RAD 3200 SERIES
SOFTWARE REQUIREMENTS SPECIFICATION

RAD2 V5.11
SUPPLEMENT
Advanced Programming Information

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RAD CONTROL AND CONFIGURATION

The operation of each RAD is controlled by sending commands to selected units via the network. The RAD returns data or information over the same network to the requesting client/host.

RAD COMMANDS

This section describes the commands used to control the RAD. The RAD software performs the following general tasks:

1) Read and filter the raw A/D counts that represent pressure and temperature.
2) Convert the pressure A/D counts to user chosen pressure units.
3) Receive and execute commands via the Ethernet, Serial or Local.
4) Output converted data, status, setup and calibration data over the Ethernet, Serial, or Local outputs.

NOTES: When a RAD module is in a “not ready” mode, all commands are disabled except STATUS and STOP.

If the software has not connected to a RAD unit using the Login command, all operations will be performed on the default RAD unit. The default RAD unit is the RAD with the lowest serial number

When a communications variable is modified, the RAD system computer must be restarted, in order for the changes to take effect.

COMMAND FORMAT

Each of the commands are explained with the following sections: command, syntax, arguments, description, and returns.

COMMAND lists the name of the command.

SYNTAX lists the format of the command. The following conventions are used:

BP	Boldface letters indicate command keywords and operators. Within the discussion of syntax, bold type indicates that the text must be entered exactly as shown.
expression	Words in italics indicate place holders for information you must supply, or information returned by the calibrator, such as a coefficient name or pressure data.
[/H]	Items in square brackets are optional.
,	Commas separate options, only one of the options may be used.
<CR>	Items in angle brackets are used for names of keys on a typical keyboard. The carriage-return key, sometimes marked as a bent arrow, Enter, or Return on the key board, is called <CR>.

Spaces, as used in the syntax, are entered as spaces.

DESCRIPTION describes the function of the command.

RETURNS lists the format of the information that the unit returns to the host.

A **PROMPT (>)** will be output when the RAD is ready to accept a command.

TCP/IP does not guarantee that packet boundaries will be maintained between a Host and a RAD module. Therefore, **ALL** commands from a Host **MUST** be terminated properly with one of two options using the NL configuration variable. The two options are:

CR-LF (ASCII 13 - ASCII 10) or CR (ASCII 13)

RAD COMMAND LIST

COMMAND SYNTAX **A/D CALIBRATION (NON-TEMPERATURE COMPENSATED)**
A2DCAL <*module*> <*index*> <*voltage*> <CR>

ARGUMENTS

module	-	The A/D module being calibrated. 0 is the RADBASE, 1 to 8 indicate pressure A/D's.
index	-	the Calibration point, 0 through 15
voltage	-	the applied calibration voltage

DESCRIPTION This command is used to produce the voltage correction table for a non-temperature compensated A/D. Although 16 points may be applied, a user may use as few as three points.

RETURNS <*nl*>

nl	-	end of line

EXAMPLE To calibrate a non-temperature compensated A/D module installed in position 1, apply a series of voltages. The entries may be as follows:

```
A2DCAL 1 0 0.0000
A2DCAL 1 1 0.5000
A2DCAL 1 2 1.0000
A2DCAL 1 3 1.5000
A2DCAL 1 4 2.0000
A2DCAL 1 5 2.5000
```

NOTE This command will only generate the correction table. It does not convert the table to a set of coefficients. Coefficients are generated by the A2DCALC command and written to the A/D module using the IDPWRITE command.

COMMAND **A/D CALIBRATION (TEMPERATURE COMPENSATED)**

SYNTAX **A2DTCAL <*module*> <*t index*> <*point index*> <*voltage*> <CR>**

ARGUMENTS

module -	The A/D module being calibrated. 0 is the RADBASE, 1 to 8 indicate pressure A/D's.
t index -	The temperature index, 0 through 7
point index -	the Calibration point, 0 through 15, for a t index
voltage -	the applied calibration voltage

DESCRIPTION This command is used to produce the voltage correction table for a temperature compensated A/D. Although 16 points may be applied at each temperature index, a user may use as few as three points.

RETURNS <*nl*>

nl	-	end of line

EXAMPLE To calibrate a temperature compensated A/D module installed in position 1, apply a series of voltages. The entries may be as follows:

```
A2DTCAL 1 1 0 0.0000
A2DTCAL 1 1 1 0.5000
A2DTCAL 1 1 2 1.0000
A2DTCAL 1 1 3 1.5000
A2DTCAL 1 1 4 2.0000
A2DTCAL 1 1 5 2.5000
```

NOTE This command will only generate the correction table. It does not convert the table to a set of coefficients. Coefficients are generated by the A2DTCALC command and written to the A/D module using the IDPWRITE command.

COMMAND SYNTAX

A/D COEFFICIENT CALCULATION (NON-TEMPERATURE COMPENSATED)

A2DCALC <*module*> <*number of points*> <CR>

ARGUMENTS

module	-	The A/D module being calibrated. 0 is the RADBASE, 1 to 8 indicate pressure A/D's.
number of points	-	the number of points in the coefficient table

DESCRIPTION

This command is used to calculate the voltage correction coefficients for a non-temperature compensated A/D. Three coefficients are generated: ADCC, ADCB, and ADCA. They will only be calculated by this command. IDPWRITE and IDPCONFIRM are used to write these coefficients to the ID chip.

RETURNS

<mod> <ac> <bc> <cc><*nl*>

mod	-	The A/D module, 0 to 8, where 0 is the RADBase and 1 to 8 corresponds to the A/D modules
ac	-	The A coefficient in the polynomial
bc	-	The B coefficient in the polynomial
cc	-	The C coefficient in the polynomial
nl	-	end of line

EXAMPLE

A series of voltages have been applied using the A2DCAL command. To generate the third order polynomial for the A/D correction for module 1,

Type: A2DCALC 1 6

The RAD software will calculate the polynomial coefficients and return them. They will not be written to the ID chip until IDPWRITE and IDPCONFIRM commands have been executed.

NOTE

This command will only generate the correction coefficients. Coefficients are written to the A/D module ID chip using the IDPWRITE command.

