INSTALLATION, OPERATION, AND MAINTENANCE

TEL171

DIGITAL TELEMETRY CONVERSION KIT

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ASSOCIATED DRAWINGS

WARRANTY

Hallikainen & Friends, a California corporation (Corp) hereby warrants, subject to the conditions herein below set forth, that should this product prove defective by reason of improper workmanship or defective materials within one (1) year from date of original purchase, Corp will repair or, at its option, replace the defective unit without charge for either parts or labor.

CONDITIONS OF WARRANTY

1. Notice. Purchaser shall notify Corp at its principal place of business by telephone within three (3) days after malfunction of the product - time is deemed of essence.

2. Proper Delivery. The unit must be shipped, freight prepaid, or delivered to the manufacturing plant of Corp located at San Luis Obispo, CA 93401, in either its original package or a similar package affording an equal degree of protection.

3. The unit must not have been previously altered, repaired or serviced by anyone other than Corp, except for replacement of plug in components with electrically identical components, or routine adjustments as outlined in the accompanying manual. Upon repair by the customer, the Corp shall replace defective plug in parts returned to Corp, but shall not be liable for any labor expenses incurred in a field repair.

4. The serial number on the unit must not have been altered or removed; the unit must not have been subject to accident, misuse, or operated contrary to the instructions contained in the accompanying manual.

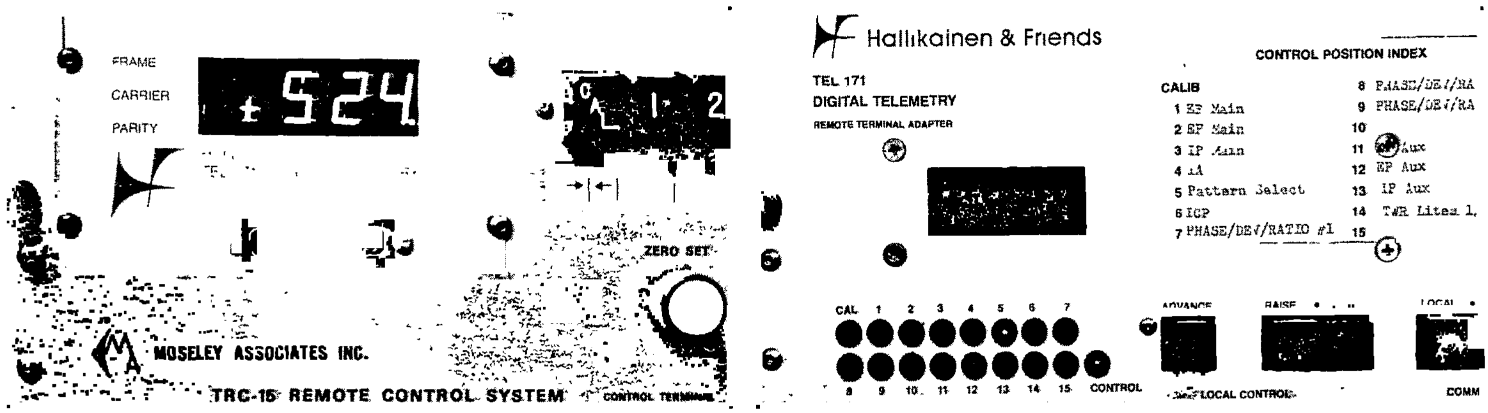
5. This warranty does not cover peripheral devices of other manufacturers supplied as part of a system by Corp (such as CRT terminals, printers, etc.); Purchaser's only remedies for malfunction with respect to such devices are with the equipment's manufacturer.

6. This warranty does not cover transportation expenses to and from service facility.

7. This warrant is in lieu of any other oral, written, or implied warranty, whether made by salesmen, agents, or other representatives of Corp.

Except to the extent prohibited by applicable law, all implied warranties made by Corp in connection with the product, including the warranty of merchantability are limited in duration to a period of one (1) year from the date of original purchase, and no warranties, whether express or implied, including said warranty of merchantability shall apply to this product after said period. Should this product prove defective in workmanship or material, the consumer's sole remedy shall be such repairs or replacements as hereinabove expressly provided; and under no circumstances shall Corp be liable for any loss or damage, direct or consequential, arising out of the use of or inability to use, this product.

Digital Telemetry
TEL 171



The TEL 171 converts your Moseley TRC-15AW or TRC-15AR to digital metering transmission, a method that eliminates the offset and gain drift in the analog metering.

A local display in the transmitter control unit duplicates the readings displayed by the studio control unit. This permits one-man weekly meter calibration.

The system consists of printed circuit boards which substitute directly for the audible metering generator, the audible metering demodulator, and the meter. The local display for the transmitter control unit includes a replacement front panel and a liquid crystal display printed circuit board.

Installation is quick and simple since the same PC mounting hardware is used, and the same wiring harness connects to the new boards.

3½ digit (-1999 to +1999) display are used. These easily read displays are updated twice a second. Should the metering carrier be lost, or a framing or parity error occur, the display at the studio will blank and a front panel LED will indicate the problem.

Through the use of digital transmission and diplay, we eliminate the error inherent in analog transmission, and simplify the task of remote meter calibration and meter reading.

Moseley, our neighbors down the road, make a good remote control. We can make it better.

Hallikainen & Friends
101 Suburban Road, San Luis Obispo, CA 93401-7590 805 541-0200

TEL 171 Specifications

H&F 1211TT Telemetry Transmitter

Substitutes for Moseley 51A5416 Audible Metering Generator.

A/D Conversion

Resolution: 3½ digits (-1999 to +1999)
Conversion Rate: 2 conversions/second
Accuracy: Limited by temperature stability of reference (LM399H).05% of reading ±1 count, 0 degrees C to 50 degrees C
Full Scale Sensitivity: 2 Volts for +1999 indication.

Data Transmission

Bit Rate: 300 Baud
Character Rate: 4 characters per conversion
Word Rate: One word per conversion (2/s), each conversion transmitted once with idle time between conversions.
Character Format: Start bit, six data bits, even parity bit, two stop bits. First four data bits carry digit code in BCD (except for on half digit where three bits carry ±, 0 or 1, and out of range indications). Last two data bits identify digit (00 half digit, 11 is last digit).
Word Format: Digits transmitted in order (0,1,2,3).
Data channel idle between conversions.
Encoding: FSK, 1270 Hz Mark, 1070 Hz Space.
Output Level: +1 dBm into 600 ohms, adjustable (line), and 5 V P-P open circuit, Z = 2.2K (subcarrier).

Display

3½ digit LCD local display.

Power Requirements

Floating +15: 35 mA
Floating -15: 30 mA
+ 5: 0.2 mA
+15: 30 mA

H&F 1221TR Telemetry Receiver

Substitutes for Moseley 51A5420 Audible Metering Demodulator.

Minimum Receive Level: -40 dBm (7.7 mV)
Data Output: Character parallel, negative 250 uS strobe, carrier, parity, and framing alarms. All TTL levels.
Power Requirements: 5V, 100 mA

H&F 1231TD Telemetry Display

Substitutes for Moseley meter.

3½ digit LED display with PROM programmed decimal points.
All metering and control data presented on front panel connector for logging for ATS.
Power Requirements: +5V, 400 mA

INTRODUCTION

The TEL171 updates the Moseley TRC-15AW or TRC-15AR remote control from analog metering to digital metering. The use of digital transmission and display eliminates the calibration drift and reading problems associated with analog transmission.

