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NeatLab:

NeatLab dramatically increases the capabilities of TNG-3B. Digital channels can be configured as either inputs or outputs. Two SPI-compatible ports are included for controlling and reading smarter sensors. All ports provide ground, power, and signal. The RJ45 connectors allow 4 lines to be grouped in a connection. Each signal conductor in an ribbon cable attached to an RJ45 connector has either power or ground as adjacent conductors, reducing cross-talk. The power budget is 100 mA when not using an external power source. The external power source allows NeatLab to source up to 500 mA (power derived from I/O lines is limited to 200 mA). The baud rate is fixed, but much higher (125 kbps). The analog to digital converter inputs support 10-bit resolution. Asserting DTR powers the NeatLab and its attached devices.

NeatLab Feature Bullets:

- USB Interface: acts as a virtual COM port at 125 kbps (8 data bits, 1 stop bit, no parity).
- Asserting DTR powers up the NeatLab processor.
- Uses FTDI virtual COM port drivers available at (http://www.ftdichip.com/FTDrivers.htm).
- 8 ADC inputs, 10-bit resolution, 0 to 5 VDC (nominal) input range. Eight or 10-bit resolution is jumper selectable (J4-J7 and J13; left side).
- 8 Individually-configurable digital I/O lines (source/sink 20 mA; J8-J12; right side).
- 2 Built-in SPI ports (J14 and J15; lower-most RJ-45 connectors on left and right sides).
- Each port connector has 2 ground and 2 power pins. Each signal line has an intervening power or ground wire.
- TNG-3B compatibility mode selectable by an internal jumper or by command.
- Command mode software interface for configuring NeatLab or outputting data.
- Internal Port D 8-bit digital I/O header (J16).
- Firmware updates via USB.

Jumpers:

There are two physical jumpers on the NeatLab board. JP1 selects TNG-3B mode when shorted. JP2 selects 8-bit A/D resolution when shorted. The jumpers are only read on power-up. Normally, NeatLab starts in command mode. When JP1 is present, NeatLab automatically enters a block mode transmission. Ports B and D are all digital inputs by default. The NeatLab mode transmits TNG-3B data packet (separator byte, 8 analog bytes, and one Port B input byte) once every 5 milliseconds (200 Hz).

JP2 selects 8-bit A/D resolution when present at power-up. If JP2 is removed, extended (2-byte) resolution is selected. Therefore, true TNG-3B compatibility is only really enabled when both JP1 and JP2 are present. In the extended A/D resolution mode, TNG=X sends two bytes for every A/D channel. The most significant byte is sent first.

These jumper settings can be overridden by command after power-up.

NeatLab Commands:

NeatLab commands are ASCII bytes (To send the "9D" command, transmit a single byte equal to that value, not the ASCII characters "9" and "D"). Command byte values are in hexadecimal. The following commands are supported:

90: Read first bank memory byte. Reads any memory location (0-255). The memory location to read is specified in the byte sent immediately following the command. The command returns one byte that is the value of that location.

9D: Return ID/version. This command returns 30 bytes: "NeatLab V1.0 ©2008 SenSyr, LLC<CR><LF>".

FE: Resets NeatLab just as if you power-cycled the device.

FF: Does nothing. If you send it 3-6 times, then you'll be sure that the next byte will be interpreted as a command byte.

ADC Commands:

A0: Read ADC Channel 0. This command returns 2 bytes in extended resolution mode: MSB, LSB. The most significant 8 bits are returned in the first byte. The second byte contains the least significant bits. There are limits to the time resolution of the samples. The ADC sampling process is independent of the data interface. At 125 kbps you could theoretically obtain 6,250 samples per second using a single channel command in extended resolution; however, the channel's data is not updated that fast. The maximum usable sample rate is about 1250 Hz. All the analog connectors are located on the left side of NeatLab—the first four 3.5 mm stereo jacks and the first RJ-45 connector. Analog channel numbers increase from 1 through 8 descending along the left side of NeatLab.