COMMAND SYNTAX

A/D COEFFICIENT CALCULATION (TEMPERATURE COMPENSATED)

A2DTCALC <*module*> <*number of temp planes*> <*number of points* <CR>

ARGUMENTS

module - The A/D module being calibrated. 0 is the RADBASE, 1 to 8 indicate pressure A/D's.

index - the Calibration point, 0 through 15

voltage - the applied calibration voltage

DESCRIPTION

This command is used to produce the voltage correction coefficients for a temperature compensated A/D. Although 16 points may be applied, a user may use as few as three points.

RETURNS

<mod> <ac> <bc> <cc><*nl*>

mod - The A/D module, 0 to 8, where 0 is the RADBase and 1 to 8 corresponds to the A/D modules

ac - The A coefficient in the polynomial

bc - The B coefficient in the polynomial

cc - The C coefficient in the polynomial

nl - end of line

EXAMPLE

A series of voltages have been applied using the A2DCAL command. To generate the third order polynomial for the A/D correction for module 1,

Type: A2DTCALC 1 6

The RAD software will calculate the polynomial coefficients and return them. They will not be written to the ID chip until IDPWRITE and IDPCONFIRM commands have been executed.

NOTE

This command will only generate the correction coefficients. Coefficients are written to the A/D module ID chip using the IDPWRITE command.

COMMAND SYNTAX **LIST A/D CORRECTION TABLE (NON-TEMPERATURE COMPENSATED)**
LIST A2DCOR <*module*> <CR>

ARGUMENTS <module> - The A/D location, 0 to 8. Where 0 is the temperature A/D and 1 to 8 are the module locations.

DESCRIPTION Lists the correction coefficients for the A/D in the specified location.

RETURNS A2DCOR <module> <index> <applied voltage> <counts>

module	-	0 to 8, Where 0 is the temperature A/D in the RADBASE and 1 to 8 are the module A/D's.
index	-	the calibration point, up to 16 points may be entered, numbered 0 to 15.
applied voltage	-	the voltage applied at the calibration point.
counts	-	the A/D counts measured at the calibration point

EXAMPLE To list the coefficients for the A/D converter in A/D module 1:

Type: LIST A2DCOR 1<CR>

The RAD will return:

```
A2DCOR 1 0 0.00000 0
A2DCOR 1 1 0.00000 0
A2DCOR 1 2 0.00000 0
A2DCOR 1 3 0.00000 0
A2DCOR 1 4 0.00000 0
A2DCOR 1 5 0.00000 0
A2DCOR 1 6 0.00000 0
A2DCOR 1 7 0.00000 0
A2DCOR 1 8 0.00000 0
A2DCOR 1 9 0.00000 0
A2DCOR 1 10 0.00000 0
A2DCOR 1 11 0.00000 0
A2DCOR 1 12 0.00000 0
A2DCOR 1 13 0.00000 0
A2DCOR 1 14 0.00000 0
A2DCOR 1 15 0.00000 0
```

COMMAND **LIST A/D CORRECTION TABLE (TEMPERATURE COMPENSATED)**

SYNTAX **LIST A2DTCOR *<module>* *<temp>*** <CR>

ARGUMENTS
- <module> - The A/D location, 0 to 8. Where 0 is the temperature A/D and 1 to 8 are the module locations.
- <t index> - The temperature index, 0 to 7

DESCRIPTION Lists the correction coefficients for the A/D in the specified location.

RETURNS A2DTCOR <module> <t index> <temp><p index> <voltage> <counts><ideal counts>
- module - 0 to 8, Where 0 is the temperature A/D in the RADBASE and 1 to 8 are the module A/D's.
- t index - the calibration point, each module may have up to 8 points. Each of these points may have up to 16 correction points.
- temp - The actual temperature of the index point, read from the ID chip.
- p index - Index point, 0 through 16 where the applied voltage, measured counts and ideal counts are read.
- voltage - the voltage applied at the p index calibration point.
- counts - the A/D counts measured at the p index calibration point
- ideal counts - the ideal counts at the p index point at the applied voltage, based on the formula:

$$\frac{AppliedVolts \times 2.852}{10} \times 32767$$

EXAMPLE To list the coefficients for the A/D converter in A/D module 1:

Type: LIST A2DTCOR 1 1<CR>

The RAD will return:

```
A2DTCOR 1 25 0.000000 0 0.000000 0 0
A2DTCOR 1 25 0.000000 1 0.000000 0 0
A2DTCOR 1 25 0.000000 2 0.000000 0 0
A2DTCOR 1 25 0.000000 3 0.000000 0 0
A2DTCOR 1 25 0.000000 4 0.000000 0 0
A2DTCOR 1 25 0.000000 5 0.000000 0 0
A2DTCOR 1 25 0.000000 6 0.000000 0 0
A2DTCOR 1 25 0.000000 7 0.000000 0 0
A2DTCOR 1 25 0.000000 8 0.000000 0 0
A2DTCOR 1 25 0.000000 9 0.000000 0 0
A2DTCOR 1 25 0.000000 10 0.000000 0 0
A2DTCOR 1 25 0.000000 11 0.000000 0 0
A2DTCOR 1 25 0.000000 12 0.000000 0 0
A2DTCOR 1 25 0.000000 13 0.000000 0 0
A2DTCOR 1 25 0.000000 14 0.000000 0 0
A2DTCOR 1 25 0.000000 15 0.000000 0 0
```

COMMAND **LIST ID CHIP IDENTIFICATION**

SYNTAX **LIST ID [<loc> <site> <device>]** <CR>

ARGUMENTS

<loc> - the ID chip location, 0 to 16

<site> - the location type, Where: A = A/D module
M = ZOC module
D = Digital Module (RDS)

<device> - must be E for EPROM

DESCRIPTION Lists the ID chip identification information. ZOC modules may only be site 1 through 8. A/D modules may be sites 0 through 8 where the Temperature A/D module can only be site 0. Digital modules are 9 through 16

RETURNS <index> <loc> <site> <device> <ID> <error>

index - Line number, used for reference only

loc - the ID chip location, 0 to 16

site - the location type, Where: A = A/D module
M = ZOC module
D = Digital Module (RDS)

device - E = EPROM
T = Temp
S = Switch

ID - the chip ID number - This number is unique for each ID chip.

error - any error that may have occurred

EXAMPLE 1 To view all of the ID information of a RAD with 2 A/D modules, an RDS, and a ZOC33 connected to A/D position 1 :

