DRC200 - The Next Generation

Hallikainen & Friends got started in broadcast transmitter remote control in 1978. We introduced the TEL171, which replaces the analog metering circuitry of the Moseley TRC-15A with digital, improving accuracy and readability. At that time, we thought the digital data was just too valuable to "keep inside the box", so we put a connector on the front and marked it "data".

As we became familiar with microprocessors, we prototyped a system that would plug into the TEL171 jack. We used an integer Basic interpreter (from Technical Systems Consultants) in the prototype. We added words to Basic, allowing an application program to get readings from the TRC-15A and send Raise or Lower commands. We ran this prototype for several months on a local directional AM station before deciding to take another design approach.

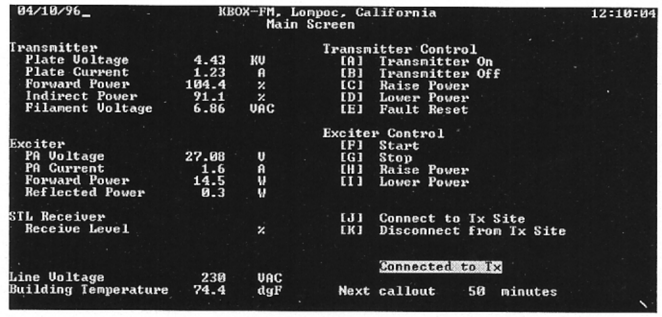
The above computer interface suffered from two shortcomings. First, it used an integer Basic. Second, it worked only with the TRC-15A. We solved the first by licensing a floating point Basic interpreter from Microsoft. To solve the second problem, we ignored the "valuable data" the on the front of the TEL171. In the PCC180 series, we built modems and wrote interface software so the PCC would emulate the studio end of several remote controls. These included the TRC-15A (with the TEL171), the TFT 7610 and the Moseley DRS-1A. The first PCC180 shipped in 1981. It is still on line in Chicago. Through a user written applications program, the system presents several user data screens, does limit checking, adjustments, pattern changes and logging.

By 1984, we decided we should make our own remote control; a full remote control system, not just a computer interface for an existing system. Again, Basic was the language of choice for the user programming of the system. The DRC190 includes a front panel alphanumeric display, allowing manual operation using the familiar "channel raise/lower" controls. User full screen displays, automatic control and logging are handled by a Basic program running in the DRC190. The DRC190 continues to be a popular system in a wide variety of applications. It's programmability and multisite capabilities has made it the system of choice for large networks (monitoring 10 to 50 transmitter sites).

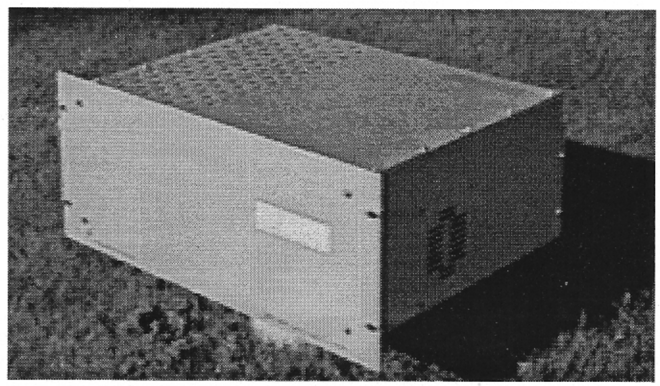
In 1988, we finally put the TEL171's "valuable data" to use. The ITO177 (designed by Bill Bordeaux of Interstellar Communications" adds words to the Basic of a Commodore 64 or 128 and drives the "data" jack on the TEL171. This low cost system continues the Basic programmability of the PCC and DRC family. The ITO178 was introduced in 1993. It consists of a card and software for an IBM compatible computer allowing automatic control and logging using the TRC-15A and TEL171.

