0.2 NCAR Hygrothermometer
Quick Reference

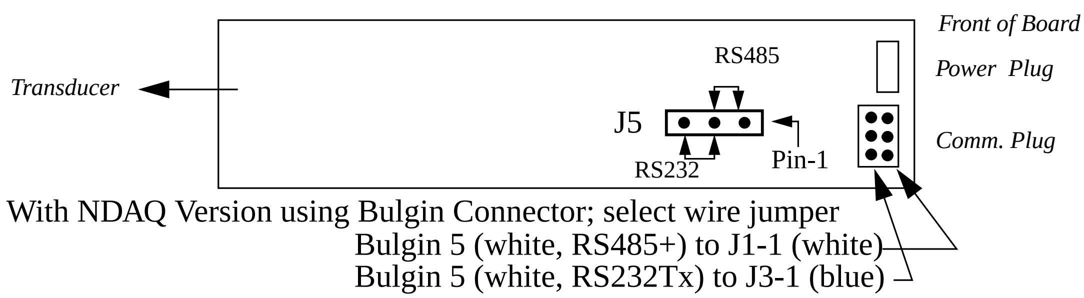
Sections Include:

0.2.1 Description:

NCAR Hygrothermometer (TRH) system is used for measuring air temperature and humidity. A Vaisala 50Y humitter is interfaced via a Crystal Semiconductor 5505 A/D serviced by a Motorola 68HC11 microprocessor which is also used for communicationing with a host computer. Data output can be broadcast automatically or polled by host computer using by either RS485 or RS232 serial communications.

0.2.2 Board Jumpers:

Jumper J5 on the CPU4AD configures the sensor for RS-485 or RS-232 communication as shown. For the NDAQ Version (with 8-pin Bulgin Connector), pin-5 must be jumpered to the correct distribution on the board as shown.



Note the board broadcasts in both RS232 and RS485. The older board design, V1.1, which allowed 8 a/d channels using a piggy back board, included 2 jumpers for communications, J5 and J6. The second jumper allowed the RS232 transmit line to be disabled.

For the board to work, jumper JP1 pins 1-2 or else 2-4 must be connected. This connects signal ground to power ground.

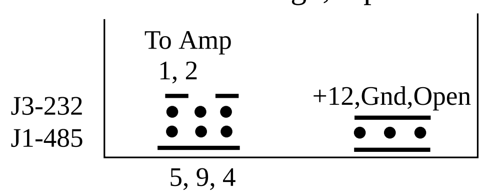
For the HexFET circuit to work and provide switchable power to an external device, JP1 pins 3-4 must be connected as well as J13 pins 1-2.

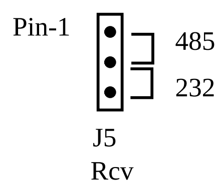
0.2.3 Wiring:

Signal	NDAQ Bulgin 8	Berg/Pin	Humitter
=====	========	======	======
+12V	1	J2-1	+PWR
Pwr ground	8	J2-2	
RS-485+	5	J1-1	Sbus communications
RS-485-	4	J1-2	Sbus communications
shield	7		open
RS232 Transmit	5	J3-1	from hygrothermometer
RS232 Receive	6	J3-2	to hygrothermometer
SigGround	7	J3-3	signal ground (optional)

Signal	EVE 9-Pin Amp	Berg/Pin	Humitter
=====	========	======	======
+12V	8	J2-1	+PWR
Pwr ground	7	J2-2	
RS-485+	5	J1-1	Sbus communications
RS-485-	9	J1-2	Sbus communications
shield	6		open
RS232 Transmit	1	J3-1	from hygrothermometer
RS232 Receive	2	J3-2	to hygrothermometer
ground	4	J3-3	signal ground (optional)

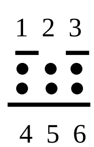
For V1. CPU4AD Design, top view:





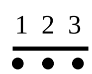
50Y wiring For single-board V1. CPU4AD Design:

50Y Berg Plug to socket
JP4 on TRH board



1 NC
2 Ground
3 +12VDC
4 T
5 Shield
6 RH

Micronel Fan Berg Plug
to socket J13 on TRH board



1 Ground
2 +12VDC

0.2.4 Default Operating Paramters Setup and Installation:

Before plugging the TRH onto a remote station, make certain that the following default operating parameters are setup properly in the EEPROM (see EE commands below):

protocol=0	for SBUS operation, otherwise 1=interactive
mode_def=0	for SBUS and/or polled operation, otherwise 1=continuous data broadcast at the defined 'data_rate'
id_def=xx	for SBUS operation, must match what EVE's config.dat will be polling. If more than 1 TRH on a station, each must have unique id_def numbers. Normally set '01'
msg_fmt	Normally set to 'C' for caled output

The hygrothermometer is normally installed on a 1.5" square tubing 'crossarm' opposite the static pressure port. The sensor bus cable should be inserted in the crossarm. Connect the loose cable end into the Hygrothermometer and slide the sensor into the crossarm with the radiation shield oriented pointing down. Secure the sensor using 1/4"x20 nylon tipped set screws in the end of the crossarm. If the station power is turned on, the Hygrothermometer fan should start when it is plugged in. If not check power connections.

0.2.5 Sensor Commands:

The Hygrothermometer supports a the full NCAR sensor bus command set and two sub-menu command sets. Several of the full sensor bus commands are not actively used but are listed below for reference.

Main Menu Commands:

MR or 'break'	System Reset
PH	Print Help (command menu)
PA, PF	Print Name/Addr, Data output format
OD	Output Data
OS	Output status
CD	Continuous data output mode
PM	Polled data output mode
FR,FC,FB	Set Output message format Raw / Calibrated / or Both
SAxx	Set sensor bus Logical Address to xx (xx= 00-ff). Note the 'id_def' value is the 'power up' address.
HEX5ON	Turn-on Hexfet
HEX5OFF	Turn-off Hexfet
AD	Enter A/D Submenu Commands
EE	Enter EEProm Submenu Commands

(Seldom or unused Commands removed with Version 2.0 CPU4AD software "*")

*ST	Set sensor time
*TSx	Broadcast synoptic sync
*SSx,y	Set Output Mode: Synoptic,char=x,offset=y tenths
*MD, MS	Hard / Soft power down

EE Submenu Commands:
Used to set or examine the default operating / bootup parameters of the sensor. Entering these commands as shown causes the sensor to report what the existing value is. Entering the commands suffixed by '=xxx..' causes the sensor to reprogram the stored value.

PH	Print Help (EE submenu commands)
PE	Print EEPROM contents
init	Initialize eeprom
s/n	Sensor Serial No.
id_def	Def Logical ID
msg_fmt	Def Msg Fmt (R,B,C)
protocol	Def Mode ('0'=Bussed,'1'=Interactive)
mode_def	Def Output Mode ('0'=Polled,1,2=Contin,3=synop)
data_rate	Def Continuous Message Rate
hexfet_def	HexFet Default '1'=on, '0'=off
EE	return to main menu commands
status_rate	Def Status Sampling Rate (sec)
sample_rate	Def sampling rate
adconfig	Set A/D configuration flag (ie that it can be used)
calrate	Set auto A/D calibration rate in seconds
thvref	Set reference voltage, usually 2.5

(Seldom or unused Commands removed with Version 2.0 CPU4AD software "*")

*cal_date	Last Calibration Date
*syncoff	Synoptic broadcast offset,1/10th-sec
*synchar	Synoptic sync character
*missing	Missing Data Flag
*dcoef	Test Double array, 2 elements
*lcoef	Test long array, 2 elements
*icoef	Test int array, 3 elements

EE Programming Caution Notes:

id_def	Must be programmed with 2-digits: ie '01', not '1' Otherwise problems can creep in, in particular non-recognized id in sbus mode causing the sensor to appear as if it isn't working.
s/n	Should be an integer, generally with 3-digits: ie '00x' (range=0 to 65536, 16-bit) Most PAM sbus sensor ingest software has a 'scanf' statement which expects an integer and anything else will cause the entire message to be discarded.
s/n	Must be programmed using the interactive, not SBUS mode. The sensor has a bug which appends the valid checksum of a 's/n=xx' command in sbus mode to the stored value. This will cause a sensor's message to get dropped similar to the note above.
msg_fmt	Is case sensative and must = 'R', 'B' or 'C' not 'c'..
init	Beware. If you use this command, everything gets reprogrammed and both the EE commands and especially the AD setup and coefficients must be re-established for your sensor.
adconfig	This flag must be set =1 after programming the a/d coefficients and channels or else the trh will not sample and report data.

