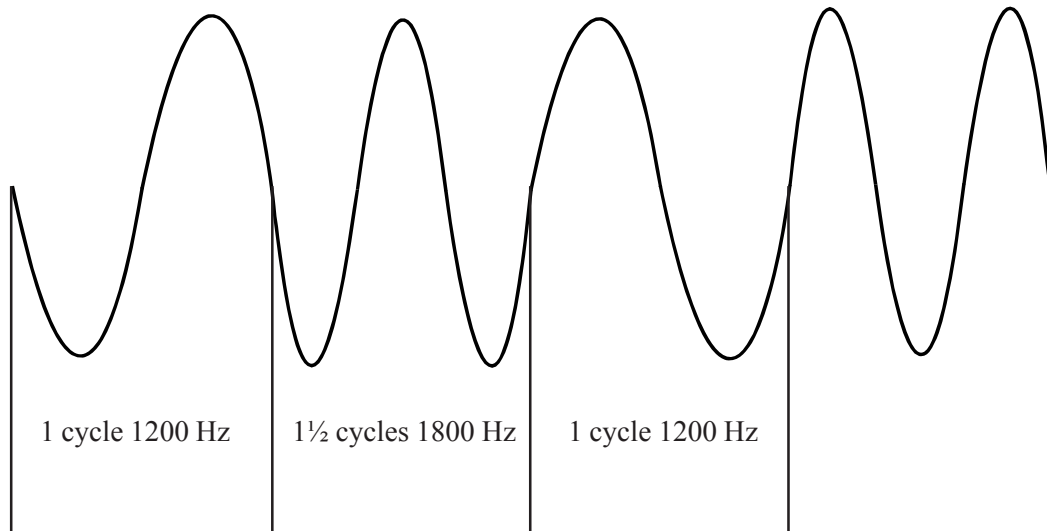
2400 Baud Test Waveform

Test Mode

In order to aid in the set up and trouble shooting of the system, the PC dispatch software can be started with an additional command line switch to enable a test mode. The test mode allows the technician to view the actual data received by the modem. To place the software in the test mode, start the program by typing:

C:> console -debug

Select the ***Main Menu*** and enter the ***Dispatch*** screen. Any messages received by the modem and forwarded to the PC will be displayed in the bottom right hand corner of the screen:

DTMF mode

In debug mode, a normal status request should appear as follows:

AC1590200

There will be 2 additional characters after the DTMF string that are the ASCII characters for carriage return and line feed. Refer to page 14 for DTMF signaling sequences to verify if the string of characters is correct for the mobile unit and status key pressed.

If the modem is not forwarding any data to the PC, it may be missing digits because of levels or distortion in the signalling. To view what is being received, select the Configure Menu, Test Mode, DTMF decode. The DTMF decoder works at full speed and will display what ever DTMF digits are received.

MSK mode

In debug mode, a normal status request should appear as 6 pairs of numbers representing the actual hexi-decimal data transmitted:

81 02 00 02 00 00

Refer to pages 16-17 for MSK signaling sequences to verify if the string of hex data is correct for the mobile unit and status key pressed.

GPS

In MSK mode, P3 outputs the data received from the mobiles equipped with GPS receivers, to a PC mapping software program. The data is sent to the PC at 9600 baud, No Parity, 8 data bits, 1 stop bit. The data sent is the standard NMEA 0183 V2.1 ASCII characters in the format:

 00512>$GPRMC,172926.00,A,3344.59095,N,11802.32305,W,000.1,000.0,210799,013.8<cr><lf>

00512>	Vehicle number 512
$GPRMC	Standard NMEA message header for GPS device, Recommended Minimum Course response.
172926.00	UTC time (Greenwich England) of position fix; format: hhmmss.ss.
V or A	Status: V indicates bad fix, A indicates valid data.
3344.59095	Latitude ddmm.mmmmm.
N or S	Latitude in reference to Equator.
11802.32305	Longitude dddmm.mmmmm.
E or W	Longitude in reference to Greenwich England.
000.1	Speed over ground, knots.
000.0	Course over ground, degrees true.
200799	Date (Greenwich England) format: ddmmyy.
013.8	Magnetic variation, degrees.

The mobiles equipped with GPS receivers will not send position data until the receivers have acquired a positive position fix (typically 2-4 minutes for a stationary vehicle). Once position has been determined, the mobile will send its GPS information on the programmed interval (1-15 minutes). The PC dispatch software connected to P3 of the 2016 can poll the GPS information at anytime by pressing *F2* (Page), *Poll GPS*.

Theory of Operation

General

All of the functions of the 2016 are under control of the microprocessor U13 which also contains the firmware operating system and interfaces to the rest of the hardware. Non-volatile data storage is contained in U10.

