APPENDIX H: MANUAL

Please see the following pages.

USER GUIDE

TRACE ™

VRT Transponder

AMCO Automated Systems

Copyright Acknowledgements

AMCO Automated Systems
107 Erskine Lane
Scott Depot, WV 25560
Phone 304-757-3300 Fax 304-757-3388

FCC Compliance

The TRACE VRT Transponder™ has been type accepted by the Federal Communications Commission under Part 15C, low power communication device transmitter. FCC ID: G8JVRT01

This device complies with Part 15 rules. Operation is subject to the following conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television

reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation distance between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experience radio/TV technician for help.

Changes or modifications not expressly approved by AMCO Automated Systems could void the user's authority to operate the equipment.

Transponder Manual and Installation Guide

Table of Contents

Chapter One

Introduction

The TRACE® VRT Transponder is the heart of AMCO Automated Systems' portfolio of products for automated meter reading (AMR).

About this Document

The Transponder manual and installation Guide provides instructions for installing and troubleshooting transponders. It also includes an overview of both AMR in general and TRACE technology in particular.

Audience

This document is designed for utility industry meter readers and supervisory staff. In order to establish appropriate levels of detail for the material, this document assumes the following:

- The user is proficient in reading meters of the type currently compatible with TRACE transponders and possesses all the skills necessary to conduct meter reading by conventional means.
- The user has little or no prior expertise in the TRACE AMR technology.
- The user is familiar with common data entry devices and techniques.

Conventions

In the interest of brevity and simplicity, this document uses the following conventions:

- Additional information relevant to a given instruction step may be shown in one of three ways:
  1. A bulleted item covers "how-to" and verification information.
  2. *An italicized NOTE contains relevant background information.*
  3. *An italicized and bolded **CAUTION** contains information important to the safety of either the user or the equipment.*
- Where reference to other parties is made, the generic masculine pronouns (he, his, him) are used. This is no way reflects bias or gender discrimination in any manner related to the users, publishers or authors of this document.

Chapter Two

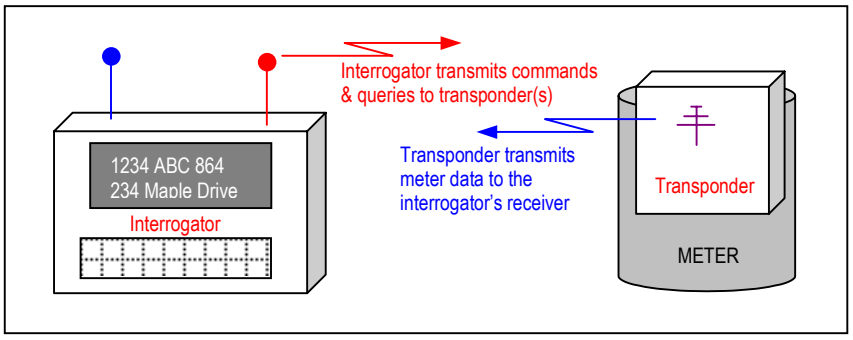
Automated Meter Reading Overview

The TRACE system uses radio frequency (RF) signals to allow utility personnel to read meters from a distance while the reader is in motion. This technology is called automated meter reading (AMR). This technology greatly increases the speed at which routes can be covered with a high degree of accuracy.

Basic AMR Components

An automated meter reading system requires the following basic components:

- **Transponder**—The transponder Interfaces with meter index mechanics, translates index reading into digital signals to capture data from meter, receives commands from an interrogator and transmits meter data.
- **Interrogator**—At its simplest, the interrogator remotely reads meter data transmitted by transponders. At more sophisticated levels an interrogator may also program transponders, store route data, "wake up" transponders, verify transponder conditions and data and set meter coordinates, among other functions.
- **Antennas**—Both the transponder and the interrogator use antennas to broadcast and receive RF signals. The transponder's antenna is typically located on the circuit board inside the transponder case. Some interrogators use external antennas (as shown in the illustration below), one for transmitting and one for receiving. Many handheld interrogators use a single antenna for both transmitting and receiving (antenna may be internal or external).