The system utilizes audible metering, as is standard in the TRC-15AW.

The TRC-15AR normally uses subaudible metering. Due to the data rates involved, subaudible transmission of digital metering is not practical.

The audible metering of the TEL171 can be used with wire lines (TRC-15AW), or FM SCA (TRC-15AR) if no programming is run on the SCA.

On FM stations using the SCA for programming and AM stations using a subaudible metering return, the use of wire lines or a remote telemetry link (available from Moseley) is recommended.

The TEL171 consists of a set of four printed circuit boards that substitutes directly for the audible metering generator, audible metering demodulator, front panel meter, and transmitter unit front panel. Connections to the transmitter and receiver boards utilize the existing wiring harness, simplifying installation. The remote meter is replaced by an LED display board, which connects to the receiver board and the Moseley channel select and raise/lower switches. The local display, which can be deleted by specifying option 1 when ordering, substitutes for the "slide-out" front panel on the transmitter unit. The local display provides an LCD indication of the metering data at the transmitter site. The local display plugs in to the telemetery transmitter board with a ribbon cable.

The system converts the metering sample at the transmitter site to a digital code. This code is displayed on the local display. It is also serialized (transmitted one data bit at a time), and optically coupled to the remainder of the circuitry. The optical coupling, along with the floating power supply provided by Moseley, allows metering of samples that have both leads above or below ground potential.

The optical coupler drives a frequency shift keyed oscillator. This converts the serial digital data to audio for transmission over wire line, SCA, or radio telemetry link.

At the studio, the FSK metering signal is fed to an active filter. This filter passes only the desired metering signal while rejecting the control signal that is present on two wire communications links, such as wire lines.

The filtered metering data feeds a demodulator. This phase lock loop demodulator converts the signal back to serial digital and provides an indication of metering carrier presence. The carrier presence indication drives the existing "read" lamp on the front panel of the Moseley, and provides display blanking in the absence of carrier, since any data obtained without carrier presence is not valid.

The demodulated data is converted back to bit parallel, buffered, and sent to the display board.

The display board latches and displays the data. The display is blanked by the presence of a parity error, framing error, or absence of carrier.

The display board also uses the Moseley channel select lines to drive a programmable read only memory (PROM) to properly place the decimal point for each metering channel.

All metering data and control lines are presented on a front panel connector for driving a logger or ATS.

I :ΓALLATION

Installation is straightforward, since existing remote control wiring is used.

It is suggested that the studio unit be taken to the transmitter site during the installation to allow test of the system.

During installation, power should be removed from each unit. If necessary, the transmitter can be kept on the air under local control.

On the transmitter unit, slide out the electronics. Lift the control demodulator board after removing the two front hold-down screws.

The left-most board (as viewed from front) on the lower level is the metering generator. Refer to installation drawing. Carefully cut each wire of the harness connecting to the metering generator board as close to the turret pin on the board as possible.

Remove the four mounting screws and the board.

Strip the insulation from the end of each cut harness wire. Crimp one of the supplied disconnect pin receptables to each wire using AMP tool # 29004-1, if available. Otherwise, solder each wire to a receptacle.

Install the H&F 1211TT board, carefully noting proper orientation in the installation drawing. Mount the board using the four screws previously removed.

The local display may be deleted by specifying option 1 when ordering the TEL171 system. If this option was specified, the following information on the local display installation should be skipped.

The existing slide out panel on the transmitter site unit is to be removed. The first step in this process is to carefully pry the mounting rings on the back of the LED clips away from the panel. These rings should be slid back over the LED leads. Carefully push each LED out of its mounting clip by pressing on the front of the LED with a small screwdriver. Each LED should snap out of its mounting clip.

With an allen driver, remove the screws holding in the switch assembly and those holding the front panel on the unit.

Carefully remove the front panel. Do not loose any of the LED mounting rings, which are now free to fall off the LEDs.

Remove the H&F 1281 Local Display board from the new front panel by releasing the locks on the plastic PC mounts.

Remove the LED mounting clips from the old front panel by squeezing in the tabs of each clip on the rear of the panel and pushing the clip out. Each of these clips should be snapped in to the new panel.

Remove the RF gasket finger stock from the old panel, and stick it to the new panel in corresponding locations.

Put the new panel in position with one or two screws. Press each LED in to the appropriate clip. Note that the control presence LED has been moved to clear the local display PC. After each LED is snapped in to position, slide the locking ring back on to the clips.

Mount the H&F 1281 PC board back in position. Mount the switches to the new front panel. Put the rest of the front panel mounting screws in position.

Plug the DIP ribbon connector in between the local display board and the telemetry transmitter board, carefully noting that pin 1 is positioned properly.

Screw down the control demodulator board using the screws supplied, and placing the plastic spacers under the board. These spacers are very important, as the control demodulator board will not clear the local display board without them.

Inspect the installation to make sure there are no short circuits between adjacent boards.

Remove the panel latches from the old panel. These can be removed by loosening the hex nut on the back of the latch slightly. The threaded ring on the front of the panel can then be removed by hand. Place these latches on the new panel.

Close the transmitter unit cabinet.

Open the studio unit cabinet. Remove the meter from the front panel. Tape the lugs on the end of the meter leads so they do not short other circuitry.

Identify the metering demodulator board on the studio installation drawing. Cut each harness wire connected to the metering demodulator board as close to the turret pin as possible. Remove the metering receiver board.

Install disconnect pin receptacles on each wire.

Carefully note the proper orientation of the H&F 1221TR board on the studio unit installation drawing. Install the 1221TR board. Plug each harness connection on the appropriate pin on the board.

Install display panel and PC in the meter hole, from the back of the panel. Secure the display panel with supplied screws, nuts, and lockwashers.

Carefully note proper orientation of 7 pin connector, and plug it on to the back of the display board. Connect the wires from this connector to the channel select and raise/lower switches, as shown in drawing.

Plug the ribbon cable into the telemetry receiver board, and the display board. Carefully note that each connector is installed properly. The end of the plug that has the cable stripe on it has pin # 1.

On the telemetry receiver board, set the DIP switch for proper operation.

For wire line, turn switch 1 off, and switch 2 on.

For radio link, turn switch 1 on, and switch 2 off.

Switches 3 and 4 are for tune up. Switch 3 should be off and switch 4 should be on for normal operation.

Temporarily turn on switch two to test the system. Connect a pair of wires between the telephone line terminals on each unit. Apply power and verify that the system is operating properly.

Initial meter calibration can be completed at this time. Set the transmitter unit to local control and step through each of the metering channels. Adjust the corresponding calibration pot for the proper indication on the studio unit. Note that the decimal point location is determined by the channel select switch on the stuido unit, so it may not be in the proper location at this time.

In this test, only the metering link will work in a radio link system, since the control signal is not being put on the wire line. In a wire system, the whole system should work at this point.

Once the test is complete, set the DIP switch as outlined above. Set the local/remote switch to remote. Return the studio unit to the stuido and install.

Once again, verify proper operation.

If a local display has been installed, it is desirable to label the new control index. A piece of "copy zip" has been supplied for this purpose. By lightly marking the proper position for each line of information on the copy zip, a neat label can be made on a typewriter. Once the new legend is typed on the copy zip, the backing is peeled off, and the copy zip is stuck to the panel over the control index markings.

OPERATION

Operation is simple!