A1: Read ADC Channel 1.
A2: Read ADC Channel 2.

A3: Read ADC Channel 3.
A4: Read ADC Channel 4.
A5: Read ADC Channel 5.
A6: Read ADC Channel 6.
A7: Read ADC Channel 7.
A8: Read ADC Channel 8.

C0: Read the first N ADC channels where N ranges from 1 to 8. The number of consecutive ADC channels to read is sent in a byte immediately following the command. The total number of bytes returned is N or N*2, depending on the resolution setting. The most significant byte of each sample is returned first.

C1: Read ADC channels 0-3.
C2: Read ADC channels 4-7.
C8: Read all ADC channels. This command returns the data for all 8 ADC channels (16 bytes).

E0: Set 8-bit ADC resolution regardless of the the on-board jumper position.
E1: Set extended ADC resolution regardless of the on-board jumper position.

Digital I/O Commands:

BC: Set Port-B configuration. This command takes the next byte received as the Port-B configuration data byte. Each bit of the configuration byte corresponds to a port bit. Set configuration bits to 1 to enable input, 0 for output. This is similar for Port D. Connectors J8-J11 correspond to bits 0-3 of Port B. The remaining 4 bits reside on the J12 RJ-45 connector on the right side of NeatLab.

DC: Set Port-D configuration. This command takes the next byte received as the Port-D configuration data byte.

BD: Write Port-B data. This command takes the next received byte as data to write to Port-B.

DD: Write Port-D data. This command takes the next received byte as data to write to Port-D.

FB: Read Port-B data. This command sends one byte read from Port-B.

FD: Read Port-D data. This command sends one byte read from Port-D.

FA: Read Port B and D together. This command returns 2 bytes—Port-B, and Port-D.

BF: Read Port B configuration data. This command returns the one-byte Port B mask.

DF: Read Port D configuration data. This command returns the one-byte Port D mask.

DB: Write B and D digital I/O ports. This command accepts the next two bytes sent as data for Ports B, and D, respectively.

Port C is not directly configurable or settable. The bits of Port C are allocated to special functions and the SPI ports.

SPI Commands:

9C: SPI Configure. This command redefines all SPI operations until the next SPI configuration byte is received or NeatLab is power-cycled. This command gets two subsequent bytes.

Byte 1:

7	6	5	4	3	2	1	0
SMP	CKE	---	CKP	--	---	SSPM1	SSPM0

SMP = SSPSTAT:SMP bit for PIC with same meaning.
1 = Input sampled at end of output.
0 = Input sampled in middle of output bit (default).

CKE = SSPSTAT:CKE bit for PIC with same meaning.
1 = Data output on leading edge of clock (default).
0 = Data output on trailing edge of clock.

CKP = SSPCON:CKP bit for PIC with same meaning.
0 = Clock normally low (default).
1 = Clock normally high.

SSPM1 and SSPM0 set the clock rate.
00=FOSC/4 (2 MHz, default)
01=FOSC/16 (500 kHz).
10=FOSC/64 (125 kHz).
11=TMR2/2 Rate (TMR2=[2 MHz/(1-256)])

Byte 2: Is the TMR2 value (0-255) or 0 if not being set.

98: SPI 1 write/read. This command requires a subsequent SPI flag byte and 1-6 or 8-256 data bytes. The SPI flag byte is detailed below. If the read bit is set, NeatLab will return the number of bytes sent. J14 (lowermost left side RJ-45) is the SPI1 connector.

7	6	5	4	3	2	1	0
R/W	S2	S1	S0	--	D2	D1	D0

R/W: This bit = 0 when data is output only.
This bit = 1 when reading data.

S2-S0: These bits specify which SPI enable line to use.
000 = Port C bit 0
001 = Port B bit 1
010 = Port B bit 2
011 = Port B bit 3
100 = Port B bit 4
101 = Port B bit 5

110 = Port B bit 6
111 = Port B bit 7

When using a Port B bit for the enable line, that bit must first be set as an output bit and initialized to logical 1 (high). Enable lines are active low.