DRC200 Features

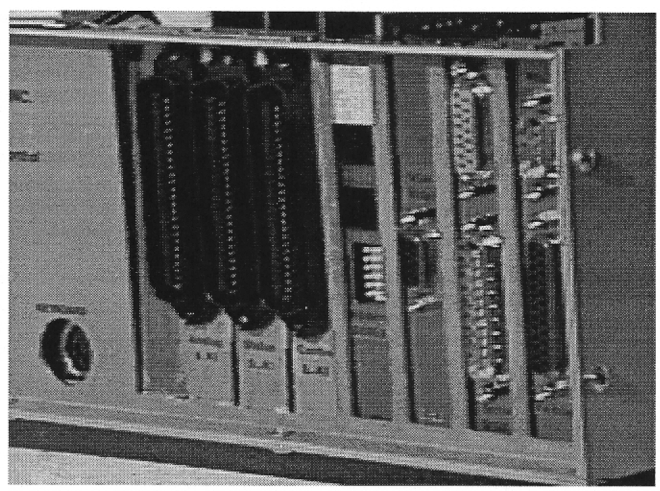
- Monitors up to 254 sites
- 48 analog inputs per site
- 48 status inputs per site
- 48 open collector control outputs per site
- Unlimited number of user defined screens
- Each screen may show data from multiple sites
- Keyboard and/or mouse commands
- Screens protected by unlimited number of usernames and passwords
- User defined log format
- Multiple sites may be printed on same log
- All user screens may review historic data using page-up and page-down keys
- Sites may be linked using two wire voicegrade dedicated circuit, UHF packet radio links, ISM spread spectrum links, or user-supplied RS232 digital data link
- User defined calibration formula for each channel allowing linear, square, deviation, indirect power and other displays
- User defined status based on hardware status inputs, analog comparisons and Boolean algebra
- User defined automatic commands sequences
- Comma delimited log file may be exported to other data analysis packages
- 486 processor, 4 meg RAM, 500 meg hard drive.
- Software runs under DOS or a DOS window in Windows
- Transmitter site unit includes 48 analog inputs, 48 status inputs, 48 control outputs, internal 2400 bps modem, VGA monitor, serial mouse, keyboard, and printer. If studio control is desired, a transmitter site unit may be used at a studio.
- Studio unit includes internal 2400 bps modem, VGA monitor, serial mouse, keyboard, and printer.
- System directly reads serial data from BE MVDS unit. Other serial interfaces planned.
- Demo disk available!



Typical user screen. Controls may be activated using keys or mouse.



Seven inch rackmount unit with 3.5 inch floppy drive for program and data transfer



Rear panel 50 conductor microribbon connectors carry metering, status, and control lines to supplied 100 conductor quick connect blocks.

New Processor

As applications programs for the DRC190 became more and more involved, the 64K memory map of the 68B02 became a limiting factor. We worked out a "RAM disk overlay" system that allows larger programs, but with some added complexity in the user program. We started looking for ways to expand the memory map. The first choice was the Motorola 68000 microprocessor. The very large nonsegmented memory map looked quite nice. We could probably port over the DRC190 code (written in 6800 assembly) using macro substitutions. However, at this time the price on IBM PC clone motherboards became too low to ignore. We could buy an 8088 motherboard for considerably less than we could build any processor board. So, we started the design of the DRC200.

DRC200

As the PC industry has advanced, the DRC200 has advanced. The DRC200 architecture allows a simple "drop in" processor upgrade. The DRC200 is currently shipping with an 80386DX40 processor instead of the 8088 used in the original design.

The DRC200 consists of a custom rack mount cabinet that holds the 80386 motherboard, power supply, and I/O boards. The I/O boards include a standard video interface, a modem, a status input board, an analog input board and a control output board.

The transmitter site user interface is a standard video monitor and keyboard, as opposed to the more typical 32 character LCD.

The modem provides communications to the control point(s). A variety of standard low cost modems can be used on dial up or leased circuits. The standard modem operates at 2400 bps.

Serial ports may also be added to the system. These may drive modems or other digital links for intersite communications or may interface with transmitter site monitoring equipment. The system software currently accepts serial data from the Broadcast Electronics MVDS transmitter control system.