The interrogator sends out an RF signal to the desired transponders. Upon receiving an authorized command the transponder transmits its stored meter data.

The TRACE AMR System Overview

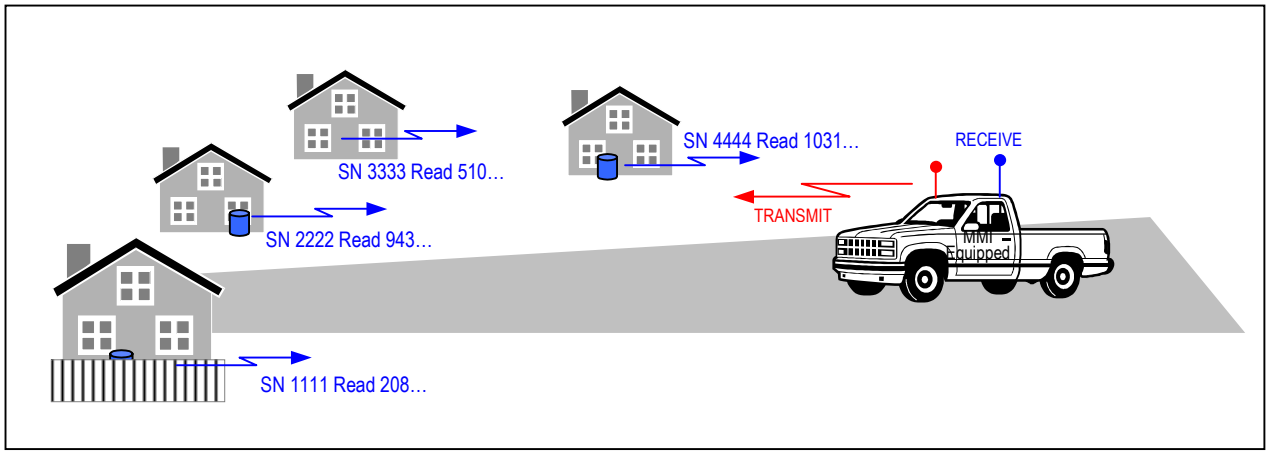
In addition to standard automated meter reading functions, AMCO's TRACE system portfolio of products permits the remote recording of tamper conditions and linking of meter latitude and longitude data using a Global Positioning Satellite (GPS) system. With the optional Vehicle Interactive Display, TRACE makes driver-to-meter orientation more intuitive and efficient.

TRACE interrogators transmit at 451.35 MHz and receive transponder messages at 415 MHz. (Transponders transmit between 414.5 and 415 MHz and receive at 451.35 MHz.)

Trace transponders, normally asleep, "wake up" and listen for an interrogation signal once every second. Only if a transponder hears its unique serial number will it transmit data back to the interrogation device, and then it goes back to sleep.

How the TRACE System Works

Utility personnel no longer have to walk up to each meter, look at its index and record its reading. Once transponders are installed on meters and programmed, meter readers simply walk or drive down each street in the route allowing the TRACE interrogator to request and record meter data automatically.



The interrogator addresses each transponder in the interrogation window individually. When the transponder "hears" its serial number and proper authorization, it transmits the current meter data. The TRACE system's frequency band allows remote reading of transponders even through walls and fences.

Acquisition of meter information begins with the transponder where data is stored continuously for later retrieval and moves to the interrogator upon command. The acquired data from a given route can be transferred to a host computer via floppy disk for processing.

The information acquisition, storage and handling process includes several basic elements:

Meter interface. Using a mechanical-to-digital interface, the TRACE transponder senses the output from the index of a utility meter, translates this into electronic form and stores it in the transponder's memory.

Transponder data acquisition. The transponder is programmed with a unique serial number at the time of manufacture. Upon installation on a meter, the current (or baseline) meter index reading is also programmed into the transponder's memory. As the meter reading advances it automatically updates transponder memory. The transponder also records changes to the tamper detection sensor.