Type: LIST ID<CR>

The RAD may return:

```
0 1 A T 28644c340000008f None
1 0 A T 286e4c3400000040 None
2 0 A T 28cddb460000000c None
3 1 A E 14ca251e010000f3 None
4 0 A E 142e8e1e01000045 None
5 1 M E 147524ef00000048 None
6 2 A T 28b1de460000003b None
7 2 A E 14e9251e0100001c None
8 9 D E 14ee241e01000054 None
```

EXAMPLE 2 To view the ID information of the ZOC module in location 1

Type: LIST ID 1 M E

The RAD may return:

```
5 1 M E 147524ef00000048 None
```

EXAMPLE 3 To view the ID information of the A/D module in location 2

Type: LIST ID 2 A E

The RAD may return:

```
7 2 A E 14e9251e0100001c None
```

EXAMPLE 4 To View the ID information of a typical DSAENCL3200

Type: LIST ID

The Enclosure may return:

```
0 1 A T 28644c340000008f None
1 0 A T 286e4c3400000040 None
2 0 A T 28cddb460000000c None
3 1 A E 14ca251e010000f3 None
4 0 A E 142e8e1e01000045 None
5 2 A T 28b1de460000003b None
6 2 A E 14e9251e0100001c None
7 9 D E 14ee241e01000054 None
```

COMMAND **LIST ID CHIP SETTINGS**

SYNTAX **LIST IDP [<loc> <site> <device> <mem>]** <CR>

ARGUMENTS

<loc>	-	the ID chip location, 0 to 16	
<site>	-	the location type, Where:	A = A/D module
			M = ZOC module
			D = Digital Module (RDS)
<device>	-	the device type, always E for EPROM	
<mem>	-	the memory type, Where	E = EPROM
			P = PROM

DESCRIPTION Lists the ID chip settings. ZOC modules may only be site 1 through 8. A/D modules may be sites 0 through 8 where the Temperature A/D module can only be site 0. If the location, site, and device are not specified, the settings for all chips will be returned.

RETURNS SET IDP <loc> <site> <device> <mem> <name> <value>

loc	-	the ID chip location, 0 to 16	
site	-	the location type, Where:	A = A/D module
			M = ZOC module
			D = Digital Module (RDS)
device	-	the device type, always E for EPROM	
mem	-	the memory type, Where:	P = PROM
			E = EPROM
name	-	the parameter name	
value	-	the parameter value	

EXAMPLE 1 To view all of the ID chip information of the chip in A/D module in position 1:

Type: LIST IDP 1 A<CR>

The RAD may return:

```
SET IDP 1 A E P DFC 1
SET IDP 1 A E P DMC 0
SET IDP 1 A E P SN 111
SET IDP 1 A E P REV A
SET IDP 1 A E P MDATE 7/1/2002
SET IDP 1 A E E ADCA 0.000000
SET IDP 1 A E E ADCB 0.996481
SET IDP 1 A E E ADCC 2.070793
SET IDP 1 A E E ECC 0.001499
SET IDP 1 A E E GAIN 0
SET IDP 1 A E E ACDATE 7/1/2002
SET IDP 1 A E E ADCD 6.50000
```

EXAMPLE 2 To view all of the ID chip information of the chip in the ZOC module in position 1:

Type: LIST IDP 1 M<CR>

The RAD may return:

```
SET IDP 1 M E P DFC 2
SET IDP 1 M E P DMC 4
SET IDP 1 M E P SN 301
SET IDP 1 M E P REV A
SET IDP 1 M E P MDATE 1/27/2000
SET IDP 1 M E E RTYPE 0
SET IDP 1 M E E RVALUE 1
SET IDP 1 M E E RCORA 0.000000
SET IDP 1 M E E RCORB 0.000000
SET IDP 1 M E E RCDATE 1/27/2000
SET IDP 1 M E E PCDATE 8/16/2002
SET IDP 1 M E E NPR1 15.000000
SET IDP 1 M E E NPR2 15.000000
SET IDP 1 M E E VALVE 1
SET IDP 1 M E E XDUCER 0
```

EXAMPLE 2 To view all of the ID chip information of the chip in the RADBASE A/D module(position 0):

Type: LIST IDP 0 A<CR>

The RAD may return:

```
SET IDP 0 A E P DFC 0
SET IDP 0 A E P DMC 0
SET IDP 0 A E P SN 25
SET IDP 0 A E P REV A
SET IDP 0 A E P MDATE 10/24/2003
SET IDP 0 A E E ADCA 0.000000
SET IDP 0 A E E ADCB 1.002526
SET IDP 0 A E E ADCC 14.007034
SET IDP 0 A E E RV 5.002700
SET IDP 0 A E E ACDATE 10/24/2003
SET IDP 0 A E E SN 126
SET IDP 0 A E E APPTYPE 0
>
```

COMMAND **LOGIN SUPERVISOR**
SYNTAX **LOGIN SUPER** <CR>

ARGUMENTS *super* - Supervisor rights.

DESCRIPTION Logs in to an individual RAD unit with supervisor rights. This command grants permission to access blocked commands and setup variables.

RETURNS <*nl*>
nl - End of line.

NOTE If the software has not connected to a RAD unit using the Login command, all operations will be performed on the default RAD unit. The default RAD unit is the RAD with the lowest serial number

COMMANDS LIST ID
LIST IDP
IDPWRITE
RESTORE
A2DCAL
A2DTCAL
A2DCALC
A2DTCALC
LIST A2DCOR
LIST A2DTCOR

VARIABLES A2DCOR
IDP

COMMAND	**LOGOUT**
SYNTAX	**LOGOUT** <CR>
ARGUMENTS	none
DESCRIPTION	Logs out of an individual RAD unit. All commands entered after a login command will be directed to the default RAD unit. The default RAD unit is the RAD with the lowest serial number
RETURNS	<*nl*> nl - End of line.
EXAMPLE	To disconnect from the current RAD unit: Type: LOGOUT<CR>

COMMAND **RESTORE**
SYNTAX **RESTORE** <CR>

ARGUMENTS None

DESCRIPTION Commands the RAD to restore all configuration variables to their **default** values.

NOTE: This will erase all conversion coefficient tables. The **RELOAD** command should be used if it is necessary to reload a configuration.

