Jaycar Electronics — Specialists in electronic kits, components and products.

KC5442: KIT – PROGRAMMABLE IGNITION SYSTEM MK2

Silicon Chip Magazine March 2007 (p16 – p27), April 2007 (p66 – p78), May 2007 (p74 – p83)

Rev 1A

Batch No: 7W9060

Customers please note:

- The supplied PCB has an overlay showing the various configurations for the different trigger inputs.
- Some case machining is required.
- Additional parts are required for the Points to Hall Effect Sensor conversion.

PLEASE READ BEFORE COMMENCING CONSTRUCTION

The guarantee on this kit is limited to the replacement of faulty parts only, as we cannot guarantee the labour content you provide. Our Service Department does not do general service on simple kits and it is recommended that if a kit builder does not have enough knowledge to diagnose faults, that the project should not be started unless assistance can be obtained. Unfortunately, one small faulty solder joint or wiring mistake can take many hours to locate and at normal service rates the service charge could well be more than the total cost of the kit.
If you believe that you may have difficulty in building this kit (which is simply a complete set of separate parts made up to a list provided by the major electronics magazines) and you cannot get assistance from a friend, we suggest you return the kit to us IN ITS ORIGINAL CONDITION for a refund under our satisfaction guarantee.
Unfortunately, kits cannot be replaced under our satisfaction guarantee once construction has been commenced.

CONTACTS:

For queries with regards to the design aspects of this kit please contact the Project Designer. It is recommended to check the designers/publishers website for further notes and errata since this document was issued.
Silicon Chip Publications, POBox 139, Collaroy Beach, NSW 2097, Tel: +61-2-99795644, Fax: +61-2-99796503
www.siliconchip.com.au, silchip@siliconchip.com.au

For **quality issues** please contact the **Production Manager** at Jaycar Electronics and provide the following information:

- Product Number
- Batch No
- Details of Quality Issue

Notes and Errata (at time of print):
It is recommended to check the designers/publishers website for further notes and errata since this document was issued, before starting construction.
The project article has been updated with relevant notes and errata. It will therefore differ from the original article published in the magazine.

Possible Substitutions			
Original Part	Original Part Desc	Subst Part	Subst. Part Desc.
N/A			

PARTS LIST
Please note that catalogue numbers refer to suitable products from the Jaycar product range. Quantities listed refer to the actual number of items required. When purchasing items separately, take pack quantities into account.
[1] *See section about Substitution* [2] **See section about Notes & Errata** [3] Processed Panel not part of Case listed
Catalogue numbers starting with "E" or listed as "Special Order" (incl. processed panels) are Kit specific and may not be readily available.

For queries with regards to the design aspects of this project please contact the Project Designer.

COMPONENTS COMMEN TO THE VARIOUS PROGRAMMABLE IGNITION CONFIGURATIONS

RESISTOR(S)

Cat.#	Qty*	Description	Component Ident And/Or Location
HP1250	10	PIN PCB 0.9MM GLD	
RR0524	9	RES 0.5W MTL 10R 1%	Brown Black Black Gold Brown
RR0564	1	RES 0.5W MTL 470R 1%	Yellow Purple Black Black Brown
RR0572	1	RES 0.5W MTL 1K0 1%	Brown Black Black Brown Brown
RR0578	1	RES 0.5W MTL 1K8 1%	Brown Grey Black Brown Brown
RR0580	2	RES 0.5W MTL 2K2 1%	Red Red Black Brown Brown
RR0596	3	RES 0.5W MTL 10K 1%	Brown Black Black Red Brown
RR0612	2	RES 0.5W MTL 47K 1%	Yellow Purple Black Red Brown
RR0620	2	RES 0.5W MTL 100K 1%	Brown Black Black Orange Brown

CAPACITOR(S)

Cat.#	Qty*	Description	Component Ident And/Or Location
RC5316	2	CAP CER NPO 22P 50V 10% P=5MM	22pF
RC5336	2	CAP CER NPO 1N 50V 10% P=5MM	1n / 1000p / 102
RC5348	1	CAP CER NPO 10N 50V 10% P=5MM	0.01uF / 10n / 103
RE6066	1	CAP ELECT RB 10U 16V 105C P=2MM 5X11MM	10uF / 16V
RE6130	3	CAP ELECT RB 100U 16V 105C P=2.5MM 5X11	100uF / 16V
RE6220	1	CAP ELECT RB 1000U 16V 105C P=5MM 10X21	1000uF / 16V
RM7010	1	CAP MKT 1N 100V P=5MM 7.5X2.5X6.5MM	1.0n / 1n0 / 102
RM7065	1	CAP MKT 10N 100V P=5MM 7.5X2.5X6.5MM	0.01uF / 10n / 103
RM7125	3	CAP MKT 100N 100V P=5MM 7.5X2.5X6.5MM	0.1uF / u1 / 100n / 104
RM7145	1	CAP MKT 220N 100V P=5MM 7.5X3.2X8MM	0.22uF / u22 / 220n / 224

SEMICONDUCTOR(S)

Cat.#	Qty*	Description	Component Ident And/Or Location
EZ9017	1	IC PROG (KC5442) 16F88-E/P* DIP18	
PI6458	1	SKT IC MACHINED 18PIN	
RQ5299	1	CRYSTAL 20MHZ HC49US	20MHZ
ZR1004	1	DIODE 1N4004 400V 1A DO41	1N4004
ZR1162	1	DIODE P4KE 13.6V 16A STANDOFF 400W AC	P16CA
ZT2115	1	TRAN BC337/BC877 NPN 50V 800MA TO92	BC337
ZV1560	1	VREG LM2940CT-5 +5V 1A L/DROP TO220	LM2940

JAYCAR ELECTRONICS PTY LTD (ABN 65 000 087 936), 100 SILVERWATER RD, SILVERWATER, NSW 2128, AUSTRALIA
Tel: (02) 9741 8555 Fax (02) 9741 8500 www.jaycar.com.au kits@jaycar.com.au