Compensation factor. For TRACE transponders using firmware Version 9 or higher, a compensation factor can also be programmed into the transponder memory ensuring the transponder readings match the compensated mechanical index reading.

Route information loading. Route data includes meter account number, address and latitude/longitude coordinates (when available), and transponder serial number. This information, along with Guide and Start files, is downloaded to the interrogator prior to commencing automated meter reading. By also tracking the vehicle or interrogator's coordinates, a GPS-equipped system determines which transponders in the route should lie within range at any given time and transmits those serial numbers requesting meter data.

Interrogation. Once placed in an interrogation mode by the meter reader, the TRACE interrogator transmits serial number(s) of the desired transponder(s) along with a command requesting the contents of each transponder's memory. Transponders are selected for reading on the basis of route and meter location information stored in the interrogator and presence of the transponder within range of the interrogator.

Route data processing. Meter data from transponders is stored in the interrogator's memory and can be transferred to the utility's host computer for processing

Chapter Three

VRT Transponder Overview

The TRACE VRT Gas Transponder is designed for use with most residential and commercial diaphragm meters from American Meter, Equimeter/Invensys®, and Sprague/Schlumberger®. The transponder can be programmed to work with a fixed factor, pressure-compensating index. The transponder maintains the current time and date, which are used to record real-time data for retrieval as required during the normal read cycle. In addition to maintaining an electronic index (e-index) reading that corresponds to the meter index reading, the transponder:

- Stores 35 daily index readings in separate e-indexes recorded at the start of the utility day.
- Maintains up to four time-of-use (TOU) e-indexes that each have programmable start and stop times.

VRT Transponder and Components

The transponder consists of a high impact plastic housing with rubber gasket; RF transmitter; receiver; tamper switch; transmit and receive antennas; battery, and various electronic components.

The transponder is shipped with mounting hardware.

The meter's existing index and index cover are attached to the transponder. The index and index cover are not shipped with the standard transponder, but in some cases may be purchased separately.

How the Transponder Works

When a transponder is installed on a meter the installer programs the transponder's e-index to correspond to the meters mechanical index. As the mechanical index accumulates count the transponder's e-index accumulates count as well from a magnet and reed switch configuration integral to the transponder. Once a day, at a pre-programmed time, the transponder stores the current index reading for that day into the e-index for that day. The transponder maintains daily reading history for the past 35 days. Four time-of-use registers with programmable start and stop times can accumulate consumption in separate e-indexes as well.

To maximize battery life, the transponder changes from its normal, low-power quiescent state every 1.5 seconds into an intermediate power state for 2.5 milliseconds in order to (1) update the e-index for the meter index, daily reading and time-of-use indexes; poll the tamper detector; and (3) check to see if a valid interrogation signal is being received. When a valid interrogation signal (including the transponder's unique serial number) is received, a two-way communication link is established. A current reading and other historical data (as required for each individual account) is transmitted to the interrogator. Data collected by an interrogator are validated, audited and stored for uploading to TRACE® Route Manager VRT Software later.

VRT™ Transponder Program Values.

At the time of manufacture transponders are programmed with the current date, time of day, and other values as specified by the utility.

Time of Day. The time of day for the time zone specified by the utility is programmed into the transponder. The time of day on the transponder can be synchronized with the clock in the interrogation device each time the transponder is read.

Daylight Savings Time. If daylight savings time is observed the utility must advise AMCO Automated Systems and the initial settings will be programmed into the transponder at the time of manufacture. Updates to daylight savings time will be communicated through Route Manager VRT ™ and interrogators.

Daily Read Capture Time. Daily read history is recorded at the same time each day for retrieval at a later date. The daily read capture time is specified by the utilty and programmed into the transponder at time of manufacture.