AD Submenu Commands:

These are used to program or examine calibration coefficients and for diagnostic message outputs needed during sensor calibration. (Note some of these commands will significantly effect the operation of the sensor; don't use them unless you know what you are doing.)

PH	Print Help (AD submenu commands)
AI	Initialize A/D's
AC	configure Ads
PC	print config (prints channel parameter settings)
REF	A/D reference parameters
DIAG	diagnostic toggle (changes output format)
COFL	coefficient load (enter new coefficients)
CHNL	channel assignment
MODL	bi/ui polar load (select a/d mode)
CALL	calibration number (select calibration routine)
AD	return to main menu command

0.2.6 Entering New A/D Coefficients:

The NCAR calibration coefficients for a 50Y probe consist of a polynomial fit for the temperature, and a polynomial fit for the RH. The equiations are of the form:

T = A0 + A1*X + A2*X^2

RH = A0 + A1*X + A2*X^2 + B0*X*T

7 coefficients are needed. Find the proper Cal-Report values to enter in this next process. NOTE: for the old version of the TRH CPU, there are 2 banks of A/D so the commands need an additional parameter such as: COFL 0 1 2<cr> (A/D 0, channel 1, coef. 2)

Type AD<cr>	This enters the calibration commands mode for the sensor.
Type PC<cr>	Show current settings

Enter the 3 coefficients for Temperature. Each command is terminated by a carriage return:

MODL 0 0	Setup unipolar mode, 0-2.5 volts range
CALL 0 1	Setup Calibration for T_50Y
COFL 0 0 a0-value	(CPU4AD) Channel 0, coefficient 0
COFL 0 1 a1-value	Channel 0, coefficient 1
COFL 0 2 a2-value	

Enter the 4 coefficients for RH

MODL 1 0	Setup unipolar mode, 0-2.5 volts range
CALL 1 2	Setup Calibration for RH_50Y
COFL 1 0 a0-value	Channel 1, coefficient 0
COFL 1 1 a1-value	

COFL 1 2 a2-value	Note sometimes this value = 0 depending upon the curve fit accuracy during cal.
COFL 1 3 b0-value	

Enable Channels for Sampling

CHNL 0 1 2	(CPU4AD) Sample channels 0, 1, and 2 in that order
CHNL 0 0 1 2	(CPU V1.1) Sample A/D #0 channels 0, 1, and 2 in that order

Type AD<cr>	To leave the calibration mode.
Type OD<cr>	To output data and verify that the temperature and RH values look reasonable.

0.2.7 Trouble Shooting Hints:

Known Problem: *Board Current Status Monitor (OS Parameter):*
With the CPU4AD version of the board, the current monitor circuit does not work. The LT1013 op-amp pin layout is different between the surface mount part and the DIP package part and the board layout person's library had the wrong pin designations for the surface mount part which is used. The 'Output Status' value reported is bogus, but fortunately the board temperature circuit does work.

Bad observed temperature / humidity:
The transducer must be clean and not resting too close to the mount. Verify that the filter is clean. Cleaning of the Vaisala 50Y Humitter is done with distilled water and a Q-Tip. To do this, carefully remove the filter cap. Do not touch the filter material because skin oils or dirt may clog it. Use a Q-Tip to swab the transducer and allow it to air dry. It may be necessary to do this more than once. Cleaning and/or replacing the filter's Gortex material is somewhat tricky. Surgeon's gloves are very handy when doing this to help prevent contamination. Prepare spare filters in the lab before going to the station. Store clean filters in a air-tight sealed bag. When cleaning the sensor it is a good idea to observe readings both before and afterwards to determine what effect it has. Always record observations about the condition of the sensor. Some environments cause accelerated degradation, molds, etc. Condensation can occur inside the filter itself which may be observed in the data usually in the morning before the vapor has had a chance to dissipate through the filter material.