DTMF Generation and MSK signaling

U8 provides the DTMF encoding and MSK encoding/decoding as well as signal filtering. The microprocessor communicates with U8 on pins 4 and 5. DTMF digits are selected by the micro, generated by U8 output on pin 23 then amplified by U4A. Level control is achieved with RV2. After amplification the audio is routed to the base radio for modulation.

DTMF Decoding

U6 is a DTMF decoder that takes audio from the mobile radio, filtered through a three stage noise and CTCSS filter and applied to pin 2. Audio level adjustment is made with RV3. U6 signals the µP via pin 15 (active high) any time DTMF is being decoded. Pins 11-14 present the decoded digit to the microprocessor as binary data.

Audio processing

Audio enters the 2016 on pin 6 of P1 and is high pass filtered by U2A which has a cut off frequency of 300 Hz and a slope of 12db/octave. U2B and U2C form a 4 pole low pass filter with a cut off frequency of 2500 Hz and a slope of 24db/octave. The filtered audio goes into U8 pin 13 an op-amp inverter with a gain of 0-20db as determined by RV3. U8 pin 14 is the output which goes to the DTMF decoder U6 and to its internal MSK decoder. Transmit audio comes from U8 pin 23 (DTMF and MSK) is amplified by U4A and output on pin 2 of P1. RV2 sets the level and J1 selects the adjustment range; In:0-200mV Out: 0-5V.

LED Display

The CPU LED is the 2016's heartbeat and should always flash at a constant 1 Hz rate.

The Tx Data and Rx Data LEDs are driven by the hardware and can indicate if the PC is communicating with the modem. These LED's will flash when ever data is being sent to the 2016 (RxD) or the 2016 is sending data to the PC (TxD).

The µP controls the COR LED directly and will depend on the programming of the COR and On-Air polarities. If the COR LED is on constant, it indicates the base radio is receiving and the 2016 will be prevented from transmitting. If the COR LED flashes, it indicates the base radio is being keyed by the local microphone and the 2016 will also be prevented from transmitting.

If the COR LED is on constant and the mobile is not receiving, the COR polarity may be programmed incorrectly, COR threshold (RV1) is improperly set or the Violet wire is not connected to a point in the radio that indicates when the channel is busy. If the COR LED flashes and the mobile is not being keyed, the On-Air polarity may be programmed incorrectly, or the Blue wire is not connected to a point in the radio that indicates the base is transmitting.

The PTT LED will be on when ever the modem is keying the base radio.

RS-232

The microprocessor has a single serial data port which is switched between P2 and P3 by analog switch U3A and U3B. U7 performs TTL to RS232 level conversion in both directions.

Memory Retention

U10 E²PROM provides data retention of programming information. The E²PROM has a data retention of up to 100 years without power applied. U10 communicates with the microprocessor on lines DATA IN and DATA OUT and CHIP ENABLE.

Logic and control: U13 is an Atmel 89C52 microprocessor with flash E²PROM memory. The microprocessor provides all of the logic and control functions for the 2016, interface to the rest of the hardware and communications with the PC for programming.

The 89C52 has four 8 bit ports that interface with the rest of the hardware on board; a brief description of each port follows:

P0.0   Serial data output to the E²PROM.

P0.1   Serial Clock output to the E²PROM.

P0.2   Audio mute output (tone stripping) active high.

P0.3   Aux 1 output active low.

P0.4   Aux 2 output active low.

P0.5   Aux 3 output active low.

P0.6   Mic Mute output active low.

P0.7   PTT output active low.

P1.0   Serial data in from U10 E²PROM

P1.1   Chip select for U10 E²PROM

P1.2   Chip select for U8 MX829

P1.3   Serial data in from U8 MX829

P1.4   Serial data out to U8 MX829

P1.5   Serial clock out to U8 MX829

P1.6   Base COR input. Polarity is determined by programming.

P1.7   Test jumper. Not used Do not install.

P2.0-3   Data Bus lines for U6 DTMF Decoder.

P2.4   Strobe Output from U6 DTMF Decoder

P2.5   Aux 1 input.

P2.6   Aux 2 input.

P2.7   Aux 3 input.

RXD   Serial Data port Rx Data

TXD   Serial Data port Tx Data

INT0   Interrupt Request from MX829

INT1   On Air detect input. Polarity determined by programming

T0   CPU LED output active low

T1   COR LED output active low

WR   Tx Data mux select

RD   Rx Data mux select

Signaling

DTMF   The outbound mobile message can be either 6 digits (normal operation) or 9 digits (time stamp):

Normal: Digit #   Range   Function

1	A-D	Destination Console
2	A-D	A: Response to base originated message
		B: Dispatch request
		C: Mobile originated message
		D: Emergency message
3	0-9	Vehicle ID MSD
4	0-9	Vehicle ID
5	0-9	Vehicle ID LSD
6	0-9	Current Status (base originated) or status request (mobile origin)

Timestamp: Digit #   Range   Function

1	A-D	Destination Console
2	A-D	A: Response to base originated message
		B: Dispatch request
		C: Mobile originated message
		D: Emergency message
3	0-9	Vehicle ID MSD
4	0-9	Vehicle ID
5	0-9	Vehicle ID LSD
6	0	Always 0
7	0-9	Current Status (base originated) or status request (mobile origin)
8	0-9	Timestamp MSD
9	0-9	Timestamp LSD

The outbound base message is always 6 digits, except when sending data messages (see next page):

Digit #   Range   Function

1	0	Always 0
2	0-9	Vehicle ID MSD
3	0-9	Vehicle ID
4	0-9	Vehicle ID LSD
5	*	Always *
6	0-D,*,#	1-9: Status request acknowledgment
		0: Interrogate
		*: Horn Honk
		#: Selective Call
		A-D: Reassign destination console

Examples: Mobile user #159 presses status #4; mobile message: AC1594; Base Response: 0159*4

Base interrogates unit #159 who is at status #6: 0159*0; Mobile Response: AA1596

DTMF Data Messages

The outbound data message is 6 DTMF digits similar to the other dispatch sequences, followed by 32 DTMF digits representing the hexadecimal values of the ASCII text message:

Digit #	Range	Function
1	0	Always 0
2	0-9	Vehicle ID MSD
3	0-9	Vehicle ID
4	0-9	Vehicle ID LSD
5	#	Signifies data message always '#'
6	0	Always 0
7-38	0-#	Hex codes for ASCII Text message 0-D, E (*) & F (#)

Example: Base sends unit #159 who is at status #6 the following data message: 'Call Shop <5 PM '
Base Output: 0159#0 43 61 6C 6C 20 53 68 6# 70 20 3C 35 20 50 4D 20
Mobile Response: AA1596

PC Communications

DTMF mode:

P3->PC: In DTMF mode, the PC will send to and receive data from the modem as ASCII characters representing the DTMF digits. Reference the above examples, the PC would send the ASCII string '0159*0' to interrogate vehicle #159. The response from the mobile (AA1596) is sent to the PC (P3) as the ASCII string 'AA1590600'; The PC output adds the '0' delimiter between the vehicle number (159) and status (6) as well as the time stamp on the end (00). The string is terminated by <lf><cr>.

If Pin 10 of *P1* is grounded (Blk/Wht) the output format is compatible with *Alkon CMS* software: AA159006000<cr>. The two zeros following the vehicle number are fixed delimters, followed by the status, another '0' delimiter and the time stamp. The string is terminated by a single <cr> *without* <lf>.

P2->PC: The billing software output (P2) would be the ASCII string '1-159-6-00'<lf><cr>. The first digit is the console number (A-D is sent as 1-4), followed by a '-', the vehicle number, another '-' the status, another '-' and the time stamp.

PC->P3: The data message example above would be sent as the ASCII string '0159#0Call Shop <5 PM '. The data message is always 16 characters in length, padded with spaces (ASCII 32 or 20 hex) if necessary. The response from the mobile (AA1596) is sent to the PC (P3) as the ASCII string 'AA1590600'<lf><cr> and to the billing software (P2) as the ASCII string '1-159-6-00'<lf><cr>.

MSK mode:

In MSK mode, the PC will send to and receive data from the modem on P3 in binary mode representing the actual hex data sent between the mobile and 2016. Refer to the next section for MSK signalling formats. Data from the PC to the 2016 is preceded with ASCII 1.

P2 will output the status information only to the billing software in the same format as above:1-159-6-00 The first digit is the console number, followed by a '-', the vehicle number, another '-' the status, another '-' and the time stamp.

MSK

The 2016 transmits and receives data packets at 1200/2400 baud and conforms to the MPT-1317 protocol for over-the-air signalling. A brief description of the MPT-1317 protocol and the 2012/2016 data messages follows:

MPT-1317

The MPT-1317 protocol consists of a data packet made up of preamble (bit reversals for receiver synchronization), a 16 bit sync word, a 6 byte address code word and 16 bits of CRC error correction data. If data bytes are attached, they are preceded by the same 16 bit synch word (preamble is sent only once), and followed by 16 bits of CRC:

Preamble	sync	address code word	16 bit crc	sync	data bytes	crc
16 bits	16 bits	48 bits	16 bits	16 bits	up to 128 bytes	16 bits

The minimum message length is 96 bits; at 1200 baud, transmission takes 80mS, at 2400 baud, 40mS.

2012/2017

The mobiles send 2 types of messages that conform with the MPT-1317 data protocol. Status messages contain preamble, sync, address code word, and crc. GPS messages contain the same, plus add another 16 bits of sync, 64 bytes of data and 16 more bits of crc for a total of 640 bits. At 1200 baud, transmission takes 533mS, at 2400 baud, 266mS.

2016

The 2016 sends 2 types of messages that conform with the MPT-1317 data protocol. Status acknowledgment and paging messages contain preamble, sync, address code word, and crc. Alpha data messages contain the same, plus add another 16 bits of sync, 64 bytes of data and 16 more bits of crc for a total of 640 bits. At 1200 baud, transmission takes 533mS, at 2400 baud, 266mS.

Address Code words

The address code word defines the message type and what action is to be taken by the 2012 or the 2016. The address code word is 6 bytes of hexi-decimal data and conform to the following format:

Address Code word   6 bytes   48 bits:

Bit 0   Always 1
Bits 1-3   System Flags
Bits 4-7   Console ID
Bits 8-23   Mobile ID
Bits 24-31   Function Code
Bits 32-39   Time Stamp
Bits 40-47   Number of data bytes to follow

Flags:

Bit 1   Retry Cleared for normal operation, set if message is a retry
Bit 2   Merlin Flag 1=Merlin 0=2012
Bit 3   CDPD Flag 1=CDPD 0=Radio

Console ID:

Bits 4-7   Console # 1-15 Source address for 2016 message, destination address for mobiles

Mobile ID:

Bits 8-23   Mobile # 1-65534 (65535=group call) 2016 dest. address, mobile source address

Function code:		2012	2017	2016
Bits 24-27	0	Status	Reserved	Acknowledge
	1	Emergency	Emergency	Negative Ack
	2	Acknowledge	Acknowledge	Interrogate
	3	Negative Ack	Negative Ack	Selective Call (2012)
	4	ANI	ANI	Horn Honk (2012)
	5	GPS message	GPS message	Set Ind. Output (2017)
	6	Reserved	Reserved	Clear Ind. Output (2017)
	7	Reserved	Reserved	Output All (2017)
	8	Reserved	Reserved	Data message
	9	Reserved	Reserved	Request GPS position
	A	Reserved	Reserved	GPS interval change (2017)
	B	Reserved	Reserved	GPS History Req (2017)
	C	Reserved	Reserved	Stun/Revive (2017)
	D-F	Reserved	Reserved	Reserved
Bits 28-31		Status request 0-9	Input Status	RS485 address 0-15

Time Stamp:

Bits 32-39	Pack BCD 00-99	Output Status	Output Data field

Data bytes:

Bits 40-47   Number of data bytes to follow 0-256

Examples:

Normal status request #5 from 2012 unit #512 to 2016 console #1: 81 02 00 05 00 00
2016 response: 81 02 00 00 00 00

Status request # 3 queued for 15 minutes from 2012 unit #1000 to 2016 #12: 8C 03 E8 03 15 00
2016 response: 8C 03 E8 00 00 00

Emergency retry from 2012 unit #512 (currently at status #2) to 2016 #1: C1 02 00 12 00 00
2016 response: 81 02 00 00 00 00

2016 #3 requests 2012 #12345 to send its GPS position: 83 30 39 90 00 00
2012 #12345 response (currently at status 9): 83 30 39 59 00 40 + sync, 64 bytes data & crc

2016 #3 sends 2012 #12345 a data message: 83 30 39 80 00 40 + sync, 64 bytes data & crc
2012 #12345 response (currently at status #1): 83 30 39 21 00 00

Dispatch Software

The PC dispatch software is used to directly communicate with the model 2016 modem and provide a complete dispatch system. It will run on any IBM® 386 or higher PC compatible with DOS version 3.3 or later, at least 640K of RAM, and a hard disk. Additionally, if you wish to access any of the printouts, you will need at least 1 printer port (the program supports LPT1-LPT4). The program supports a mouse or trackball, and monochrome as well as CGA, EGA and VGA monitors.

DTMF/MSK mode

The 2016 can be configured for DTMF mode compatible with Speedcall® 916 signalling or MSK mode compatible with MPT-1317 signalling. The version of firmware in the microprocessor determines which mode the modem operates in.

The PC dispatch software also has 2 discreet versions, one for DTMF dispatching and one for MSK dispatching. The features that are accessible will depend upon which version of PC software you receive with the modem.

Installing the software

Before installing and running the software, add the following line to your autoexec.bat program:

SET CLIPPER=E000;F30

Installing the Software

At the DOS prompt, type the following:

A:>INSTALL   or   B:>INSTALL

The install program will check your computer's autoexec.bat file and make any necessary changes to it in order to work with this program (the install program will prompt you first before making any changes to your computer). If the install program modifies your autoexec.bat file, you MUST reboot your computer before running the program in order for the changes to take affect.

The install program will create a sub-directory named "2016" and copy all of the necessary files to that directory. Answer all of the prompts that appear on screen or press <ESC> to cancel the install.

Starting the Program

To run the program, type the following at the DOS prompt:

C:>CD\2016   {Moves to the dispatch directory}

C:>CONSOLE [-C1/-C2]   {Starts the program}

The command line switches (-C1 or -C2) are optional; they are used to specify a different com port at program start-up. The program checks for the existence of a mouse or track ball. If it detects that the mouse driver software is installed, a message will appear in the lower left corner of the screen and the mouse cursor will appear. Refer to the mouse driver software instructions for proper installation procedures.

Ensure that the modem output (P3) is connected to the proper PC communications port. When the program is first installed, it assumes com port #1. To specify comport 2, start the program with the "-C2" command line switch. The program remembers the com port setting and it will not be necessary to use the command line switch every time the program is started.

The main menu bar will then appear across the top of the screen, with the highlight on *Main*. Press <ENTER> or the first letter of any of the main menu bar items to activate a drop down menu of choices (clicking the left mouse button on any of the main menu bar items will have the same affect). When the drop down menus are displayed, any of the sub menu items may be selected in the same way: by pressing the first letter of the item, by moving the highlight with the up/down arrow keys and pressing <ENTER> or by clicking the left mouse button on the desired item.

Pressing the right/left arrow keys will move the drop down menu to the next item. Select the HELP menu; three items should be displayed: *General*, *Locate* and *About*. *General* help will explain how to use the mouse and menu selections. *Locate* is a list of all functions in the program listed alphabetically, and the path to access them. *About* contains information about the program, which version it is, an who to call for support.

There is also on-line help available at any time within the program by pressing *F1*, or clicking the left mouse button on the *[HELP]* icon. Use the up/down arrow keys, the page up/page down keys, or home/end keys to move through the help text. Pressing <ESC> or the right mouse button returns to normal program execution.

Menu Items

The following section describes each of the sub menu items; there is a separate section on the main dispatch screen starting at page 22.

Main

Dispatch All of the dispatch functions including call logging, selective calling, horn honk activation, interrogation, console assignment and data messages are activated though the main dispatch screen. A separate section beginning on page 22 explains all of the features and functions. Please refer to the section entitled "Running the program for the first time" on page 21 before using the dispatch screen.

Save This item allows you to save the current dispatch log to disk. Upon selecting Save, you will be asked for the name of the file to save as; only valid DOS names are allowed (no spaces or special characters). A default name is supplied that represents today's date. To view a directory of saved dispatch logs, press *F2*. If you must leave the dispatch program in order to access another program on your computer, be sure that the current log is saved so that you may recall it at a later time and continue dispatching with the same call log.

Retrieve This item allows you to load a previously saved dispatch log for browsing or printing at a later time. Use Retrieve to continue logging dispatch calls in the event that you had to quit the program in order to use another program on your computer. To view a directory of saved dispatch logs, press *F2*. Loading a saved call log will dump the contents of the current call log. If the current call log has not been saved, you will be prompted before another call log is loaded.

Printouts The program will print the currently selected call log, or the currently selected driver list. The call log may be sorted by vehicle #, or chronologically. The driver list may be sorted by name or vehicle #.

Quit Terminates the program and returns to DOS. You will be asked for confirmation if the current call log has changed and has not been saved.

Configure

Status Tags Enter the 10 status tags here for display in the main dispatch screen. These tags will also appear in the call log printout and call log history.

Vehicle Tags Select the driver list you wish to use for dispatching. The main dispatch screen uses this file to display information about the vehicle number as status calls are logged. Enter the name of the file you wish to load or press ***F2*** for a directory of driver files. After the file is loaded, you may browse or edit the list. To add drivers to the list, move to the bottom of the file and press the down arrow key. To delete a driver, move the highlight to that line and press the <Delete> key. The record will be marked for deletion and will be removed from the file upon exit from the edit mode.

To create a new driver list, enter the new file name at the entry menu and answer "Y" to the prompts. Add new drivers as above. The program will remember the last driver file used and load that file when the program is next started.

Canned Messages (MSK Mode only) This menu allows you to pre-define up to 6 "canned messages" that can later be recalled in the dispatch screen to facilitate sending alpha-numeric text messaging. Select the message to edit and press <Return>. The cursor will appear and you can then change the message. Press <Return> at the last line to save the message.