Since metering transmission is digital, the zero and calibrate controls no longer require adjustment. The offset and gain errors are corrected for during each conversion cycle of the A/D converter.

All that is required for routine operation is to select the required metering channel, wait for the reading to stabilize, and read it.

If an ATS controller or transmitter logger is plugged into the data jack, the channel selector must be left in calibrate to give full control to the ATS or logger.

Calibration of each metering channel is accomplished the same as previously. The local meters are read and the calibration pots adjusted for the same readings at the studios.

If local display has been installed, remote meter calibration can be achieved entirely at the transmitter site, since the studio indication will duplicate the local display indication. Adjust the appropriate calibration pot for the proper indication on the local display.

I'. TALLATION IDEAS

Remote control installation should be thought out. By properly combining the control and metering functions, verification of proper control operation is available.

Suggested installation would have raise and lower turn the filaments on and off when the filament voltage is being metered. The plate on off function should be paired with the plate voltage metering. A station that changes between day and night power should have the day/night power select function paired with transmitter plate current. This way, the operator can see that a change actually occurred. On FM stations determining power by the indirect method, the power trim control should be on the plate current metering channel, since that is the parameter that is generally most affected by power trim. Stations determining power by the direct method (such as AM's and some FM's) should pair up the power trim with the power indication (antenna current, common point current, or transmission line power). Through the use of simple voltage dividers, metering signals can be made up that indicate transmitter site status. On the channel that selects main or standby transmitter, a half scale reading might indicate that the standby transmitter is driving the antenna, full scale indicates the main transmitter is driving the antenna. A zero reading indicates something is wrong. Similarly, directional stations can develop a sample to indicate which pattern the station is in. Full scale might mean day, half scale is night, zero indicates one of the phasor relay interlocks is open.

To save metering channels, it is quite common to have raise and lower on a particular metering channel select whether ratio or phase of the selected tower will be read. This can be expanded to show tower light operation for that particular tower when neither raise or lower is activated.

On stations using an antenna monitor without remote phase polarity indication, the metering wires in to the TRC-15 can be reversed to indicate a negative phase at the studio, if desired, once the TEL171 is installed.

Similarly, stations that are remoting their frequency monitor no longer need to introduce an offset into the metering sample, since the TEL171 accepts both positive and negative sample voltages.

T ORY OF OPERATION

Telemetry Transmitter 1211TT

The telemetry transmitter board converts the selected analog metering sample to digital code. This digital code is then properly sequenced for digital transmission, and synchronization and error detection pulses are added. The A/D converter and data formatting circuitry operates on a floating power supply to allow reading of samples independent of ground.

The serial data is optically coupled to the remainder of the circuitry to maintain the ground isolation.

The optical isolator drives a frequency shift keyed oscillator. This converts the digital data to an audible signal suitable for transmission over voice grade circuits.

The FSK (frequency shift keyed) oscillator is followed by a line driver amplifier for driving a phone line, subcarrier generator, or remote telemetry link.

The telemetry transmitter board contains on board power supply regulation for the digital circuitry.

A/D converter. U01 is the analog to digital converter. Metering samples are run through a low pass filter formed by R27 and C16. R27 also allows the clamp diodes on the input of U01 to protect it from excess sample voltage.

U01 uses a modified dual slope method for analog to digital conversion. A comparison is run between the time it takes to charge the integration capacitor (C1) on the reference voltage to the time it takes to discharge the capacitor on the sample voltage. As part of this conversion cycle, U01 also stores any internal offset voltage on C2, and corrects for the offset. Since the output is the ratio between the sample and the reference voltage, the metering accuracy is determined by the stability of the reference voltage. R4, R28, R29 and U02 provide a stable, temperature stabilized, reference voltage for the A/D conversion.

R5 sets the clock frequency for U01. The clock is set at approximately 33 KHz, which gives a conversion rate of two per second. Although the conversion rate could be higher, this rate is used to give a more readable display.

R6 and D1 regulate the -15 volt supply to -3.3 volts for U01.

The digital output of the A/D is multiplexed BCD. Output Q0 is the least significant bit with Q3 as the most significant bit of the BCD code.

DS1 through DS4 are the digit select outputs. The appropriate DS output is high during the time a valid code for that digit is on the Q outputs. During the transition of Q outputs between digits, none of the DS lines are high.

The EOC output goes high at the end of each conversion. This is tied to the DU (data update) input. This causes the BCD output to be updated at the end of each conversion.

Immediately after the end of each conversion, the updated data is transmitted to the studio unit. After transmission, the formatting circuitry is idle until the next EOC pulse.

Data formatting. Prior to an EOC pulse, U05, a 4 bit counter, is set to 4 (Q2 = 1, Q1 = 0, Q0 = 0).

The TBMT output of U07 is high, indicating the transmitter buffer is empty, and U07 is ready to accept data. The TBMT output of U07 is inverted by U03B, and applied to the $\overline{EA}$ input of U04A. This low input on the $\overline{EA}$ input enables the A section of U04. Since Q0 and Q1 of U05 are both low, DS1 pulses from U01 appear on the ZA output of U04A. These DS1 pulses are applied to all the inputs of U04B. Since the $\overline{EB}$ input is high (since Q2 of U05 is high), the ZB output remains low. The ZB output is inverted by U03A and applied to the $\overline{DS}$ input of U07. This active low data strobe input samples data when low and starts transmitting the data when it goes high. Since it is remaining high, nothing happens.

At the end of conversion in the A/D, the EOC line goes high for approximately 3 uS. This pulse sets U05 to zero.

At the end of the EOC pulse, DS1 goes high for 120 uS. This pulse is routed through U04A (since the Q0 and Q1 outputs of U05 are low) and through U04B (since the Q2 output of U05 is now also low). This high pulse appearing on the ZB output of U04B is inverted by U03A and applied to the $\overline{DS}$ input of U07. At the end of the $\overline{DS}$ pulse, the TBMT output of U07 goes low for about 1 mS.

The UART (Universal Asynchronous Receiver/Transmitter) U07 is double buffered. Once data has been transferred from the input buffer to the serial transmitter, the transmit buffer is again ready to receive data. This is why, on the first character transmitted, the TBMT line stays low for only a millisecond while it takes a full 33 mS to transmit the character.

When the TBMT output goes low, the CP (positive edge triggered clock input) of U05 goes high, advancing the count from zero to 1. At this time, also, the $\overline{EA}$ input of U04A is driven high preventing any more DS pulses from getting to U07.

When TBMT goes back high (indicating U07 is ready for more data), U04A is again enabled. This time, since U05 is now set to one, the DS2 strobe is routed to the $\overline{DS}$ input of U07. Once again, TBMT goes low, advancing the count in U05, and disabling U04A. This time TBMT stays low until slightly after the first character has been transmitted and the second character loaded into the serial transmitter. Once TBMT goes high again, DS3 is sent to the $\overline{DS}$ input of U07.

When U05 has advanced to a count of three, DS4 starts U07. This time, when TBMT goes low, U05 advances to a count of four making its Q2 output high. This disables U04B. U07 receives no more strobes and transmits no more data after DS4 until another EOC pulse.