The status input board accepts 16 or 48 TTL inputs. These can be driven by contact closures to ground, open collector outputs or TTL/CMOS drivers. All inputs include pull-up resistors and series current limiting resistors.

The analog input board accepts 16 or 48 DC or AC sample voltages. This board uses the MAX134 digital multimeter chip. The user can set the input voltage range on each channel to 40 mV full scale to 400 V full scale, DC or AC. The board includes an RMS to DC converter to handle AC sample voltages. It also includes a temperature sensor IC, allowing the temperature inside the DRC200 to be measured. Since this is generally just a few degrees above ambient, an approximation of room temperature is available with no external hardware. One side of each analog input is grounded, but differential voltages can be measured using software techniques (Vab=Va-Vb).

The control output board provides 16 or 48 open collector control outputs. These can directly drive most transmitter site control inputs. The board also includes a watchdog timer, and bytewide memory sockets for special applications. These sockets can accept EPROM, EEPROM, or static RAM. The memory can be mapped anywhere in the processor memory map (including above 1 Meg). When these sockets are used, memory address assignments are determined by a PAL chip on the board. RAM chips can be battery backed and write protected.

The status, analog and control inputs/outputs appear on the rear panel on 50 pin "microribbon" connectors. Prewired cables and "66" type punch down blocks are provided with the system.

Up to two each of the A/D, status or control boards may be in a transmitter site unit, allowing 96 channels of metering, status and control. Since the system motherboard has 8 slots, use of this many I/O boards may limit the number of other boards the system accepts.

System Software

The system includes a 200 megabyte (minimum) hard drive at each site. This hard drive holds the system software, configuration files, and log files.

A spread sheet is used to calibrate and configure the system.

Analog Metering

Column A holds the sample voltage range for the A/D converter. Column B holds the actual sample voltage. This number is inserted by the A/D converter as it scans through the analog inputs. Note that there are several channels where the scale is marked "skip". The A/D software skips channels that have been so programmed, preventing the A/D from wasting time on channels with no sample voltage.

Column C typically holds a formula that scales a sample voltage to engineering units. For example, cell C0 contains the formula

(B0*8.325/1.25) ; TxA Plate KV

This scales the sample voltage held in cell B0 (typically 1.25 volts here) to read 8.325, which corresponds to 8.325 KV plate current. These "linear" calibrations typically have the desired reading in the numerator and the actual sample voltage (as read from the sample cell, such as B0) in the denominator. Such a formula can be easily expanded to introduce an offset, handle a nonlinear function (such as square law power) or perform other calculations. Any text following a semicolon is ignored, allowing comments.

In the example, cell C2 calculates output power based on the sample voltage out of a reflectometer. The reflectometer sample is in cell B2 and has a voltage of 1.25 when power is 35 KW. The power is proportional to the square of the sample voltage.

(35*(SQR(B2))/(SQR(1.25)) ; TxA TPO KW

The system can be configured with LOTS of serial ports. These ports may be used for intersite communications or to "talk" with transmitter site equipment that has an RS232 serial interface. The system currently includes a driver for the Broadcast Electronics MVDS transmitter control system. The word MVDS is a three argument function in the spreadsheet (just as SQR is a single argument function). The expression below returns the most recently received MVDS data from MVDS unit 2, line 18, number 2. The system supports two MVDS units per site, so the first argument determines which of these two units to use. The MVDS outputs data (from its logging port) in a screen or printer format. The second argument in the MVDS function determines which line of the printed or displayed data the particular reading is located on. The third argument determines "which number" on the line to use. The system scans each line looking for numbers. On the BE FM35 MVDS screen, the forward power for IPA 2 is the second number on line 18.

```
(MVDS(2,18,2))  ; TxB IPA2 Fwd Watts
```

All the analog readings of column C are sent to all sites on a significant change in any reading. These readings are then stored on hard disk or stored in RAM (on ROM based systems). The user screen display program then refers to this data to build the user screens.