RETURNS <*nl*>
nl - End of line.

EXAMPLE To Restore the RAD to the default configuration, with no conversion coefficient tables,
Type: RESTORE<CR>

WARNING

This command should not be used unless a RAD configuration is completely unknown and unusable. This command will reset all configuration variables to their default values, which includes setting all MPF files to zero. This could result in the loss of all coefficients for any modules listed in the Profile List.

For best results when a configuration must be reset, it is recommended that the **RESTART** or **RELOAD** commands be used rather than the **RESTORE** command.

COMMAND **WRITE ID CHIP VARIABLES**

SYNTAX **IDPWRITE <*location*> <*site*> <*device*> <*memory*>** <CR>

ARGUMENTS

location - The location of the device. Valid values are 0 through 8, Where 0 can only be the Temperature A/D.

site - A for an A/D, or M for a Module

device - The memory device in the A/D or module. This must always be E for EPROM. The software will select the Device family based on the Name to be modified.

memory - E for EPROM, or P for PROM. Data stored in PROM may only be set once. If PROM data are set at the Scanivalve Factory, they may not be modified in the field. Data stored in EPROM may be modified by a user.

DESCRIPTION

The ID Chip write process requires two commands to complete. The IDPWRITE command stages the ID chip identification variables and prepares the software to write to the ID Chip PROM or EPROM. This command does not actually perform the write. The write process does not occur until a IDPCONFIRM command is issued. The IDPCONFIRM command is considered to be part of the IDPWRITE command

RETURNS

SET IDP <*location*> <*site*> <*device*> <*memory*> <*name*> <*value*>

location - The location of the device. Valid values are 0 through 8, Where 0 can only be the RADBASE Temperature A/D.

site - A for an A/D, or M for a Module

device - The memory device in the A/D or module. This must always be E for EPROM. The software will select the Device family based on the Name to be modified.

memory - E for EPROM, or P for PROM. Data stored in PROM may only be set once. If PROM data are set at the Scanivalve Factory, they may not be modified in the field. Data stored in EPROM may be modified by a user.

name - The name of the variable

value - The value of the variable

EXAMPLE

The IDP variables for the EPROM in a ZOC module have been programmed using the SET IDP Variable commands. When all of the variables have been set, the RAD software must be set up to write to the EPROM. The following command is entered:

IDPWRITE 1 M E E

The RAD returns the following:

SET IDP 1 M E E RTYPE 0
SET IDP 1 M E E RVALUE 1
SET IDP 1 M E E RCORA 0.000000
SET IDP 1 M E E RCORB 0.000000
SET IDP 1 M E E RCDATE 1/26/2004
SET IDP 1 M E E PCDATE 1/1/2000
SET IDP 1 M E E NPR1 1.000000
SET IDP 1 M E E NPR2 1.000000
SET IDP 1 M E E VALVE 2
SET IDP 1 M E E XDUCER 0
Type IDPCONFIRM to confirm IDP write or STOP to escape

If the data is correct, issue the IDPCONFIRM command to write the variables to the EEPROM. If the data are not correct, type STOP and repeat the process to correct the errors.

RAD CONFIGURATION VARIABLES

CONVERSION VARIABLES (Group C)

VARIABLE	**A2DCOR <*code*>**
VALID VALUES	0 or 1
DEFAULT VALUE	1
DATA TYPE	Integer
DESCRIPTION	Sets the A/D Correction ON or OFF. 0 - Sets A/D Correction OFF 1 - Sets A/D Correction ON

MODULE PROFILE VARIABLES (Group P)

VARIABLE	**RADSN <*serial number*>**
VALID VALUES	Any valid integer up to 4 digits
DEFAULT VALUE	0000
DATA TYPE	Integer
DESCRIPTION	The serial number of the RAD.

VARIABLE	**SNn <*serial number*>**	Where n = the module position number
VALID VALUES	Any valid integer up to 4 digits	
DEFAULT VALUE	0000	
DATA TYPE	Integer	
DESCRIPTION	The serial number of the module installed in slot n.	

IDENTIFICATION CONFIGURATION VARIABLES (Group I)

VARIABLE	**CONOUT <*code*>**
VALID VALUES	1, 2, or 3
DEFAULT VALUE	2
DATA TYPE	integer
DESCRIPTION	Determines if output data are to be sent to the console. 1 - Output to the Console 2 - Output data to the Console if comment was input from the keyboard. 3 - Output data to disk file: scanxxx.dat, no display of data
NOTES	If CONOUT is set to 3, the following rules apply. ▸ The first SCAN command will open the file: scan000.dat. This file will remain open until a CLOSE command is issued. If the file is not closed, subsequent SCAN commands will append data to that file. ▸ When the first file is closed, the next SCAN command will open a new file: scan001.dat. The file name will increment each time a file is closed and a new SCAN command issued. ▸ The counter used to increment the file name is reset when the RAD.exe program is exited. When the RAD.exe program is re-started, the first file name will be scan000.dat. ▸ Data are written to the file in the format defined by the variable BIN. If BIN is 0, data are written in ASCII format. If BIN is 1 or 2, data are written in Binary format. ▸ If the RAD.exe program is quit before a CLOSE command is received the data buffered for the current open file will be lost.

The information describing CONOUT is for legacy issues only. The new RAD software (V5.00 and higher) will recognize CONOUT 3 as FILEOUT 1.

ID CHIP CONFIGURATION VARIABLES (Group ID)

VARIABLE **IDP *<loc> <site> <device> <mem> <name> <value>***
VALID VALUES See Below
DEFAULT VALUE Varies
DATA TYPE Integer
DESCRIPTION Sets the values in an ID Chip. This variable will be used rarely by a user. The ID chips are pre-programmed at the time of manufacture. It is recommended that a customer understand the information in the Section defining the RAD ID Chip Data Format before attempting to modify a setting using this configuration variable.

- Loc - The location of the device. Valid values are 0 through 8, Where 0 can only be the Temperature A/D.
- Site - A for an A/D, M for a Module, or D for a Digital Module.
- Device - The memory device in the A/D or module. This must always be E for EPROM. The software will select the Device family based on the Name to be modified.
- Mem - The memory device type. P for PROM or E for EPROM. The Identification data stored in PROM cannot be modified by a user.
- Name - The name of the EEPROM data to be modified. Refer to the following lists of parameter names that may be modified.
- Value - The new value.

