Date: 1-26-12

Subject: PICPCAP Version 5.2 Release Notes

Re: Version 5

From: LDL

Summary

The following lists a summary of the changes:

- Added the new decoding algorithms. Currently fixed at up to 8 touches, can be adjusted to do less or more, RAM dependent. The new decoding algorithms are less sensitive to thresholds
- Updated communications protocols for multi-byte responses to commands
- Added significant debugging communications functionality. Created "sendDebugBytes" function to transmit all diagnostic messages.
- Converted all existing diagnostic messages over to use sendDebugBytes system.
- Added Diagnostic message filtering capability (commands SETDIAGMASKCMD and GETDIAGMASKCMD). NOTE – this can cause modes to appear to not be operating correctly, as the diagnostic messages transmitted during that mode may be suppressed.
- Significant clean-up of communications functions to improve readability and decrease code size.

Diagnostic Masking

All Diagnostic Messages now have a valid, unique ID and are all transmitted by the sendDebugData function. That function implements a fairly simple diagnostic mask system. It will only transmit diagnostic messages with an ID that is present in the current diagnostic mask. Use the SETDIAGMASKCMD and GETDIAGMASKCMD commands to modify which entries are in the diagnostic mask.

Current Diagnostic IDs:

ID	Name	Description
0x01	SELFRAWDIAGNOSTICS	Self Raw data
0x02	MUTUALRAWDIAGNOSTICS	Mutual Raw data
0x05	SELFCONTROLLERDIAGNOSTICS	Self Controller Processed data (after baselining)
0x06	MUTUALCONTROLLERDIAGNOSTICS	Mutual Controller Processed data
0x09	RAWSELFADCDIAGNOSTICS	Self Raw ADC measurements (typically for noise testing)
0x0A	RAWMUTUALADCDIAGNOSTICS	Mutual Raw ADC measurements
0x11	LONGSELFSCANDIAGNOSTICS	Bulk Self Raw ADC measurements – 512 values
0x12	LONGMUTUALSCANDIAGNOSTICS	Bulk Mutual Raw ADC measurements – 512 values
0x1A	FINDTOUCHES	Diagnostics for the findTouches function

0x1B	FINDNEXTPEAK	Diagnostics for the findNextPeak function
0x1C	FINDFINELOCATION	Diagnostics for touch interpolation (findFineLocation)
0x1F	DIAGIMAGESTART	Diagnostic message that indicate the beginning of a decode cycle
0x1E	DIAGIMAGEEND	Not used
0x20	DIAGSELFDATA	Self Data captured during touch decoding
0x21	DIAGMUTDATA	Mutual Data captured during touch decoding
0x22	TOUCHDATAROUGH	Rough touch location early in the processing cycle
0x23	TOUCHDATAFINE	Fine(interpolated) touch location early in the processing cycle
0x24	DIAGNUDGE	Diagnostic information for the Nudge function
0x25	DIAGCOLCACHE	Diagnostics for the mutual measurement column cache This ID has several “sub-IDs” for different data.
0x26	DIAGTOUCHREPORT	Touch Report Diagnostics – contains all information on final touch location.
0x27	DIAGASSOCIATETOUCH	Diagnostics for the touch association function.
0x30	DIAGFINEX	Fine X Location from the interpolation function
0x31	DIAGFINEY	Fine Y Location from the interpolation function

Communications Changes

These are the changes performed to the communications packets:

I. Touch Packet Modifications

The location of the touch IDs has been modified in order to support additional touch IDs.

Original Touch Packet:

Packet\Bit	7	6	5	4	3	2	1	0
0	1	T1	T0	0	0	P2	P1	P0
1	0	X6	X5	X4	X3	X2	X1	X0
2	0	0	0	X11	X10	X9	X8	X7
3	0	Y6	Y5	Y4	Y3	Y2	Y1	Y0
4	0	0	0	Y11	Y10	Y9	Y8	Y7

T1, T0: Touch Packet ID (Currently only uses T0 for ID0 / ID1)

P2,P1,P0: Pen State (Currently only uses P0 for Pen Down/Pen Up)

X11,X10,…,X0: X Coordinate of touch

Y11,Y10,…,Y0: Y Coordinate of touch

New Touch Packet:

Packet\Bit	7	6	5	4	3	2	1	0
0	1	T3	T2	T1	T0	P2	P1	P0
1	0	X6	X5	X4	X3	X2	X1	X0
2	0	0	0	X11	X10	X9	X8	X7
3	0	Y6	Y5	Y4	Y3	Y2	Y1	Y0
4	0	0	0	Y11	Y10	Y9	Y8	Y7

T3, T2, T1, T0: Touch Packet ID (Currently uses T2,T1,T0 for IDs 0-7)

P2,P1,P0: Pen State (Currently only uses P0 for Pen Down/Pen Up)

X11,X10,…,X0: X Coordinate of touch

Y11,Y10,…,Y0: Y Coordinate of touch

II. Communications Protocol Changes

No modifications have been made to the format of the communications sent TO the controller, but modifications have been made to the responses from the controller to allow for multiple bytes of response data.

Original Communications Protocol

Command:

0x55	<size>	<command>	<data 0>	…	<data N>

Old Command Response (from firmware)

0x55	**0x01**	<result/data>

This response format would only allow a single result byte.

New Command Response:

0x55	<size>	<result>	<command>	<data 0>	…	<data N>

Size: Number of bytes remaining in the packet. Minimum size for a response is 2 – result and command, with no data.

Result: 0 for success, Non-zero for failure.

Command: The command the firmware is responding to (for synchronization)

Data 0 – Data N: The bytes of data in the response.

Potential Command Results:

0x00 – DEFAULTSUCCESS – the command was completed successfully

0xFE – COMMANDTIMEOUT – An entire command was not received within the timeout

0xFF – UNRECOGNIZEDCOMMAND – The command was not recognized

III. Command Set

Two new commands were added to the command set:

0xD0 – GETDIAGMASKCMD

Send

0x55	**0x01**	**0xD0**

Receive

0x55	<size>	<result>	**0xD0**	<Max Mask Size>	<Mask 0>	…	<Mask n>

Description:

This command retrieves all of the non-0xff values in the current diagnostic mask. (0xff is defined as “do not transmit”)

0xD1 – SETDIAGMASKCMD

Send

0x55	**0x01**	**0xD1**	<Mask 0>	…	<Mask n>

Receive

0x55	<size>	<result>	0xD1

Description:

This command sets the entire contents of the diagnostic mask. Up to <Max Mask Size> mask bytes may be transmitted to the controller. If fewer than <Max Mask Size> bytes are transmitted, the remaining entries in the mask are filled with **0xff** (do not transmit).

User Ram Parameters

Here is the entirety of userRam, with descriptions for the new parameters

Name	Type	Offset	Description
flag1	unsigned char	0	
numberOfRXChannels	unsigned char	1	
numberOfTXChannels	unsigned char	2	
customFlag	unsigned char	3	
xmul	unsigned short	4	
ymul	unsigned short	6	
General Parameters			
rxDiagChannel	unsigned char	8	
txDiagChannel	unsigned char	9	
adcADCS	unsigned char	10	
shChargeTime	unsigned char	11	
baseUpdateTime	unsigned char	12	
Self Parameters			
selfScanTime	unsigned char	13	
selfTouchThres	unsigned char	14	
selfDivider	unsigned char	15	
selfDelayTime	unsigned char	16	
selfCurrent	unsigned char	17	
maxminSelfThres	unsigned char	18	
selfSampleFreq	unsigned char	19	
selfOversample	unsigned char	20	
selfReplaceThres	unsigned char	21	
selfLPFilterValue	unsigned char	22	
selfMaxDelta	unsigned char	23	
PVCFGSelf	unsigned char	24	
FVRSelf	unsigned char	25	
Mutual Parameters			
mutScanTime	unsigned char	26	
mutThres	unsigned char	27	
mutDivider	unsigned char	28	
mutDelayTime	unsigned char	29	
mutCurrent	unsigned char	30	
maxminMutThres	unsigned char	31	
mutSampleFreq	unsigned char	32	
mutOversample	unsigned char	33	
mutReplaceThres	unsigned char	34	
mutLPFilterValue	unsigned char	35	