Status

The system accepts 48 status inputs on each status input board. A status input may be referred to anywhere in the spreadsheet using the STATUS(chan) function. STATUS(chan) returns a 0 if the status input is high (+5 volts). It returns a 1 if the input is pulled low. Status information to be used on user screens should be put in column D. For example,

```
(STATUS(21))   ; TxA Blower On
```

is true (1) if status input is pulled low by the transmitter blower on status output.

An expression may also be put in a column D cell. For example,

```
((STATUS(23)*NOT(STATUS(1)))+(STATUS(33)*STATUS(1)))   ; Sel Tx on
```

is true IF status(23) is true and status(1) is false, OR, status(33) is true and status(1) is true. Here, status(23) is true if TxA plates are on; status(33) is true if TxB plates are on; status(1) is true if TxB is selected. So, if the selected transmitter has its plates on, the expression is true. Note that multiplication (*) is used for AND, while addition (+) is used for OR, just as in Boolean algebra. Any non-zero number is considered to be true, while zero is false. NOT returns 0 if its argument is non-zero and returns 1 if its argument is zero.

Automatic Control

Control outputs are driven by PULSE commands. These can be combined with IF statements to provide automatic control. For example

```
:IF (D23*E0*(C2<31.5)) PULSE(1,14,0.5)  ; TxA APC Power Raise
```

D23 (hardware STATUS(23)) is 1 if the TxA plates are on, otherwise it is 0. Cell E0 is assigned by the user program to be a flag indicating whether the automatic power control is on. If E0 is 1, the APC is on. If E0 is 0, the APC is off. The expression (C2<31.5) is true (1) if the contents of cell C2 (TxA output power) is less than 31.5 KW. If the result of this multiplication is nonzero, indicating this transmitter is on, the APC is on, and the power is less than 31.5 KW, a output 14 is pulsed on (low) for 0.5 seconds.

Data Transmission Format

On a (user defined) significant change in any analog reading in column C or status change in column D, all the data in columns C and D is sent to all sites (control and transmitter sites) in the system. At each site, this data is stored in a log file on the hard disk. Each record of data consists of the site number, the date, time, status (column D), comment, and the analog readings (column C). The "comment" field can be filled when a log data transmission is due to a LOG command. Control point software prints the comment field along with readings. The data is transmitted and stored as comma delimited ascii.

User Screens

Of course, asking an operator to find readings in the spread sheet would be difficult. The system allows you to build user screens.

User screens are designed during system installation. A screen consists of a "form" of fixed data (such as parameter label and units) and variable data. The "form" of the screen is specified in the first 25 lines of a screen descriptor file. Plain text and character graphics (lines, boxes, etc.) may be used to specify the fixed format of the screen. In the first 25 lines of the screen descriptor file, variable data is specified with a tilde followed by a number (for example, ~12). The system software refers to the remainder of the file (beyond line 25) to determine what to substitute for the tilde expressions. For analog meter readings, the tilde definition line specifies the tilde number, the fact that a meter (or analog) value is to be substituted, the site number (site numbers are between 1 and 254, one screen may include data from several sites), the color with which the reading is to be displayed, the "field width", and the number of places after the decimal point. If limit checking is desired, a "status mask", color, lower limit and upper limit may be added to the meter description line. The status mask checks the status (from transmitter site spreadsheet column D) to determine whether limit checking should occur. For example,

```
~5 meter 1  2  7    5 2 33      132  31.5  36.7     ; TPO KW
```

"drops" in a value in the "tilde 5" screen position. The value is from site 1, meter channel 2. The color is 7 (light gray). The value occupies five character positions on the screen (field width of 5) and has two digits after the decimal point. Limit checking on this parameter is enabled if status 33 is true (we'd use -33 if it were to be enabled when status 33 was false). If the reading is outside the limits, the color changes to 132 (flashing red). 31.5 and 36.7 are the lower and upper limits. The semicolon indicates the beginning of a comment. This comment indicates we are looking at the transmitter power output in kilowatts. This particular transmitter is licensed for 35 KW.