Time of Use Registers. Time of use registers, if activated, accumulate consumption recorded by the transponder between the start and stop time set for each TOU register. If activated the TOU register must be active for a minimum of 00:29:59 (hh:mm:ss) and a maximum of 23:44:59 (hh:mm:ss). TOU registers can start on the hour or in 15-minute intervals after the hour (12:15:00 PM is a valid start time / 12:07:00 PM is not a valid time). TOU registers must end at the end of the hour or in 15-minute intervals thereafter (01:59:59 PM is a valid stop time / 02:13:59 is not). TOU registers can overlap – for example, TOU 01 can run from 08:00:00 AM until 10:29:59 PM and TOU 02 can run

from 10:15:00 AM until 2:29:59 PM. TOU registers can span midnight – a start time of 08:00:00 PM with a stop time of 01:59:59 AM is valid.

Index Drive Size / Subcounts per Revolution / Pre-Dividers. The number of subcounts recorded with each revolution of the drive dial on 1-ft^3 and 2-ft^3 indexes is one. A 1-ft^3 index requires 100 revolutions to yield 100 ft^3 and a 2-ft^3 index requires 50 revolutions to yield 100 ft^3. Therefore, the pre-divider for a 1-ft^3 index is 100 and for a 2-ft^3 index it is 50.

Pressure Compensation Factor. When a transponder is used in conjunction with a pressure compensated index a compensation factor can be programmed into the transponder memory by the utility at the time of installation. This instructs the transponder's microprocessor to compute adjustments to the meter reading as needed. Compensation factors are unique for specific indexes and can be obtained by contacting AMCO Automated Systems' Customer Service Department at (304) 757-3300.

Specifications

The following table shows the VRT Transponder specifications:

Power	One (1) lithium – Thionyl chloride 275 amp-hours; 20 years calculated life under normal working conditions. The battery can be easily replaced in the field.
FCC Compliance	Part 15, Subpart C: a user license is not required (FCC ID G8JVRT01)
RF Transmitter	414.5 MHz, +0.5, -1.0 MHz; 4,000 uV/m @ 3m.
RF Receiver	451.35 MHz; -70 dBm sensitivity
Materials	• Housing: high-impact plastic, weatherproof, UV protected for outdoor installation. • Circuit-card assembly: conformal-coated • Corrosion–protected external-housing screws
Operating Temperature Range	-22°F to 158°F (-30°C to 70°C)
Storage Temperature Range	-40 °F to 185°F (-40°C to 85°C)
Humidity	5-95% Relative (non-condensing)
Weight	6 oz. Excluding index and index cover.
Serial Numbers	Up to eight digits, starting at 6500000

Chapter Four

Transponder Installation & Programming

Installation

1. Prior to removing the existing index and index cover, verify that the transponder style is compatible with the meter style.

2. Verify that the battery is properly seated, and that the battery wires are flush to the left side of the transponder wall (facing the rear of the transponder). *Note: When transporting transponders to the field for installation please take care not to jar the housing and dislodge the battery from the bracket.*

3. Verify that the transponder is in good working order by querying the transponder for the meter reading using an SRP, PI, or any other appropriate interrogation device.

4. If the transponder is in good working order, remove the existing index and index cover from the meter. Remove the gasket and any adhesive material from the meter – a scraper or putty knife is recommended for this task.

5. Using the self-tapping index screws provided, mount existing index to the transponder, verifying that the index wriggler is properly mated with the transponder wriggler.

6. Mechanical Check
   a. Once the index is attached to the transponder, perform a quick spin test to verify that the index rotates freely and without resistance. If the index is rotated 3 times in the clockwise direction, be sure to rotate it 3 times in the counter-clockwise direction to assure that no additional subcounts or counts are inadvertently placed on the mechanical index. Subcounts added to the e-index during this procedure will be cleared when the transponder is programmed to the mechanical index reading.

7. Sub-Count Check
   a. Rotate the transponder wriggler such that the drive dial is in the 12 o'clock position.

   b. Read the transponder subcounts using an SRP, making note of the subcount value.

   c. While facing the index rotate the drive dial 3 times in the counter-clockwise direction, stopping at the 12 o'clock position.

   d. Read the transponder subcounts using an SRP, making note of the new subcount value. The new subcount value should read 3 subcounts higher than the original reading. If the new subcount value is less than the original subcount value, please consider

the possibility that the subcounts rolled over. If the values do not meet to your expectations, repeat from Step 7a.