Memory Device Type P (PROM) - All Family Codes - Values may not be modified by a user

DFC	Device Family Code	0 = RAD Temperature A/D Board 1 = RAD Pressure A/D Board 2 = Pressure Scanner Module 3 = RAD Digital I/O Device 4 = Test Fixture (BASM3200) 5 = Voltage Scanner Module (EIM)
DMC	Device Model Code	Family Code = 0 0 = 16 Bit 100 KHz, 5V Ref. Family Code = 1 0 = 16 Bit 100 KHz Family Code = 2 0 = ZOC 3016 1 = ZOC 17 2 = ZOC 22 3 = ZOC 23 4 = ZOC 33 Family Code = 3 0 = Remote Digital Switch, 8 channels Family Code = 4 0 = BASM3200 Family Code = 5 0 = ZOC16EIM 1 = ZOCEIM16 2 = ZOCEIM32
SN	Serial Number	Number 0 – 4096
REV	Revision	Letter Code A – P
MDATE	Manufacture Date	MM/DD/YYYY

Memory Device Type E (EEPROM) - Family Code 0

ADCA	A/D Correction Coefficient A	The A coefficient of A x^2 + Bx + C.
ADCB	A/D Correction Coefficient B	The B coefficient of A x^2 + Bx + C.
ADCC	A/D Correction Coefficient C	The C coefficient of A x^2 + Bx + C.
ADCD	A/D Correction Coefficient D	The D coefficient used in the Temperature correction algorithm.
RV	Reference Voltage	The measured voltage reference value used in the temperature calibration.
ACDATE	A/D Calibration Date	MM/DD/YYYY
SN	RAD Serial Number	Number 0 – 4096
APPTYPE	RAD Application Type	0 = Standalone 1 = Enclosure

Memory Device Type E (EEPROM) - Family Code 1

ADCA	A/D Correction Coefficient A	The A coefficient of A x^2 + Bx + C.
ADCB	A/D Correction Coefficient B	The B coefficient of A x^2 + Bx + C.
ADCC	A/D Correction Coefficient C	The C coefficient of A x^2 + Bx + C.
ECC	Excitation Current Correction	Actual measured excitation current (1.5 mA ideal with exact 5 V reference).
GAIN	Gain Code	0 = 2.852 Gain (Standard)
ACDATE	A/D Calibration Date	MM/DD/YYYY

Memory Device Type E (EEPROM) - Family Code 2

RTYPE	RTD Type Code	0 = Platinum 385 1= Nickel-Iron
RVALUE	RTD Value Code	RTD Type Code = 0 0 = 100 Ohm 1 = 500 Ohm 2 = 1000 Ohm RTD Type Code = 1 0 = 604 Ohm
RCORA	RTD Correction A	A term for Callendar-Van Dusen equation.
RCORB	RTD Correction B	B term for Callendar-Van Dusen equation.
RCDATE	RTD Calibration Date	MM/DD/YYYY
PCDATE	Pressure Sensor Calibration Date	MM/DD/YYYY
NPR1	Nominal Pressure Range 1	Value must be in PSI
NPR2	Nominal Pressure Range 2	Value must be in PSI
VALVE	Pressure Valve Arrangement	0 – No Valve 1 – X1 2 – X2 3 – NPx (Normal Px Mode) 4 – NO (Normal Open) 5 – IP
XDUCER	Transducer Type	0 – Differential 1 – Delta 2 – Absolute

Memory Device Type E (EEPROM) - Family Codes 3, 4, and 5

No programmable Values

Error and Event Log File (ERRLOG.TXT)

An Error and Event Log File was added to Version 2..00 of the RAD Software. All events and errors are logged to this file. The file will be created by the software if it does not exist. All events and errors are appended to the file as they occur. The file will be opened each time the RAD software is started and closed when the RAD software is shutdown. This file will not be automatically erased, but the file may be deleted manually. Old errors and events may be deleted from the file using a text editor. The file is in the RAD Folder. An example of entries showing the startup of the RAD software with some errors and events concluded by a normal shutdown is shown below.

---------- ERRLOG Opened at Date:1/15/2004 Time:0:2:40.766
DsmRad Ver 2.00 Copyright (c) Scanivalve Corp. 2002 - 2004 at Date:1/15/2004 Time:0:2:40.766
WARNING: No RDS present at location 9 at Date:1/15/2004 Time:0:3:42.284
EVENT: Scan started at Date:1/15/2004 Time:1:21:6.292
EVENT: Scan stopped, stop received Scangroup 0 Frame 16 at Date:1/15/2004 Time:1:21:11.449
EVENT: Calz started at Date:1/15/2004 Time:1:21:15.966
ERROR: CalZ temp or module out of range at Date:1/15/2004 Time:1:21:23.667
EVENT: Calz finished at Date:1/15/2004 Time:1:21:23.687
EVENT: Scan started at Date:1/15/2004 Time:1:21:50.405
ERROR: Invalid command at Date:1/15/2004 Time:1:23:27.875
EVENT: Scan stopped, stop received Scangroup 0 Frame 7 at Date:1/15/2004 Time:1:21:53.99
EVENT: Scan started at Date:1/15/2004 Time:4:54:54.798
EVENT: Scan stopped, stop received Scangroup 0 Frame 15 at Date:1/15/2004 Time:4:54:59.535
EVENT: Scan started at Date:1/15/2004 Time:4:55:14.787
EVENT: Scan stopped, stop received Scangroup 0 Frame 107 at Date:1/15/2004 Time:4:55:43.258
EVENT: Scan started at Date:1/15/2004 Time:4:55:58.750
EVENT: Scan stopped, stop received Scangroup 0 Frame 49 at Date:1/15/2004 Time:4:56:12.149
---------- ERRLOG Closed at Date:1/15/2004 Time:7:46:0 145

RAD ID Chip Data Format

The RAD system uses the Dallas DS2430A EEPROM chip for storing information about various system components. The information travels with the hardware, allowing the system to configure itself after power-up. The DS2430A has two memory areas; a 64 bit permanent memory that is written once during the manufacturing, and a 256 bit area that can be written multiple times.

The permanent memory area will contain information necessary to identify the device in a format that is consistent over all of our device types. The 256 bit memory area will have a device dependent format.

Permanent Memory Data Format

The permanent memory area contains a Device Family Code, a Device Model Code, a Serial Number, a Revision Code, and a Manufacture Date.

Permanent Memory 64 Bits			
Bits	Name	Description	Assigned Values
4	DFC	Device Family Code	0 = RAD Temperature A/D Board 1 = RAD Pressure A/D Board 2 = Pressure Scanner Module 3 = RAD Digital I/O Device 4 = Test Fixture 5 = Voltage Scanner Module
4	DMC	Device Model Code	Family Code = 0 0 = 16 Bit 100 KHz, 5V Ref., Gain = 2.852 Family Code = 1 0 = 16 Bit 100 KHz Family Code = 2 0 = ZOC 3016 1 = ZOC 17 2 = ZOC 22 3 = ZOC 23 4 = ZOC 33 Family Code = 3 0 = RDS Remote Digital Switch, 8 Channels Family Code = 4 0 = BASM3200 Family Code = 5 0 = ZOC16EIM 1 = ZOCEIM16 2 = ZOCEIM32
12	SN	Serial Number	Binary Number 0 – 4096
4	REV	Revision	Letter Code A – P
16	MDATE	Manufacture Date	DDDDDMMMMYYYYYYY DDDDD = Day (1 – 31) MMMM = Month (1 – 12) YYYYYYY = Years Past 2000 (0 – 128)
24		Spare	

EEPROM Memory Data Format

The EEPROM data format is device dependent. The five device families are listed in the following tables.

RAD Temperature A/D Board (Device Family = 0) EEPROM Memory 256 Bits			
Bits	Name	Description	Assigned Values
32	ADCA	A/D Correction Coefficient A	The A coefficient of $Ax^2 + Bx + C$. 32 bit floating point coefficients.
32	ADCB	A/D Correction Coefficient B	The B coefficient of $Ax^2 + Bx + C$. 32 bit floating point coefficients.
32	ADCC	A/D Correction Coefficient C	The C coefficient of $Ax^2 + Bx + C$. 32 bit floating point coefficients.
32	RV	Reference Voltage	32 bit floating point number equals measured output of voltage reference.
16	ACDATE	A/D Calibration Date	DDDDDMMMMYYYYYYY DDDDD = Day (1 – 31) MMMM = Month (1 – 12) YYYYYYY = Years Past 2000 (0 – 128)
12	SN	RAD Serial Number	Binary Number 0 – 4096
8	APPTYPE	RAD Application	Integer, Binary Number 0 - 255 0 = Standalone, (Default) 1 = Enclosure ENCL3200
92		Spare	

RAD Pressure A/D Board (Device Family = 1) EEPROM Memory 256 Bits			
Bits	Name	Description	Assigned Values
32	ADCA	A/D Correction Coefficient A	The A coefficient of $Ax^2 + Bx + C$. 32 bit floating point coefficients.
32	ADCB	A/D Correction Coefficient B	The B coefficient of $Ax^2 + Bx + C$. 32 bit floating point coefficients.
32	ADCC	A/D Correction Coefficient C	The C coefficient of $Ax^2 + Bx + C$. 32 bit floating point coefficients.
32	ECC	Excitation Current Correction	32 bit floating point number equals deviation from 1.5 mA ideal with exact 5 V reference.
16	ACDATE	A/D Calibration Date	DDDDDMMMMYYYYYYY DDDDD = Day (1 – 31) MMMM = Month (1 – 12) YYYYYYY = Years Past 2000 (0 – 128)
8	GAIN	Gain Code	0 = 2.852 Gain
104		Spare	

Pressure Scanner Module (Device Family = 2) EEPROM Memory 256 Bits			
Bits	Name	Description	Assigned Values
8	RTYPE	RTD Type Code	0 = Platinum 385 1= Nickel-Iron
8	RVALUE	RTD Value Code	RTD Type Code = 0 0 = 100 Ohm 1 = 500 Ohm 2 = 1000 Ohm RTD Type Code = 1 0 = 604 Ohm
32	RCORA	RTD Correction A	A term for Callendar-Van Dusen equation. Two 32 bit floating point numbers.
32	RCORB	RTD Correction B	A and B terms for Callendar-Van Dusen equation. Two 32 bit floating point numbers.
16	RCDATE	RTD Calibration Date	DDDDDMMMMYYYYYYY DDDDD = Day (1 – 31) MMMM = Month (1 – 12) YYYYYYY = Years Past 2000 (0 – 128)
16	PCDATE	Pressure Sensor Calibration Date	DDDDDMMMMYYYYYYY DDDDD = Day (1 – 31) MMMM = Month (1 – 12) YYYYYYY = Years Past 2000 (0 – 128)
32	NPR1	Nominal Pressure Range 1	32 Bit Floating Point Number, units of PSI
32	NPR2	Nominal Pressure Range 2	32 Bit Floating Point Number, units of PSI
8	VALVE	Pressure Valve Arrangement	0 = None 1 = X1 2 = X2 3 = NPX 4 = NO 5 = IP
8	XDUCER	Transducer Type	0 = Differential 1 = Delta 2 = Absolute 3 = True Delta P 4 = EIM
64		Spare	
RAD Digital I/O Device (Device Family = 3) EEPROM Memory 256 Bits			
Bits	Name	Description	Assigned Values
256		Not Used	
Test Fixture (Device Family = 4) EEPROM Memory 256 Bits			
Bits	Name	Description	Assigned Values
256		Not Used	
Voltage Scanner (Device Family = 5) EEPROM Memory 256 Bits			
Bits	Name	Description	Assigned Values
256		Not Used	

Binary Scan Packets

Packets without Module-Port Information

Byte	Name	Value
0	Binary ID	1 = EU (EU =1) 2 = Raw (EU = 0)
1	Group ID	1 to 8 If Tag Bit is set, 80 Hex will be merged with the Scan Group Number. (81 to 88)
2 and 3	Number of Channels	0 to 512
4 through7	Frame Number	1 to 2^{32}
8 through 11	Time in milliseconds	0 to 2^{32}
12 through 15	Channel 1 Data	4 bytes per channel
16 through19	Channel 2 Data *	4 bytes per channel
: : : : : :	: : : :	: : : :
(4n + 8) through (4n + 11)	Channel n Data *	4 bytes per channel

* Optional based on Number of Channels setting.

Packets with Module-Port Information

Byte	Name	Value
0	Binary ID	3 = EU with channels (EU =1) 4 = Raw with channels (EU = 0)
1	Group ID	1 to 8 If Tag Bit is set, 80 Hex will be merged with the Scan Group Number. (81 to 88)
2 and 3	Number of Channels	0 to 512 (Byte 2 is LSB)
4 through7	Frame Number	1 to 2^{32}
8 through 11	Time in milliseconds	0 to 2^{32}
12 through 19	Channel 1 Data	Data (4 bytes), Module (2 bytes), Port (2 bytes)
20 through 27	Channel 2 Data *	Data (4 bytes), Module (2 bytes), Port (2 bytes)
: : : : : :	: : : :	: : : :
(8n + 4) through (8n + 11)	Channel n Data *	Data (4 bytes), Module (2 bytes), Port (2 bytes)

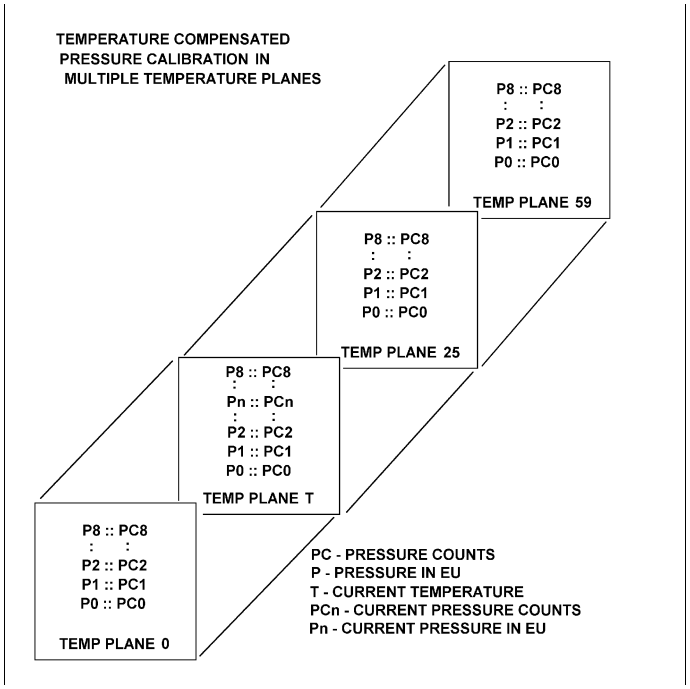
* Optional based on Number of Channels setting.

When BIN is set to 1 and the BINADDR is set to a value other than zero, the data from the AUX or CAL commands are converted to a BINARY format and output over the UDP binary port specified in the BINADDR variable. The data format is:

<ID byte> - 1 byte, the value will be 1 if the data are from a calibrator or 2 if the data are from an auxiliary unit.

<pressure> - 4 bytes of floating point binary pressure data

APPENDIX A - TEMPERATURE COMPENSATED PRESSURE CONVERSION



FORMULAS:

Pressure interpolation within current temperature plane:

$$P_{n_t} = \frac{1}{PC_{1_t} - PC_{0_t}}((PC_{1_t} - PC_{n_t})P_{0_t} - (PC_{0_t} - PC_{n_t})P_{1_t})$$

Calculation of entries in current temperature plane:

$$P_{n_t} = \frac{1}{PC_{1_t} - PC_{0_t}}((PC_{1_t} - PC_{n_t})P_{0_t} - (PC_{0_t} - PC_{n_t})P_{1_t})$$

Calculation of entries in current temperature plane:

$$P_t = \frac{1}{T_{25} - T_0}((T_{25} - T)P_{0_0} - (T_0 - T)P_{0_{25}})$$

APPENDIX B - ENGINEERING UNIT CONVERSION CONSTANTS

UNITSCAN Setting	Engineering Unit	PSI to EU 1 psi =	EU to PSI 1 EU =
ATM	Atmospheres	0.068046 A	14.6960 psi
BAR	Bars	0.068947 b	14.5039 psi
CMHG	Centimeter of Mercury	5.17149 cmHg	0.193368 psi
CMH2O	Centimeter of Water	70.308 cmH_2O	0.014223 psi
DECIBAR	Decibar	0.68947 db	1.4504 psi
FTH2O	Foot of Water	2.3067 ftH_2O	0.43352 psi
GCM2	Gram per square Centimeter	70.306 g/cm^2	0.014224 psi
INHG	Inch of Mercury @ 0°C	2.0360 inHg	0.491159 psi
INH2O	Inch of Water @ 4°C	27.680 inH_2O	0.036127 psi
KGCM2	Kilogram per square Centimeter	0.0703070 kg/cm^2	14.2235 psi
KGM2	Kilogram per square Meter	703.069 kg/m^2	0.0014223 psi
KIPIN2	kips per square inch(ksi)	0.001 kip/in^2	1000.0 psi
KNM2	Kilonewton per square Meter	6.89476 kN/m^2	0.145038 psi
KPA	Kilopascal	6.89476 kPa	0.145038 psi
MBAR	Millibar	68.947 mb	0.014504 psi
MH2O	Meter of Water	0.70309 mH_2O	1.42229 psi
MMHG	Millimeter of Mercury	51.7149 mmHg	0.0193368 psi
MPA	Megapascal	0.00689476 Mpa	145.038 psi
NCM2	Newton per square Centimeter	0.689476 N/cm^2	1.45038 psi
NM2	Newton per square Meter	6894.76 N/m^2	0.000145038 psi
OZFT2	Ounce per square Foot	2304.00 oz/ft^2	0.000434028 psi
OZIN2	Ounce per square Inch	16.00 in/ft^2	0.062500 psi
PA	Pascal	6894.76 Pa	0.000145038 psi
PSF	Pound per square Foot	144.00 lb/ft^2	0.00694444 psi
TORR	Torr	51.7149 T	0.0193368 psi

APPENDIX C - CHANGE LIST

This section contains change information to assist a user in determining the differences between different versions of software.

Version 1.00 - December 5, 2002
- First release.