A user screen can also display system status (based on data in column D at a particular transmitter site). For example of, a simple status display statement

```
~60  status 1 35 2 ok 132 open  ; TxB Interlocks
```

fills in the "tilde 60" space on the screen. It uses status from site 1, cell D35. If this cell is true (nonzero), the word "ok" is shown in color 2 (green). If D35 is false (zero), the word "open" is shown in color 132 (flashing red).

Status may also be combined with a key to be both a menu selection and a status display. Pressing the key sends the appropriate command to toggle the status. The status display portion of such a screen entry could be

```
~42 status 1 32 1 Off  2 Off  ; Status(1,32) Filaments on
~43 status 1 32 2 On   1 On   ; Status(1,32)
```

Tilde 42 displays the word "Off" in color 1 (blue) if cell D32 at site 1 is true and in green if D32 is true. Similarly, tilde 43 displays the word "On" in green if cell D32 at site 1 is true, and in blue if it is false. On most monitors, green is considerably brighter than blue. In this manner, it appears to be a couple backlit legends that light up in green when that state is true. Either the Off or On is lit green. The other is lit dimly in blue. The portion of the screen descriptor file that uses ~42 and ~43 is shown below. Pressing the F1 key toggles the filaments between on and off.

```
[F1] Filaments     ~42     ~43
```

User Commands

Any transmitter site spreadsheet command may be sent to a transmitter site from a control point. On its arrival, the command will be executed immediately (it is dropped into a procedure called the "immediate spreadsheet"). The screen descriptor files contain data describing what is to be done on a key being pressed. A few key description lines follow.

```
FF1 screen cssxBhlp.scr             ; Get Chi-Shing-Shan Tx B help screen
AF1 command 1 ':pulse(1,21,0.5):log("Tx B Filament off command")'
SF1 command 1 ':pulse(1,20,0.5):log("Tx B Filament on command")'
```

The first line causes the system to load another screen descriptor file (cssxBhlp.scr) when function key 1 is pressed. This displays a help screen. Other screens may show other transmitters, other sites, a system general view, or whatever the user likes. Each screen descriptor file also loads a new set of key commands, so keys have a different meaning depending upon which screen is displayed.

The second line sends a couple commands to site 1 when ALT-F1 is pressed. The first command pulses control output 21 on for 0.5 seconds. The second command sends a log record (all status and readings from this site) with the comment field containing the text "Tx B Filament off command". This causes the readings and text to be printed at all sites.

The third command line is similar, only it acts in response to SHIFT-F1.

The DRC200 also supports a mouse user interface. A mouse description line in the screen descriptor file is very similar to a key description line. A few examples follow.

```
; Mouse descriptions
;    x1 y1 x2 y2 command
mleft  1 25 12 25 screen csshlp.scr           ; Chi-Shing-Shan help screen
mleft 25 18 32 18 command 1 ':pulse(1,1,0.5):log("Tx Off Command")'
mleft 33 18 39 18 command 1 ':pulse(1,0,0.5):log("Tx On Command")'
mleft 25 19 32 19 command 1 ':pulse(1,2,0.5):log("Select Tx A Command")'
mleft 33 19 39 19 command 1 ':pulse(1,3,0.5):log("Select Tx B Command")'
mleft 25 21 32 21 command 1 ':pulse(1,30,0):assign(D5,0):log("Select Local Pgm")
mleft 33 21 39 21 command 1 ':pulse(0,30,0):assign(D5,1):log("Select STL Pgm")
mleft  1 22 18 22 screen csstxA.scr           ; Get txA screen
mleft  1 23 18 23 screen csstxB.scr           ; and TxB screen
mleft  1 24 23 24 screen main.scr             ; back to main screen
```

Each line identifies which mouse button (mleft or mright), the screen coordinates where the mouse is to be active, and the command(s) to be sent on a mouse click.

Special Keys

Most key definitions are contained in the screen descriptor files, as described above. A few keys are predefined.