HARDWARE / WIRE(S) / MISCELLANEOUS (small)

Cat.#	Qty*	Description	Component Ident And/Or Location
EF1154	1	SCREW M3X6MM SLOT R/HD ZP	
EF1167	4	SCREW M3X20MM POZI CSK SP	
HM3212	1x2 & 1x3 way	HEADER SGL VRT 40WAY P=2.54MM	
HM3240	2	JUMPER SHUNTS P=2.54MM	
HP0149	1	WASHER NYLON M3 FLAT WHT	
HP0403	1	SCREW M3X10MM PHIL R/HD SP	
HP0414	1	SCREW M3X25MM PHIL R/HD SP	
HP0425	5	NUT M3 SP	
HP0433	8	WASHER MTL M3 S/PRF INT/T SLV	
HP0905	2	SPACER MTL TAPPED HEX M3X15MM	
HP0921	4	SPACER NYLON TAPPED HEX M3X6.3MM	
HP1350	2	LUG SOLDER TIN ID4.3XID2X17.6MM0	
LF1250	3	FERRITE BEADS FX1115	
LO1242	1	RING CORE IRON HY2 15X8X6.5MM	
NS3015	1	SOLDER 60/40 1MM	
PM0852	2sets	NUT SET LOCKING (D CONNECT) L6MM	1set = 1nut, 1 washer, 1screw
PM0854	2	SCREW (D CONNECT) 13MM	
ST0335	1	SWITCH TGL MINI SPDT SLD TAG	
WW4016	70cm	WIRE EN CU 0.5MM 24BS	
WW4032	20cm	WIRE TIN CU 0.71MM 22AWG	
WH5533	10cm	HEATSHRINK 5MM X 1.2M BLK	

HARDWARE / WIRE(S) / MISCELLANEOUS (large)

Cat.#	Qty*	Description	Component Ident And/Or Location
EB2211	2	PNL ALU 80X35X2MM	
EC8250	1	PCB (KC5442) NTN 05104071 102X81MM 03/07	with overlay
HB5064	1	ENCL BOX DIECAST 119X93.5X56.5MM	with screen printed lid
HP0725	2	CABLE GLAND IP68 4-8MM	
HP1203	4	CABLE TIE 100X3MM BLK	
PS0768	1	SKT PCB D25 HI-SPEC SOLDER	
WH3012	2m	CABLE HU RND 13X0.12MM L/D BRN	
WH3014	2m	CABLE HU RND 13X0.12MM L/D YEL	
WH3040	2m	CABLE HU RND 24X0.2MM H/D RED	
WH3041	2m	CABLE HU RND 24X0.2MM H/D BLK	
WH3042	2m	CABLE HU RND 24X0.2MM H/D GRN	

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KC5442: KIT – PROGRAMMABLE IGNITION SYSTEM MK2 Rev 1A

COMPONENTS SPECIFIC TO THE VARYING PROGRAMABLE IGNITION CONFIGURATIONS

Cat.#	Total	((Points Qty))	(Reluctor Qty)	{Hall Effect Qty}	[[Crane Qty]]	[Piranha Qty]	Description	Component Ident And/Or Location
HP1250	2		1	2	2	2	PIN PCB 0.9MM GLD	
RC5332	1		1				CAP CER NPO 470P 50V 10% P=5MM	470p / 471 / n47
RR0548	1			1			RES 0.5W MTL 100R 1%	Brown Black Black Black Brown
RR0550	1				1	1	RES 0.5W MTL 120R 1%	Brown Red Black Black Brown
RR0604	1				1	1	RES 0.5W MTL 22K 1%	Red Red Black Red Brown
RR3274	2	1					RES 5W W/W 100R	5W 100R
RT4656	1		1				TRIMPOT 25TURN 100K TOP ADJ SPECTROL	100K / 104
RR0572	1		1	1			RES 0.5W MTL 1K0 1%	Brown Black Black Brown Brown
RR0596	2		2				RES 0.5W MTL 10K 1%	Brown Black Black Red Brown
RR0612	1		1				RES 0.5W MTL 47K 1%	Yellow Purple Black Red Brown
ZT2115	1		1				TRAN BC337/BC877 NPN 50V 800MA TO92	BC337
RM7022	1		1				CAP MKT 2N2 100V P=5MM 7.5X2.5X6.5MM	2.2n / 2n2 / 222

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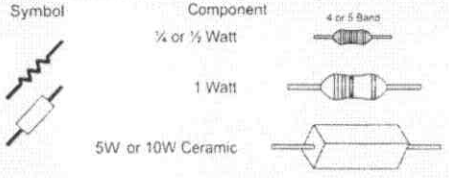
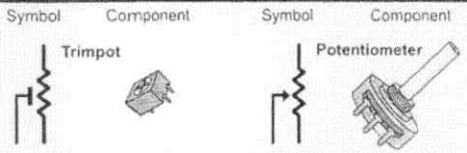
COMPONENT IDENTIFICATION

This section will help you to match some of the symbols used in schematics (electronic circuit diagrams) to the physical component used in the actual product. You will see the symbol on the left and the component on the right.

