

The Improved Parabolic + Noise Filter System

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The Parabolic Stop and Reversal Indicator

The Parabolic stop and reversal (parab) indicator was introduced by J. Welles Wilder in *New Concepts in Technical Trading Systems*. The parab is a trend following indicator which is always long or short the market. This indicator is now standard on all modern technical analysis software. The parab can be applied to any bar chart such as, monthly, weekly, daily, hourly, or even point and figure charts.

The parab creates a trailing stop that is at first far enough away from the initial buy price so that price retracements in the early stages of the trend do not drop below the trailing stop price and stop you out of your position. As the price trend matures the trailing stop moves closer and closer at an accelerating rate to recent local lows of the current price, until the stop is penetrated by adverse price movement and a sell signal is given (opposite logic applies for sell signal).

The shape, slope and speed of the parab is controlled by three parameters, the starting acceleration factor (startAF), the increment that the starting acceleration factor can change when a new price high or low is made (incAF), and the maximum acceleration factor (maxAF), the maximum value the acceleration factor can be increased to. Because of the way the parab is calculated, the shape of the parab curve resembles a parabolic type curve, hence it's name.

We will demonstrate the calculation of the parab with the daily bar chart of IBM in Figure 1 and the Excel spreadsheet of IBM in Figure 2.

The parab parameters are startAF=0.02, incAF=0.02 and maxAF=0.20. On 10/02/01, IBM broke through to the upside of the previous day's down sloping parab stop loss of 92.83. A buy position was established at the stop loss price of 92.83. The stop loss was put at the lowest low of the previous downtrend which was 87.49. Thus the first stop loss value of the parab on 10/2/01 is 87.49 and the AF is equal to the starting AF of 0.02. The next day, 10/3/01, IBM made a new high of 97.62. Since IBM made a new high the starting AF is increased by incAF to 0.04. The new stop loss is calculated as $\text{New Stop Loss} = 87.49 + 0.04 \times (97.62 - 87.49) = 87.69$. The general formula is:

$$\text{New Stop Loss} = \text{Old Stop Loss} + \text{AF} \times (\text{EP} - \text{Old Stop Loss})$$

Where EP(extreme price) is equal to the highest high encountered while long. In addition AF is only increased if a new high is made. Otherwise AF stays the same. AF can only be increased to the maximum AF.

On 10/4/01 IBM made another new high of 98.88. The AF is increased by 0.02 and becomes 0.06 and the EP becomes 98.88. The new stop loss is $87.69 + 0.06 \times (98.88 - 87.49) = 88.14$. On 10/5/01 IBM did not make a new high. Thus AF remained at 0.06 and EP remained at 98.88. The New Stop Loss = $88.14 + 0.06 \times (98.88 - 88.14) = 88.78$.

In addition to the above calculations, the parab Stop Loss for tomorrow can not be placed within the price ranges of the current or previous bar. If it is then if you were long the stop loss would

be placed at the lowest of today's or yesterday's low as it was on 10/22/01. If you were short then the stop loss would be placed at the highest of today's or yesterday's high.

Most software packages only allow one to vary the AF increment and the AF maximum, fixing the starting AF at 0.02. This restriction hampers the trend following abilities of the Parabolic and will be relaxed in this study by allowing different starting values in our search for optimum parameters later in this article..

The Parabolic + Noise Filter

Many times as the parab stop loss hugs the price curve it is penetrated by a price bar by a small amount, as it was on 11/01/01 in Figure 1, generating an opposite signal. The price then immediately turns around and resumes going in the direction it was going before this penetration occurred causing a costly whipsaw loss. Many of the whipsaws losses are caused by noise or randomness in the price series. Thus if the parab stop loss is to represent the trend of a real price series it must have the capability to ignore small penetrations of noise level amounts. To this end, I have modified the Parabolic Stop Loss formula to include a variable that allows the parab stop loss not to reverse unless penetrated by a defined amount. I define this new parameter as x_o , for noise crossover increment. In addition the starting value for the stop loss is always set at the previous low or high. In some instances the system will produce less whipsaws if the starting value of the stop loss is the previous high minus some amount called x_{pr} or the previous low minus x_{pr} . I call this new five parameter Parabolic, **parabxot**.

Data Discussion

For this article we will use 30 minute bar prices of the Nasdaq-100 Index Tracking security traded on the AMEX and known by the symbol QQQ. We will use 30 min QQQ bars from 9/18/2001 to 10/26/2001 to develop the system parameters. We will use 30 minute QQQ bars from 10/29/2001 to 11/09/2001 to test the parameters found in the previous segment on data it has not been optimized on, namely out-of-sample data.

The Parabxot System Defined

In general what we will be doing is following the plotted curve of **parabxot**. When the price of the current bar exceeds yesterday's value of the parabxot by the amount x_o , we will go long. When the price of the current bar falls below yesterday's value of the parabxot by the amount x_o , we will go short.

Buy Rule:

- Buy $\text{parabxot}[1] + x_o$ Stop.

Sell Rule:

- Sell $\text{parabxot}[1] - x_o$ Stop.

Where $\text{parabxot}[1]$ is yesterday's value of parabxot.

Finding The System Parameters Using Walk Forward Optimization

There are five system parameters to find. *StartAF*, the starting value of AF. *IncAF*, the amount AF is incremented, *maxAF*, the maximum amount AF can go to. x_o , the noise amount the price bar has to cross over the parabolic curve in order to generate a buy or sell signal and x_{pr} , the

extra amount to add or subtract from the starting price of the parabolic stop loss. The best parameters will be defined as those values that give the best Net Profits and best Total winning Bars to Total Losing Bars ratio with the minimum drawdown and minimum largest losing trades. In addition, the results should be stable, e.g. the profits, wins, and drawdowns should not change by much as the parameters move by a small amount away from their optimum values. Also in choosing the “best” parameters, we considered only those parameters sets whose maximum consecutive losses were 4 or less. The maximum consecutive losses are constrained to 4 or less because in real time trading it is tough to follow a system that has more than 4 losses in a row. Optimization is defined as the search for the parameter values that give the best results as defined above. It should be noted that in this stage of system development, the only thing indicated by the optimum values that are found in the test portion is that the data has been *curve fitted* as best it can with this system. Without further testing on out-of-sample data there is no way to tell if the system will work in the future.

Results

Figure 3 presents a table of the test window selected optimum parameters for the QQQ 30min bar data series.

Start Date	End Date	startAF	IncAF	maxAF	xo	xpr
09/18/01	10/26/01	0.01	0.045	0.20	0.05	0

Figure 3 Optimum Parameter Values For Test Data Segments

Figure 4 presents the performance summary of the test window segment from 9/18/01 to 10/26/01 using the optimum parameters for the test windows shown in Figure 3.

Figure 5 presents the performance summary of the out-of-sample data segment from 10/29/01 to 11/09/01. This performance represents what would have happened in *real time* if one used the parameters found in the test sections. Slippage, and commissions are not included.

Figure 6 presents a specialized percentage trade by trade summary from 9/18/01 to 11/09/01. Note that the trades from 10/26/01 to 11/09/01 are the out-of-sample trades generated from the optimized parameters from the test sections of 9/18/01 to 10/26/01.

Figure 7 presents a 30 minute bar chart of QQQ with the **parabxot** indicator superimposed and all the buy and sell signals from the trade by trade summary of Figure 6 indicated on the charts. Also included at the bottom of the charts are the bar by bar profit or loss of each trade. The lower plot tracks the runup and drawdown of each trade.

Discussion of System Performance

As can be observed from the test sample Performance summary in Figure 4 and the out-of-sample performance summary of Figure 5, the out-of-sample performance was in line with the test sample performance. The out-of-sample section average bars in winners and losers, the drawdowns, and the profits factors were very close to the test in-sample sections. This inline performance in the out-of-sample section indicates that 5 weeks of 30 minute bar test data was enough to capture the intraday price dynamics of QQQ.

Observing the out-of-sample performance summary of Figure 5, we can see that the system did better on long trades than short trades. This better long performance was due to a longer uptrend

in QQQ during this time period. The average trade (win & loss) was \$367 in the test section and \$291 in the out-of-sample section indicating stability in the parameter selection. There were no really big winners or big losers indicating steady returns.

In observing the chart we can see that the system did very well in catching every major intraday trend of QQQ . Overall the **parabxot** system did a good job in minimizing the losses due to the inevitable whipsaws that will occur in any trading system and maximizing the profits from the major intraday trend moves of QQQ.

References

Wilder, J. Welles, *New Concepts in Technical Trading Systems*, Trend Research, 1978.

FIGURE 2 IBM Parabolic Stop Loss Calculation

Date	H	L	C	EP	AF	SAR
9/26/01	94.45	90.30	91.27	103.40	0.14	96.25
9/27/01	91.50	87.49	89.89	103.40	0.16	95.02
9/28/01	92.71	89.90	92.28	103.40	0.16	93.82
10/01/01	93.48	91.34	92.71	103.40	0.16	93.48
10/02/01	93.90	92.10	93.73	93.90	0.02	87.49
10/03/01	97.62	92.40	96.79	97.62	0.04	87.69
10/04/01	98.88	96.80	97.30	98.88	0.06	88.14
10/05/01	98.45	95.37	98.01	98.88	0.06	88.78
10/08/01	99.00	96.75	98.11	99.00	0.08	89.40
10/09/01	98.50	96.76	97.14	99.00	0.08	90.17
10/10/01	97.30	94.90	97.14	99.00	0.08	90.87
10/11/01	99.35	96.65	99.24	99.35	0.10	91.55
10/12/01	101.00	98.00	100.83	101.00	0.12	92.50
10/15/01	102.76	100.00	102.00	102.76	0.14	93.73
10/16/01	103.00	99.66	102.11	103.00	0.16	95.03
10/17/01	106.45	102.96	102.96	106.45	0.18	96.85
10/18/01	103.75	100.78	101.25	106.45	0.18	98.58
10/19/01	102.74	100.07	102.56	106.45	0.18	100.00
10/22/01	105.78	101.90	105.17	106.45	0.18	100.07
10/23/01	106.69	104.55	105.69	106.69	0.20	101.26
10/24/01	108.75	106.09	108.57	108.75	0.20	102.76
10/25/01	110.85	106.75	110.85	110.85	0.20	104.38
10/26/01	112.10	109.62	111.15	112.10	0.20	105.92
10/29/01	110.70	108.66	108.67	112.10	0.20	107.16
10/30/01	109.75	107.76	108.67	112.10	0.20	107.76
10/31/01	111.12	108.17	108.18	112.10	0.20	107.76
11/01/01	110.17	106.90	109.82	106.90	0.02	112.10
11/02/01	110.25	108.77	109.36	106.90	0.02	112.00
11/05/01	110.59	109.08	109.94	106.90	0.02	111.89
11/06/01	114.80	109.40	114.18	114.80	0.02	106.90
11/07/01	115.20	113.03	113.88	115.20	0.04	107.07
11/08/01	115.56	113.61	113.85	115.56	0.06	107.41
11/09/01	114.90	113.10	114.09	115.56	0.06	107.90

Figure 4 Test-Sample Performance Summary for QQQ paraxot System
qqq-30 min bars 9/18/2001 - 10/26/2001

Performance Summary: All Trades

Total net profit	\$ 11770.000	Open position P/L	\$ 0.000
Gross profit	\$ 16770.000	Gross loss	\$ -5000.000
Total # of trades	32	Percent profitable	59%
Number winning trades	19	Number losing trades	13
Largest winning trade	\$ 2980.000	Largest losing trade	\$ -710.000
Average winning trade	\$ 882.632	Average losing trade	\$ -384.615
Ratio avg win/avg loss	2.295	Avg trade(win & loss)	\$ 367.813
Max consec. winners	4	Max consec. losers	4
Avg # bars in winners	16	Avg # bars in losers	8
Max intraday drawdown	\$ -2540.000		
Profit factor	3.354	Max # contracts held	1

Performance Summary: Long Trades

Total net profit	\$ 8450.000	Open position P/L	\$ 0.000
Gross profit	\$ 10720.000	Gross loss	\$ -2270.000
Total # of trades	16	Percent profitable	63%
Number winning trades	10	Number losing trades	6
Largest winning trade	\$ 2980.000	Largest losing trade	\$ -710.000
Average winning trade	\$ 1072.000	Average losing trade	\$ -378.333
Ratio avg win/avg loss	2.833	Avg trade(win & loss)	\$ 528.125
Max consec. winners	4	Max consec. losers	2
Avg # bars in winners	18	Avg # bars in losers	9
Max intraday drawdown	\$ -1600.000		
Profit factor	4.722	Max # contracts held	1

Performance Summary: Short Trades

Total net profit	\$ 3320.000	Open position P/L	\$ 0.000
Gross profit	\$ 6050.000	Gross loss	\$ -2730.000
Total # of trades	16	Percent profitable	56%
Number winning trades	9	Number losing trades	7
Largest winning trade	\$ 1420.000	Largest losing trade	\$ -550.000
Average winning trade	\$ 672.222	Average losing trade	\$ -390.000
Ratio avg win/avg loss	1.724	Avg trade(win & loss)	\$ 207.500
Max consec. winners	5	Max consec. losers	3
Avg # bars in winners	13	Avg # bars in losers	6
Max intraday drawdown	\$ -2300.000		
Profit factor	2.216	Max # contracts held	1

Figure 5 Out-Of-Sample Performance Summary for QQQ parabxot System
qqq-30 min bars 10/26/2001 - 11/009/2001

Performance Summary: All Trades

Total Net Profit	\$3,500.00	Open position P/L	\$0.00
Gross Profit	\$6,020.00	Gross Loss	(\$2,520.00)
Total # of trades	12	Percent profitable	58.33%
Number winning trades	7	Number losing trades	5
Largest winning trade	\$2,580.00	Largest losing trade	(\$890.00)
Average winning trade	\$860.00	Average losing trade	(\$504.00)
Ratio avg win/avg loss	1.71	Avg trade (win & loss)	\$291.67
Max consec. Winners	2	Max consec. losers	1
Avg # bars in winners	17	Avg # bars in losers	6
Max intraday drawdown	(\$2,070.00)		
Profit Factor	2.39	Max # contracts held	1

Performance Summary: Long Trades

Total Net Profit	\$2,480.00	Open position P/L	\$0.00
Gross Profit	\$2,570.00	Gross Loss	(\$90.00)
Total # of trades	6	Percent profitable	83.33%
Number winning trades	5	Number losing trades	1
Largest winning trade	\$1,180.00	Largest losing trade	(\$90.00)
Average winning trade	\$514.00	Average losing trade	(\$90.00)
Ratio avg win/avg loss	5.71	Avg trade (win & loss)	\$413.33
Max consec. Winners	5	Max consec. losers	1
Avg # bars in winners	15	Avg # bars in losers	7
Max intraday drawdown	(\$580.00)		
Profit Factor	28.56	Max # contracts held	1

Performance Summary: Short Trades

Total Net Profit	\$1,020.00	Open position P/L	\$0.00
Gross Profit	\$3,450.00	Gross Loss	(\$2,430.00)
Total # of trades	6	Percent profitable	33.33%
Number winning trades	2	Number losing trades	4
Largest winning trade	\$2,580.00	Largest losing trade	(\$890.00)
Average winning trade	\$1,725.00	Average losing trade	(\$607.50)
Ratio avg win/avg loss	2.84	Avg trade (win & loss)	\$170.00
Max consec. Winners	1	Max consec. losers	4
Avg # bars in winners	22	Avg # bars in losers	6
Max intraday drawdown	(\$2,430.00)		
Profit Factor	1.42	Max # contracts held	1

FIGURE 6 Specialized Trade By Trade Summary
QQQ 30min parabxot System Trade Size = 1000 Shares 09/18/2001 to 11/09/2001

Entry Date	Entry Time		Entry Price	Exit Date	Exit Time	Exit Price	Bars InTrd	Trade \$P&L	Trade %P&L	Trade Max\$Pft	Time	Trade Max\$DD	Time
9/18/01	1530	Sell	30.72	9/19/01	1530	29.30	14	1,420	4.62%	1,970	1430	0	1530
9/19/01	1530	Buy	29.30	9/20/01	1530	29.14	14	(160)	-0.55%	810	1600	(240)	1300
9/20/01	1530	Sell	29.14	9/21/01	1330	28.44	10	700	2.40%	1,440	1000	(60)	1530
9/21/01	1330	Buy	28.44	9/25/01	1230	29.71	26	1,270	4.47%	1,660	1030	(430)	1400
9/25/01	1230	Sell	29.71	9/25/01	1615	29.70	8	10	0.03%	570	1400	0	1230
9/25/01	1615	Exit	29.70	9/26/01	1130	29.00	4	(700)	-2.36%	0	1615	(700)	1130
9/26/01	1130	Sell	29.00	9/27/01	1430	27.73	20	1,270	4.38%	1,500	1230	(70)	1130
9/27/01	1430	Buy	27.73	9/28/01	1500	28.88	15	1,150	4.15%	1,440	1330	0	1430
9/28/01	1500	Sell	28.88	10/1/01	1400	28.80	12	80	0.28%	640	1130	(320)	1530
10/1/01	1400	Buy	28.80	10/2/01	1430	28.89	15	90	0.31%	540	1130	(290)	1530
10/2/01	1430	Sell	28.89	10/3/01	1100	29.16	7	(270)	-0.93%	450	1500	(270)	1100
10/3/01	1100	Buy	29.16	10/4/01	1400	32.13	20	2,970	10.19%	3,480	1130	0	1100
10/4/01	1400	Sell	32.13	10/5/01	1330	31.17	13	960	2.99%	1,820	1030	(70)	1400
10/5/01	1330	Buy	31.17	10/8/01	1430	31.73	16	560	1.80%	980	1130	(70)	1330
10/8/01	1430	Sell	31.73	10/9/01	1530	31.43	16	300	0.95%	570	1200	(160)	1615
10/9/01	1530	Buy	31.43	10/9/01	1600	30.96	1	(470)	-1.50%	0	1530	(470)	1600
10/9/01	1600	Sell	30.96	10/10/01	1000	31.48	2	(520)	-1.68%	0	1600	(520)	1000
10/10/01	1000	Buy	31.48	10/11/01	1430	34.03	23	2,550	8.10%	3,070	1330	0	1000
10/11/01	1430	Sell	34.03	10/11/01	1600	34.59	3	(560)	-1.65%	60	1500	(560)	1600
10/11/01	1600	Buy	34.59	10/12/01	1200	33.95	6	(640)	-1.85%	110	1030	(640)	1200
10/12/01	1200	Sell	33.95	10/12/01	1600	34.49	8	(540)	-1.59%	640	1300	(540)	1600
10/12/01	1600	Buy	34.49	10/17/01	1030	34.37	31	(120)	-0.35%	900	1000	(680)	1000
10/17/01	1030	Sell	34.37	10/18/01	1130	33.30	16	1,070	3.11%	1,870	1615	(570)	1100
10/18/01	1130	Buy	33.30	10/22/01	1330	33.84	32	540	1.62%	820	1000	(840)	1200
10/22/01	1330	Sell	33.84	10/22/01	1600	34.36	5	(520)	-1.54%	110	1400	(520)	1600
10/22/01	1600	Buy	34.36	10/23/01	1300	34.55	8	190	0.55%	920	1030	0	1600
10/23/01	1300	Sell	34.55	10/24/01	1030	34.85	9	(300)	-0.87%	220	1500	(420)	1400
10/24/01	1030	Buy	34.85	10/24/01	1615	35.37	12	520	1.49%	630	1330	0	1030
10/24/01	1615	Exit	35.37	10/25/01	1330	35.09	8	280	0.79%	1,010	1030	0	1615
10/25/01	1330	Buy	35.09	10/26/01	1200	36.27	11	1,180	3.36%	1,710	1030	0	1330
Out-Of-Sample Trades Below													
10/26/01	1200	Sell	36.27	10/30/01	1400	33.69	32	2,580	7.11%	3,090	1030	(480)	1300
10/30/01	1400	Buy	33.69	10/31/01	1600	33.99	18	300	0.89%	1,120	1500	(300)	1615
10/31/01	1600	Sell	33.99	11/1/01	1130	34.88	5	(890)	-2.62%	50	1615	(890)	1130
11/1/01	1130	Buy	34.88	11/2/01	1100	34.99	13	110	0.32%	620	1000	(320)	1230
11/2/01	1100	Sell	34.99	11/2/01	1230	35.79	3	(800)	-2.29%	0	1100	(800)	1230
11/2/01	1230	Buy	35.79	11/5/01	1600	36.76	21	970	2.71%	1,270	1500	(380)	1400
11/5/01	1600	Sell	36.76	11/6/01	1430	36.97	11	(210)	-0.57%	310	1400	(240)	1100
11/6/01	1430	Buy	36.97	11/7/01	1430	38.15	14	1,180	3.19%	1,580	1330	(20)	1500
11/7/01	1430	Sell	38.15	11/8/01	1000	38.68	5	(530)	-1.39%	200	1600	(530)	1000
11/8/01	1000	Buy	38.68	11/8/01	1430	38.69	9	10	0.03%	600	1100	0	1000
11/8/01	1430	Sell	38.69	11/9/01	1300	37.82	11	870	2.25%	1,170	1130	0	1430
11/9/01	1300	Buy	37.82	11/9/01	1615	37.73	7	(90)	-0.24%	130	1330	(220)	1430

FIGURE 1 Parabolic Calculation Example

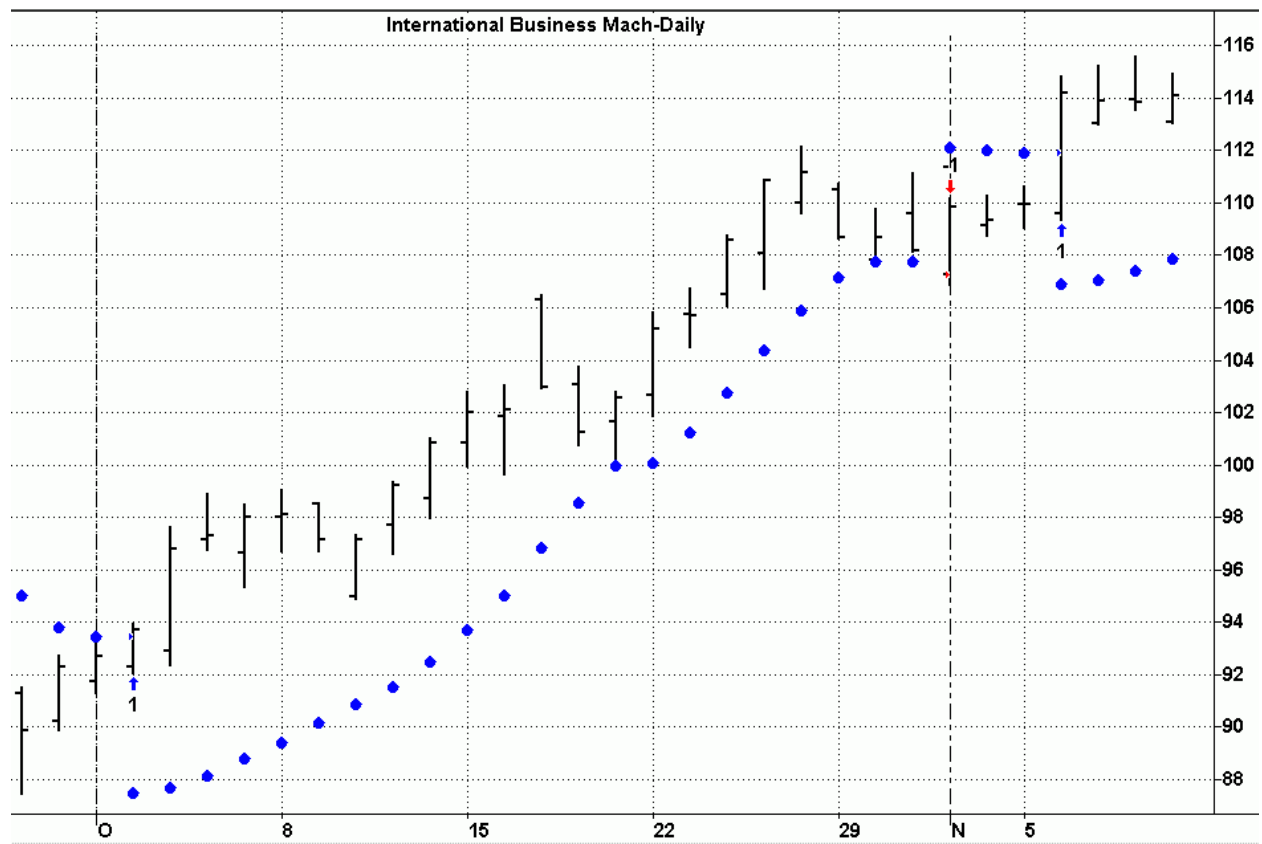


FIGURE 7 Parabxot System QQQ 30 min Bar Chart

