

Current Engine Ignition Tuning

by Larry Klusza, 2024

Background

When the GTO was first built, it was common for dealers and repair shops to utilize tuning and analyzing equipment manufactured by the Sun Electric Corporation. During this pre-computer age, they were the latest thing.



To utilize the equipment effectively, Sun also produced detailed tune-up reference material for the cars and trucks of the period.

The AMA information included with the PHS documentation lists the distributor assembly used on the GTOs standard 350 hp version of the 400-cu engine as having part number 1111148. I found the Sun Tune-up Chart for this engine showing the performance specifications for the 1111148 distributor, which indicates how much spark advance it provides and at what rpm.

I used this information as the basis for creating a “tune” for the *Progression Ignition* Bluetooth programmable electronic distributor.

The distributor measures either vacuum or pressure in **KPa**. To have that make a bit more sense for folks, Progression Ignition documentation provides a handy conversion chart of KPa to **inHg**. (Inches of mercury) which I used to create various tunes.

The Sun Tune-up chart expresses timing in distributor degrees. Since the distributor runs at half the speed of the crankshaft, the rpms and degrees of timing at the distributor must be multiplied by 2 to equate to crankshaft degrees, which is used to establish engine timing. For the purpose of this document, all specifications quoted have already been converted to crankshaft degrees.

Our GTO engine runs at about 9.1:1 compression and is also equipped with the “068” *Ram Air III* camshaft. This cam has a bit more overlap than the standard one. As such, it needs a bit more fuel and timing to run effectively. Currently, the reliable hot idle vacuum is measured to be about 15 inHg.

KPA to Engine Vacuum at Sea Level	
KPA	Manifold Vacuum (inHg)
100	0.0
95	1.5
90	3.0
85	4.4
80	5.9
75	7.4
70	8.9
65	10.3
60	11.8
55	13.3
50	14.8
45	16.2
40	17.7
35	19.2
30	20.7
25	22.1
20	23.6

The stock tune specified an initial advance of **9°** set at the crankshaft with a timing light, the stock distributor would have provided an “all in” total of **28°** of mechanical advance by 4600 rpm. This results in approximately **37°** advance at wide open throttle (WOT). Part-throttle cruise introduces vacuum advance to the mix. The distributor provided up to **22°** more at between 15 to 17 inHg. Added to the initial and mechanical timing, the engine could see between **45°** and **59°** total timing at part-throttle cruise.

Tuning Parameters

Given that today's unleaded/ethanol blended fuels are a far cry from the leaded pure premium specified for this engine at the time of production, some concessions had to be made. The heads were rebuilt with new valves, valve springs, valve guides, seals, and hardened seats. Reduced compression pistons were used during the overhaul, dropping the compression from 9.75:1 actual (10.25:1 advertised) down to a more manageable 9.1:1 compression. With an appropriate ignition tune, doing so enables the engine to operate on modern premium unleaded fuel without detonation.

That said, initial trials duplicating the parameters of the standard factory points-type distributor with the Progression Ignition Bluetooth electronic distributor resulted in poor performance and noticeable detonation on modern 91 octane ethanol blended fuel. There was simply too much timing for the engine to use in its new configuration. It was also determined that the vacuum advance mechanism was a large source of the detonation problem. After much research into the performance aspects of high-performance adjustable vacuum advance canister tuning for modern engines, it became clear that a slightly reduced amount of vacuum advance should begin at approximately 8 – 10 inHg and be fully deployed at around 2 inHg *before* a given engine's vacuum reading at hot idle. Optimum hot idle AFR was achieved by tuning for highest vacuum (15-16 Hg.) and then setting one step richer for insurance against lean-out and detonation. Once complete, then ignition tuning could begin. For our purposes that would equate to a fully deployed vacuum advance reading of 13 inHg.

The Tune

Historically, most engines also respond to a bit more initial timing, so it was decided to incorporate that into the new tune. Doing so necessitated reducing the total amount of mechanical advance and shifting its “all in” point from 4600 rpm down to 3000 rpm to maintain performance yet avoid detonation. After many trial and error attempts, an acceptable tune that provided very snappy performance on 91 octane unleaded fuel without detonation in our 9.1:1 compression engine was achieved. That tune, created in our programmable Bluetooth distributor, has provided the best results and is broken down as follows:

- Initial advance timing: **18°**.
- Total mechanical (centrifugal) advance timing: **16° max (34° in the app [16°+18° initial] all in by 3000 rpm)**.
- Additional vacuum advance: **16° max** starting at **80 KPa (5.9 inHg)** and fully deployed at **55 KPa (13.3 inHg)** which is 2 inHg less than our best hot idle reading of 15 inHg. See the highlighted cells in the KPa chart.
 - The aggressive vacuum deployment is achieved by selecting the “aggressive” mode check-box in the distributor tuning app.
- EFI keeps the idle @ about 650 rpm in drive or park.

The timing table is illustrated on the next page.