This data formatting system results in one set of data being transmitted for each A/D conversion. It also insures that all the data sent in one word (four characters) is from the same conversion. Although this is not particularly important to an operator viewing a display, it is very important when the system is used for logging or ATS. As an example, assume that the current reading is 710. The data transmitter has transmitted the seven and the one. The A/D completes another conversion and this time comes up with 709. A non-synchronous system would then transmit the nine from the latest conversion. It changes the one to a zero the next time around. This is allowable for an operator, but with a logger or ATS, the reading would become 719 instead of 710 or 709. This illustrates the importance of this data formatting technique.

We now see that the UART has been requested to send four characters and then await the next EOC. Let us now look at the data that the UART has sent.

When U07 (the UART) was receiving DS1 immediately after EOC, valid data for the first digit was on the Q outputs of U01. This particular digit is not coded in BCD, since it is only a half digit. Instead, the various bits are used to indicate if the half digit is a zero or one, if the reading is positive or negative, and if the reading is out of range of the A/D. This data is presented to four of the parallel data inputs on U07 (DB1 through DB4). The count off U05 is fed to the remaining two data bits (DB5 and DB6). The UART ends up being loaded with four bits representing the value of a digit along with two bits indicating which digit it is. The first half digit is coded 00 on DB5 and DB6. The last digit is coded 11 on DB5 and DB6. DB1 is the least significant bit of the BCD while DB5 is the least significant bit of the digit identification.

UART operation. U07 converts the parallel data presented on its inputs (DB1 through DB6) to serial, adds synchronizing pulses and an error detection bit.

U06 operates as a schmitt trigger astable multivibrator to generate a 4.8 KHz clock signal for U07. C4 bypasses an internal voltage reference in U06. C5 charges and discharges through R10 and R11. When the voltage across C5 drops to 1.7 volts, U06 pin 3 goes high. C5 then starts charging. When the voltage across C5 reaches 3.3 volts, U06 pin 3 goes low, and C5 starts discharging. R10 is adjusted to give the proper clock frequency of 4.8 KHz.

U07 divides the 4.8 KHz clock by 16 to transmit 300 Baud (300 bits per second). U07 is connected to transmit six data bits, two stop bits, and an even parity bit. The use of two stop bits slows the data transmission slightly, but allows for greater variation in transmit and receive speeds before losing synchronization. The parity bit is made a one if there is an odd number of ones in the data bits, giving an even total. If there is already an even number of ones in the data, then parity is left at zero. On receiving the data, the parity is checked. If a bit was lost, it would probably show up as a parity error.

The data is always sent in the following order: start bit, DB1, DB2, DB3, DB4, DB5, DB6, parity, stop bit one, stop bit two. If another character is to follow, its start bit immediately follows the last stop bit.

The start bit is always zero, and the stop bits are always one. Between characters, the idle state is one.

A data receiver starts its clock on the leading edge of the start bit and then samples each of the data bits in the middle of their assigned times. It then stops and awaits the next start bit. This is often called a start-stop code.

The idle state of a data link is often called the mark condition. Here, mark represents a one, space represents a zero. This terminology started in the early days of wire telegraph when loop current would cause a pen to mark the paper, while the absence of loop current would leave a space on the paper. The operator would then read the marks and spaces, which represented a Morse code. The mark and space terminology is still with us.

The serial output (SO) of U07 is high in the mark condition, and low in the space condition. When it is low, it biases Q1 into conduction, lighting the LED in U12. The light from the LED causes the transistor in U12 to conduct, pulling pin 9 of U09 to ground. When SO is mark, pin 9 of U09 is allowed to go high.

F. generation. U09 is an RC oscillator. The frequency is determined by C16 and R12 and R14 or C16 and R13 and R15, depending upon whether pin 9 is high or low. When pin 9 is high, R13 and R15 determine the frequency. This allows R13 to be used to adjust the mark frequency and R12 to adjust the space frequency. The 300 Baud FSK standard calls for a mark frequency of 1270 Hz and space frequency of 1070 Hz. R12 and R13 are adjusted for these frequencies.

U09 puts out an FSK sine wave on pin 2. The level is dropped by R24 and R25 to the appropriate level for driving U10. R25 is adjusted to give the required line or subcarrier output level, typically +1 dBm line (when loaded with 600 ohms), and 5 volts P-P (open circuit voltage) on the "subcarrier" output.

R23 and C10 prevent oscillation to U10. C9 provides DC blocking; D2 and D3 protect the circuitry against voltages that may appear on the line.

U11 provides a floating regulated +5 volts for the logic.

The H&F 1211TT telemetry transmitter board performs A/D conversion and data transmission using AFSK.

Telemetry Receiver 1221TR

The telemetry receiver board receives AFSK (audio frequency shift keyed) data from the telemetry transmitter board, demodulates it back to serial digital, and then separates it back out to bit parallel character serial data. This data then drives the display board.

S1A and S1B select whether the input of the receiver board should be connected to the wire line or the subcarrier demodulator. In most cases, the switches will be set to select the wire line (S1B closed) on a TRC-15AW, and will be set to select subcarrier demodulator (S1A closed) on a TRC-15AR.

R1, D1, and D2 protect the circuitry from dangerous voltages that may be present on an input. C1 allows R5 to bias the input of U7A. Due to the high value of R3, the receiver board presents very little load to the input. U7A converts this high impedance input to a low impedance through the use of amplifier gain.

The remainder of U7 forms a band pass filter to pass the 1070 Hz to 1270 Hz data and its sidebands, while rejecting anything else that may be present, especially control tone. The control tone for the TRC-15A may be up to 30 dB stronger than the metering signal to be received. The control tone varies between 300 and 400 Hz. The filter attenuates this tone enough to allow the system to operate with 45 dB line loss (the control circuit is only rated at 30 dB).

R19 sets the sensitivity of U01, the AFSK demodulator. If it is overly sensitive, invalid data will be displayed with the absence of metering carrier. If it is not sensitive enough, no data will be displayed.

S1C and S1D allow U01 to be tuned. With S1C closed and S1D open, a 1170 Hz square wave should be present on TP-1. R25 can be adjusted to restore this value. For normal operation, S1C is open and S1D is closed.

U01 is a phase lock loop FSK demodulator. When carrier is present, pin 5 gets pulled low and pin 6 is allowed to go high. Pin 7 is the data output. It is low when the incoming audio is on the mark frequency. All the digital outputs of U01 are open collector. For this reason, pins 6 and 7 are tied together for a wired AND connection. For these two pins to go high, carrier must be present AND the input audio must be on the space frequency. This results in the data output being held in mark condition (which is the idling state) when no carrier is present.

The carrier presence signal is inverted twice by U6E and U6D. After the first inversion, the state is low if carrier is absent. This point is sent to the display board to blank the display and light an alarm lamp when there is no metering carrier. After the second inversion, the state is low when carrier is present. This point is connected to the front panel "read" LED on the TRC-15. The other end of the LED goes to the control generator board of the TRC15 so that the LED is lit only when the control generator is not stepping and carrier is present.

The FSK data is inverted by U6F and applied to the serial input of U03. Here, the receive portion of this UART undoes the coding that was done in the telemetry transmitter. It is also set up for six data bits, even parity, and two stop bits. U02 feeds 4800 Hz to the receive clock input to make the system run at 300 Baud. RD1 through RD6 correspond directly to DB1 through DB6 at the transmit end. Again, RD1 through RD4 represents the value of a digit, while RD5 and RD6 identify which digit.