D2-D0: These bits specify the number of data bytes to send/receive (1-6). When D2-D0 equals 7, the next byte sent will be interpreted as the number of subsequent bytes in the message. If this next byte is zero, no bytes are sent or received.

99: SPI 2 write/read. This command requires a subsequent SPI flag byte and 1-6 or 8-256 data bytes. The SPI flag byte is detailed below. If the read bit is set, NeatLab will return the number of bytes sent. J15 (lowermost right side RJ-45) is the SPI 2 connector.

7	6	5	4	3	2	1	0
R/W	S2	S1	S0	--	D2	D1	D0

R/W: This bit = 0 when data is output only.
This bit = 1 when reading data.

S2-S0: These bits specify which SPI enable line to use.
000 = Port C bit 1
001 = Port B bit 1
010 = Port B bit 2
011 = Port B bit 3
100 = Port B bit 4
101 = Port B bit 5
110 = Port B bit 6
111 = Port B bit 7

When using a Port B bit for the enable line, that bit must first be set as an output bit and initialized to logical 1 (high). Enable lines are active low.

D2-D0: These bits specify the number of data bytes to send/receive (1-6). When D2-D0 equals 7, the next byte sent will be interpreted as the number of subsequent bytes in the message. If this next byte is zero, no bytes are sent or received.

Block data commands:

In the interest of maintaining some sort of streaming mode, the block data commands were created. In TNG-3B compatibility mode, the default block rate is 200 blocks/second.

A data block (packet) consists of a start byte (alternating 55/AA) followed by one or more data bytes. The data bytes sent are defined by settable parameters (see B8 and B9 commands).

B0: Block send off. Turns off block data transmission.

B1: Block send on. Turns on block data transmission as per last (or default) B4, B8, and B9.

B4: Set sample interval. Two subsequent bytes (HB,LB) determine the interval between transmissions. The minimum sample interval is very much affected by the baud rate and block size. Each count corresponds to one millisecond. The smallest count is 1. NeatLab can send 12.5 bytes each millisecond. Therefore, NeatLab can send 1000 TNG-3B compatible blocks per second, maximum.

B8: Set number of ADC Channels to send. Subsequent byte is number of channels starting at 0.

B9: Set DIO mask. One subsequent data byte determines what digital data is sent, as follows:

7	6	5	4	3	2	1	0
--	--	--	--	--	PF	PD	PB

Where PF = 1 to send Flag Byte.
PD = 1 to send Port D data.
And PB = 1 to send Port B data.

Program Autoloader:

This allows most of the FLASH program memory of the PIC18F4520 processor of NeatLab to be reprogrammed via the USB connection. A portion of program memory is preserved (0x7C40 through 0x7FFF). This section of memory contains the autoloader code and program memory reserved by the ICD2 in debug mode. The autoloader cannot overwrite itself. A new autoloader can be pointed to in new code that would allow subsequently loaded code to reuse that space though.

AF: Starts autoloader mode. Block data transmissions are disabled. When the process completes normally, the microcontroller will be reset. Otherwise, the NeatLab will need a power cycle.

Block mode should be disabled and the input buffer flushed prior to issuing the AF command. Subsequent to sending 0xAF, the programming program should send 0xCC. NeatLab will respond with a 0x60 device ID byte, and then with a "K". The "K" indicates that it is OK to start processing autoloader commands.

Each time the NeatLab is ready for a new command, a "K" is sent. If the last command caused an error, an "E" will be seen. If the checksum (negated sum of the previous message bytes) is found to be bad, an "N" is returned.

The two most significant bits of the first byte sent in each message are operation flags. Bit 7 indicates a block erase. Bit 6 indicates a block read. With those bits masked off, the most significant byte corresponds to the uppermost address pointer. For example, the string, 0x80,0x7C,0x00,0x00,0x04 would erase 64 bytes of program memory starting at address 0x007C00. If the first byte was 0x40 (and the checksum byte 0x44), the command would read the 32 byte block at 0x007C00. The 4th byte is the byte count (0 in these examples).

