

Arduino TITO and Player Tracking Project

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Portions of the Arduino SAS protocol implementation by Ian Walker

Additional testing and troubleshooting by NLG member Eddiie

HARDWARE REQUIRED

Arduino Mega 2560 R3

<https://www.amazon.com/gp/product/B01H4ZLZLQ/>

RFID RC 522

<https://www.amazon.com/gp/product/B07KGBJ9VG/>

W5100 Ethernet Shield

<https://www.amazon.com/gp/product/B00AXVX5D0/>

MAX3232 Serial port (or compatible)

<https://www.amazon.com/gp/product/B083L99CGZ/>

6' USB Cable

<https://www.amazon.com/dp/B00NH11KIK>

6' M-F 9-pin straight-through serial cable

<https://www.amazon.com/dp/B006W3XVZK>

Micro-SD memory card – 32GB or smaller

<https://www.amazon.com/gp/product/B073K14CVB>

Compatible slot machine

- Tested on IGT S2000/GameKings, Bally, WMS and Konami machines; will probably work on others based on the SAS 6.x protocol; you will need a compatible cable to connect to the serial port on the machine

Player tracking bracket with an existing card reader, compatible VF (or LCD) display and a compatible keypad

Compatible Vacuum Fluorescent Display or LCD

- Project defaults to an IEE Compatible VF Display such as: IEE 03601-95A-40 using modified library included
- DataVision DV-16236 displays using the LiquidCrystal library
- Noritake GU-7000 Series displays using modified library included
- 1602A LCD displays using the LiquidCrystal library

Compatible Keypad (Optional)

- Project defaults to a Bally Systems Player Tracking 6x2 Keypad P/N 105123F
- Bally Systems Player Tracking 3x4 Keypad
- ACT 8x2 Keypad

Dupont M-F jumper wires (quantity and length depends on configuration)

CAT5 cable long enough to reach from your network jack to the top box (or use a WiFi-RJ45 dongle)

<https://www.amazon.com//dp/B07QXNWRWJ>

Serial cable to connect to game

- For IGT Games: 5-pin Dupont to Male DB9 Serial pigtail (I reused the one from the BETTORSlots TITO board; I have not found a source for these yet – see Figure 1)

At least 3 RFID cards

<https://www.amazon.com/gp/product/B01FR66KW1>

5 Watt or greater USB Power Brick

3D printed case for Arduino (or something to protect Arduino from shorting-out on metal in upper cabinet)

- <https://www.thingiverse.com/thing:30270>
- <https://www.thingiverse.com/thing:1364105>

BEFORE YOU BEGIN

These instructions assume familiarity with electronics, coding and slot machine configurations. If you are new to any of these then this project may not be for you. My instructions were not written for beginners. You may damage your game or the Arduino/TITO hardware if you do not understand what you are doing.

UPGRADING FROM EARLIER VERSIONS

- If you are upgrading from a version before 20210216 you will need to make changes to your config.txt file. There are new properties that must be added and changed properties that must be edited. Please see the 'Arduino TITO and Player Tracking Project - File Formats.txt' file in the download for the changes.
- There is an updated version of the Card Server (APTS.EXE) in this release. You will need to update all of your boards to the new sketch and the Card Server exe at the same time (if using APTS).
- There is an updated version of the Web UI in this release. You will need to update the 'index.html' file on your SD card with the one in the included \SD Card Files folder.

WIRING

- The Ethernet Shield attaches to the Arduino Mega via the built-in pin headers
- Display Wiring
 - o If using an IEE VFD then pins 1-10 should go to data pins 22-31 respectively; VFD Pin 11 to 5V, and Pin 12 to Ground (Assumes IEE Vacuum Fluorescent Display 03601-95A-40)
 - o If using a 1602a LCD or equivalent – Pin 1 to Ground, Pin 2 to 5V, Pin 3 to Ground, Pin 4 to data pin 22, Pin 5 to Ground, Pin 6 to data pin 23, Pins 11-14 to data pins 27-24 respectively, pin 15 to 5V through 220ohm resistor and pin 16 to Ground
 - o If using a DataVision DV-16236 or equivalent – Pin 1 to Ground, Pin 2 to 5V, Pin 4 to data pin 22, Pin 5 to Ground, Pin 6 to data pin 23, and Pins 11-14 to data pins 27-24 respectively
 - Reference: http://www.datavision.com.tw/en/lcm_01_1.php?P_Id=9
 - o If using a Noritake VFD GU140X16G-7003 or equivalent – Pin 1 to 5V, Pin 2 to data pin 3, Pin 3 to Ground, Pin 4 to data pin 5, pin 6 to data pin 7
 - Reference: https://www.noritake-iron.com/site2017/images/Specs/VFD/MDG/GU140x16J-7000x/7003/gu140x16j-7003_e01-h8.pdf
 - This assumes display is preset to Async Serial; if set otherwise then a different pinout and library will be required
 - **IMPORTANT! The sketch will hang on Initializing if you test it without the Noritake display attached**
 - **WARNING! This display draws more power than my desktop PC USB could provide and exhibited strange behavior when all of the hardware was tested together. A 5W wall adapter provided sufficient power to prevent this condition**
- Keypad Wiring (See Figure 2 for examples of tested keypads)