Upon receiving a complete character, U03 changes the RD lines to the new data and drives DAV (data available) high. This charges C23 through R31. When C23 charges to 3.3 volts, pin 3 of U09 goes low, driving data available reset ($\overline{\text{RDAV}}$) low. This resets the DAV flip flop in U03, discharging C23 and causing U09 pin 3 to go high again. This sequence results in a 250 uS low strobe during the time that valid data is available.

At the same time the data becomes available, U03 puts out any errors it has detected. This can be a parity error (number of data bits mark plus parity bit was not even) or a framing error (required two stop bits not present). These error signals are inverted and buffered and presented to the display board. On each of the error lines (framing, parity, missing carrier), a low indicates that an error is present.

The data outputs of U03 are buffered for driving TTL and presented to the display board.

U05 provides regulated +5 volts for the digital circuitry.

U04 forms a schmidt trigger oscillator, similar in operation to U02. The output at pin 3 is a 30 KHz square wave, alternating between zero and +15 volts. When pin 3 is high, C20 charges to 15 volts through D4. When pin three goes low, the negative end of C20 remains 15 volts below the positive end, which is now at ground. This forces the negative end of C20 to -15 volts. C22 is allowed to charge through D3, developing a negative voltage. D3 prevents C22 from discharging when U04 pin three goes high again. With no load, this circuit develops -15 volts across C22. When loaded by U03, the voltage drops to -12 volts. This provides the required negative voltage supply for U03.

The H&F 1221TR board receives AFSK data, and converts it to bit parallel, character serial data for driving the display board.

Telemetry Display 1231TD

The 1231TD board receives bit parallel, character serial data from the telemetry receiver board, latches the data, and displays it. The board also presents the data to the "outside world" for use in logging or ATS systems. The 1231TD board contains a programmable read only memory (PROM) that is programmed to properly position the displayed decimal point for each metering channel. Indications of error signals and display blanking are provided.

Receive data bits one through four (RD1-RD4) are presented to the data inputs of U5, U6, and U7. On the last three digits, RD1 through RD4 represent the digit value in BCD. The data is latched, converted to seven segment, and drives the appropriate segments of the displays U8 and U9. R8 to R32 provide current limiting for the displays.

Receive data bits five and six (RD5 and RD6) indicate which digit's data is currently being received. A code of 00 indicates the data is for the first half digit, while a code of 11 indicates the data is for the least significant digit.

RD5 and RD6 are presented to U2 along with the data strobe from the receiver board. During the time that all data is valid (RD1 through RD6), the receive board will send a 250 uS low strobe. The addressed output of U2 goes low during the time the strobe is present. This low output pulse represents a strobe to the appropriate digit latch, causing it to latch the data presently on the bus. On U5, U6, and U7, the data must be stable during the time that the $\overline{EL}$ input is low. This requirement is satisfied by the circuitry.

Since the first half digit is not in BCD, it requires special attention. On the half digit, RD2 is high if the reading is positive. RD3 is low if the half digit is one. Since RD3 drives the D2 input of U4, the Q2 output will be low if the half digit is one. This low turns on Q1, lighting segments B and C of the half digit.

In a similar manner, if RD2 is high, the $\overline{Q1}$ output will be low, turning on Q2, lighting the plus sign.

U4 is a dual D flip flop that transfers data on a positive clock edge. This results in the data being transferred on the trailing edge of the data strobe. The data is still valid at this time.

Alarm signals from the receiver board are presented to the inputs of U3A. In the event of an alarm condition (such as loss of metering carrier, parity error, or framing error), the appropriate line will be pulled low. This will light the LED indicating what the problem is, and force the output of U3A high. This sets both the flip flops asynchronously in U4. This results in $\overline{Q1}$ being low and Q2 being high. Q2 being high results in the leading one being blanked.

The high from the output of U3A is inverted by U3B. The resulting low blanks the digits driven by U5, U6, and U7.

In the presence of an alarm, all digits are blanked and an LED is lit indicating what the problem is.

The channel select (CS) lines from the Moseley TRC-15 are presented to U1. R1 through R4 are "pull down" resistors, resulting in the inputs being low unless they are pulled up by the switches in the Moseley.

U1 is programmed to provide a low output for all decimal points except those that are to be lit. As each channel is selected, U1 evaluates the channel select information and lights the proper decimal point. The decimal points are lit through current provided by the power supply through R33 to R36. When the output of U1 is low, the appropriate decimal point is shorted out, and does not light.

All data (RD1 - RD6), the data strobe, the alarm signals (parity, frame, carrier absence), the channel select lines, and the Moseley raise and lower lines are available on a front panel connector. If the Moseley TRC-15 is left in the calibrate position, complete control is available on this connector. It can be utilized for parameter logging or ATS control.

Local Display 1281LD

The 1281LD Board works in a manner similar to the 1231TD board, previously described. The 1281LD board receives bit parallel, character serial data from the telemetry transmitter board, latches the data, and displays it. The 1281LD board differs from the 1231TD in that the

1281LD utilizes a liquid crystal display (LCD), while the 1231TD uses an LED display. The LCD uses less power, as there is less power available in the transmitter unit.

Note that the data format and pinout on the interface connector of the 1281LD is the same as that used on the 1231TD. Note also that the 1281LD receives its power from the telemetry transmitter board. The 1281LD operates on the floating supply from the Moseley TRC-15A.

Received data bits one through four (RD1-RD4) are presented to the data inputs of U4 (DF411). U4 is a four digit LCD driver. It contains an internal back plane oscillator, drivers, decoders, and data latches. BCD data is presented to the BO-B3 inputs of U4. U4 latches the BCD data into the appropriate digit on a high strobe on the digit select lines (D1-D3). U4 then drives the LCD segments with a square wave that is in phase with the backplane for segments that are not to be displayed, and out of phase with the back plane on segments that are to be displayed. C1 works with the circuitry in U4 to form the back plane oscillator.

Note that only three digits of U4 are used, as only three digits of the data are in BCD. The remaining half digit is handled by U2.

U1 routes the negative strobe from the telemetry transmitter board to the proper digit latch by interpretting the digit select bits RD5 and RD6. U1 puts out a positive strobe on the appropriate output.

U2 contains four LCD drivers and latches. A high input to U2 causes an out of phase output to the LCD, causing the segment to display. The strobe inputs to U2 are driven by the QO output of U1. This strobe goes high when data for digit zero is available on RD1-RD4. U2 latches and displays digit zero. When RD3 is high, the plus sign on the LCD is displayed. When RD4 is low, U3 presents a high input to input 4 of U2. This causes output 2 of U2 to be out of phase with the back plane, causing the leading digit "1" to be displayed.

CIRCUIT ADJUSTMENTS

1211TT Telemetry Transmitter

Clock Frequency. With no sample input connected (the TRC-15A in the calibrate position) connect a frequency counter to TP-1 with the ground connected to TP-4. Adjust R10 for 4.8 KHz.

Mark Frequency. Connect a frequency counter to one of the board outputs (terminal 10 or 11). The counter ground can be connected to chassis ground. Force the AFSK generator in to the mark condition by shorting TP-2 to TP-3. Adjust R13 for 1.270 KHz.

Space Frequency. Connect a frequency counter to one of the board outputs (terminal 10 or 11). The counter ground can be connected to chassis ground. Force the AFSK generator in to the space condition by shorting TP-2 to TP-4. Adjust R12 for 1.070 KHz.

Output Level. Connect an audio voltmeter to terminal 10 referenced to chassis ground. Adjust R25 for the desired indication, typically +1 dBm.