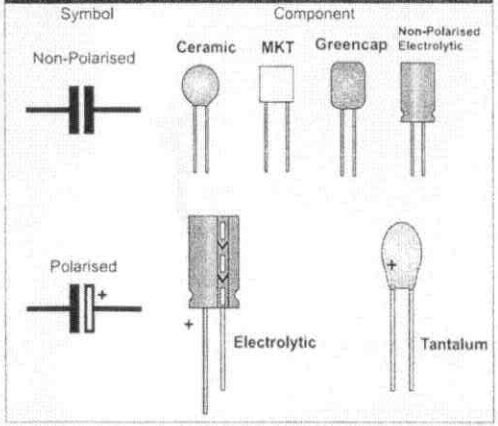
RESISTORS



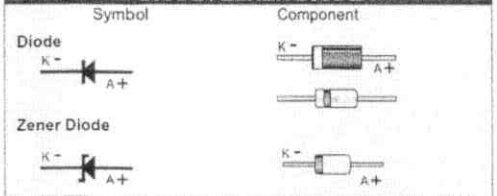
VARIABLE RESISTORS



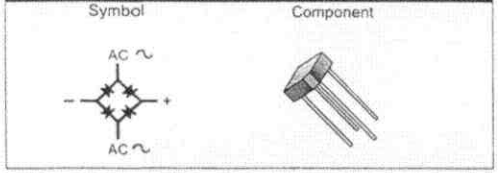
CAPACITORS



DIODE / ZENER DIODE

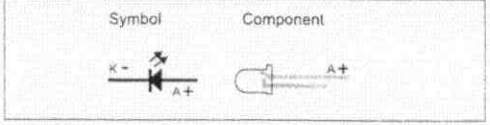


BRIDGE RECTIFIER

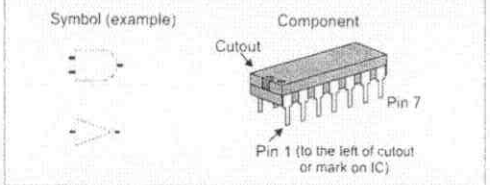


COMPONENT IDENTIFICATION

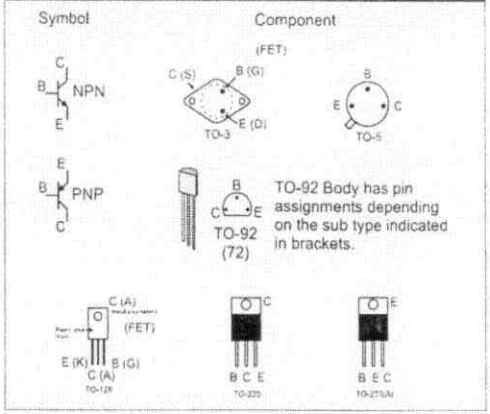
LED's



INTEGRATED CIRCUIT (IC)



TRANSISTORS



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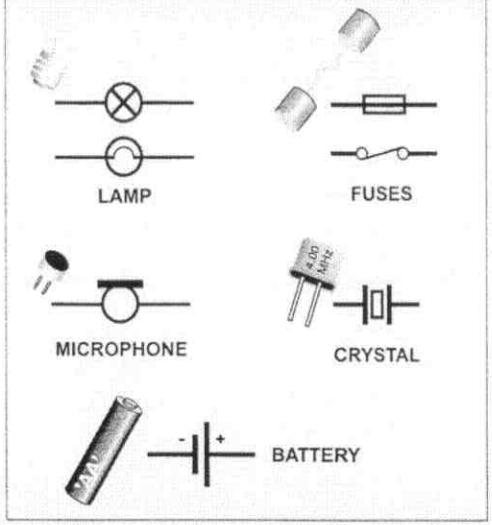
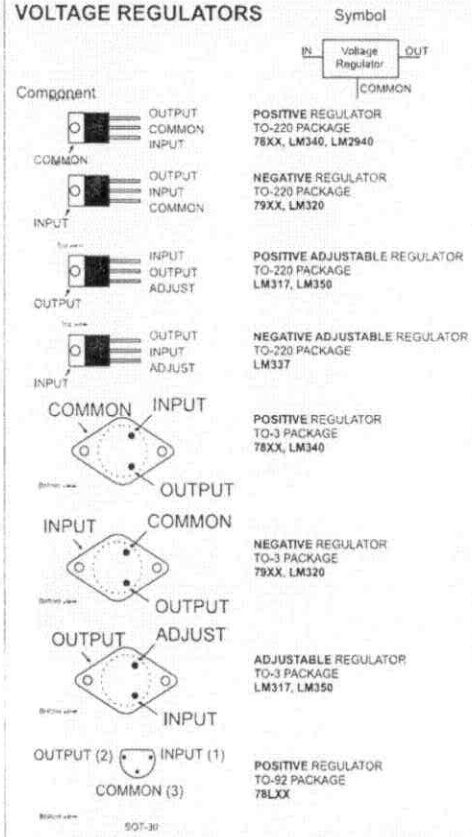


COMPONENT IDENTIFICATION

VOLTAGE REGULATORS



OHM'S LAW

The most basic law in electronics. The relationship between resistance, voltage and current is determined by Ohm's Law (*). If you know two out of the three values you can work out the third.

V= IxR
I= V/R
R= V/I

The formulas are:

V is Voltage
I is Current in Amps and
R is resistance in Ohms

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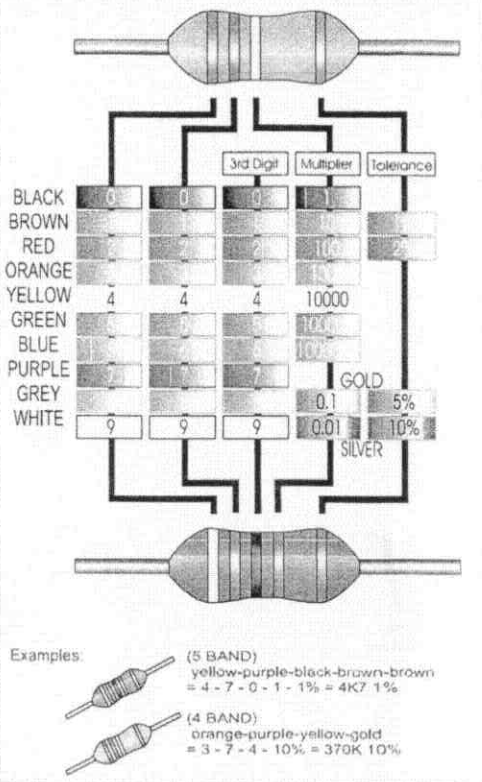
No 1 for Kits