Version 1.01 - February 13, 2003
- Added support for RDS Modules
- Increased DOUT Channels to 64 to support 8 RDS Modules.
- Added error checking for USB on startup.

Version 1.02 - March 21, 2003
- Improved USB error tolerance
- Corrected " No ID Read " error in some computers
- Corrected Local Sign on errors
- No changes in commands or configuration variables.

Version 1.03 - Not Released

Version 1.04 - April 11, 2003
- Added CLOSE Command to close scanxxx.dat file. Valid only when CONOUT is set to 3.
- Added support to write Binary Data to Local Hard Disk.

Version 1.05 - May 2003
- Enabled Immediate Scan when SCANTRIG is set to 1
- Corrected bug in the Scan Function when ADTRIG set to 1
- Corrected bug in DOUT settings when Scan Function is exited
- Deleted Digital Input Variables DINCALZ, DINPG, DINSCAN, DINSTRIG.

Version 2.00 - February 2004
- Software modified to support a new USB driver
  - VID - 0BD7
  - PID - A020
  - Authorization Key - 5484A968A36F1FF4
  - APAUSB.SYS
  - APAUSB2K.INF
  - APAUSBPROP.DLL
- Added Tag bit function - ADTRIG option 2
- Added No QUEUE option
- Added support for DSA3216 Enclosure
  - TWOAD
- Added Scan Recovery Options
  - RESCAN
- Added A/D Correction for Non-Temperature Compensated A/D Modules
  - A2DCAL
  - A2DCALC
  - LIST A2DCOR

Added A/D Correction for Temperature Compensated A/D Modules
A2DTCAL
A2DTCALC
LIST A2DTCOR
Added Temperature Gradient Compensation
TGRAD
Added A/D Module Temperature Polling
TEMPPOLL
Added Error and Event Log File
ERRLOG.TXT

Version 2.01 - released February 2004
Corrected a bug in the RESTART Command
Eliminated a possible duplication of the SET CHANNEL assignments in Scan Group 1
Added an Error output if A/D correction values are not valid when A2DCOR is enabled

Version 2.02 - Released February 2004
Added a TCP/IP function to prevent data loss when transferring large amounts of TCP/IP data.

Version 2.03 - Released February 2004
Corrected a bug in the Analog to Digital Correction function when TWOAD is set to 1.

Version 2.04 - Released March 2004
Corrected a channel alignment problem in CAL, CALINS and CALZ commands when in the TWOAD mode.

Version 2.05 - Not Released

Version 2.06
Repaired a bug in the RESTART Command to re-initialize the RAD.hex file without crashing the program.
Added support for DSM RTD values from MPF files (DSM Temp A/D's have lower gain than RAD A/D's)
Added support for ID Chip information in Enclosure mode of Operation
Added support for the Temperature Gradient Calculation
Added BankA, BankB, and BankUsr Commands to the Digital group
Revised the A2DTCALC algorithm
Restored Support for CALCMD and AUXCMD Commands
Improved the response time of the LIST SYS Command - ID chips are not polled if the U option is not used.
Added Temperature ID chip selection for the RADBASE
Changed default of CurrentA2DT from 0.0 to 35
Fixed a bug in the CALCMD Command
Corrected an A/D temperature coefficient mapping error when in the enclosure mode.
Corrected a RTD mapping error when in the enclosure mode.

Version 3.00
Changed RAD.exe to use blocking threads on input to yield processor time back to Windows.
Switched to the Windows default TCP/IP socket buffer
Increased the maximum setting of FM to 20.
Added the command: DELETELOGFILE.
Added test for Error Log file size greater than 5242880

Version 3.01 - Released February 2005

Removed the GETFILE command
Added DOUTPU command
Added a limit check to the Scan Group Average Variables
Corrected a bug in the external trigger
Corrected a bug in the TRIG command
Corrected a bug in STARTCALZ

Version 3.02 - Released March 2005

Added ID chip support of EIM Voltage Scanners

Version 2.10 - Released May 2005

Reverted back to the non-blocking thread version to improve stability and data transfers. The command and configuration variables in this version are identical to v3.02.

Version 5.01 - Released February 2007

Rewrote RAD.exe to run as a service in Windows XP instead of an application.

Removed Commands:	DIN
Added Commands:	LIST P ALL, CALZ ALL, SCAN ALL, STOP ALL, LOGIN, LOGOUT,
Removed Variables:	CONOUT, FM, QPKTS, HAVENET, NETIN, TWOAD
Added Variables:	FILEOUT, FILEPREFIX,
Password protect Commands:	LIST ID, LIST IDP, IDPWRITE, RESTORE, A2DCAL, A2DTCAL, A2DCALC, A2DTCALC, LIST A2DCOR, LIST A2DTCOR
Password protect Variables:	A2DCOR, IDP

Version 5.03 - Not Released

Version 5.04 - Released August 2007

Corrected a bug in the TEMPPOLL function
Removed RESTART and RELOAD commands

Version 5.05 - Released September 2007

Corrected a bug in the ID chip polling

Version 5.06 - Released October 2007

Corrected a bug in the Scan All Command
Added support for Legacy Rad modules at bootup

Version 5.07 - Released January 2008

Corrected problem with DOUTPU.
Write points to event log during fill.
Use 0 C master point below 0C.

Version 5.08 - Released October 2008

Corrected a bug in the Digital Outputs
Added support for “legacy” RAD and ZOC modules - without ID chips
Added “Fast Scan” mode to scan 16 channel blocks in ZOC22 and ZOC33 modules.

Version 5.09 - Not Released

Version 5.10 - Released May 2009

Modified data stored in files saved under the SAVE <file> command
Modified data stored in the EVENTLOG.txt file to minimize file size
Improved support of “legacy” RAD and ZOC modules
Added error output pattern to the DOUTSCAN variable - Pattern will be set if data from any module exceeds or equals ±32767 A/D counts when EU is set to 0
Added error output pattern to the DOUTSCAN variable - Pattern will be set if data from any module sets MAXEU or MINEU when EU is set to 1
Added SET SNx command to the Advanced commands (Password Protected)
CALPER is now fixed at the value set in PERIOD
CALAVG is fixed at 32

Version 5.11 - Released April 2011

Added a gain code of 2 for special A/D modules
Corrected a timing problem that caused A/D #2 to always indicate 1.00 degree C after a TGRAD