Pressing the page-up key removes the DRC200 from the "real time display" mode. Each page-up moves the DRC200 display back in time, reviewing data in the hard drive log records. The user can scroll forwards and backwards through time watching a sequence of events and variations in transmitter parameters. Page-up moves the display back in time; page-down moves the display forward; and escape returns the system to a real time display mode.

Alt-D sets the system display to a specific date, allowing review of previous dates system displays. Alt-T sets the system display to a specific time.

Alt-L logs a user into the system. Each system user has a username, a password, and a security level. When a username and password are entered, any existing user at that site is logged out. The system security level is set to that of the new user. All command or screen key or mouse descriptions in the screen descriptor files may have associated security levels. If the currently logged in user does not have a sufficient security level, the command is not executed. This is generally used to keep unauthorized users from getting to critical screens. The use of individual usernames and passwords compares favorably with the two or three password limit of competing systems.

Alt-G logs out the current user and sets the security level to zero, returning the system display to the main screen. All user logins and logouts are printed on all system logs.

Automatic Logging

The DRC200 includes automatic logging. Log formats are user defined using descriptor files similar to the screen descriptor files. A typical "log record" may consist of one or several lines that includes the data from a site on the arrival of important data from any site.

Intersite Communications

Sites typically communicate over two wire voice-grade circuits. These may take the form of leased lines, dial-up lines, microwave subcarrier circuits or other radio links. RS232 serial digital interfaces are also available, allowing communications over digital links. The system can also utilize radio packet modems, allowing several stations to share a single UHF frequency.

Each site in the system acts as a packet data router. The system may be configured with the circuits in any topology. The system learns the routing to each site and routes data packets appropriately.

The Future

We have several low cost upgrades in the works for the DRC200. These include communications with standard data terminals, DTMF/Voice, logging to fax, and email.

Standard data terminal communications will allow terminals in the $500 area to be used as control point terminals, reducing system costs.

DTMF/Voice will allow user interaction with the system from a standard DTMF telephone. The DTMF/Voice interface will be very similar to the normal screen/keyboard interface. User defined screen descriptor files will tell the system what to say and how to respond to DTMF keystrokes, just as the present screen descriptor files act. At this point, we are leaning towards the use of recorded voice instead of synthesized voice. This allows the user to have the system say ANYTHING as opposed to working from a limited library.

Logging to fax should prove especially useful on systems relying on DTMF/Voice. In such systems, users often must manually log transmitter parameters. Once this feature is available, a DRC200 system would dump a day's log to a station's fax machine a little past midnight each day.

The DRC190 has a popular voice intercom. The modems and communications methods used in the DRC200 do not allow the use of a voice intercom. We will, however, provide a "text intercom" similar to email or talk systems on internet.

System Pricing

DRC200 16 Channel Unit	$3,000
16 analog inputs	
16 status inputs	
16 open collector control outputs	
101 key keyboard	
Mouse	
Dot matrix log printer (9.5 inches wide)	
VGA color monitor	
200 megabyte hard drive	
3.5 inch 1.44 meg floppy drive	
2400 bps 2 wire modem (leased or dial-up)	
DRC200 48 Channel Unit	$4,000
48 analog inputs	
48 status inputs	
48 open collector control outputs	
101 key keyboard	
Mouse	
Dot matrix log printer (9.5 inches wide)	
VGA color monitor	
200 megabyte hard drive	
3.5 inch 1.44 meg floppy drive	
2400 bps 2 wire modem (leased or dial-up)	
DRC200 Control Point Unit	$1,500
101 key keyboard	
Mouse	
Dot matrix log printer (9.5 inches wide)	
VGA color monitor	
200 megabyte hard drive	
3.5 inch 1.44 meg floppy drive	
2400 bps 2 wire modem (leased or dial-up)	

Options

8 serial ports (for communications or MVDS)	$ 250
Radio packet modem	$ 350
EF Johnson P channel telemetry transceiver	$ 750

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