Define Parameters All of the program variables are accessible from this menu. You may enable and set the password for the program, enable/disable the Pyramid trademark on program start-up, select the printer and com ports to use, enable/disable the call log printout (from the dispatch screen) and the beep when calls are received.

Modem Parameters

PTT delay: .1-2.5 Seconds The amount of time the modem will delay after keying the radio before sending its message. If set too low, part of the message may be missed by the receiving radio, especially if the transmission must go through a hill-top repeater. If set to 0, the modem is configured for a trunking base and the blue wire (on-air detect) should be connected and on-air programming configured accordingly. If Pin 12 of P1 is grounded (Pink) the PTT delay is doubled for special applications.

COR Polarity: High/Low Determines whether the violet wire (pin 7 mobile COR detect) is active high or active low. RV1 is used to set the COR threshold. See page 7 for alignment instructions.

On-Air Polarity: High/Low Determines whether the blue wire (pin 3 mobile on-air detect) is active high or active low. On conventional radios, the blue wire is not connected. On trunking radios, the blue wire is connected to a point that indicates the radio is actually transmitting and is used to determine when the radio has acquired a voice channel. This function is not used for conventional radios.

Console: The message protocol contains a routing code that determines which console the mobiles will send their status to and will accept calls from.

In ***DTMF*** mode, the modem can be configured to respond as any combination of 4 consoles A-D. Upper case letters indicate selected consoles. If all upper case, the modem will respond to all incoming status requests. If all lower case, the modem can be used to monitor traffic without generating any responses. In ***MSK*** mode, select 1-15.

Speed (MSK mode only): 1200/2400 In MSK mode, controls the over-the-air signalling speed. Select either 1200 or 2400 baud. This parameter must match the signalling speed of the 2012 mobiles.

Test Mode

DTMF:

DTMF Decode displays all DTMF tones that the modem receives. The tone decoder runs at full speed and can be used to display sequences sent by 2012 mobiles and 2016 bases to determine if the units are operating properly.

DTMF Encode allows you to send DTMF tones and set deviation level. A DTMF keypad appears with all 16 digits; pressing any of the keyboard keys (or clicking on the keypad with the left mouse button) will key the radio and send that tone until another key or <ESC> is pressed.

The last menu items allows you to key the radio without modulation. The radio will remained keyed until <ESC> is pressed.

MSK:

Send MSK will key the base radio and send alternating 1's and 0's to the radio in order to set the modulation level until <Esc> is pressed.

The last menu items allows you to key the radio without modulation. The radio will remained keyed until <ESC> is pressed.

Help

In addition to the on-line help that is available by pressing *F1*, three additional help menus are available. *General* explains how to use the menus and mouse, *Locate* is a listing of all program functions listed alphabetically and the path to access them, and *About* gives you version information and who to call for support.

Running the program for the first time

Before entering the main dispatch screen, please read this section which will help you set up the software correctly.

The first time you start the program, it will use default values for all of the operating parameters. One of the parameters, the com port to use for dispatching, is set to com 1. If your mouse or trackball is connected to this port, the program will not log calls, and the mouse cursor will act erratically. To override this default setting, start the program with the command line switch "-C2".

After the program has been successfully started, you should select the *Configure* menu, *System Parameters* and set up all of the program variables. If the modem is connected to the computer, select *Modem Parameters*, configure the 2016 and verify operation. Select the *Test Mode* menu, algin the modem as described on page 8 of this manual.

When the modem is working properly, select the *Status Tags* menu. Enter the status tags you wish to use for dispatching and press <ESC> to exit.

Select the *Vehicle Tags* menu. Create and edit your start up driver list as described on page 20.

The program will remember all of these settings, so it will not be necessary to go through this procedure every time the program is started. You are now ready to use the main dispatch menu.

Dispatching

Now that the program is properly configured and you are familiar with all of the menu items, you are ready to use the main dispatch screen. Select *Main, Dispatch;* the screen should appear as below:

```
          The Dispatcher   Ver 4.24                      [Help]


    Status     ◄ 1    2    3    4    5    6    7    8    9   10 ►

  In Service   ▐██▌
  Loading
  Leaving Plant
  Arrive Job
  Begin Pour
  Finish Pour
  Leaving Job
  Arrive Plant
  Out Service
  Dispatch Req
                             = Vehicle Info =
  Name:             Vehicle Type:                    03:07:13
  Last Called:      Lic #:            Max Load:   yds 03/20/02
  Clip Board :

  F2 Page    F4 Find     F6 History  F8 Clip Board   Vehicle:
  F3 Clear   F5 Drivers  F7 Colors   F9 Send Data    Status:
                                                  = Last Received =

              Press <ESC> to quit
```

The highlight will be in the upper left hand corner. This highlight may be moved with the cursor keys or by clicking the left mouse button anywhere in the inner dispatch screen; the highlight may also be moved to the Last Received field to always update the vehicle information based on the last mobile message received. All incoming calls will be logged in the call history, and the vehicle number will be appended to the proper status row. If printing is enabled, the information will be sent to the printer as each new call is received. The complete call log may also be printed at any time by selecting the *Printouts* menu.

As the vehicles change status, their number will be removed from the old status row (except from Dispatch Req.) and added to the end of the new status row. The order of the status row display is from oldest to newest (left to right). If the highlight is on a vehicle number, the vehicle information will be displayed in the lower mid section of the screen. This information is retrieved from the currently selected driver list. If an incorrect driver list is loaded (or the program cannot find the vehicle number in the list) "???" will be displayed for all vehicle information.

The last received vehicle and status request are displayed in the lower right hand part of the screen. A complete call history may be viewed by pressing *F6*.

The other main functions of the dispatch screen are listed in the bottom section of the dispatch window and may be selected by pressing the indicated "F" key, or clicking the left mouse button on the description.

Function Keys

F2: Page   (DTMF mode)

There are four different paging functions: ***Selective call, Horn Honk, Interrogate***, and ***Assign Console***. If the highlight is on a vehicle number in the main dispatch screen, that vehicle will be "suggested" for paging. Enter the vehicle number you wish to page and press <RETURN>. If Assign console was selected, you will also be prompted for the console code (A-D). To page a group of vehicles, substitute the "#" wildcard character. Example: Entering "15#" will page units 150-159; entering "1##" will page units 100-199; entering "###" will page all units in the fleet.

If an individual unit has been paged, it will respond and the last called window will show "Acknowledged". The call history will record both the page and the acknowledgment.

F2: Page   (MSK mode)

There are four different paging functions: ***Selective call, Horn Honk, Interrogate,*** and ***Poll GPS***. If the highlight is on a vehicle number in the main dispatch screen, that vehicle will be "suggested" for paging. Enter the vehicle number you wish to page and press <RETURN>. To page a group of vehicles, enter "GROUP"; all units in the fleet will be paged.

If an individual unit has been paged, it will respond and the last called window will show "Acknowledged". The call history will record both the page and the acknowledgment. If Poll GPS was selected, the 2012 will respond, but the GPS information will be sent to the GPS PC instead (connected to P2).

F3: Clear

To clear a vehicle or group of vehicles from the display, select *F3*. If the highlight is on a vehicle number, three selections are possible: The individual vehicle, the entire row or the entire screen. If "All" is selected it will also clear the current call log and call history. If the current log has not been saved, you will be prompted first before the call log is cleared.

If an emergency sequence was received from a mobile, F3 is used to clear the emergency indication only.

F4: Find

With a screen full of vehicle numbers, it may be difficult to locate an individual unit. Pressing *F4* will allow you to enter a vehicle number to find. If the vehicle number is on the display screen, the highlight will be repositioned on the vehicle number entered. If vehicle number is also in the dispatch request queue, preference will be given to the non-dispatch status. The dispatch window may pan left or right to display a found vehicle number, depending upon how many calls are being displayed and the position of the vehicle number within the status.

F5: Driver List

Pressing *F5* will display a pop up window showing all drivers and vehicle numbers in the currently selected driver list in numerical order. Use the up/down arrow keys to browse the list, or press <ESC> to return to main dispatch screen.

F6: Call History

Pressing *F6* will display a pop up window showing the complete call log in chronological order. The last seven calls will be displayed with the highlight at the top of the window. Use the up/down arrow keys to browse the call log, or press <ESC> to return to the main dispatch screen.

F7: Assign Color

By moving the highlight to a particular vehicle number on screen and pressing *F7*, you can assign one of six different color attributes to the drivers as they appear on screen. This makes it easier to locate individual vehicles, or separate the display by crews for subfleets. If the vehicle number is not found in the current driver list, you will not be able to assign a color, and the vehicle will always be displayed as black text. The program remembers the color assignment even if the program is terminated.

F8: Clip Board

Each vehicle may have a message assigned to it which will be displayed when ever the highlight is on that vehicle number. To edit the field, move the highlight to the desired vehicle # and press *F8* or click the left mouse button on the message field. The message is stored on disk and will remain if the program is exited.

F9: Data Message

Pressing *F9* will allow you to send an alpha numeric text message to an individual driver or a group of drivers. If the highlight is on a vehicle number, that vehicle will be suggested for the data message; press <Return> or enter the vehicle number directly (see *F3* for group calling parameters). After a vehicle has been selected, a text message window appears that allows you to enter the data message.

DTMF mode: The message is one line of 16 characters and will be sent by pressing <Return>.