kits@jaycar.com.au

COMPONENT REFERENCE CHART

Ver 1.2 - 01.12.2004

RESISTOR COLOUR CODES

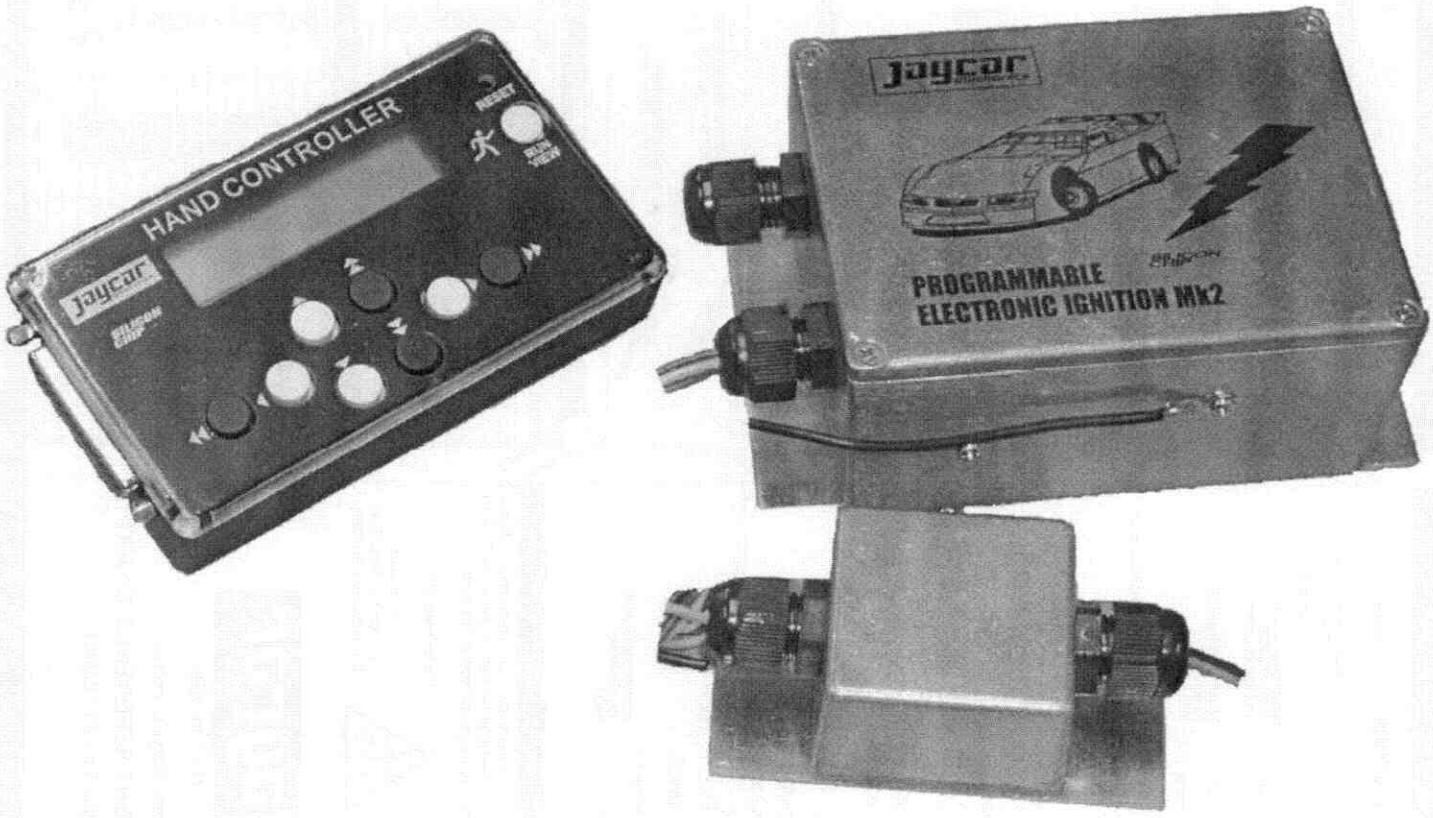


CAPACITOR CODES

Microfarads (u)	Nanofarads (n)	Picofarads (p)	EIA code
-	-	100pF	101
-	0.22nF	220pF	221
0.001uF	1nF	1000pF	102
0.0047uF	4.7nF	4700pF	472
0.01uF	10nF	-	103
0.047uF	47nF	-	473
0.1uF	100nF	-	104
0.47uF	470nF	-	474
1uF	1000nF	-	105

ZENER DIODES (1 WATT UNLESS SPECIFIED)

Part no.	Voltage	Part no.	Voltage
1N4728	3V3	1N4744	15V
1N4729	3V6	1N4745	16V
1N4730	3V9	1N4746	18V
1N4731	4V3	1N4747	20V
1N4732	4V7	1N4748	22V
1N4733	5V1	1N4749	24V
1N4734	5V6	1N4750	27V
1N4735	6V2	1N4751	30V
1N4736	6V8	1N4752	33V
1N4737	7V5	1N4753	36V
1N4738	8V2	1N4754	39V
1N4739	9V1	1N4761	75V
1N4740	10V	1N5349B	12V 5W
1N4741	11V	1N5352N	15V 5W
1N4742	12V	1N5374	75V 5W
1N4743	13V		



Programmable Ignition System for Cars. Pt1

by John Clarke

Want to program the ignition timing on your car? Now you can, with this completely new design. It can be used in older cars which presently do not have electronic ignition or used as an "interceptor" for cars with engine management systems.

OUR PREVIOUS Programmable Ignition was originally published in March 1996 and proved to be a very popular project with readers. This was subsequently updated as the Programmable Ignition Timing (PIT) Module in the June and July 1999 issues of SILICON CHIP.

The updated PIT module included a basic 2-step advance curve and a 1-step vacuum advance that changed the timing according to engine load. In operation, it was used to control the High Energy Ignition design from the June 1998 issue.

This latest Programmable Ignition from SILICON CHIP is far more advanced in features and its ability to produce an accurate advance curve. It is also a complete stand-alone ignition system that is triggered by an engine position sensor and then drives the ignition coil. It can be triggered from one of many sensors in a distributor, including points, reluctor, Hall effect, optical trigger and the 5V signal from the car's Engine Control Unit (ECU).

In order to measure engine load, the Programmable Ignition can use a Sensym absolute pressure sensor. In fact, provision has been made to mount this sensor directly on the PC board, the sensor then being connected to the engine manifold via plastic tubing.

Alternatively, you can connect the ignition circuit to an existing manifold pressure sensor if present. This is commonly called a Manifold Absolute

BLANK

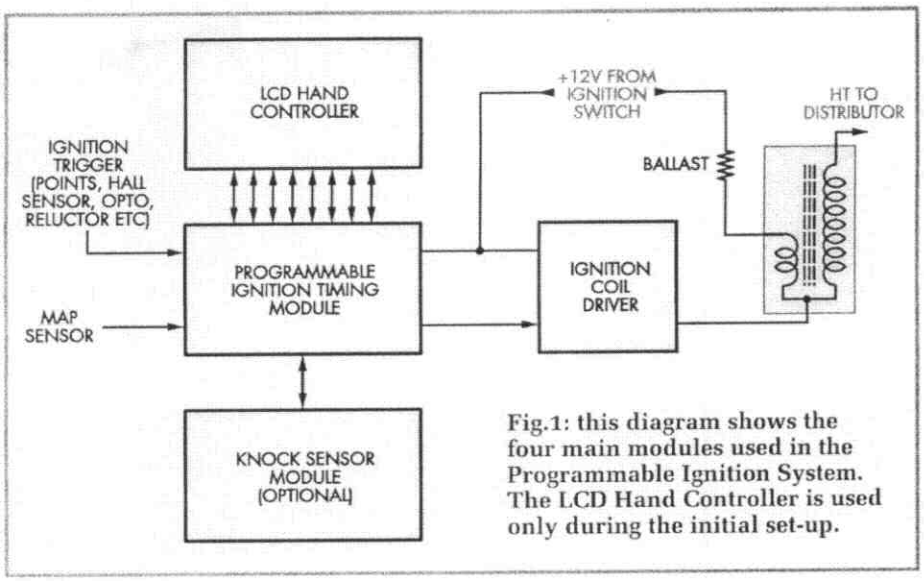


Fig.1: this diagram shows the four main modules used in the Programmable Ignition System. The LCD Hand Controller is used only during the initial set-up.

Pressure (or MAP) sensor and is found on many cars these days. You could also use a secondhand MAP sensor from an auto wrecker.

Changing the timing

A fully effective ignition system needs to increase the timing advance with increasing RPM and to alter the timing according to engine load – all with a fair degree of precision. Additionally, some means to detect detonation (knock) and retard the timing would be an advantage. In this way, the ignition can be advanced further than would otherwise be possible without knock sensing.

This latest SILICON CHIP Programmable Ignition incorporates all these features. What's more, there is an option to select between two separate ignition-timing curves using a switch. This option is ideal if you are running both petrol and gas, where a different timing curve is required for each type of fuel.

Fig.1 shows the complete system. It comes in four modules: an LCD Hand Controller, a Programmable Ignition Timing (PIT) module, an Ignition Coil Driver module and a Knock Sensor module. The first three modules are mandatory, while the fourth, the Knock Sensor module, is optional.

The heart of the system is the Programmable Ignition Timing module, based on a PIC16F88-E/P micro. It is programmed by the LCD Hand Controller and it delivers a signal to the Ignition Coil Driver. The latter, as its name suggests, then drives the ignition coil.

LCD Hand Controller

The LCD Hand Controller is similar to the one featured in our book "Performance Electronics for Cars". It was originally designed for setting up the Digital Pulse Adjuster, Digital Fuel Adjuster and Independent Boost Controller projects featured in that book.

The Hand Controller is used during the initial setting-up procedure. It plugs into the main unit and can be used while the engine is either running or stopped. It is then normally disconnected from the main unit after all adjustments have been made.

Using the Hand Controller, you can set all the initial parameters and also program the ignition advance/retard curve. Several pushbutton switches on the Hand Controller enable these changes to be made.

Knock sensor

The optional Knock Sensor module enables "pinging" to be sensed and the ignition timing retarded for a brief period. In brief, engine pinging is monitored by the Knock Sensor and the Programmable Ignition Timing (PIT) module for the first 6ms after each spark. However, at high RPM, there is less than 6ms between each firing and so knock signal monitoring is done between each spark and the start of the next coil dwell period.

When engine knock is detected, the timing is retarded for the next 10 sparks. The amount of retardation varies according to the severity of the knock signal. More details on this are given in the specifications.

Different uses

The Programmable Ignition can be used either as an interceptor or for fully mapped ignition timing. In the interceptor role, it can vary the existing ignition timing by advancing or retarding it from its current value – ie, it can be used to alter the timing signals from the car's ECU.

Alternatively, when used to completely replace the existing ignition timing, you will need to obtain the advance/retard curve for your vehicle so that the entire timing curve can be produced by the Programmable Ignition. For some vehicles, you may

Main Features

- Advance and retard adjustment over a wide range
- Plug-in LCD Hand Controller for adjustments
- Hand Controller LCD shows values and settings for adjustment
- Suitable for single-coil ignition systems with a distributor
- Can be used as a timing interceptor or as a replacement ignition
- Ignition timing mapped against RPM and engine load
- Interpolated values used for RPM and load values between sites
- Optional single map or dual timing maps
- Single map has 15 RPM sites x 15 engine load sites
- Dual maps each have 11 RPM sites x 11 engine load sites
- 1° or 0.5° adjustments
- Dwell adjustment
- Knock sensing indication with optional ignition retard
- Suits 1 to 12-cylinder engines (4-stroke) and 1 to 6-cylinder 2-stroke engines
- Two debounce settings
- High-level or low-level triggering
- Points, reluctor, Hall effect, digital signal or optical triggering
- Works with many pressure sensors (MAP sensors)
- Minimum and maximum RPM adjustments
- Minimum and maximum engine load adjustments
- Diagnostic RPM and load readings
- Add-on knock sensing unit (optional)
- Requires evenly spaced firing between cylinders. For V-twins, you will need two ignition systems and a separate trigger for each cylinder.

be able to obtain the curves from the manufacturer. For other cars, you will need to plot out the existing curve and transfer the resulting timing map to the Programmable Ignition.