Configuration memory space starts at 0x300000. The NeatLab processor has program memory from 0x0000 to 0x7FFF (32k bytes). The last 960 bytes (0x7C40 through 0x7FFF) are not writable via the autoloader.

A typical write memory block command (hex bytes):
000A E020 1292 4CEF 01F0 1282 4CEF 01F0 8150 1514 506E 0DEC 03F0 8350 1614 516E 0DEC 03F0 1A

The last byte is the checksum. The first 3 bytes are the starting memory address, which must be on a 32-byte bounary (0x00, 0x20, 0x40, 0x60, 0x80, 0xA0, 0xC0). The 4th byte is the byte count (0x20).

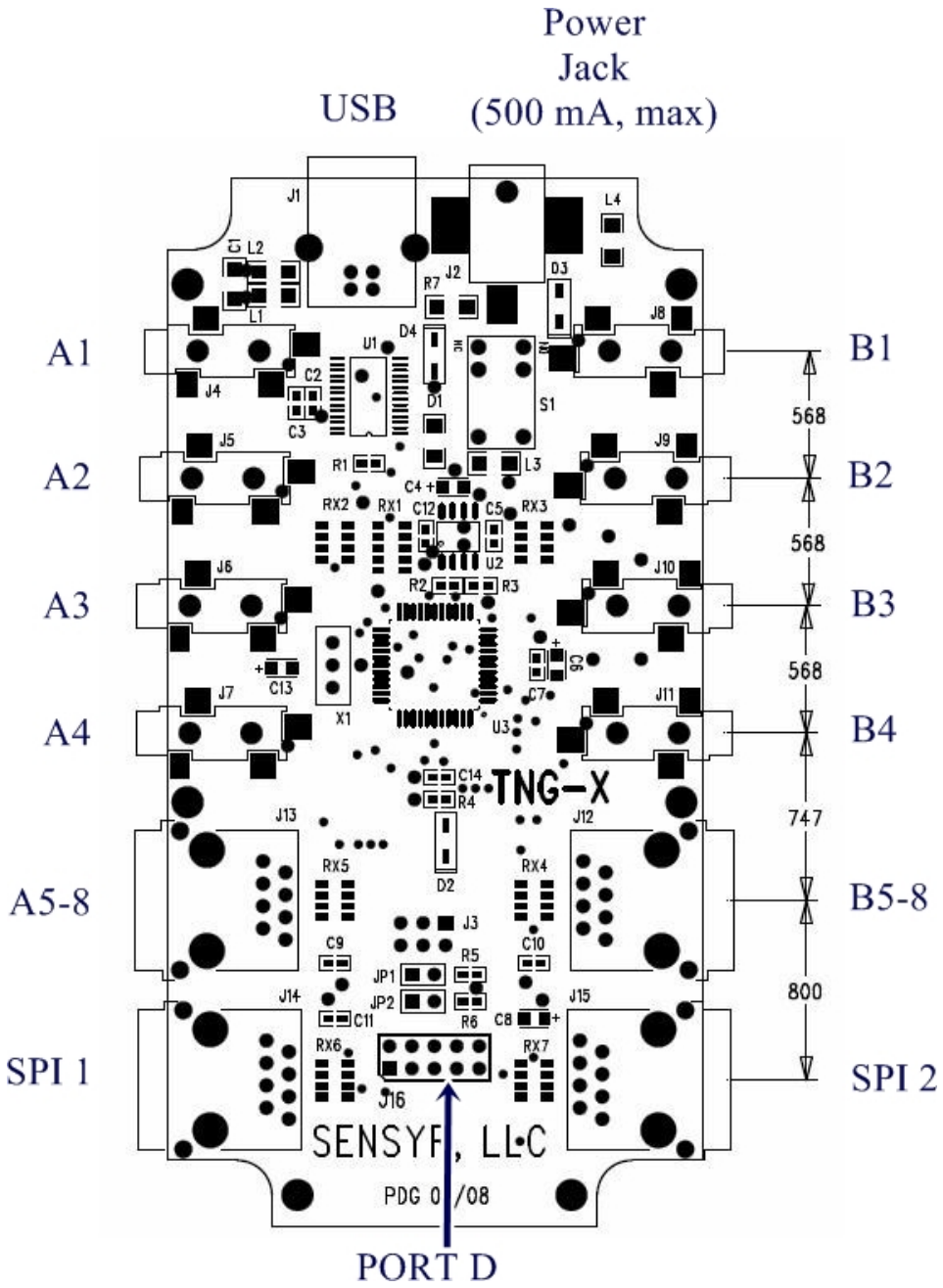
Command Table:

90	Send RAM byte	B0	Block Send Off	D0		F0	
91		B1	Block Send On	D1		F1	
92		B2		D2		F2	
93		B3		D3		F3	
94		B4	Set Sample Int.	D4		F4	
95		B5		D5		F5	
96		B6		D6		F6	
97		B7		D7		F7	
98	SPI 1	B8	Set ADC Mask	D8		F8	
99	SPI 2	B9	Set DIO Mask	D9		F9	
9A		BA		DA		FA	Read B and D
9B		BB		DB	Write B and D	FB	Read Port B
9C	SPI Configure	BC	Config. Port B	DC	Config. Port D	FC	
9D	ID command	BD	Write Port B	DD	Write Port D	FD	Read Port D
9E		BE		DE		FE	Reset
9F		BF	Get Port B Conf.	DF	Get Port D Conf.	FF	Sync
A0	ADC Ch. 0	C0	ADC Ch. 0-N	E0	8-bit ADC		
A1	ADC Ch. 1	C1	ADC Ch, 0-3	E1	10-bit ADC		
A2	ADC Ch. 2	C2	ADC Ch. 4-7	E2			
A3	ADC Ch. 3	C3		E3			
A4	ADC Ch. 4	C4		E4			
A5	ADC Ch. 5	C5		E5			
A6	ADC Ch. 6	C6		E6			
A7	ADC Ch. 7	C7		E7			
A8		C8	ADC Ch. 0-7	E8			
A9		C9		E9			
AA		CA		EA			
AB		CB		EB			
AC		CC		EC			
AD		CD		ED			
AE		CE		EE			
AF	Autoloader	CF		EF			

Fully-Populated Block:

		7	6	5	4	3	2	1	0
Byte 1	Separator Byte:	55 or AA							
Byte 2	Flag Byte	**PF**	**PD**	**PB**	**--**	**ADC3**	**ADC2**	**ADC1**	**ADC0**
Byte 3	A0 MSB	**A0H**							
Byte 4	A0 LSB	**A0L**							
Byte 5	A1 MSB	**A1H**							
Byte 6	A1 LSB	**A1L**							
Byte 7	A2 MSB	**A2H**							
Byte 8	A2 LSB	**A2L**							
Byte 9	A3 MSB	**A3H**							
Byte 10	A3 LSB	**A3L**							
Byte 11	A4 MSB	**A4H**							
Byte 12	A4 LSB	**A4L**							
Byte 13	A5 MSB	**A5H**							
Byte 14	A5 LSB	**A5L**							
Byte 15	A6 MSB	**A6H**							
Byte 16	A6 LSB	**A6L**							
Byte 17	A7 MSB	**A7H**							
Byte 18	A7 LSB	**A7L**							
Byte 19	Port B	Port B							
Byte 20	Port D	Port D							

NeatLab PCB:


Power
Jack
USB
(500 mA, max)
A1
A2
A3
A4
A5-8
SPI 1
B1
B2
B3
B4
B5-8
SPI 2
568
568
568
747
800
TNG-X
SENSYF, LLC
PDG 0 /08
PORT D

RJ-45 Connector Pinout:

SPI connections in parentheses