- If using the Bally 6x2 or 3x4 keypad - Wire Pin 1 on keypad to data pin 39, Pin 2 to 38, Pin 3 to 41, Pin 4 to 40, Pin 5 to 43, Pin 6 to 42 and Pin 7 to 45; Pin 8 is not used
- If using the ACT 8x2 keypad – Wire Pin 1 on the keypad to data pin 38, Pin 2 to 39, Pin 3 to 40, Pin 4 to 41, Pin 5 to 42, Pin 6 to 43, Pin 7 to 44, Pin 8 to 45; Pin 9 is not used
- Pins 38-45 should be used for all keypads; exact pinout will vary
- The Serial board needs to be wired into 5V, Ground and pins 18 & 19 for Rx and Tx respectively; You will need to find a place to mount the serial board – it can be hot-glued to the Ethernet Shield as long as no components are touching
- The RFID board needs to be wired into data pins 49-53 as follows:

SDA=53 SCK=52 MOSI=51 MISO=50	GND=Ground RST = 49 3.3V = 3.3V
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You will need to power the Arduino board from the Accessory Outlet in the base of the slot machine using a USB power brick (5W or greater). A 6' USB cable is recommended to reach the top cabinet. It may be possible to get power from the top-cabinet but that is beyond the scope of this document

- Do not power the board from any built-in USB port on the game – it will not provide enough power

You will also need to run a CAT5 cable into the top box for the network or use a WiFi-RJ45 dongle – which will require separate power

Compatible WiFi dongle: <https://www.amazon.com//dp/B07QXNWRWJ>

INITIAL SETUP

- Assumes you have the Arduino IDE setup, the board and COM port settings are correct and all required libraries are installed, including
 - o IniFile*
 - o IeeFlipNoFrills, Noritake GU-7000 or LiquidCrystal
 - The sketch default configuration is a 20x2 LCD using the LiquidCrystal Library
 - You will need to use the included modified libraries for the IeeFlipNoFrills or the Noritake displays
 - For the Noritake library there is another section of code to enable in the setup() function
 - o SPI*
 - o MFRC522*
 - o Ethernet*
 - o SD*
 - o Keypad*
 - The sketch defaults to a Bally compatible 6x2 or 3x4 matrix
 - o TimeLib (<https://github.com/PaulStoffregen/Time>)

*Can be downloaded via the Arduino IDE Library Manager

- Format the MicroSD Card as FAT32
- Edit the included config.txt file with your settings and preferences; then copy it and the index.htm file to the SD card
 - o The scrolling text options have a max length of 255 characters
 - o Other text options have a limit of 30 characters (with exception of Casino Name – which should not exceed max width of your display)
 - o Other options are Boolean or Integers
 - o **Important: Set the display dimensions to the correct size based on your display**
 - Some VFDs like the Noritake calculate the display size in pixels; Example: a GU140X16G-7003 is a 140x16 display; so the displayWidth should be 140 and the displayHeight should be 16
 - You will need to adjust the displayCols and displayRows to match the character dimensions of the display; Example: the GU140X16G-7003 emulates a 20x2 character display; so the displayCols should be 20 and the displayRows should be 2
 - Setting these incorrectly will cause display problems
- Insert the SD card into the slot on the Ethernet Shield
- Connect the board to your computer and load the ArduinoTITOPlayerTrackingV2 Sketch
- Modify the sketch as needed to enable support for your display and keypad; see inline comments for the relevant sections
- Open the Serial Monitor
- Download the sketch to the Arduino
- Wait for the app to finish initializing
- Place your first card over the RFID reader – it will create a default player tracking file on the SD Card. Note the cardID in the Serial Monitor. This will be your first player card
- Remove the card from the reader and place a different card on the reader. This will create a second card file which you can edit into the Admin card. Note the cardID in the Serial Monitor