Plotting out this timing curve is not hard to do and can, in fact, be done using the Programmable Ignition system itself and a timing light.

In practice, the ignition timing is mapped out in an array of either two 11-RPM by 11-engine load site maps or as a single 15-RPM by 15-engine load site map. Timing arrays (or ignition maps) are the most common method that car manufacturers use to set the ignition advance curve for both RPM and engine load.

Mapping is a way of plotting the advance curve as a series of steps rather than setting an ignition advance or retard value at every possible engine RPM and load value. Thus mapping sets the ignition advance or retard values at specified preset points for both RPM and engine load.

For example, we can specify the timing advance to be 25° at 3000 RPM and 28° at 3400 RPM. However, we do not specify individual values at 3100, 3200 or 3300 RPM. Instead, the advance values at these RPMs are interpolated (ie, calculated), based on the values set for 3000 and 3400 RPM.

At 3200 RPM, the amount of advance is easily calculated because it is exactly in the middle between the 3000 RPM and 3400 RPM sites. The advance change between 3000 RPM and 3400 RPM is 3° (ie, from 25° to 28°) and half of this is 1.5°. So the advance required at 3200 RPM is simply 25° + 1.5° = 26.5°.

Another calculation is required for engine load values that are in-between the specified load sites.

For our Programmable Ignition, if you require two separate engine advance curves then you need to select the 11x11 arrays. If only one advance curve is required, you then have the option of using a 15x15 array for greater accuracy.

By the way, don't confuse the ignition timing map with the MAP (manifold air pressure) sensor. They are two completely different things.

Plotting the timing values

We used the Programmable Ignition, the LCD Hand Controller and a timing light to plot out the ignition timing values for a 1988 2-litre Ford Telstar. We'll describe exactly how this is done in some detail in a later article.

The resulting timing vs RPM values were tabled (Table 1) and then plotted using Microsoft Excel. These files will be available on our website so that you can use the tables and edit the values (just by wiping over the values and rewriting them) to suit your car's engine. It is not really necessary to use Excel though and you can just as easily use a pencil and piece of paper to draw out the map instead.

Fig.2 shows the ignition timing versus RPM and engine load from 1000-5000 RPM. Since we have 11 RPM sites, each RPM site covers a span of 400 RPM.

RPM0 is an extra site and is shown covering the range from 0-1000 RPM. The RPM0 wording is shown on a different line because it is not an actual

		RPM0	Min RPM										Max RPM
	RPM Site		RPM1	RPM2	RPM3	RPM4	RPM5	RPM6	RPM7	RPM8	RPM9	RPM10	RPM11
	Load Site	0	1000	1400	1800	2200	2600	3000	3400	3800	4200	4600	5000
Min load	LOAD1	16	16	18.5	21.5	23	25.5	29	32	36	38	42.5	44
	LOAD2	15	15	17.5	20.5	22	24.5	28	31	35	37	41.5	43
	LOAD3	14	14	16.5	19.5	21	23.5	27	30	34	36	40.5	42
	LOAD4	13	13	15.5	18.5	20	22.5	26	29	33	35	39.5	41
	LOAD5	12	12	14.5	17.5	19	21.5	25	28	32	34	38.5	40
	LOAD6	11	11	13.5	16.5	18	20.5	24	27	31	33	37.5	39
	LOAD7	10	10	12.5	15.5	17	19.5	23	26	30	32	36.5	38
	LOAD8	9	9	11.5	14.5	16	18.5	22	25	29	31	35.5	37
	LOAD9	8	8	10.5	13.5	15	17.5	21	24	28	30	34.5	36
	LOAD10	7	7	9.5	12.5	14	16.5	20	23	27	29	33.5	35
Max load	LOAD11	6	6	8.5	11.5	13	15.5	19	22	26	28	32.5	34

Table 1: these ignition advance values were measured for a 1988 2-litre Ford Telstar using a timing light and the Programmable Ignition itself.

RPM site and cannot be adjusted. It has the same values as RPM1.

RPM0 is shown because it explains what the advance curve is below the minimum RPM1 site while the engine is being started. The same thing happens for RPM above RPM11. In this case, the advance remains at the RPM11 values.

Engine load is shown with LOAD1 as the minimum engine load while LOAD11 is the maximum engine load. LOAD1 is usually accessed when the engine is on overrun while LOAD11 is usually accessed under acceleration or when the car is climbing a hill. The load values were measured using a second hand pressure sensor from an automotive wrecker. These were then converted to load values ranging from 1-11.

The curve can be plotted in three dimensions showing RPM, load and ignition advance. If you use our Excel file, then the curve will be automatically replotted when ever a value is altered.

Using the Hand Controller

As mentioned above, the Hand Controller is used to enter the settings and to enter the ignition map. The values are displayed on the 2-line 16-character LCD screen. There are eight direction pushbuttons, a Run/View pushbutton and a Reset.

The Reset switch is recessed to prevent accidental activation. It is used to return all mapped advance or retard values to 0°. The eight direction pushbuttons alter the values and can configure the display to show the different settings or a different load site.

Finally, the Run/View pushbutton only works in the Timing mode. This mode is selected using a jumper link on the Programmable Ignition Timing Module.

RUN modes

The Timing mode has four possible display modes, selected by pressing the Run/View pushbutton. It selects one of four modes – called SITE, FULL, DIAG and VIEW – in cyclic fashion.

Each display mode shows a slightly different aspect of the mapping sites. One feature in common is that they all display the MAP and the current advance or retard value on the top line, although there is a difference in the displayed value as we shall see.