If the system is driving a subcarrier generator, it may be desirable to set R25 for the desired output voltage on terminal 11. This is typically 5 volts peak to peak.

1221TR Telemetry Receiver

Demodulator Tuning. Connect a frequency counter to TP-1, referenced to chassis ground. Open switch 4 on the DIP switch, and close switch 3. Adjust R25 for 1.170 KHz. Close switch 4 and open switch 3.

Wire/Radio Select. If system is to be used on a wire line, close switch 2 and open switch 1. If system is to be used on a radio link, close switch 1 and open switch 2.

Clock Frequency. Connect a frequency counter to TP-2, referenced to chassis ground. Adjust R29 for 4.8 KHz.

Demodulator Sensitivity. Insert a 45 dB pad between the transmitter and studio units. Adjust R19 until the "carrier" lamp just goes out and valid data is displayed.

1211TT PARTS LIST

Component Designation	H&F P/N	Description
C1 - C2	1521-1040	Mallory EWF05010; 0.1 uF, 50V, Mylar
C4	1508-1031	Mallory TA-110; .01 uF, 100 V, Ceramic
C5 - C6	1529-1030	Mallory SXM-110; .01 uF, 160 V, Polystyrene
C7	1508-5032	Mallory MAG5015; .05 uF, 50 V, Ceramic
C9	1510-2271	Mallory VTT220F10;220 uF, 10 V, Electrolytic
C10 - C11	1508-1040	Mallory MAG1601; 0.1 uF, 16 V, Ceramic
C12	1508-1031	Mallory TA-110; .01 uF, 100 V, Ceramic
C13 - C14	1508-2240	Mallory MAG25022; 0.22 uF, 25 V, Ceramic
C15	1510-1060	Mallory VTT10D63; 10 uF, 63 V, Electrolytic
C16	1508-1040	Mallory MAG1601; 0.1 uF, 16 V, Ceramic
C17	1508-2240	Mallory MAG25022; 0.22 uF, 25 V, Ceramic
D1	4825-0746	1N746 Zener Diode, 3.3 V, 400 mW
D2 - D3	4825-4744	1N4744 Zener Diode, 15V, 1W
Q1	4849-2907	2N2907 Transistor or Equivalent
R1	4711-4115	Resistor, Carbon, 1.1M, ¼ W, 5%
R4	4711-4752	Resistor, Carbon, 7.5 K, ¼ W, 5%
R5	4711-4824	Resistor, Carbon, 820 K, ¼ W, 5%
R6	4711-4102	Resistor, Carbon, 1 K, ¼ W, 5%
R8	4711-4472	Resistor, Carbon, 4.7 K, ¼ W, 5%
R9	4711-4471	Resistor, Carbon, 470 ohms, ¼ W, 5%
R10	4766-2502	Trim Pot, CTS Berne X201R502B, 5K
R11	4711-4123	Resistor, Carbon, 12 K, ¼ W, 5%
R12- R13	4766-2103	Trim Pot, CTS Berne X201R103B, 10K

1211TT PARTS LIST (Cont'd)

Component Designation	H&F P/N	Description
R14	4711-4913	Resistor, Carbon, 91 K, ¼ W, 5%
R15	4711-4683	Resistor, Carbon, 68 K, ¼ W, 5%
R16	4711-4473	Resistor, Carbon, 47 K, ¼ W, 5%
R17 - R18	4711-4512	Resistor, Carbon, 5.1 K, ¼ W, 5%
R19	4711-4103	Resistor, Carbon, 10 K, ¼ W, 5%
R20	4711-4221	Resistor, Carbon, 220 ohms, ¼ W, 5%
R21	4711-4222	Resistor, Carbon, 2.2 K, ¼ W, 5%
R22	4711-4473	Resistor, Carbon, 47 K, ¼ W, 5%
R23	4711-4279	Resistor, Carbon, 2.7 ohms, ¼ W, 5%
R24	4711-4104	Resistor, Carbon, 100 K, ¼ W, 5%
R25	4766-2502	Trim Pot, CTS Berne X201R502B, 5 K
R26	4711-4561	Resistor, Carbon, 560 ohms, ¼ W, 5%
R27	4711-4104	Resistor, Carbon, 100 K, ¼ W, 5%
R28	4712-0253	MEPCO 50-23ZA25K00B, Resistor, Precision, 25K, 5 PPM TCR
R29	4712-0103	MEPCO 50-23ZA10K00B, Resistor, Precision, 10K, 5 PPM TCR
U01	3130-1443	MC14433, 3½ digit A/D converter
U02	3130-0399	LM399H, 6.95 volt reference, temp. stabilized
U03	3130-4011	CD4011, CMOS quad NAND gate
U04	3130-4539	CD4539, CMOS dual 4 input multiplexer
U05	3130-4029	CD4029, CMOS 4 bit U/D counter
U06	3130-0555	NE555V, Timer
U07	3130-1013	General Instrument AY-5-1013 UART
U09	3130-2206	XR2206CP, Function Generator
U10	3131-0380	LM380-8 or LM380CN, Audio Power Amp
U11	3130-3505	LM340T5, 5 volt regulator

1211TT PARTS LIST (Cont'd)

Component Designation	H&F P/N	Description
U12	3717-0002	Monsanto MCT2, optical isolator
	1706-1221	Printed Circuit Board
	2100-0005	DIP socket, 8 pin, gold solder tail
	2100-0006	DIP socket, 14 pin, gold solder tail
	2100-0008	DIP socket, 16 pin, gold solder tail
	2100-0037	DIP socket, 24 pin, gold solder tail
	2100-0022	DIP socket, 40 pin, gold solder tail
	2100-0003	AMP P.N 60803-2 disconnect pins
	2100-0004	AMP P/N 60789-1 receptacles

1221TR PARTS LIST

Component Designation	H&F P/N	Description
C1	1508-1031	Mallory TA-110; .01 uF, 100 V, Ceramic
C2	1535-3960	Mallory TAC396K010P04, 39 uF, 10 V, 10 %, Tantalum
C3 - C8	1529-1030	Mallory SXM110; .01 uF, 160V, Polystyene
C9 - C10	1508-1031	Mallory TA-110; .01 uF, 100 V, Ceramic
C11	1529-2230	Mallory SXL139; .039 uF, 63 V, Polystyrene
C12	1508-1040	Mallory MAG1601; 0.1 uF, 16 V, Ceramic
C13	1521-5040	Mallory EWF05050; 0.5 uF, 50 V, Mylar
C14	1529-1030	Mallory SXM110; .01 uF, 160 V, Polystyrene
C15	1529-4720	Mallory SXM247; .0047 uF, 160 V, Polystyrene
C16	1508-2240	Mallory MAG25022; 0.22 uF, 25 V, Ceramic
C17 - C18	1508-1031	Mallory TA-110; .01 uF, 100 V, Ceramic
C19	1508-2240	Mallory MAG25022; 0.22 uF, 100 V, Ceramic
C20	1535-2261	Mallory TAC226K015P014, 22 uF, 15 V, Tantalum
C21	1508-2240	Mallory MAG25022; 0.22 uF, 25 V, Ceramic
C22	1535-2261	Mallory TAC226K015P014; 22 uF, 15 V, Tantalum
C23 - C25	1508-1031	Mallory TA-110; .01 uF, 100 V, Ceramic
C26	1529-1030	Mallory SXM-110; .01 uF, 160 V, Polystyrene
C27	1508-2240	Mallory MAG25022; 0.22 uF, 25 V, Ceramic
D1 - D2	4825-4744	1N4744 Zener Diode, 15 V, 1 W
D3 - D4	4800-4002	1N4002 diode
R1	4711-4472	Resistor, Carbon, 4.7 K, ¼ W, 5 %
R2	4711-4103	Resistor, Carbon, 10 K, ¼ W, 5%