- Remove the card from the reader and place a different card on the reader. This will create a third card file which you can edit into the System Bonus card. Note the cardID in the Serial Monitor
- Unplug the Arduino; remove the SD Card and insert it into your PC/Laptop. Edit the player tracking card files accordingly. Details on the file formats are in the 'Arduino TITO and Player Tracking Project - File Formats.txt' file
- After editing the files replace the SD card in the Arduino
- Mount the hardware into the slot machine's top box. Your specific player tracking bracket and options may vary – use your best judgement on how to mount the hardware. I removed the existing card reader electronics (leaving the slot and frame) and mounted the RFID reader on top of the slot so it can read the cards when inserted. The mounting of your VF (or LCD) display depends on the type of display and the player tracking bracket
- Run the USB power wire down through the cabinet and route it to the accessory outlet
- Run the CAT5 Ethernet cable down through the cabinet and out to your network outlet
- Run the Serial Port cable down through the cabinet and connect it to the serial pigtail (if you are replacing a BETTORSlots TITO board; otherwise an adapter will need to be created) Running this cable may be a tight fit – you may need to remove the grommet in the cabinet pass-through or shave down the cable-end to make it fit
- Power the machine and test
 - o Assumes you are replacing an existing TITO board or have already setup your machine per the instructions later in this document

CARD SERVER (OPTIONAL)

- Included in the package is a self-contained web server (APTS.EXE) designed to host and serve the card data to multiple slot machines. It can be run on any Windows 10 PC with the .NET Core 3.1 runtime (<https://dotnet.microsoft.com/download/dotnet-core/3.1>)
 - o If you have multiple machines (each with one of these boards) you can also designate one of the machines to host the card data and then set the other machines to be clients by setting their localStorage option to 0 and populating the serverIPAddress with the IP of the machine to act as host. That machine (or more specifically the board) will need to be powered for it to serve card data to the other machines
- Place the EXE in a folder on your PC. Cards will be created in this folder
- You will need to disable Windows Firewall or add a rule to allow connections to port 80
- The app must be run as an Administrator
- If you have configured your machines to use the card server and it is not running then player tracking will be unavailable
- In each config.txt file set the localStorage option to 0 and set serverIPAddress to the IP Address of the computer running the Card Server

ADMIN MENU

- The Admin Menu can be entered by inserting the Admin Card or pressing [CLR] on the keypad and then entering the Admin Pin followed by [ENT] on the keypad
 - o The Admin Pin defaults to 1234 and is adjustable in the config.txt file
- The display will change to 'ADMIN MENU'. In this mode you can perform the following actions from the keypad:
 - o Press 1 to Add Credits; after selecting this option use the keypad to enter the number of credits to add to the game
 - o Press 2 to Unmute the game
 - o Press 3 to Mute the game
 - o Press 4 to Unlock the game
 - o Press 5 to Lock the game
 - o Press 6 to Enable the Bill Validator
 - o Press 7 to Disable the Bill Validator
 - o Press 8 to Enable Change-to-Credits feature
 - o Press 9 to Disable Change-to-Credits feature
 - o Press 0 to Exit Admin Menu
- Remove the Admin Card or press '0' to return to the attract mode

PLAYER MENU

- The Player Menu can be entered by pressing [ENT] on the keypad while a Player Card is inserted.
- The display will change to 'PLAYER MENU'. In this mode you can perform the following actions from the keypad:
 - o Press 1 to Show Comp Balance
 - o Press 2 to Use Comp Credits
 - o Press 0 to Exit Player Menu
- Remove the Player Card or press '0' to return to the attract mode

PLAYER COMPS

Players can earn Comp Credits while playing the game at a rate specified by the 'compPercentage' setting in the config.txt file. It defaults to 0.01 comps per credit played – so if you play 100 credits you will earn 1 comp credit. Setting compPercentage to zero will disable the comp system.

Comp Credits can be redeemed at the machine by entering the Player Menu (instructions above) and using option 2. Only whole-credits can be redeemed.

REMOTE ACCESS

- This version includes a web interface for controlling various aspects of the game as well as the player tracking display
- It is compatible with the BETTORSlots IOS/Android apps (except tournament mode)

Arduino TITO and Player Tracking

Game Name: **GameKing** IP Address: **192.168.1.249**
Current player: **No Card Inserted**

Add Credits	1000
Sound On	Sound Off
Unlock Play	Lock Play
Enable Bill Validator	Disable Bill Validator
Change/Credits On	Change/Credits Off
Game Statistics	Player Statistics
Reset Handpay	Update Player Name

Update Display

Enter your custom message here

Update Message

Update Ticket Info

Casino Name/Location

Address Line 1

Address Line 2

Update Ticket Info

This device is compatible with the BETTORSlots Android/IOS apps for remote control.