This tune provides a maximum of **34°** total wide-open throttle (WOT) timing, and up to **50°** of total timing under various cruise conditions. Here is the timing table as seen in the Progression Ignition smartphone app:

1816v16m8055x Rev Limit: 5400												
	10	18	20	23	25	27	29	32	34	34	34	34
101	10	18	20	23	25	27	29	32	34	34	34	34
94	10	18	20	23	25	27	29	32	34	34	34	34
86	23	18	20	23	25	27	29	32	34	34	34	34
79	23	18	21	24	26	28	30	33	35	35	35	35
71	23	18	26	29	31	33	35	38	40	40	40	40
64	23	18	30	33	35	37	39	42	44	44	44	44
57	23	18	35	38	40	42	44	47	49	49	49	49
49	23	18	36	39	41	43	45	48	50	50	50	50
42	23	18	36	39	41	43	45	48	50	50	50	50
34	23	18	36	39	41	43	45	48	50	50	50	50
27	23	18	36	39	41	43	45	48	50	50	50	50
20	23	18	36	39	41	43	45	48	50	50	50	50
...	450	650	990	1320	1660	1990	2330	2660	3000	3800	4600	5400

When generating and storing tunes in the Progression Ignition app on my smartphone, I use the following nomenclature methodology: e.g., **1816v16m8055x**

- The first two numbers (**18**) are the initial crankshaft timing.
- The second two numbers (**16v**) are the degrees of vacuum advance (denoted by the “v”)
- The third two numbers (**16m**) are the degrees of centrifugal (mechanical) advance (denoted by the “m”)
 - **NOTE:** The app only lets you set the max rpm-based timing (**34°**), which is the initial timing advance and centrifugal advance timing combined. So, $34^\circ - 18^\circ = 16^\circ$ mechanical advance (**m**).
 - File name limitations in the smartphone app prevented me from indicating that the mechanical advance was all in by **3000 rpm**.
- The last four digits are actually two pairs. The first pair (**80**) represent the KPa when vacuum advance starts and the second pair (**55**) is the KPa level by which vacuum advance is fully deployed.
- The presence or absence of the “x” on the end indicates whether or not the “aggressive” deployment feature of the vacuum advance was used for that specific tune.

➡ Remember that the accuracy of any tuning done with the app is dependent upon the distributor being locked down at 10° BTDC, measured at the crankshaft timing mark with a timing light. However, using a timing light in the normal manner will only display the timing produced by the current tune used by the distributor.

In order to see a “true” reading of 10° BTDC while using the electronic distributor, you would need to use a “calibration” tune, limiting timing to just the 10° so that you can properly verify it at the crank with a timing light. Creating such a tune is detailed on the next page.

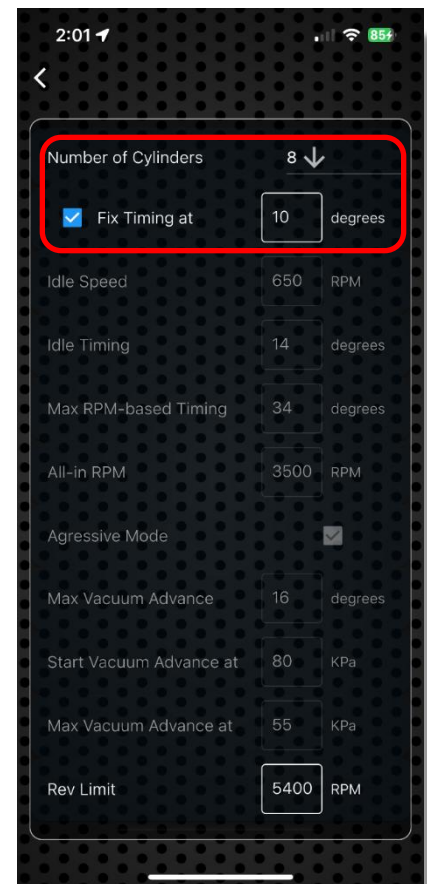
Calibration

During initial installation, the instructions called for the distributor to be set at **10° BTDC at the crankshaft** using a timing light. You would then lockdown the distributor in place. This procedure synchronizes the distributor to the engine. From that point on, any further timing adjustments would be made by the distributor, using the tuning app only.

Should you wish to verify the physical 10° BTDC base timing you would need to create and store a “calibration” tune in your smartphone using the tuning app for this purpose.

To do so, perform the following steps:

1. Open the tuning app on your phone and select “Generate Table.”
2. Select to put a check in the “Fix Timing at” check box.
 - a. NOTE: The timing window should already indicate the default 10 degrees.
3. Scroll down on the screen and select “Generate Table” button to create the table.
 - a. The screen will change to show an unnamed table completely filled with “10s”. This is your calibration table.



	101	94	86	79	71	64	57	49	42	34	27	20
101	10	10	10	10	10	10	10	10	10	10	10	10
94	10	10	10	10	10	10	10	10	10	10	10	10
86	10	10	10	10	10	10	10	10	10	10	10	10
79	10	10	10	10	10	10	10	10	10	10	10	10
71	10	10	10	10	10	10	10	10	10	10	10	10
64	10	10	10	10	10	10	10	10	10	10	10	10
57	10	10	10	10	10	10	10	10	10	10	10	10
49	10	10	10	10	10	10	10	10	10	10	10	10
42	10	10	10	10	10	10	10	10	10	10	10	10
34	10	10	10	10	10	10	10	10	10	10	10	10
27	10	10	10	10	10	10	10	10	10	10	10	10
20	10	10	10	10	10	10	10	10	10	10	10	10
...	300	660	1130	1590	2050	2520	2980	3450	3910	4370	4840	5400

4. In the lower left-hand corner of the table is a cell with 3 dots.
 - a. Touch this cell to bring up a menu.
5. From this menu, choose “Save” and give the table a name, such as “Calibration” then select “save.”

The calibration tune will be saved to your phone and is then available for use anytime you wish to verify the initial physical 10° BTDC setting at the crankshaft with a timing light.

When you are done using the calibration tune, be sure to upload any other normal tune stored on your phone back to the distributor. Verify by choosing “Active Table” from the tuning app main menu.