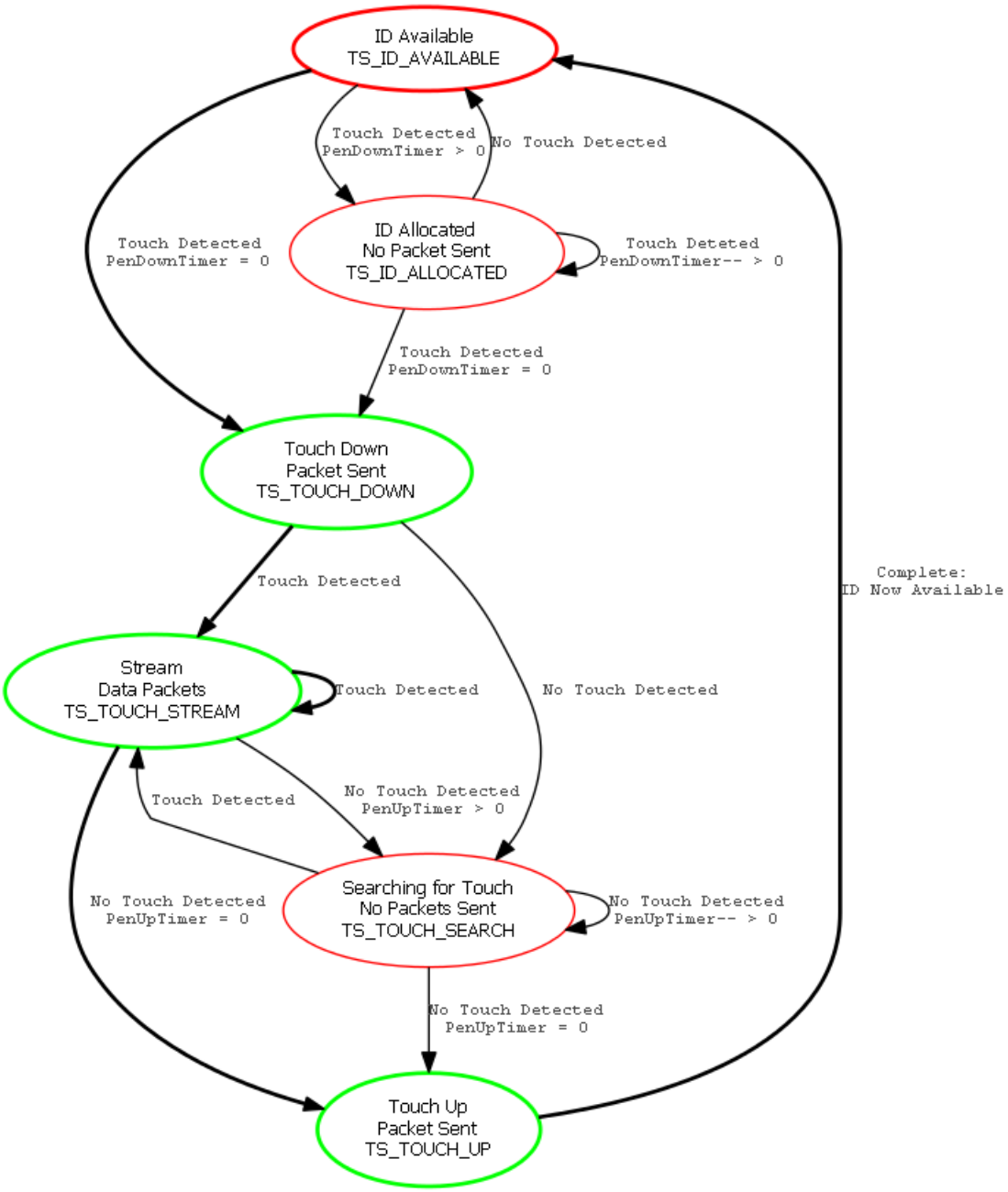
mutMaxDelta	unsigned char	36	
FVRMut	unsigned char	37	
PVCFGMut	unsigned char	38	
Decode & Tracking Parameters			
flipState	unsigned char	39	This determines the orientation of the sensor with respect to the coordinate output. It is a selection of bit flags, with the following values and meanings: Bit 1 (0x01) – flip X value (x = 1023 – x) Bit 2 (0x02) – flip Y value (y = 1023 – y) Bit 3 (0x04) – Swap X and Y (temp = X, X = Y, Y = temp) The flip operations are performed in the above order in the firmware.
numOfAvg	unsigned char	40	This parameter configures the number of prior coordinates to average into the current value to smooth the final output. **Default: 8**, Max: TOUCH_HISTORY, Min: 1
minCuspDelta	unsigned char	41	Minimum positive and negative slopes to either side of a peak required to identify a potential touch. **Default: 5**, Max: 255, Min: 1, Recommended Range: Max: 20
weightThreshold	unsigned char	42	Weight function value that no longer allows a potential match (any value below this may be a potential match). **Default: 255**, Max: 255, Min: 1
minTouchDistance	unsigned char	43	Minimum distance (interpolated coordinates) allowed between two touch locations. If two locations are closer than minTouchDistance, one is suppressed. **Default: 150**, Max: 255, Min: 0, Recommended Range: Max: 255, Min: 100
penDownTimer	unsigned char	44	The number of sensor scans in a row that a touch must be identified prior to touch data being transmitted. **Default: 1**, Max: 255, Min: 0, Recommended Range: Max: 5
penUpTimer	unsigned char	45	Then number of sensor scans in a row that a touch must NOT be identified prior to a touch up packet being transmitted. Default: 3, Max: 255, Min: 0, Recommended Range: Max: 5, Min 1
Port Maps			
rxPinMap[MAXRX]	unsigned char	Starts at 46	
txPinMap[MAXTX]	unsigned char	Starts at 46 + MAXRX	