8. Mounting Transponder
   a. Visually align transponder wriggler with meter wriggler.

   b. Mate the transponder wriggler with the meter wriggler. (Picture here, all three TP styles)

9. Holding the transponder on the meter, place the index cover onto the transponder, verifying that the index cover weep holes are at the bottom.

10. Secure transponder to the meter using the mounting bolts provided. The recommended torque range is 14-26-in-lbs.

11. Install the tamper seals into the index cover receptacles.

12. Remove the auxiliary label from the transponder and attach it to your field order.

Programming

*Note: Transponders not installed on meters may accumulate **sub-counts** during shipping. Sub-counts are automatically reset to zero when the current e-index reading is programmed. With the exception of transponders delivered on meters, all transponders (even those mated with indexes set at 0000) should be programmed after installation on the meter to confirm that the subcount is set at zero when the transponder is placed in service.*

*The **tamper flag** is set to "false" or "not tampered" when the transponder is programmed. The orientation of the transponder at the time that it is programmed will be the "not tampered" orientation for future reference. If a transponder is mounted on a meter which is subsequently installed in a different orientation, you may need to reprogram the transponder to remove it from a tampered condition.*

Please refer to the SRP manual for programming instructions, if required.

1. **Index Reading**
   Program the transponder's e-index value to the value of the mechanical index.

2. **Current Date**
   This value is programmed at the factory, but will be lost in the event of a power interruption. If necessary, program the transponder with the current date.

3. **Current Time**
   This value is programmed at the factory, but will be lost in the event of a power interruption. If necessary, program the transponder with the current time.

4. **Daily Read Capture Time**

This value is programmed at the factory and is retained in the event of a power interruption. The value can be reprogrammed if your requirements change.

5. **Daily Read History**
   The value in each Daily Read e-index is recorded at a pre-determined time every day and can be retrieved for up to 35 days. In the event of a power interruption these values are lost and cannot be retrieved.

6. **Time of Use (TOU) e-index Parameters**
   There can be different values for each TOU e-index. These values are programmed at the factory, but will be lost in the event of a power interruption. If your requirements change the TOU start and stop times can be reprogrammed at any time.

7. **Time of Use (TOU) e-index Values**
   The value in each TOU e-index accumulates as the mechanical index registers consumption. In the event of a power interruption the values in each TOU e-index is lost and cannot be recovered.

8. **Index Drive Size / Subcounts per Revolution / Pre-Dividers**
   The pre-divider value is programmed at time of manufacture and is dependant on the drive size of the meter/index being used with the transponder. This value can be reprogrammed by the utility if your requirements change. The pre-divider value resides in flash memory and it is not lost in the event of a power interruption.

9. **Pressure Compensation Factor**
   The pressure compensation factor programmed by the utility at time of installation is lost in the event of a power interruption, and must be reprogrammed. Compensation factors are unique for specific indexes and can be obtained by contacting AMCO Automated Systems' Customer Service Department at (304) 757-3300.

10. **Next Daylight Saving Time Day Number**
    The transponder's internal clock will automatically switch to daylight saving time on the date represented by the value entered into this field. The value must represent a future date. Please refer to table [TABLE 01] for a list of valid entries. This value is programmed at the factory for the next valid date after it is shipped, but must be updated by the utility for subsequent periods. In the event of a power interruption the value is retained.

11. **Next Standard Time Number**
    The transponder's internal clock will automatically switch to standard time on the date represented by the value entered into this field. The value must represent a future date. Please refer to table [TABLE 01] for a list of valid entries. This value is programmed at the factory for the next valid date after it is shipped, but must be updated by the utility for subsequent periods. In the event of a power interruption the value is retained.