1221TR PARTS LIST (Cont'd)

Component Designation	H&F P/N	Description
R3	4711-4104	Resistor, Carbon, 100K, ¼ W, 5%
R4	4711-4103	Resistor, Carbon, 10 K, ¼ W, 5%
R5 - R6	4711-4104	Resistor, Carbon, 100 K, ¼ W, 5%
R7	4711-4153	Resistor, Carbon, 15 K, ¼ W, 5 %
R8	4711-4821	Resistor, Carbon, 820 ohms, ¼ W, 5 %
R9 - R10	4711-4164	Resistor, Carbon, 160 K, ¼ W, 5 %
R11	4711-4223	Resistor, Carbon, 22 K, ¼ W, 5%
R12	4711-4122	Resistor, Carbon, 1.2 K, ¼ W, 5%
R13 - R14	4711-4244	Resistor, Carbon, 240 K, ¼ W, 5 %
R15	4711-4912	Resistor, Carbon, 9.1 K, ¼ W, 5 %
R16	4711-4242	Resistor, Carbon, 2.4 K, ¼ W, 5 %
R17 - R18	4711-4104	Resistor, Carbon, 100 K, ¼ W, 5 %
R19	4766-2502	Trim Pot, CTS Berne X201R502B, 5 K
R20	4711-4104	Resistor, Carbon, 100 K, ¼ W, 5 %
R21	4711-4183	Resistor, Carbon, 18 K, ¼ W, 5 %
R22	4711-4204	Resistor, Carbon, 200 K, ¼ W, 5 %
R23	4711-4104	Resistor, Carbon, 100 K, ¼ W, 5 %
R24	4711-4514	Resistor, Carbon, 510 K, ¼ W, 5 %
R25	4766-2502	Trim Pot, CTS Berne X201R502B, 5 K
R26 - R27	4711-4512	Resistor, Carbon, 5.1 K, ¼ W, 5 %
R28	4711-4123	Resistor, Carbon, 12 K, ¼ W, 5 %
R29	4766-2502	Trim Pot, CTS Berne X201R502B, 5 K
R30	4711-4472	Resistor, Carbon, 4.7 K, ¼ W, 5 %

1221TR PARTS LIST (Cont'd)

Component Designation	H&F P/N	Description
R31	4711-4473	Resistor, Carbon, 47 K, ¼ W, 5 %
R32	4711-4222	Resistor, Carbon, 2.2 K, ¼ W, 5 %
R33 - R40	4711-4103	Resistor, Carbon, 10 K, ¼ W, 5 %
R41	4711-4512	Resistor, Carbon, 5.1 K, ¼ W, 5 %
S1	5134-0001	AMP 435166-2, quad DIP switch
U01	3130-2211	XR2211, FSK Demodulator
U02	3130-0555	NE555V, Timer
U03	3130-1013	General Instrument AY-5-1013, UART
U04	3130-0555	NE555V, Timer
U05	3130-3505	LM340T5, Regulator
U06	3130-7404	7404, Hex Inverter
U07	3130-3900	LM3900, Quad Amplifier
U08	3130-7407	7407, Hex Buffer
U09	3130-0555	NE555V, Timer
	1706-1221	1221TR PC Board
	2100-0005	DIP Socket, 8 pin, gold solder tail
	2100-0006	DIP Socket, 14 pin, gold solder tail
	2100-0022	DIP Socket, 40 pin, gold solder tail
	2100-0003	AMP 60803-2, disconnect pins
	2100-0004	AMP 60789-1, receptacles

1231TD PARTS LIST

Component Designation	H&F P/N	Description
DS1 - DS3	3714-0050	Monsanto MV50, Red LED
J2	2100-0028	AMP 205738-3, 25 pin D connector
Q1 - Q2	4849-2907	2N2907 transistor
R1 - R4	4711-4221	Resistor, Carbon, 220 ohms, ¼ W, 5 %
R5 - R7	4711-4471	Resistor, Carbon, 470 ohms, ¼ W, 5 %
R8 - R32	4711-4121	Resistor, Carbon, 120 ohms, ¼ W, 5 %
R33 - R36	4711-4271	Resistor, Carbon, 270 ohms, ¼ W, 5 %
R37 - R38	4711-4472	Resistor, Carbon, 4.7 K, ¼ W, 5 %
U1	3130-6330	General Instrument 6330-1 PROM
U2	3130-4556	CD4556, dual 1:4 decoder
U3	3130-4023	CD4023, triple 3 input NAND
U4	3130-4013	CD4013, dual D flip flop
U5 - U7	3130-4511	CD4511, BCD to 7 segment decoder/latch/driver
U8	2453-6750	MAN6750, 1½ digit LED display
U9	2453-6740	MAN6740, 2 digit LED display
	1706-1231	1231TD PC board
	2100-0006	DIP socket, 14 pin, gold solder tail
	2100-0008	DIP socket, 16 pin, gold solder tail
	2100-0001	AMP 50462-7, component pin receptacle
	2100-0025	AMP 1-601214-3, ribbon cable
	2100-0038	AMP 86427-1, 7 pin MODIV connector
	2100-0027	AMP 86016-1, pins for MODIV connector
	1400-0401	Front panel

1281LD PARTS LIST

Component Designation	H&F P/N	Description
C1	1508-2526	Mallory GP225, Capacitor, Ceramic, .0025 uF, 1 KV
U1	3130-4555	CD4555, Dual 1:4 decoder, active high
U2	3130-4054	CD4054BE, 4 segment LCD driver
U3	3130-4011	CD4011, Quad 2 input NAND
U4	3130-7211	Intersil ICM7211IPL, 4 digit LCD decoder latch driver
DS1	2453-0201	AND FE201-D, 3½ digit LCD
Subassembly	0010-1281	H&F Local Display Subassembly
Front Panel	1400-0403	Local Display Front Panel
PC	1706-1281	Printed Circuit Board, Local Display
	2100-0001	AMP 50462-7, Component Pin
	2100-0006	Dip Socket, 14 pin, gold soldertail
	2100-0008	Dip Socket, 16 pin, gold soldertail
	2100-0022	Dip Socket, 40 pin, gold soldertail
	2100-0025	AMP 1-60124-3 or AP 924106-12-R, Ribbon cable with 14 pin DIP connectors each end.
	2800-0092	Weckesser SP-92MA, Nylon Spacer

PARTS KIT PRICE LIST

1 July 1982

H&F P/N	Description	Price ($)
0040-0010	TVA142 Mike Gain Increase Kit	5.00
0040-0020	TVA132 Lamp Kit	10.00
0040-1120	LOG112/121 Logging System Semiconductor Kit	150.00
0040-1310	TVA132-1 Basic Spare Parts Kit	95.00
0040-1311	TVA132-1 Complete Spares Kit, less VU Meter	165.00
0040-1312	TVA132-1 Complete Spares Kit, with VU Meter	255.00
0040-1320	TVA132-0 Basic Spare Parts Kit	120.00
0040-1321	TVA132-0 Complete Spares Kit, less VU Meter	185.00
0040-1322	TVA132-0 Complete Spares Kit, with VU Meter	275.00
0040-1420	TVA142-0 Basic Spare Parts Kit	92.00
0040-1421	TVA142-0 Complete Spare Parts Kit	185.00
0040-1423	TVA142-1 Complete Spare Parts Kit	195.00
0040-1429	TVA142 Crosstalk Reduction Kit	50.00
0040-1711	TEL171 Semiconductor Kit	135.00

Hallikainen & Friends

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Hallikainen And Friends

PROM Programming for TEL171

Instructions

Please fill in the table below with the maximum expected reading on each metering channel of your Moseley TRC-15A. We will program the system for proper decimal point display.