When the 11x11 maps are selected (from the settings mode), the display will show either **MAPα** or **MAPβ**, depending on which map is selected. If the 15x15 map is selected, then the display will only show **MAP**, without the alpha or beta symbols.

Following the MAP legend, the display shows the advance or retard value. The display format depends on whether the setting is for 0.5° or

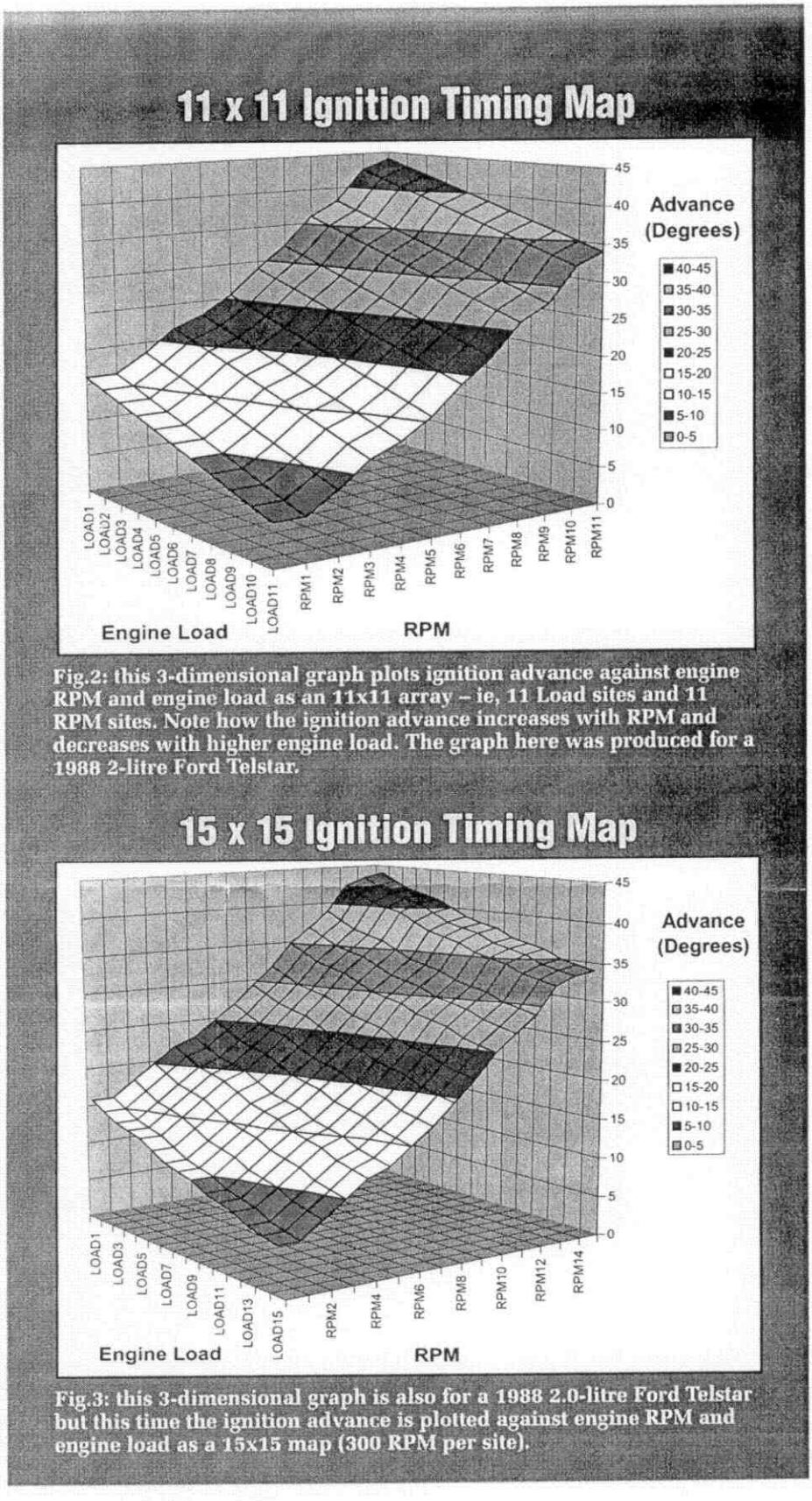
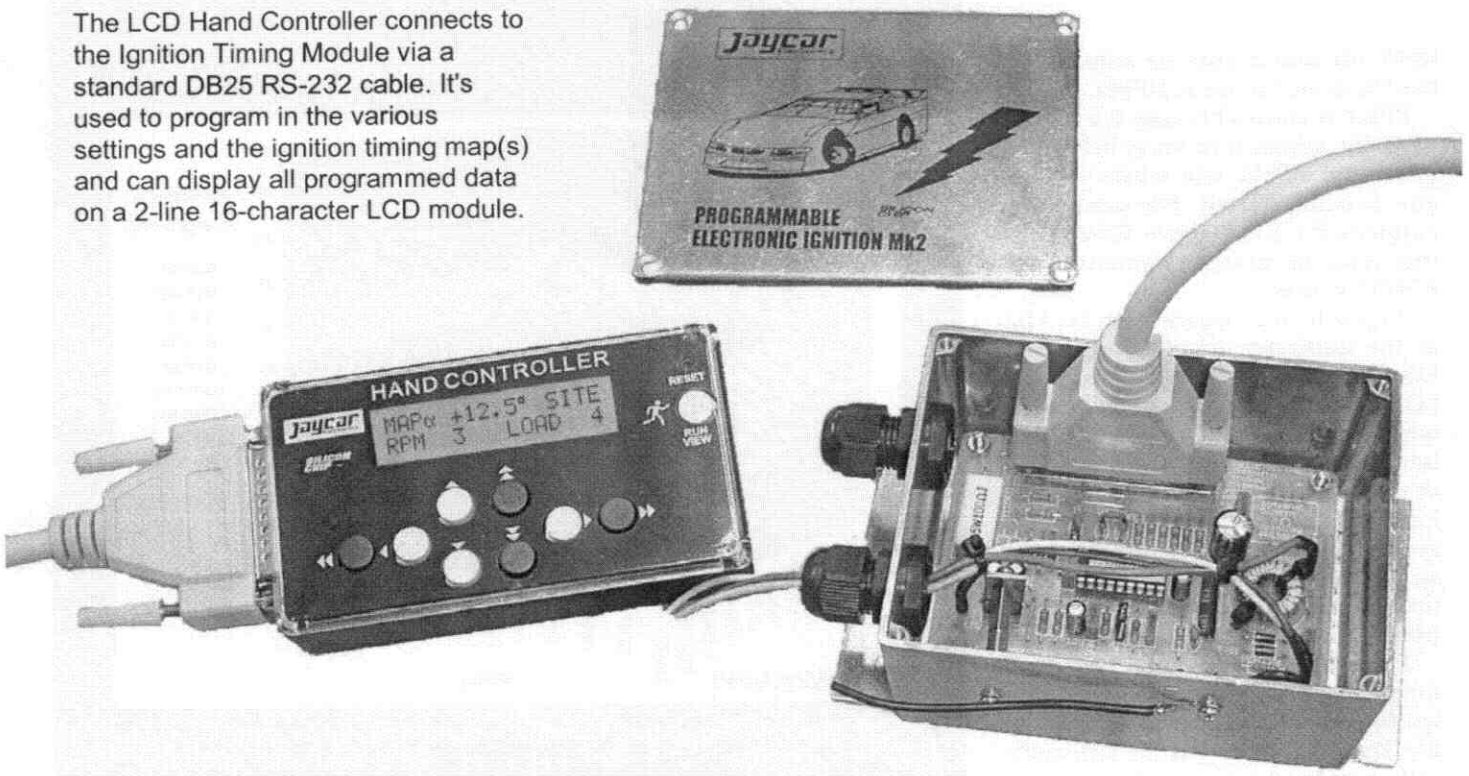


