GLOSSARY OF TECHNICAL INDICATORS

The following glossary provides a comprehensive listing of all the technical analysis studies available on Telemet Orion intraday and historical charts as of 9/2/97. For each indicator, a brief description is accompanied by the formula and standard interpretation, where appropriate. Questions and comments regarding this glossary should be directed to Client Services/Support at (703) 548-2042.

Arms Ease of Movement

This is a momentum indicator developed by Richard Arms. It combines price and volume to indicate the relative ease with which prices are rising or falling. When a small price change is accompanied by heavy volume, the indicator returns a value near zero, indicating that prices are not moving easily. Conversely, when a large price change is accompanied by low volume, the indicator returns a large positive (negative) value indicating that prices are increasing (decreasing) easily.

$$EMV = \left[\frac{H + L}{2} - \frac{H_p + L_p}{2} \right] \div \frac{V}{H - L}$$

    H,L,V current high, low, and volume
    H_p,L_p previous high and low

Interpretation: Buy when EMV>0. Sell when EMV<0.

Directional Movement Index (DI+, DI-)

This is a momentum indicator developed by J. Welles Wilder, Jr. Current and previous high, low, and closing prices are compared to measure the magnitude of upside and downside price moves, relative to the "true range." When the difference between today's high and yesterday's high is positive, the index displays a positive value on the DM+ curve and zero on the DM- curve, and visa-versa. The more the daily price change approaches or exceeds the true range extremes, the more the indicator curve deviates from the zero line, indicating strong price momentum in the current direction. After the index curves are smoothed for daily price volatility, it is the more positive curve that is used to signal market direction and momentum.

    DM+ = H - H_p or 0 if result < 0
    DM- = - (L - L_p) or 0 if result < 0

    TR = largest absolute value of H - L, H - C_p, or L - C_p

    DM+,DM-   positive, negative nominal directional movement
    H,L   current high and low
    H_p,L_p,C_p previous high, low, close

TR   true range

DM+, DM-, and TR are exponentially smoothed over n periods you specify.

$$DI+ = \frac{Smoothed\ DM+}{Smoothed\ TR} \qquad DI- = \frac{Smoothed\ DM-}{Smoothed\ TR}$$

Interpretation: Buy (sell) when DI+ crosses above (below) DI-.

Directional Movement Index (DX, ADX)

This is a momentum index developed by J. Welles Wilder, Jr. to indicate the magnitude of price directionality. The index should be used in conjunction with an index such as DI+/DI- which indicates the direction of price momentum. The DX curve indicates the magnitude of change in the DI+ and DI- indicators, and the ADX depicts a smoothed DX. When DX and ADX and are increasing, it is believed prices are exhibiting strong directionality and an appropriate position should be entered. Small DX and decreasing ADX indicate diminishing directionality and provide signals for exiting positions.

$$DX = \left| \frac{(DI+) - (DI-)}{(DI+) + (DI-)} \right|$$

ADX = DX exponentially smoothed over n periods you specify

Interpretation: Initiate (exit) positions when ADX is rising (falling).
Expect a reversal of trend when absolute value of difference between DX and ADX becomes large.

Money Flow

This momentum indicator uses the current and previous high and low prices to determine price direction, then weights price changes by volume to indicate whether money is flowing into or out of a stock. When rising prices are accompanied by increasing volume, the indicator curve displays positive values, suggesting investors are buying the security. Negative money flow indicates investors are selling.

$$MF = MF_p + (V \times P)$$

$$P = \frac{H+L}{2} - \frac{H_p + L_p}{2}$$

MF	money flow
P	current period average price
V,H,L	current period volume, high, and low
H_p,L_p	previous period high and low

Interpretation: Buy when MF>0. Sell when MF<0.

Moving Average (Smoothing): Simple

The most basic and widely used trend indicator, the simple moving average smoothes the period to period fluctuations within a raw data sample to reveal the average value at a given point in time. The indicator calculates the mean for a series of data contained within a specified range bounded by the present period and an earlier period. For each successive calculation, the data sample is adjusted by dropping the oldest data point from the prior calculation and adding the latest data, such that the width of the range remains constant as it "moves." The simple moving average gives equal weighting to each data point in the series. A rising moving average curve indicates an overall upward bias in the raw data, and visa-versa. It is believed that when the raw data cross the moving average curve, the data will continue to move in the same direction.

$$MA_n = \frac{1}{n} \times \sum_{i=1}^{n} C_i$$

MA_n simple moving average for n periods
n number of periods you specify
i period position within data series
C_i closing price at period i

Interpretation: Buy (sell) when last price crosses above (below) moving average curve.
                Buy (sell) when slope of moving average curve changes from negative (positive) to positive (negative).

Moving Average (Smoothing): Exponential

The exponential moving average calculates a weighted mean for a series of data by adding a percentage of the most recent data to the previous value of the moving average. Rather than dropping the oldest data in the series to keep the data range constant as time advances, the smoothing constant causes the most recent data to be most heavily weighted and the oldest data to be least weighted. The exponential moving average is often preferred by technicians over the simple moving average for analyzing historically volatile markets.

$$MA_n = k \times (C - MA_p) + MA_p$$

$$k = \frac{2}{n+1}$$

MA_n exponential moving average for n periods
C current closing price

MA$_p$ previous period exponential moving average
k   smoothing constant
n   number of periods you specify

Interpretation: Buy (sell) when last price crosses above (below) moving average curve.
                Buy (sell) when slope of moving average curve changes from negative
                (positive) to positive (negative).

Moving Average (Smoothing): Weighted

The weighted moving average calculates a weighted mean by summing sequentially
weighted data, then dividing the result by the sum of the terms of a data sequence. The
most recent data are given the highest weighting because they are multiplied by the
highest terms in the weighting sequence. For each successive calculation, the data sample
is adjusted by dropping the oldest data point from the prior calculation and adding the
latest data, such that the width of the range remains constant as it "moves." Like the
exponential moving average, the weighted moving average is often preferred by
technicians over the simple moving average for analyzing historically volatile markets.

$$MA_n = \frac{\sum_{i=1}^{n}(i \times C_i)}{\sum_{i=1}^{n} i}$$

MA$_n$ weighted moving average for n periods
n   number of periods you specify
i   period position within data series
C$_i$ closing price at period i

Interpretation: Buy (sell) when last price crosses above (below) moving average curve.
                Buy (sell) when slope of moving average curve changes from negative
                (positive) to positive (negative).

Moving Average - 2 Line

Plotting two moving averages simultaneously enables the analyst to identify the overall
trend of a data series and to smooth the period to period fluctuations of the data around
the trend. Two moving averages covering time periods of differing widths are plotted
together. The longer-term moving average curve is used to identify the overall trend,
while the shorter-term curve acts as a surrogate for the raw data. It is believed that when
the shorter curve crosses the longer curve, the raw data will continue to move in the same
direction. Technicians often prefer smoothing the raw data with a short-term moving
average to curtail premature signals.

Interpretation: Buy (sell) when the shorter-term moving average curve crosses above (below) the longer-term curve.

Moving Average Convergence/Divergence (MACD)

MACD is a momentum indicator developed by Gerald Appel. It consists of the indicator curve, the zero line, and a "trigger line." The indicator curve depicts the vertical distance between two exponential moving average curves covering time periods of differing widths (traditionally 12 and 26 periods). The trigger line is an exponentially smoothed curve of the indicator curve (traditionally over 9 periods). The zero line indicates where the short-term and long-term moving average curves would intersect if plotted separately. As prices move further away from the trend indicated by the longer-term moving average, the MACD indicator line becomes more positive or negative, depending upon the direction of price movement. As prices move closer to the trend, the MACD indicator approaches zero. By first smoothing the price volatility with the short-term moving average, then smoothing the indicator with the trigger line, it is believed the MACD provides very reliable trend reversal and confirmation signals.

$$MACD = MA_s - MA_l$$

MA_s exponential moving average of closing prices for s periods you specify
MA_l exponential moving average of closing prices for $l > s$ periods you specify

An exponential moving average of MACD for t periods you specify is plotted on top of the MACD as a "trigger line."

Interpretation: Buy (sell) when MACD crosses above (below) the trigger line or zero line. Look for divergence between price data and MACD curve.

Moving Average - Percent Bands (Envelope)

This indicator combines the trend following properties of a moving average with a price envelope to identify the trading range along the trend. A moving average is computed for the data series, then bands are plotted above and below the moving average curve at distances equal to a specific percentage of the moving average values. The analyst might select a percentage such that a majority of the historical prices will be contained between the upper and lower bands. When prices approach the upper (lower) band, it is an indication that the market is trading at the top (bottom) of its historical range and that a price reversal may be imminent. When prices penetrate the bands, strong momentum in the same direction is indicated.

$$Upper\ Band = MA_n \times (1 + P)$$
$$Lower\ Band = MA_n \times (1 - P)$$

MA_n moving average of closing prices for n periods you specify

P   a percentage of MA_n which you specify

Interpretation: Buy (sell) when prices fall below (rise above), then rise above (fall below) lower (upper) band.

Moving Average - Standard Deviation Bands (Bollinger)

A variation on percent bands, this indicator developed by John Bollinger incorporates volatility into the definition of a price envelope. A moving average is computed for the data series, then bands are plotted a specific number of standard deviations (traditionally two) above and below the moving average curve. In addition to the typical indications given by other price envelopes, a narrowing of the Bollinger bands can signal a large price move may be imminent.

$$\text{Upper Band} = MA_n + (m \times STD_n)$$
$$\text{Lower Band} = MA_n - (m \times STD_n)$$

$$STD_n = \sqrt{\frac{\sum_{i=1}^{n}(C_i - MA_n)^2}{n}}$$

MA_n moving average of closing prices for n periods you specify
STD_n standard deviation of closing prices for n periods you specify
m   number of standard deviations you specify
C_i closing price for period i

Interpretation: Look for narrowing of bands to indicate large price move imminent. Buy (sell) when prices fall below (rise above), then rise above (fall below) lower (upper) band.

Price - Channel

This is a trend following indicator which identifies price support and resistance levels. The highest and lowest prices achieved over a specific number of periods are indicated by bands plotted above and below the price curve. When prices approach the upper (lower) band, it is an indication that the market is trading at the top (bottom) of its historical range. When prices penetrate the bands, strong momentum in the same direction is indicated.

$$\text{Upper Band} = MaxHi_n$$
$$\text{Lower Band} = MaxLo_n$$

$MaxHi_n$ highest high achieved during past n periods you specify, ending on the previous period

MinLo$_n$ lowest low achieved during past n periods you specify, ending on the previous period

Interpretation: Buy (sell) when upper (lower) band is penetrated.

Price - Rate of Change

This indicator is a commonly used price momentum oscillator. The current price is compared against a previous price to measure the magnitude of price change over a specific period of time. The rate of change curve is smoothed and plotted against a horizontal line equal to one. Indicator values much greater or less than one signal strong price momentum in the same direction, while values near one reflect little momentum.

$$ROC = \frac{C}{C_n}$$

ROC   price rate of change for current period
C   current period closing price
C$_n$ closing price n periods prior to current period

The ROC curve is smoothed over m periods you specify.

Interpretation: Buy (sell) when ROC crosses above (below) one.
         Look for divergence between indicator and price to signal price reversals.

Price - Spread

This indicator provides a visual depiction of the price relationship between two securities over time. The price of one security is subtracted from the price of another for each period in the data sample, and the resulting indicator curve is plotted against a zero line. Typically, the curve will rise and fall and occasionally cross the zero line as the price relationship between the two securities fluctuates. This indicator is most commonly used by traders of derivative products (futures and options contracts) to evaluate price imbalances among related contracts and their underlying cash markets.

$$PS = C_1 - C_2$$

PS   price spread
C$_1$ closing price for first security
C$_2$ closing price for second security

Interpretation: Initiate appropriate position when price spread becomes historically wide or narrow.

Relative Strength - Comparative/Relative Strength - S&P 500

Similar to the price-spread indicator, relative strength depicts the price relationship between two securities over time. The price of one security is divided by the price of another for each period in the data sample, and the resulting indicator curve is plotted against a horizontal line representing parity. Typically, the curve will rise and fall and occasionally cross the horizontal line as the price relationship between the two securities fluctuates. This indicator is most commonly used to identify markets and securities that have outperformed related markets and securities in the past and, therefore, may have stronger investment appeal.

$$RS = \frac{C_1}{C_2}$$

RS   relative strength
C_1 closing price for first security
C_2 closing price for second security

Interpretation: When considering a purchase between two related securities, initiate a position in the one with the higher relative strength.
When price and relative strength exhibit trends in the same direction, look for a reversal in relative strength to signal a reversal in price.

Relative Strength Index (RSI)

Developed by Wells Wilder, the RSI is a widely used price momentum oscillator which measures price velocity by tracking positive and negative price changes from one period to the next. Incremental net positive and negative changes in closing price are tallied and smoothed by an exponential moving average, then a ratio between the smoothed positive and negative changes is constructed for the final RSI computation. When positive net change is large (small) relative to negative net change, the RSI returns a small (large) value. Traditionally, the RSI is believed to indicate overbought (oversold) conditions when its curve falls below 30 (rises above 70). The RSI is preferred by some analysts over other momentum oscillators, like the stochastic indicator, because the method by which data is dropped from the front end of the series results in less erratic fluctuations in the RSI curve.

$$RSI = 100 - \frac{100}{1 + R}$$

$$R = \frac{+P_n}{-P_n}$$

$$+P = |C_i - C_{i-1}| \qquad \text{if } C_i - C_{i-1} > 0$$
$$-P = |C_i - C_{i-1}| \qquad \text{if } C_i - C_{i-1} < 0$$

RSI	relative strength index
+P,-P	incremental positive or negative price change at period i
$+P_n,-P_n$	exponential moving average of +P,-P for n periods you specify
C_i,C_{i-1}	closing price at period i and period prior to period i

Interpretation: Buy (sell) when indicator falls below 30 (rises above 70).
Look for divergence between the indicator and price to signal trend reversals.

Stochastic

Developed by George C. Lane, this is a price velocity oscillator which identifies overbought and oversold conditions by relating closing prices to the security's trading range during a specific period. The indicator curve, or %K, is smoothed and plotted against a slower, second smoothing of the indicator called the "trigger line," or %D. The %K and %D curves oscillate between zero and 100, indicating the security is trading at the lowest or highest area of its trading range, respectively. Buy and sell signals are given when the faster %K crosses the slower %D or when either curve extends above or below specific threshold levels.

$$\%K = \frac{C - L_n}{H_n - L_n} \times 100 \text{ smoothed for j periods you specify}$$

$$\%D = \%K \text{ smoothed for k periods you specify}$$

%K	indicator line
%D	trigger line
C	current closing price
L_n,H_n	lowest low and highest high achieved during past n periods you specify

Interpretation: Buy (sell) when both curves extend below (above) a specific threshold (usually 20 for buy signals and 80 for sell signals).
Buy (sell) when %K crosses above (below) %D.
Look for divergence between price and %D to signal trend reversals.

TICK

This is a short-term breadth indicator that provides an instantaneous measure of market strength based upon price movement of individual issues. At any moment during the trading day, TICK can be computed for a particular market by subtracting the total number of downtick trades from the total number of uptick trades. Positive (negative) indicator values are generally considered bullish (bearish), but extreme values can signal imminent trend reversals. TICK can be applied to end of day data, but its intraday applications are more commonly used.

TICK=U-D

U   number of exchange listed securities whose last trade was an uptick
D   number of exchange listed securities whose last trade was an downtick

Interpretation: Buy (sell) when TICK enters positive (negative) territory.
            Look for extremely high or low indicator values to signal price trend
            reversals.

TRIN (Arms Short-term Trading Index)

Developed by Richard W. Arms, Jr., TRIN is a breadth indicator which measures and
compares strength of market advances and declines based upon volume. At any moment
during the trading day, TRIN can be computed for a particular market by dividing the
ratio of advancing issues to declining issues by the ratio of advancing volume to declining
volume. Indicator values less (greater) than one are bullish (bearish), indicating more
volume is flowing into (out of) advancing issues as compared to declining issues. TRIN
can be applied to end of day data, but its intraday applications are more commonly used.

$$\text{TRIN} = \frac{\text{ADV}/\text{DECL}}{\text{AVOL}/\text{DVOL}}$$

ADV,DECL   number of exchange listed advancing, declining issues
AVOL,DVOL total volume for exchange listed advancing, declining issues

Interpretation: Buy (sell) when TRIN falls below (rises above) one.

Volatility

Volatility refers to the degree by which the price of a security can be expected to vary
over a given period of time. Numerous volatility measurement techniques abound, but
the most common technique measures the standard deviation of closing prices from their
mean value, expressed as a percentage of the most recent closing price. Low (high)
volatility values indicate prices can be expected to vary little (greatly) from their mean
over time. Some analysts have observed that high (low) volatility can signal market tops
(bottoms), while others compare volatility of related securities in determining which one
best fits their investment objectives. Volatility is a primary variable input for models
used by derivatives traders to determine the fair value of listed contracts on an underlying
security.

$$\text{Volatility} = 1 + \frac{\text{STD}_n}{\text{C}} \quad \text{smoothed for m periods you specify}$$

$$STD_n = \sqrt{\dfrac{\sum\limits_{i=1}^{n}(C_i - MA_n)^2}{n}}$$

STD_n standard deviation of closing price for n periods
C, C_i closing price for current period, period i
Ma_n moving average of closing prices for n periods
n   number of periods you specify

Interpretation: Buy (sell) when volatility becomes historically low (high).

Volume

Volume depicts the number of a security's trading units (shares/contracts) changing hands during a specified time period. It provides a gauge of market enthusiasm associated with the price activity of a security. Volume trends tend to lead price trends, and a peak in volume often signals the completion of a price advance, while a volume trough can signal the end of a price decline. Periods of price consolidation are often characterized by sideways price movement, accompanied by declining volume. Price penetration of a trend, support, or resistance line is often confirmed by a sharp increase in volume.

Volume - Chaikin Accumulation/Distribution Oscillator

This is a volume momentum oscillator developed by Mark Chaikin. A cumulative volume figure is increased or decreased each period by a percentage of current period volume, according to a comparison between closing price and the trading range mid-point. A longer-term smoothing of the Chaikin index is subtracted from a shorter-term smoothing, resulting in a curve that oscillates above and below zero. Positive (negative) values indicate above average buying (selling) volume momentum.

$$ADO = AD_j - AD_k$$

$$AD = AD_p + \left[\left(C - \dfrac{H - L}{2} \right) \times V \right]$$

ADO   accumulation/distribution oscillator
$AD_{j,k}$ AD smoothed for j and k>j periods you specify
AD   current period Chaikin accumulation/distribution index
AD_p previous period Chaikin accumulation/distribution index
C,H,L,V   current period close, high, low, and volume

Interpretation: Look for divergence between the oscillator and price to signal a reversal in price trend.

Buy (sell) in the direction of a price trend on an upturn (downturn) of the oscillator while in negative (positive) territory.

Volume - Granville On Balance Oscillator

This is a volume momentum oscillator developed by Joseph E. Granville. A cumulative volume figure is increased (decreased) each period by current period volume if net price change is positive (negative). A longer-term smoothing of the Granville index is subtracted from a shorter-term smoothing, resulting in a curve that oscillates above and below zero. Positive (negative) values indicate above average buying (selling) volume momentum.

$$OBO = OBV_j - OBV_k$$

$$OBV = OBV_p + \left(\frac{C - C_p}{|C - C_p|}\right) \times V$$

OBO	on balance volume oscillator
$OBV_{j,k}$	OBV smoothed for j and k>j periods you specify
OBV	current period Granville on balance volume index
OBV_p	previous period Granville on balance volume index
C,V	current period closing price and volume
C_p	previous period closing price

Interpretation: Look for divergence between the oscillator and price to signal a reversal in price trend.
Buy (sell) in the direction of a price trend on an upturn (downturn) of the oscillator while in negative (positive) territory.

Volume - Williams Variable Accumulation Oscillator

This is a volume momentum oscillator developed by Larry Williams. A cumulative volume figure is increased or decreased each period by a percentage of current period volume, according to a comparison between the open/close differential and the trading range. A longer-term smoothing of the Williams index is subtracted from a shorter-term smoothing, resulting in a curve that oscillates above and below zero. Positive (negative) values indicate above average buying (selling) volume momentum.

$$WVO = VAD_j - VAD_k$$

$$VAD = VAD_p + \left(\frac{C - O}{H - L}\right) \times V$$

WVO	variable accumulation oscillator
$VAD_{j,k}$	VAD smoothed for j and k>j periods you specify

VAD   current period Williams variable accumulation index
VAD_p previous period Williams variable accumulation index
O,C,H,L,V   current period open, close, high, low, and volume

Interpretation: Look for divergence between the oscillator and price to signal a reversal in
price trend.
Buy (sell) in the direction of a price trend on an upturn (downturn) of the
oscillator while in negative (positive) territory.

Volume Index Positive

This is a cumulative volume indicator which tracks price momentum only during periods
of rising volume. For periods whose volume exceeds previous period volume, a
cumulative volume figure is increased or decreased by a percentage of current period
volume, according to the percent change in price. High (low) indicator values reflect
increased buying (selling) on increased volume. The premise of this indicator is that less
sophisticated investors, following the crowd into the marketplace, are responsible for
increases in volume. The indicator attempts to depict the market behavior of less
sophisticated investors, so a high value for the indicator is interpreted as a bearish sign.

$$PVI_n = PVI_p + \left(\frac{C - C_p}{C_p} \times PVI_p \right) \qquad \text{if } V > V_p$$

$$PVI_n = PVI_p \quad \text{if } V \le V_p$$

PVI_n current positive volume index smoothed for n periods you specify
PVI_p previous positive volume index
C, C_p current and previous closing prices
V, V_p current and previous volume

Interpretation: Buy (sell) when PVI establishes a negative (positive) trend.

Volume Index Negative

This is a cumulative volume indicator which tracks price momentum only during periods
of declining volume. For periods whose volume fails to exceed previous period volume,
a cumulative volume figure is increased or decreased by a percentage of current period
volume, according to the percent change in price. High (low) indicator values reflect
increased buying (selling) on decreased volume. The premise of this indicator is that low
volume reflects the absence in the marketplace of all but the most sophisticated investors.
The indicator attempts to depict the market behavior of sophisticated investors, so a high
value for the indicator is interpreted as a bullish sign.

$$NVI_n = NVI_p + \left(\frac{C - C_p}{C_p} \times NVI_p \right) \qquad \text{if } V < V_p$$

$$\text{NVI}_n = \text{NVI}_p \qquad \text{if } V \geq V_p$$

NVI$_n$ current negative volume index smoothed for n periods you specify
NVI$_p$ previous negative volume index
C,C$_p$ current and previous closing prices
V,V$_p$ current and previous volume

Interpretation: Buy (sell) when NVI establishes a positive (negative) trend.

Williams %R

This price velocity oscillator developed by Larry Williams depicts the exact negative inverse of the stochastic oscillator. The current period closing price is compared to the recent trading range to indicate overbought and oversold conditions. Large (small) negative values indicate oversold (overbought) conditions.

$$\%R = \frac{H_n - C}{H_n - L_n} \times (-100) \qquad \text{smoothed over m periods you specify}$$

C   current closing price
L$_n$,H$_n$ lowest low and highest high price during n-period lookback you specify

Interpretation: Buy (sell) when indicator curve extends below (above) a threshold level
              (usually -80 for buys and -20 for sells).
              Look for divergence between price and %R to signal trend reversals.