The TEL171 displays 3½ digits. If your plate voltage is typically 1.5 KV, we would program for a display of +1.500. If your plate voltage is typically 5.0 KV, we program for a display of +5.00.

Under the heading of "parameter", list the parameter being read, such as main transmitter plate voltage. Under the heading "Maximum Expected Reading," list the maximum expected reading, with proper decimal point location and units (KV, Amps, mA, etc.). These units should match those logged on your operating log so that transmitter logging becomes a matter of copying down the readings as they are displayed.

Metering Channel	Parameter	Maximum Expected Reading
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Station:

Engineer:

Phone Number:

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Test Procedure: TEL171

The TEL171 is tested twice. As there are separate production orders for each subassembly and the finished product, each subassembly is tested as part of the subassembly production order. These subassemblies are then put in subassembly stock. Once all subassemblies have been tested, the production order for the TEL171 is started. Here, each required subassembly is pulled from stock and put on the test jig as a system. Proper operation and adjustment is verified. The system is then burned in for one day, then packaged and placed in finished goods stock.

<u>Test</u> Procedure: 0010-1211 Telemetry Transmitter

1. Do a physical inspection of the assembly. Verify that all chips are properly installed. Verify that all solder connections are good, and that the board shows high assembly quality.

2. Put the board on the test jig, ideally with the rest of a system also on the test jig.

3. Using the frequency counter, scope, and 10X prope, adjust R10 for 4.775 KHz on TP-1. Note that the test jig sample switch should be in the left position to provide a ground to the floating circuitry. We adjust for 4.775 KHz because the circuit tends to drift upwards as it warms up. It will ideally drift to 4.800 KHz. If necessary (especially if U6 is made by TI), R11 can be reduced to 6.8 K to reach the required frequency.

4. Connect the scope to output terminal 10 (white/black wire on test jig). Adjust R25 for 4 volts P-P.

5. With scope still conected as above, jumper TP-2 to TP-3. Adjust R13 for 1.270 KHz (+/- 5 Hz).

6. Remove above jumper. Jumper TP-2 to TP-4. Adjust R12 for 1.070 KHz (+/- 5 Hz).

7. Set the test jig polarity switch to the left. Verify that U7 (the UART) pins 38 and 39 have +5 volts on them. A jumper must be installed during assembly and is occasionally missed.

8. Set test jig polarity switch to left (+). Adjust sample pot full counter-clockwise (it is a multiturn pot). The local display should read 000. Slowly adjust the pot clockwise to run the display one digit at a time through 0009. Verify that each number in sequence can be accomplished. Increase the pot further running the "tens" digit through each possiblity (000, 010, 020, 030. . . 090). Again, verify that each digit can be accomplished. Repeat for the hundreds digit. Finally, verify that the pot can be increased to a reading of +1999. Set the test jig sample pot for a display of approximatel +1500. Verify that setting the polarity switch to the right gives the same indication (+/- 5 counts), but negative. Set the polarity switch in the center position. Verify that the display indicates between -1 and +1.

9. After successfully completing the above tests, put a green sticker on the UART and put the board in stock.

Test Procedure: 0010-1221 Telemetry Receiver

1. Complete a visual inspection of the board, insuring that the assembly is of the highest quality.
2. Put the board on the test jig, along with other working boards.
3. Connect the scope to terminal 2. Close switch 2, open switch 1. The 4 volt P-P FSK signal from the transmitter board should be visible. Open switch 1, close switch 2. A very small signal should be visible.
4. Close switch 4, open switch 3.
5. Using the scope, frequency counter and 10x probe, adjust R29 for 4.775 KHz on TP-2. If necessary, R28 can be reduced to 6.8 K.
6. Connect the scope to U1-7. Set it for DC coupling and triggerring. Adjust R25 so that one bit time is 3.33 mS. The bit time should be the same for a high or low bit.
7. Run R19 through its range. At one end, it should be possible to make the display carrier light come on. After several tries, each of the display error lights should come on, verifying the operation of the parity and frame checking circuitry. In addition, whenever the display carrier lamp is on, the test jig LED should be out. Whenever the display carrier lamp is out, the test jig LED should be on. Set R19 to mid-range.
8. Run the test jig sample pot and switch thru their range insuring proper operation of the display.
9. After successfully completing the test, put a green dot on the UART and put the board in stock.
10. CHECK PIN 38 + 39 FOR +5 = JUMPER

Test Procedure: 0010-1231 Telemetry Display

1. Insure that the board is assembled to the highest quality.
2. Plug in the test PROM. Insure that there is not a short between pins 9 and 10 of the test PROM once plugged in.
3. Wire the display into the test jig.
4. Using the sample pot and switch, run each digit through all possibilities, insuring that there are no missing codes, segments that do not light, or segments that do not go out, and that the polarity sign works properly.
5. Using the first 15 switches on the test jig, insure that the decimal point positioning circuitry works properly.
6. By reducing the sensitivity pot on the receiver board repeatedly, insure that each of the display error lights can be made to light. Restore the receiver sensitivity control to mid-position.
7. Attach the front panel to the display assembly. Insure that all required hardware is included.
8. Remove the test PROM from its socket. Install the ribbon cable and multicolor cable.

9. Put a green dot on the board that has successfully ›mpleted the test. Put the board in stock.

Test Procedure: 0010-1281 Local Display

1. Insure that the assembly of the board is of high quality.
2. Connect the display to the test jig. Run the test jig sample pot and switch through the range, insuring that all digits and polarity are displayed properly.
3. Attach the board to the panel, connect the associated dip cable.
4. Attach a green dot to the 7211 dirver chip of those boards that pass the test.

Test Procedure: 0000-1710 TEL171 Telemetry System

1. Run a set of board through a one day burn in.
2. At conclusion of burn in, insure that the following tests are passed.
3. Check clock frequency on transmitter and receiver boards. They should be 4.800 KHz +/- 25 Hz.
4. Check the FSK frequencies on the transmitter board. They should be 1270 and 1070 Hz, +/- 10 Hz.
5. Check the transmitter board output level. It should be 4 volts P-P.
6. Insure that the bit timing on the receiver board is 3.3 mS per bit, +/- 0.3 mS.
7. Insure that both displays display all digits, polarity, and error signals properly.
8. Package the system as below:
9. The system goes in a 12x12x4 box.
10. Place one copy of each current product literature sheet EXCEPT distributor price list in the bottom of the box.
11. Put 2 copies of the TEL171 instruction book in the bottom of the box.
12. Put an envelope of 30 disconnect pin receptacles in the box.
13. Put an index sheet in the box.
14. Wrap each board in bubble sheet and place them in the box.
15. Seal the box, label the side (TEL171), and put it in finished good inventory.