MSK mode: The message is 4 lines of 16 characters. To Send one of the pre-programmed "Canned Messages", press *F2* and select the desired message. The pre-programmed message is copied back to the text entry window and can be added to or changed if desired. Pressing <Return> sends the data message to the vehicle or vehicles.

Panning the dispatch window

If more than 10 vehicles are in a single status, you can pan to the left or right by holding the <Ctrl> key and pressing the left or right arrow keys in order to view the other vehicles. If a status row contains more vehicles than can be displayed, a red arrow will appear at the end of the row indicating that the window can be panned to display the vehicles.

Notes:

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Parts List

Reference	Description	Part #
C1	2200 pfd 0805 chip cap	1010-03-5222
C2,C3,C18-C21	10 pfd 0805 chip cap	1010-03-5100
C4-C7	.47 µfd 1206 tantalum chip cap	1610-04-5474
C8,C9,C12,C22,C23	.1 µfd 0805 chip cap	1010-03-5104
C10,C17,C24,C25	2.2 µfd 1206 tantalum chip cap	1610-04-5225
C11	1000 pfd 0805 chip cap	1010-03-5102
C13,C14	.01 µfd 0805 chip cap	1010-03-5103
C15	3300 pfd 0805 chip cap	1010-03-5332
C16	6800 pfd 0805 chip cap	1010-03-5682
C26,C27	100 µfd SMT electrolytic	1410-09-6107
C28	1 µfd 1206 tantalum chip cap	1610-04-5105
DS1,DS4,DS5	Red LED	4001-01-2501
DS2	Yellow LED	4001-01-2503
DS3	Green LED	4001-01-2502
D1-D4	BAV99 Dual diode sot-23	3110-01-0099
D5	1N4001 1A silicon	3110-11-4001
F1	Fuse, 1A SMT	2610-04-0010
P1	DB15-M Connector	7401-00-0012
P2, P3	DB9-F Connector	7409-00-0011
P4	2.5mm Jack	7401-02-0050
Q1, Q2	2N4403 pnp sot-23	3010-01-4403
Q3	FMMT38CT npn darlington sot-23	3010-01-0038
Q4-Q9	2N4401 npn sot-23	3010-02-4401
RN1	2.2 K Resistor network	2002-07-5222
RV1, RV2	Potentiometer, 20K	2060-08-5203
RV3	Potentiometer, 100K	2060-08-5104
R9,R18,R29,R30,R33-R35,R40,R41,R43,R49	10K 0805 chip resistor	2010-03-5103
R11,R12,R19-R24,R39,R50,R53	22K 0805 chip resistor	2010-03-5223
R13-R17	330 Ohm 0805 chip resistor	2010-03-5331
R25	120K 0805 chip resistor	2010-03-5124
R26-R28	1K 0805 chip resistor	2010-03-5102
R10,R44,R45	1M 0805 chip resistor	2010-03-5105
R31,R32,R36,R37	24K 0805 chip resistor	2010-03-5243
R38,R46	47K 0805 chip resistor	2010-03-5473
R42,R48,R51	100K 0805 chip resistor	2010-03-5104
R47,R52,R54	2.2K 0805 chip resistor	2010-03-5222
TP1	Test Point	7300-13-0001
U1	74C14 Hex Inverter	3510-01-7414
U2	MC3403 Quad Op Amp	3410-01-3403
U3	4053 Analog mux	3410-01-4053
U4	LM2904 Dual op-amp	3410-01-2904
U6	8870 DTMF decoder	3410-01-8870
U7	MAX202 RS232 line driver	3410-01-0202
U8	MX829 MSK Processor	3710-01-0829
U9	MCP101T Reset Controller	3410-11-0450
U10	93C56 E²PROM	3610-01-9356
U11	LM7805 1A 5V regulator	3400-08-7805

U12 .... LM78L08 8V Regulator 3410-10-7808
U13 .... AT89C52 μP 3610-02-8952
VR1 .... MOV Surge protector 18V 2580-02-0018
X1 .... 3.58 MHz Crystal 6010-01-3579
X2 .... 4.032 MHz Crystal 6010-01-4032
X3 .... 14.7456 MHz Crystal 6010-01-1474

Extruded aluminium case 8100-01-5010
ABS Front panel 8200-02-2503
Aluminium end panel 8200-04-2016
DB15 Right Angle PCB Mt 7409-00-0012
DB9 Right Angle PCB Mt 7409-00-0011
10ft. radio cable with DB-15F conn. ... 7500-10-1301
4-40 x 3/8" SS cap screw 8000-34-4406
4-40 SS nut 8000-54-4400
4-40 x ¼" SS philips 8000-24-4404

2016 Parts Locator