Most functions are self-explanatory; The Change/Credits feature allows you to enable adding credits by pressing the Change (or Service) button. The number of credits added on each press is set in the config.txt file.

The Update Message option allows you to change the default scrolling text message; it resets to the value in the config.txt when the board is reset.

The Update Ticket Info option allows you to change the information printed on the cash-out ticket.

GAME MANAGER

Included in this version is the Game Manager Windows Application. It allows you to manage one or more game machines via a simple interface. It can be run on any Windows 10 PC with the .NET 5.0 runtime (<https://dotnet.microsoft.com/download/dotnet/5.0>)

Click 'Add Game' to add a new row to the grid. Only the IP Address is needed as the other fields will be populated by the game data. Double-click on the row's IP Address cell to edit it. Then press Refresh to query the game for data. You can delete a game by selecting the row in the grid and clicking 'Delete Game'. For the Game Controls – you can select one or more games to control/update by holding down the [CTRL] key while clicking on each row.

The screenshot shows the 'Arduino TITO and Player Tracking - Game Manager' application window. It features a table with columns for Game Name, IP Address, Arduino Clock, Is Online, Last Response, Credits, Total In, Total Won, Total Games, Games Won, Games Lost, Current Player, Games Played, Games Won, Games Lost, Total Won, Comps Earned, and Tournament Score. Below the table are several control panels: 'Game Controls' with buttons for Add Credits, Sound On/Off, Unlock/Lock Play, Enable/Disable Bill Validator, Change Credits On/Off, Reset Handpay, and Sync Date/Time; 'Tournament Mode' with a dropdown for duration, a text field for starting credits, and buttons for Sync Arduino Clocks, End Tournament, and Start Tournament; 'Update Display' with a text input for a custom message and an Update Display button; and 'Update Ticket Info' with text inputs for Casino Name/Location, Address Line 1, and Address Line 2, along with an Update Ticket Info button. At the bottom, a reminder states: 'Reminder! Not all games support all features and options. Thank you.'

Game Name	IP Address	Arduino Clock	Is Online	Last Response	Credits	Total In	Total Won	Total Games	Games Won	Games Lost	Current Player	Games Played	Games Won	Games Lost	Total Won	Comps Earned	Tournament Score
Wild Triple Strike	192.168.1.99		<input checked="" type="checkbox"/>	OK	555	14114	21999	4827	645	4182	Marc Davis	1077	94	983	3747	11.40	
GameKing	192.168.1.249		<input type="checkbox"/>	OK	154	41569672	39493418	23192	10302	12890	Teri Davis	0	0	0	154	0.00	

TOURNAMENT MODE

The Game Manager allows you to select two or more machines to play in a tournament mode. You can specify the duration and the starting credits. To begin tournament play each player must have a Player Tracking Card and it must be inserted in the machine they want to play. Each machine is checked to see if the player card is present and the correct number of credits are on the machine. If there are too many credits you will need to play it down or cash out the machine. The Game Manager will apply the correct number of starting credits when the game starts. There is a 30-second countdown and then the games will unlock and play can begin.

The player's score during the tournament will be visible in the Player Tracking Display. Players cannot add additional credits during tournament mode.

The tournament will run until the clock expires or the host can end the tournament early from the Game Manager. If a player removes their Player Card while the tournament is in progress or they run out of credits their game will end early and they will not be allowed back in until the tournament ends. The winner will be displayed in the Game Manager and on the winning machine's Player Tracking Display.

NOTES ABOUT TOURNAMENT MODE

- This is NOT SAS HOST Tournament mode; this is my own implementation which should work on any game compatible with my board.
- Tournament mode depends on the games being in-sync with the host (Game Manager) clock. The Arduino hardware does not have a true real-time clock – so we have to do it in software. The clocks can drift slightly and network latency can slightly affect the times – but the Game Manager will attempt to update the clocks on each refresh.
 - o Since there can be a delay in the HTTP response back from the board it is not uncommon for the displayed time to be a little off from one machine to the next – but the internal time on the board should be correct
- There is a 30-second countdown clock to the actual tournament start; this is to give both players and the machines enough time to respond to the Game Manager and set things up. Don't be surprised if some games respond faster than others – especially over WiFi. The games should start roughly at the same time (+- 1 second).
- It is not absolutely necessary for the games to be in perfect time-sync.
- I have only tested this on two machines – and it worked, but your mileage may vary.

NOTES ABOUT GAME MANAGER

- If a player card is inserted in a game you can edit the Player's Name by double-clicking on the name in the grid, changing it and then pressing [ENTER] or clicking away from the field.
- My games did not always accept the Sync/Date Time command on the first try; not sure if this is an issue with the game or the data yet
- This is definitely a BETA app; expect bugs

CONFIGURING YOUR IGT MACHINE (S2000/GameKing)

Before getting started with setting up your IGT machine for TITO please ensure your Bill Validator is working correctly and your Ticket Printer can print clear and legible tickets. You will also need a Keychip appropriate for your type of machine. These instructions assume familiarity with the Keychip process. Note – keychips and menu option locations vary from model-to-model. Please consult your IGT user manual or me if you have questions.

1. Clear any credits off your machine
2. Keychip your machine
3. Once in the Keychip Menu, ensure your Denomination, Devices, Limits and Game settings are as you want them
4. Setup the Comm Options as follows
 - a. IGT SAS Primary Channel = Channel 3
 - b. SAS Secondary = Off
 - c. Bally Miser = Off
 - d. Progressive Link = 7
 - e. WAMM 1.0 = Off
5. Setup the Validation/Redemption Options as follows
 - a. Validation = System Validation
 - b. Redemption = SAS Redemption
6. Setup the IGT SAS Options as follows
 - a. System Bonusing = SAS Legacy
7. Setup the SAS Channel (Primary Channel) Options as follows
 - a. Address = 1
 - b. Legacy Bonus = Enabled (X)
 - c. Validation = Enabled (X)
8. Setup the Machine Terminal Options as follows
 - a. Voucher Limit Follows = Credit Limit
9. Save all options and make any other changes you wish before pressing Return to Game to exit the keychip menu

Test the game by inserting money and then pressing Cash Out to generate a ticket. The ticket serial number should match the number of credits you inserted. Insert the ticket into the machine, it should accept it for the same number of credits.

CONFIGURING YOUR IGT MACHINE (AVP)

Please see this video for how to configure your AVP Game:

<https://www.youtube.com/watch?v=JKjyeFQPltA>

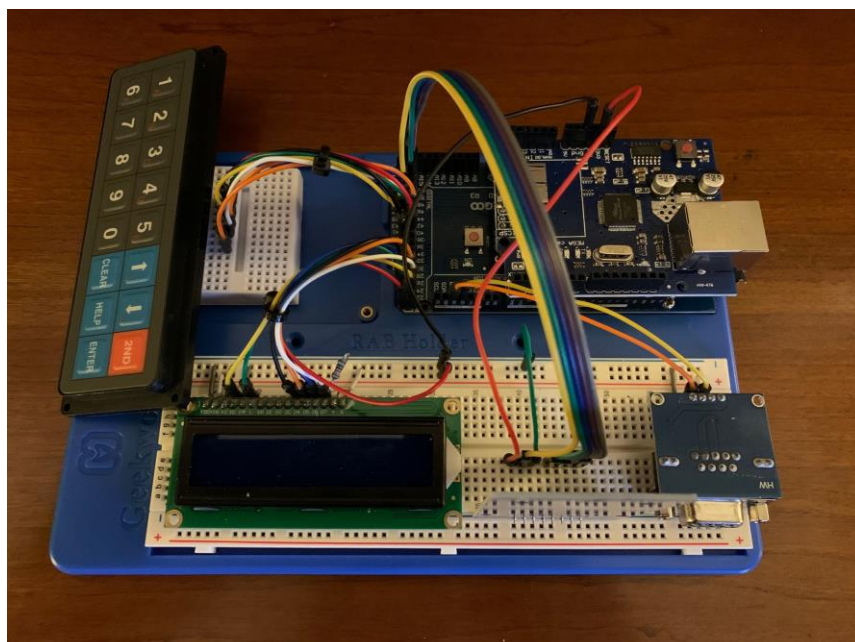
NOTES

- This project uses specific hardware and libraries. It may be possible to switch out the Ethernet Shield for another. I DO NOT RECOMMEND using a WiFi Shield – had nothing but problems during testing
- If you do not have a display or card slot (or only wish to use this as a TITO solution) you can set the option 'onlyTITO' to 1 in the config.txt
- Not all machines support the Audio Mute or the Remote Handpay Resets – in those cases the commands will be ignored by the machine

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PHOTOS



Mockup using 1602LCD and 8x2 Keypad

FIGURE 1: IGT Serial Cable



IGT S2000/GameKing Serial Pinout

DB9 Male	Signal direction	S2000 J82
2 Receive Data	←	1 Transmit Data
3 Transmit Data	→	2 Receive Data
5 Signal Ground	---	5 Signal Ground

FIGURE 2: Compatible/Tested Keypads