Chapter Five

Troubleshooting

The following table offers troubleshooting tips for some common Transponder conditions. For all other matters, contact AMCO Automated Systems.

Symptom	Possible Cause	Solution
Transponder cannot be interrogated with an SRP, MMI or PI Device	The incorrect serial number has been entered into the interrogator	Verify that the correct serial number is being interrogated
	The transponder is not within range of the interrogation device	Be certain that the interrogator is within range of the transponder. An SRP should be within 3 inches of the transponder. If operating an MMI in Lat/Long or GEO Mode be certain that the transponder is in the reading window.
	Interference from another interrogation device.	Verify that no other interrogations are taking place, either with an SRP, PI, URFI, or MMI.
	Interference from another interrogation device.	Any MMI within range of the transponder must have the transmitter turned off while you are interrogating with the SRP.
Transponder will not program	The SRP is out of range of the transponder.	Move the SRP (and particularly the top, where antenna resides) closer to the transponder.
	The programming device (SRP, PI) is attempting to communicate with the incorrect transponder serial number	Correct the serial number in the programming device.
Transponder will not read from street	Malfunctioning Interrogator	Check operation of interrogator on known good transponder
	Interference from external sources	Clear area around transponder of metal objects (lawn chairs, bicycles, etc.).
	Hard-to-read location	Place a known good transponder at the same location and attempt to read both units from the street. If the new unit will read replace the old unit and reinstall it on a meter with shorter range requirements.
Tamper flag will not reset	The orientation of the transponer at the time it was programmed is different from the current orientation of the transponer.	Reprogram the e-index reading. This will reset the tamper to “false” and establish the “no tamper” position of the transponder.
I rotated the drive hand forward three times and back three times but the subcount increased anyway.	Transponders will accumulate subcounts with rotation of the drive hand in either the counterclockwise or clockwise direction.	If the index is rotated in reverse during installation and/or troubleshooting procedures the transponder should be reprogrammed to the current index reading to reset subcounts to zero.

Table 01 - DST / ST Date Values

		Daylight Saving Time Starts		ST Starts		
	Year	Date	Day No.	Date	Day No.	
	2002	04/07/02	96	10/27/02	299	
	2003	04/06/03	460	10/26/03	663	
	2004	04/04/04	824	10/31/04	1034	
	2005	04/03/05	1188	10/30/05	1398	
	2006	04/02/06	1552	10/29/06	1762	
	2007	TBD		TBD		
	2008	TBD		TBD		
	2009	TBD		TBD		
	2010	TBD		TBD		
	2011	TBD		TBD		
	2012	TBD		TBD		
	2013	TBD		TBD		
	2014	TBD		TBD		
	2015	TBD		TBD		
	2016	TBD		TBD		
	2017	TBD		TBD		
	2018	TBD		TBD		
	2019	TBD		TBD		
	2020	TBD		TBD		
	2021	TBD		TBD		
	2022	TBD		TBD		
	2023	TBD		TBD		
	2024	TBD		TBD		
	2025	TBD		TBD		

Table 02 - TOU Time Slots

Time Slot	Start Time	End Time
1	12:00:00 AM	12:14:59 AM
2	12:15:00 AM	12:29:59 AM
3	12:30:00 AM	12:44:59 AM
4	12:45:00 AM	12:59:59 AM
5	1:00:00 AM	1:14:59 AM
6	1:15:00 AM	1:29:59 AM
7	1:30:00 AM	1:44:59 AM
8	1:45:00 AM	1:59:59 AM
9	2:00:00 AM	2:14:59 AM
10	2:15:00 AM	2:29:59 AM
11	2:30:00 AM	2:44:59 AM
12	2:45:00 AM	2:59:59 AM
13	3:00:00 AM	3:14:59 AM
14	3:15:00 AM	3:29:59 AM
15	3:30:00 AM	3:44:59 AM
16	3:45:00 AM	3:59:59 AM
17	4:00:00 AM	4:14:59 AM
18	4:15:00 AM	4:29:59 AM
19	4:30:00 AM	4:44:59 AM
20	4:45:00 AM	4:59:59 AM
21	5:00:00 AM	5:14:59 AM
22	5:15:00 AM	5:29:59 AM
23	5:30:00 AM	5:44:59 AM
24	5:45:00 AM	5:59:59 AM
25	6:00:00 AM	6:14:59 AM
26	6:15:00 AM	6:29:59 AM
27	6:30:00 AM	6:44:59 AM
28	6:45:00 AM	6:59:59 AM
29	7:00:00 AM	7:14:59 AM
30	7:15:00 AM	7:29:59 AM
31	7:30:00 AM	7:44:59 AM
32	7:45:00 AM	7:59:59 AM
33	8:00:00 AM	8:14:59 AM
34	8:15:00 AM	8:29:59 AM
35	8:30:00 AM	8:44:59 AM
36	8:45:00 AM	8:59:59 AM
37	9:00:00 AM	9:14:59 AM
38	9:15:00 AM	9:29:59 AM
39	9:30:00 AM	9:44:59 AM
40	9:45:00 AM	9:59:59 AM
41	10:00:00 AM	10:14:59 AM
42	10:15:00 AM	10:29:59 AM
43	10:30:00 AM	10:44:59 AM
44	10:45:00 AM	10:59:59 AM
45	11:00:00 AM	11:14:59 AM
46	11:15:00 AM	11:29:59 AM
47	11:30:00 AM	11:44:59 AM
48	11:45:00 AM	11:59:59 AM
49	12:00:00 PM	12:14:59 PM
50	12:15:00 PM	12:29:59 PM
51	12:30:00 PM	12:44:59 PM
52	12:45:00 PM	12:59:59 PM
53	1:00:00 PM	1:14:59 PM
54	1:15:00 PM	1:29:59 PM
55	1:30:00 PM	1:44:59 PM
56	1:45:00 PM	1:59:59 PM
57	2:00:00 PM	2:14:59 PM
58	2:15:00 PM	2:29:59 PM
59	2:30:00 PM	2:44:59 PM
60	2:45:00 PM	2:59:59 PM
61	3:00:00 PM	3:14:59 PM
62	3:15:00 PM	3:29:59 PM
63	3:30:00 PM	3:44:59 PM
64	3:45:00 PM	3:59:59 PM
65	4:00:00 PM	4:14:59 PM
66	4:15:00 PM	4:29:59 PM
67	4:30:00 PM	4:44:59 PM
68	4:45:00 PM	4:59:59 PM
69	5:00:00 PM	5:14:59 PM
70	5:15:00 PM	5:29:59 PM
71	5:30:00 PM	5:44:59 PM
72	5:45:00 PM	5:59:59 PM
73	6:00:00 PM	6:14:59 PM
74	6:15:00 PM	6:29:59 PM
75	6:30:00 PM	6:44:59 PM
76	6:45:00 PM	6:59:59 PM
77	7:00:00 PM	7:14:59 PM
78	7:15:00 PM	7:29:59 PM
79	7:30:00 PM	7:44:59 PM
80	7:45:00 PM	7:59:59 PM
81	8:00:00 PM	8:14:59 PM
82	8:15:00 PM	8:29:59 PM
83	8:30:00 PM	8:44:59 PM
84	8:45:00 PM	8:59:59 PM
85	9:00:00 PM	9:14:59 PM
86	9:15:00 PM	9:29:59 PM
87	9:30:00 PM	9:44:59 PM
88	9:45:00 PM	9:59:59 PM
89	10:00:00 PM	10:14:59 PM
90	10:15:00 PM	10:29:59 PM
91	10:30:00 PM	10:44:59 PM
92	10:45:00 PM	10:59:59 PM
93	11:00:00 PM	11:14:59 PM
94	11:15:00 PM	11:29:59 PM
95	11:30:00 PM	11:44:59 PM
96	11:45:00 PM	11:59:59 PM

Note: TOU registers cannot start and end with the same time slot.