Fig.2: this 3-dimensional graph plots ignition advance against engine RPM and engine load as an 11x11 array – ie, 11 Load sites and 11 RPM sites. Note how the ignition advance increases with RPM and decreases with higher engine load. The graph here was produced for a 1988 2-litre Ford Telstar.

Fig.3: this 3-dimensional graph is also for a 1988 2.0-litre Ford Telstar but this time the ignition advance is plotted against engine RPM and engine load as a 15x15 map (300 RPM per site).

The LCD Hand Controller connects to the Ignition Timing Module via a standard DB25 RS-232 cable. It's used to program in the various settings and the ignition timing map(s) and can display all programmed data on a 2-line 16-character LCD module.



1° resolution. In all cases, a "-" sign indicates a retard value, while a "+" sign indicates an advance value. When there is no change in advance or retard, the value simply shows 0.0 for the 0.5° resolution setting or 0 for the 1° resolution setting.

The advance or retard value is changed using the Up (▲), Down (▼), Step Up (⏫) and Step Down (⏬) pushbuttons. The ▲ and ▼ pushbuttons increase or decrease the setting by the resolution value; ie, by either 0.5° or 1° for each switch press.

By contrast, the ⏫ and ⏬ pushbuttons change the advance/retard value by 2° on 0.5° resolution and by 4° on 1° resolution. The resulting values are stored in memory and remain there even if power is turned off, unless they are changed by the pushbuttons or by the Reset switch.

At the end of the top line, the display shows either SITE, FULL, DIAG or VIEW, to indicate the selected mode. Note that the SITE, FULL and DIAG modes are called the "Run" modes because they show what sites are accessed while the engine is running.

Site mode

The SITE mode is displayed each time the Programmable Ignition is powered up when the Run/View mode is selected with the jumper link. In this mode, the second line shows the current RPM site and the current LOAD site. These are from sites 1-11 when the 11x11 mapping is selected or from 1-15 when the 15x15 mapping is selected.

The advance or retard value is shown as the value entered at that load site. In practice, the LOAD and RPM sites only change with changes in engine RPM and engine load. In other words, this is a real time display that shows the current load and RPM sites and the current advance or retard value setting.

Full mode

Pressing the Run/View pushbutton brings up the FULL mode. In this case, the second line shows the RPM site as before (eg, RPM1) but it also shows the actual position between this site and the next. For example, with the 11x11 ignition timing map (Fig.2), each site is 400 RPM away from the next.

In practice, however, the RPM is measured in 100 RPM steps. As a result, the display shows the RPM 1 position as RPM 1;0, RPM 1;1, RPM 1;2 or RPM 1;3. These values correspond to 1000, 1100, 1200 and 1300 RPM respectively. There is no RPM 1;4 position as this becomes the RPM 2;0 site for 1400 RPM.

If you don't understand this, it will become clearer when we describe how the Programmable Ignition is set up in the forthcoming articles.

Similarly for the LOAD sites, the position within the site is shown after the semicolon (;). Note that the word LOAD is abbreviated to just LD, so that the values fit within the display line.

In the FULL display mode, the advance or retard value is the interpolated value that is calculated for the positions between each load site.

Let's go back to our earlier example and consider the RPM 6 (3000 RPM) and RPM 7 (3400 RPM) sites. At these sites, the advance is 25° and 28° respectively. This means that at RPM 6;0 the advance value will be displayed as +25.0°, while at RPM 7;0 the value will be shown as + 28.0°.

The interpolated value will be shown for RPM values between these two sites. For example, at 3200 RPM (RPM 6;2), the advance value will be +26.5°. Consequently, this is the value that will be shown at site RPM6;2.

Note that this is a simplistic example because we are ignoring the fact that the LOAD value could also be in-between LOAD sites. In that case, both the RPM and LOAD values are interpolated to give the advance or retard value.

Note also that if the advance or retard value is increased or decreased in this mode, it will be the interpolated value that is displayed rather that the site value. The site that will be