Verify the fan is working properly. Sufficient aspiration is needed for good measurements. Clogged blades or worn/dirty bearings can be a significant problem. Replace fan as needed.

SBUS problems:
These can cause data to appear erroneous even though some data is apparantely coming through. This most likely will happen if the sensor is too slow to respond to a valid command per the sbus specification. If the data messages appear incomplete, or an improper response is received to a valid command (such as a correct response, but for the previous command you entered via the EVE talk), then an excessive sensor response should be expected. The EVE sbus command can be adjusted for 'delay' that is greater than the specified 100mS: see the EVE manual for adjusting the configuration file to correct for this problem. Another likely problem if there are more than one trh sensors on the

bus is that two or more sensors are programmed with the same ID number and are both trying to respond at the same time. This is generally easy to detect using the talk program and plugging in each sensor by itself in sequence to confirm its ID number (ie id_def).

No communications:
This can be caused by either hardware or software errors.

1) Verify operation of sensor bus. Stop the data system using the EVE system console. Type "talk" and at the first menu select the proper port (usually /tyCo/1). At the next menu select sensor bus mode (S). At the next menu select check all possible sensor addresses (option 3). Do any other sensor bus sensors respond (the RMYoung sensor)?

NO) Check cabling, check power to sensor bus, check serial-option board in PAM electronics box.

YES) Check terminals at Hygrothermometer. Verify power and sensor bus connections with a volt meter.

2) Verify operation of the Hygrothermometer with sensor bus test cable. This cable is a short (2 meter) cable which can be used to connect between the electronics box and a sensor bus sensor. The Hygrothermometer must be removed from the cross-arm in order to do this.

a) On the EVE system console use "talk" to try and communicate with the sensor. Use option 3 from the main sensor bus talk menu to try and find the sensor's address on the bus. It should usually be set to either 0x01 or 0x02.

b) If the address is not found, then stop the data collection on EVE and talk to the sensor in normal mode using RS-485, 9600 baud, 8 data bits, and no parity. Hit the <ESC> key three times to place the sensor in interactive mode. Type "SA01" to set the sensor address to 0x01. If no response is received, then the problem is either:

- bad serial hardware or fuse in electronics box.
- bad Hygrothermometer

If the sensor is not communicating, this may mean that the RS485 communications transceiver has been damaged. This can be easily determined by disassembling the sensor and resetting the jumper 'J5' so that it will operate in RS232 mode instead of RS485. Refer to the wiring noted above and connect the sensor to a dumb terminal, apply power and observe whether or not the sensor is communicating. If it does, then the RS485 driver, chip U3, should be replaced.

0.2.8 Beacon / Compass Adaptation for SHEBA:

The SHEBA TRH configuration includes an electronic compass and strobe beacon. These devices are controlled via a piggy-back board on the TRH CPU which includes a HexFET to turn on/off each independently and a DC/DC converter to provide the 6 volts needed for the Beacon. Additional TRH commands for manipulating these devices include:

BEACON	turns the beacon on under manual control only
BEACOFF	turns the beacon off, manual control only
COMPON	ditto (these were later disabled to become..)
COMPOFF	ditto
HEATON	ditto (these were later adaptations for the sonic heaters)
HEATOFF	ditto (stolen from the original compass hexfet circuit)

The electronic compass in normally turned on and off every 20 seconds under control of the TRH software. These cycling rate was chosen during checkout and debugging but may not be appropriate for normal station operations. Cycling of the compass was implemented in order to save station power during SHEBA. To change the cycling rate of the sensor the 'EE' commands must be used. Enter the EVE talk program to directly communicate with the sensor, then enter the commands:

EE	goes into the configuration commands.
compon=xxx	xxx is the number of seconds to keep the compass up
compoff=yyy	yyy is the no. of seconds to keep the compass off
EE	to get back into normal command sequence
MR	reset the sensor with the new config.

Note that if you want the compass to stay up continuously, simply set the 'compoff=1' and perhaps the compon='a big number'.

The Compass orientation is setup such that the 'North' or 0-degrees is aligned with the back of the TRH sensor, towards the cross-arm: