Trace MMI Overview

The Trace® Mini-Mobile Interrogator (MMI) is portable data retrieval and storage system designed to provide remote meter reading in conjunction with the Trace meter transponders. The Trace system is designed to convert the mechanical index reading of a utility meter to a duplicate electronic register reading. This electronic register reading is transmitted via radio frequency (RF) signals to the MMI. The Trace MMI reads each transponder by use of a RF interrogation that consists of a unique serial number along with a command requesting the contents of the electronic register. Each transponder is selected for reading on either a first-in-first-out (FIFO) basis, a latitude/longitude (L/L) basis, or a combination of the two GEO modes. The MMI obtains route data from a customer supplied floppy disk containing the street address, latitude/longitude, and serial number of each transponder that is to be read.

The MMI uses a GPS-based navigation system that tracks the vehicle position. If the Lat/Lon mode of interrogation has been selected, whenever the MMI comes into the range of a particular transponder it begins to send an interrogation for that unit. When the transponder receives a signal with the correct serial number it transmits its electronic register reading, tamper status and an error detection code.

The MMI listens for each transponder reply using an 8-channel receiver. Reply data integrity is confirmed by monitoring receiver data tracking signals and by an error detection code know as a BCH code. A transponder reply is only accepted if the BCH code analysis is valid. This ensures that the data was received without error. The meter reading along with the transponder status, receiver channel activity, time of the read, and vehicle position at the time of the read is stored in an output file contained on a floppy disk. Once the MMI has been initialized with the appropriate route data, the system will collect readings automatically, allowing the operator to drive the route in a safe and efficient manner.

Operation

Once the MMI is unpacked and the external components are properly connected, the route disk may be inserted. Once the MMI is powered on, it performs several internal self-checks. The indication and results of these tests are displayed on the hand-held terminal. Some self-check problems will require the operator to press a key to acknowledge the error before continuing. Please consult the trouble-shooting section of this manual if errors occur during testing which prevent normal usage of the MMI. Once the self-check has been completed, the MMI will read in a new route from the floppy disk (if the MMI is not resuming an interrupted route). From here, the reading mode is automatically entered, and meter reading may begin. Initially, MMI operating parameters are determined by the setting in the Guide File. Many of these parameters may be overridden using the system setup menu contained within the tools menu, discussed in the command mode operating section.

Reading Mode

During normal operation of the MMI, the Latitude/Longitude (Lat/Lon or L/L) or GEO mode of interrogation is used and only transponders in the interrogation window are interrogated. The interrogation window is an imaginary area surrounding the MMI that is used to determine which transponders should be interrogated. This is simply a means in which only certain transponders are selected for interrogation. Correspondingly, the route may be driven in any order, since the MMI is constantly computing which distances are less than 2000 feet. The window size typically never needs to be changed, but it may be necessary to reduce it, for example, when there are

many transponders in a small area. The smaller window size will allow for a smaller group of transponders to be placed in the interrogation window, allowing them to be polled more quickly. The window size also may be increased if there is some inaccuracies in the stored position of a transponder, and you want to be sure that it is interrogated. If the window size is too small, the MMI may never interrogate a particular transponder, which if interrogated, would probably respond. Likewise, if the window size is set too large, then too many transponders may be located in the window, which will slow down the interrogation for each one.

If the transponder Lat/Lon database is known to be good, then the performance enhancement feature known as Dynamic Windowing may be enabled. This feature examines the route transponder density in real time, and adjusts the interrogation window automatically to allow only the optimum number of transponders into the window at a given time.

The MMI should typically be used in the GEO mode of interrogation, although there ma be some instances where the FIFO mode may be necessary. In the FIFO mode, the MMI scans the entire list of transponders in memory, and will attempt to read each unread transponder one-by-one. If there is a large number of unread transponders in the database, then this method can become very slow, even becoming ineffective. The FIFO mode should only be used with a small number of transponders, and with the MMI either stationary, or moving slowly. The FIFO mode may be used in the unlikely event that there are problems with the navigation system. In FIFO mode, the vehicle location is not used, therefore the data from the GPS system is not needed.

While in the Reading mode, various display items are used to provide feedback to the operator. Using the parameters in the Guide file, or through the System Setup sub-menu, the option may be selected to display information for each transponder with a good status as it is processed by the MMI. Along with this option, the MMI can be directed to beep with each good read. If desired, all display options may be turned off, or any combination of options may be turned on.

The MMI may be placed in the Command mode at any time during operation. While in the Command mode, the polling of transponders in route is suspended. During the execution of a particular route, the operator may change any of the System Setup data in the route, but improper settings may adversely affect the performance of the MMI. In the event that the System Setup parameters have been altered, and the original settings are unknown, the operator may use the Break option, to halt the MMI. The MMI may then be re-powered, and the default Guide file settings will be restored, and the prior progress of the route will resume from the point where it was at before it was turned off. The MMI may be anywhere along the route when power is restored.

The vehicle position is constantly calculated and updated by the GPS navigation system. The current vehicle position is used with the Lat/Lon or GEO mode of interrogation to determine which transponders are within range of the vehicle, and may therefore be interrogated. The current vehicle position is also used with either interrogation mode to mark the Lat/Lon coordinates at the moment a good read takes place. The resulting position data is stored with the other data for the transponder that responded. The mode of interrogation may be changed at any time during the reading mode by pressing the backspace key. This will change the current interrogation mode from FIFO to GEO to L/L. The mode of interrogation may also be changed using the System Setup command within the Tools sub-menu.

As shown in the following table, several pieces of information are displayed for a good transponder reply during the reading mode (if the option to do so has been enabled). The first item displayed is the serial number. Next, the meter reading is displayed. The next item is the

tamper status. A '.' is displayed for a non-tampered transponder. A 'T' is displayed for a tampered transponder, 'R' for a tamper reset, and a 'F' is displayed if the tamper reset command failed. The last field displayed is the street address of the meter.

10:22	Mode : FIFO	Good : 200	GPS : A	IW : ALL
2539216	1235	T	123 South Main Street	
2558131	10144	.	96 Valley View Drive	
0078067	9411	T	5995 Hagley Drive	
0078067	……..	R	5995 Hagley Drive	
2121441	104551	T	4545 W. Brown Deer Road	
2121441	……..	F	4545 W. Brown Deer Road	

Typical Reading Mode Display

A status line, shown above, is displayed at the top of the screen during the reading mode. The time, mode of reading, number of good reads, GPS status, and number of transponders inside the interrogation window are displayed. The GPS status area may be at one of three statuses; 'A' indicates the GPS receiver is communicating with the MMI and is producing valid position data, and the self-navigation option is active and functioning. The status 'N' indicates the GPS receiver is communicating, but is not currently producing valid position data, and finally '-' indicates that the GPS receiver is not communicating with the MMI properly.

GPS Self Navigation & Lost Coverage Antennas

While in the Reading mode using either L/L or GEO modes, the MMI depends on the continual position updates provided by the GPS receiver. Since the GPS receiver is listening to satellites at various positions in the sky, objects such as tall buildings, trees and high-growing foliage may block the view of some necessary satellites. When such a blockage occurs, the GPS receiver is temporarily unable to provide Lat/Lon coordinates. This naturally presents a serious problem while in L/L or GEO modes.

An option known as self-navigation is available that can continue producing Lat/Lon position updates during brief GPS blockages. While in self-navigation mode, each time the MMI receives a reply from a transponder, it takes the stored Lat/Lon coordinate for that transponder and updates the vehicle position. While in self-navigation mode, the Dynamic Window feature is disabled as long as the MMI is continually receiving transponder replies, and the time between successive reads is brief, then the self-navigation mode will continue. If however, a period of no read activity occurs, then the self-navigation mode will be terminated, and the FIFO mode will become active. Once self-navigation mode is terminated, it will not resume again until the GPS status transitions from active to inactive. At the time valid GPS position data becomes available again, the previous reading mode will become active, features such as Dynamic Window will be resumes, if enabled.

The MMI will alert the operator whenever the GPS becomes unable to produce position data for any reason while in either L/L or GEO modes. Any time the GPS data becomes unavailable, both an audible and message alert will be presented on the handheld terminal. When the GPS position becomes unavailable, and self-navigation mode is unable to continue to produce position data, and GPS data is still unavailable, then an alert will be given indicating that no position data is available, and FIFO mode is being initiated. Finally, when GPS position data is restored, then another alert will be issued indicating this status. Upon the resumption of GPS data, the reading

mode which was active prior to the loss of position data, as well as any performance enhancement features will be restored.

Reading Mode Performance Enhancement Features

This section describes three MMI performance enhancement features that are often employed to achieve a greater read success in certain situations. These features are the GEO mode of interrogation, Dynamic Interrogation Window, and Frequency Scan. The interrogation mode and the Dynamic Interrogation option may be enabled or disabled at any time through the System Setup menu contained within the Tools command. The interrogation mode may also be changed by pressing the backspace key while in Reading mode. The Frequency Scan option is controlled from the Frequency Control menu within the Tools command.

GEO Mode

As described in the Reading mode section, the GEO mode is similar to L/L mode in that it uses the Lat/Lon locations of transponders to determine whether or not they should be interrogated. However, it differs by also including in the interrogation window any transponder that does not have a Lat/Lon coordinate. This most often occurs as new transponders are added to an existing route. Most utilities do not have a means of assigning a Lat/Lon coordinate at the time the transponder data is added to the route. As a result, any new and uninitialized transponder would never be read while in L/L mode, which is the primary mode of interrogation. Ordinarily, such transponders would have to be read using FIFO mode, which would require the operator to be aware of where each uninitialized transponder was located, and then switch interrogation modes until the desired uninitialized transponder reading was obtained. On all but the smallest routes, this need to constantly change interrogation modes would prove too unproductive to be practical.

It is when a small number of uninitialized transponders are mixed into the route, that GEO mode is used. GEO gets its name since transponders without coordinates are geocoded as they are read. Geocoding is simply an action that assigns a Lat/Lon coordinate to an object. Since the MMI records Lat/Lon information from each transponder as it is read, once a read occurs there now exists an approximate Lat/Lon coordinate for that transponder that may be used the next time that transponder is uploaded to the MMI.

Because the recorded Lat/Lon coordinate position is the position where the MMI obtained the reading, and *not* where the transponder is actually located, an additional restriction is placed on the transponder before its reading is accepted. Each time a transponder reply is received, a measure of its signal strength is recorded. The signal strength is proportional to the distance to the transponder. As the MMI moves closer to the transponder, the received signal strength increases. Therefore, the goal is to ensure that an uninitalized transponder is read in GEO mode at a shorter range than normal. This ensures that the recorded Lat/Lon coordinate will be effective the next time the transponder is read using its new coordinates. To force this range restriction, a minimum signal strength requirement is set in the System Setup menu that will be applied only to uninitailized transponders being read in GEO mode. Other transponders with Lat/Lon coordinates, as well as any transponder in FIFO mode will not face this restriction. Any transponder reply that does not meet the signal strength requirement will result in a NO_RD status. This is the same status, which occurs any time the MMI does not receive a reply from a transponder. The default minimum signal strength setting will most not likely ever need to be altered.

Dynamic Interrogation Window

Another performance enhancement feature implemented in the MMI is the Dynamic Interrogation Window. Ordinarily, the interrogation window is set to a particular fixed radius, and is not altered. This is normally acceptable for routes that have a consistent installation density. However, on routes where there are widely varying installation densities, a fixed interrogation window size can actually cause performance degradation. If an excessive non-adjustable window size is used on a dense route, then the MMI will not have as much time to re-interrogate transponders that are close, but have not yet been read. This would result in either missed transponder readings, or would require the operator to slow the vehicle to an unacceptable speed. Likewise, if the non-adjustable window size becomes too small, then some transponders may never be interrogated at all due to the vehicle speed and errors in the Lat/Lon coordinate information. To overcome these limitations, the dynamic interrogation feature may be enabled by the System Setup menu within the Tools command. When enabled, this feature will automatically adjust the interrogation window size once per second to try to maintain a fixed number of transponders in the window. This ensures that in situations where there are a large number of transponders in a small area, the interrogation window size will be kept smaller, so time is not wasted on interrogating transponders that are farther away. Also, it ensures that in situations where there is a small number of transponders in a large area, the interrogation window size will be allowed to grow, which prevents transponders from never being interrogated at all.

Frequency Scan

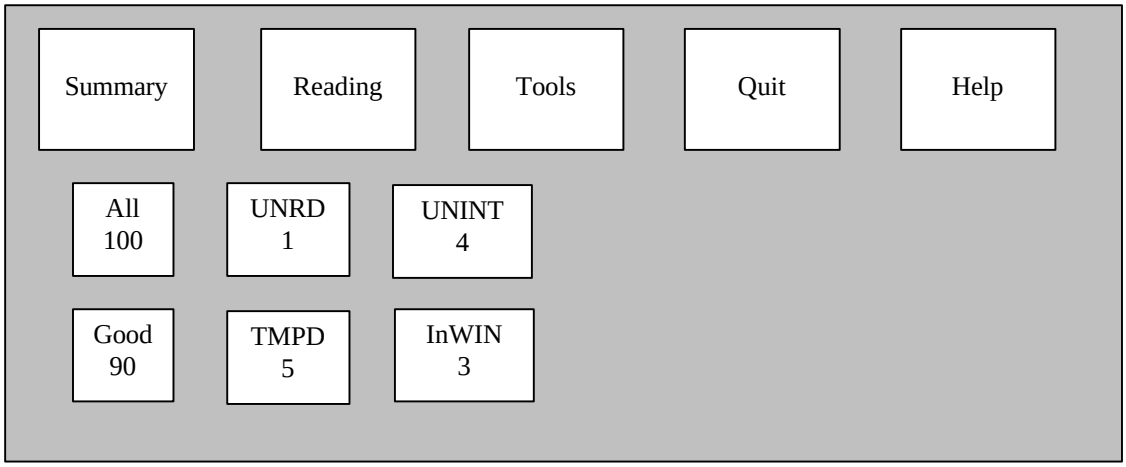
To accommodate older transponders, whose reply frequency has drifted down beyond normal limits, the frequency scan feature may be enabled. This feature is enabled in the Frequency Control menu contained in the Tools command. This feature will tune receiver channel 1 between two frequency limits defined in the Frequency Control menu. This allows transponder replies at abnormally low frequencies to be received, without any special or additional effort. However, one caution should be noted when using this feature. Since a receiver channel 1 is changing frequencies quite often, a transponder was at another. This results in a potentially increased read time for transponders that have abnormally low reply frequencies. The amount of speed degradation is related to how wide the frequency scan is. The wider the frequency scan range, the potentially slower the response time will be for low frequency transponders. By default the upper frequency limit for the scan is one channel below the lowest channel currently programmed in channels 2-8. Both limits may be arbitrarily changed within the Frequency Control menu.

Command Mode

The operator may stop reading at any time by pressing any key other than the backspace key on the hand-held terminal. Doing so will place the MMI in the Command mode, where various operations are available. Stopping the reading process in this manner will not affect any previously read transponders, and the Reading mode may be entered or exited as often as necessary. All transponder data is stored in non-volatile memory, which protects valuable data from being lost in the event of main power loss. This also allows the operator to quickly and easily pause the MMI while in the process of reading a route, and resume reading the remainder of the route at a later time. While in command mode, transponder interrogation is suspended.

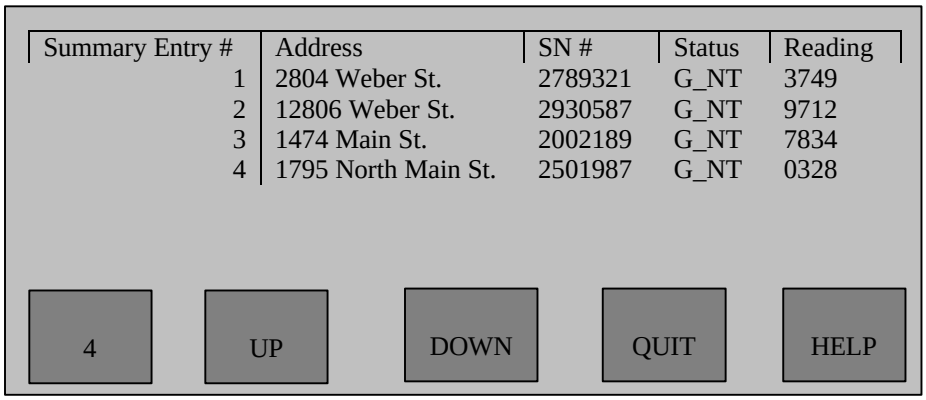
Summary Command

The Summary command menu is the invoked by pressing the ‘S’ key while in Reading mode, or while the main Command mode menu is displayed. The six Summary command menu selections display the total number of transponders having a particular status. As an example, this information can be used to identify how many transponders have been tampered with, then display each address so that a visual inspection of the transponder may be performed.



Summary Command Sub-Menus

The Summary command menus display information in the format shown below. When the operator selects a particular Summary command menu, the MMI searches the route for only those transponders that have responded accordingly.



The six menus of the Summary command detail the various possible states for the transponders in route. This serves to give a quick, detailed look at the progress being made in the reading of the route.

The definition of each Summary command menu and associated transponder states are discussed below:

All All transponders in route will be displayed.
Unrd Any unread transponders in the route will be displayed.
Unint Any transponders that have never been polled will be displayed.
Reminder: The MMI will not poll a transponder until it is in the Interrogation window while in the Lat/Lon or GEO mode of reading, Or unless it has not Lat/Lon coordinate, and GEO mode is active.
Good Those transponders that have been successfully read, including tampered units, will be displayed. Refer to the next table for a summary of transponder status definitions.
Tmpr Any transponders which have returned a tamper status will be displayed.
Inwin In the Lat/Lon mode of reading, all transponders which are in range of the MMI read window and are displayed. In the FIFO mode of reading, all unread transponders will be displayed as being in the window.

Particular entries may be searched for in any of the summary displays by using the **S** (search) key. This will allow the operator to input a street number, street name, serial number, or just a part of an entry that corresponds to a transponder of interest. The summary display will then display only those transponders that match the search string and are in the main summary category initially selected.

The operator may also jump to a particular entry in the summary display, by typing in the desired entry number and pressing the Enter key. The display will then start at that entry a scroll down from there. The number displayed in the box above the S key is the total number of entries that match the search string. Help is available at any time in the summary screen by pressing the H key.

Within some of the Summary sub-menus there are various status labels placed on each transponder entry. These statuses reflect the success of a transponder read or show why a read failure was detected. The Code field shown in the following table corresponds to the code field in the MMI output data file.

Status	Description	Code	Tamper	Good Read	Good Status
UNINT	Uninterrogated	10	N/A	No	No
G_NT	Good; Not Tampered	01	No	Yes	Yes
G_NR	Good; Not Reset	03	Yes	Yes	Yes
G_TR	Good; Tamper Reset	07	Yes	Yes	Yes
G_T_RF	Good; Tamper Reset Filed	0B	Yes	Yes	Yes
G_T_RP	Good; Tamper Reset Pending	0F	Yes	Yes	No
NO_RD	No Read	20	N/A	No	No
BAD_RD	Bad Read	40	N/A	No	No
*BAD_NR	Bad Meter Reading Checksum	41	N/A	No	No
*BAD_ID	Bad Serial Number Checksum	42	N/A	No	No
*BAD_B2	Both Checksums Bad	43	N/A	No	No
N_T_RP	No Read; Tamper Reset Pending	2F	Yes	Yes	No
B_T_RP	Bad Read; Tamper Reset Pending	4F	Yes	Yes	No
PENDING	Pending; was UNINT prior	90	N/A	No	No
PENDING	Pending; Was G_T_RP prior	8F	Yes	Yes	NO
PENDING	Pending; Was NO_RD prior	A0	N/A	No	No
PENDING	Pending; Was BAD_RD prior	C0	N/A	No	NO
*Status Pertains to 3rd Generation Transponders Only					

Transponder Status Definitions

The transponder definitions shown in the above table are described below:

UNINT The transponder has never been polled because it has never been within the interrogation window. The Tamper field in the above table does not apply with this status since the transponder has never been read.

G_NT The transponder has replied with a good read, no tamper condition.

G_NR The transponder has replied with a good reading and is showing a tamper status, but the MMI is not going to reset the tamper condition as controller by the system configuration. The system configuration may be changed in the System Setup menu, or by changing the values in the Guide file.

G_TR The transponder has replied with a good reading and was showing a tamper status, and the MMI successfully reset the prior tamper condition.

G_T_RF The transponder has replied with a good reading and is showing a tamper status, but the MMI was not able to verify if the tampered condition was reset. This may occur if the MMI goes out of range of the transponder while still trying to interrogate it to verify the tamper status. The reading for the transponder is good, but the tamper condition may or may not still exist.

NO_RD The transponder has been polled, but the minimum number of receiver channels did not receive enough good data to pass the channel matching. This usually occurs when a transponder is still too far away from the MMI.

BAD_RD The transponder has been polled and the receiver was able to lock on to incoming data, but the BCH error detection has failed. This may occur if the MMI is in an area of strong interference, and is usually corrected when the MMI gets closer to a transponder.

BAD_MR The 3rd generation transponder has replied with an indication that the meter reading checksum has failed. This could be due to a new battery inserted into the transponder, or due to a malfunction. The transponder should be checked and reprogrammed. The meter reading should not be trusted.

BAD_ID The 3rd generation transponder has replied with an indication that the serial number checksum has failed. This could be due to a new battery being inserted into the transponder, or due to a malfunction. The transponder should be checked and reprogrammed. The meter reading should not be trusted.

BAD_B2 The 3rd generation transponder has replied with an indication that both the meter reading and serial number checksums have failed. This could be due to a new battery being inserted into the transponder, or due to a malfunction. The transponder should be checked and reprogrammed. The meter reading should not be trusted.

N_T_RP The transponder has replied with a good reading and is showing a tamper status, but during the tamper-reset verification, the transponder reply resulted in a ***NO_RD*** status. The reading for the transponder is good, but the tamper condition may or may not still exist.

B_T_RP The transponder has replied with a good reading and is showing a tamper status, but during the tamper-reset verification, the transponder reply resulted in a ***BAD_RD*** status. The reading for the transponder is good, but the tamper condition may or may not still exist.

PENDING The transponder has replied with a particular non-good status, and is now in a transition between the prior status, and a new status.