Decode & Tracking Algorithm

I. Key Concepts

A. Touch State Machine

Every touch utilizes the following state machine:



All green states include data packets being transmitted. All red states do not transmit data. The bold lines (around the "outside") are the minimum state sequence, although during normal operation all states are utilized.

II. Functions & Short Descriptions

For full documentation, please review the Doxygen output located in the Doxygen directory of the firmware release.

Functions

void	**decodeInit** (void)
	Initializes all decoding related data structures.
unsigned char	**findTouches** (void)
	drives the touch decoding algorithm. Loads potential touch locations into the touchSet data structure.
unsigned char	**findNextPeak** (unsigned short *values, unsigned char numValues, unsigned char startLocation, unsigned char threshold)
	Analyzes the data in 'values' and attempts to identify peaks or 'cusps' in the data. Will flag significant changes in slope or a change from a positive to a negative slope.
unsigned char	**nudgeLoc** (**TOUCHDATA** *tData)
	Analyzes selected node and adjacent nodes to identify where the "true" peak is. If current node is not the highest point, it "nudges" that point to the higher location, then re-analyzes.
unsigned char	**findFineLocation** (**TOUCHDATA** *tData)
	Analyzes the mutual measurements of the points adjacent to the peak point to interpolate a higher resolution location.
unsigned char	**associateTouches** (void)
	Associates touches in touchSet with touch IDs in touchIDset. This is done by looking at a "matrix" of touch weights, which are determined by using the 'touchWeight' function. The "best" match for all touches will attempt to be made, including using a slightly worse weight for one touch to allow for a better weight for another touch.
unsigned char	**touchWeight** (unsigned char touchID, unsigned char potentialTouch)
	Generates a "weight" for a given touch point with regard to an existing touch ID. The lower the return value, the better the match.
unsigned char	**simpleDistance** (**UINTCOORD** pointA, **UINTCOORD** pointB)
	Provides a simple distance between the two given points. avoids all "high" math - divide, square, square root, etc. So generates a "manhattan" distance - that is, the distance on the X axis, plus the distance on the Y axis.

void	**extrapolateTouch** (**TOUCHID** *thisTouch, **UINTCOORD** *next)
	Linear extrapolation of where the next touch location will be, given the history of the associated touches with the ID.
void	**handleTouches** (void)
	Looks through every touch ID, process and transmits those that are in a state that should be transmitted - TOUCH_DOWN, TOUCH_STREAM, and TOUCH_UP are the only states that should be transmitted.