Implementation Notes for installing the Adaptronic e420c onto the 1UZFE Engine

Test system

The test vehicle was a Toyota Soarer which was originally fitted with the 1UZFE. The vehicle had been converted to manual transmission, and a supercharger had been fitted to the engine.

Installation

The following summarises the main details of the installation:
1. The automatic gearbox was replaced with a R154
2. A Yella Terra YT1500 (Eaton M90) supercharger was fitted to the intake of the 1UZFE engine
3. The factory ECU remained connected in a piggyback configuration, so that communication with the digital dash was retained
4. A 3 bar MAP sensor was added, and connected instead of the airflow signal to the original loom
5. An air temperature sensor was added to the intake, and connected instead of the air temperature signal on the original loom.

The wiring of the installation is given on the last page of this document.

Installation Details

The final page of this document shows the wiring diagram to map the Adaptronic connectors to those of the factory ECU.

Triggering and real-time outputs

The original cam angle sensors and crank angle sensor are retained. The factory crank sensor has one output which pulses every 30 crank degrees, which gives the ECU timing information. Each cam sensor has an output which pulses every 720 degrees, which gives the ECU cylinder and a timing reference.

The injector firing sequence is set to "Fully Sequential, half speed", and "Batch on crank". The current is set to 1.9A as each output is driving two injectors, and the peak-hold drive type is selected. This mode gives a semi sequential configuration with four groups of two injectors, as on the factory ECU configuration.

Dwell time is set to 5000μs. Ignition timing during cranking is triggered using the normal ignition timing mode. The ignition pattern is set to "alternate outputs" to cause the ECU ignition output to toggle between the two ignition subsystems.

Auxiliary Outputs

The following summarises the auxiliary outputs as defined in this application:

Output	Function
1	Airflow signal generated for factory ECU
2	Not used
3	Fuel pump control
4	Not used
5	Idle stepper motor
6	Idle stepper motor
7	Idle stepper motor
8	Idle stepper motor

Auxiliary Inputs

The following summarises the auxiliary inputs as defined in this application:

Input	Function
1	Electrical load input
2	Closed throttle input (disabled)
3	Not used
4	Not used
5	Not used
6	Not used
7	Not used
8	Not used

Tuning system

As this engine has a single plenum and a throttle a long way from the inlet ports, the traditional MAP based tuning system is used.

Special functions and control

The ECU runs in closed loop using the standard oxygen sensor. Under high load conditions, the ECU's target AFR is set to richer than the factory oxygen sensor can measure, and hence the ECU switches to open loop mode. This allows maximum power production with adequate engine safety when required as well as running at stoichiometry at other times.

The factory idle motor was used with no modification. The Toyota stepper motor system uses a 125-step motor. There is no neutral or clutch switch on this engine, so

the VSS type operation is employed. Target idle speed is set to 600 RPM when the engine is warm. Extra air is admitted by the idle motor when the engine is cold by increasing the idle position.

The fuel pump is controlled by the factory fuel pump controller, which gets its command from the ECU. This is done by the factory ECU by supplying a variable duty signal 0-5V signal to the fuel pump controller. In this installation, we just drive the fuel pump at 100% duty cycle when required. This is done by using a separate pull-up resistor to a 5V supply, and pulling the output to ground when the fuel pump is to be disabled (using "Inverted fuel pump" option for the auxiliary output).

The VSV is still controlled by the factory ECU in this installation. This was done for the sake of simplicity. In other installations it could be connected directly to an auxiliary output of the Adaptronic ECU and configured as a purge valve output (I understand that it acts merely as a purge valve for the charcoal canister).

In this installation, the air conditioning control is handled by the factory ECU, but there is no reason why this could not be handled by the Adaptronic, with a pull-down resistor to drive the air conditioner request input. In this installation the air conditioner output from the factory ECU triggers a digital input on the Adaptronic to signal the idle-up requirement.

Fooling the Factory ECU to eliminate fault code generation

- Injector loads - these were left open circuit on the factory ECU. It appears not to have any current sensing to check that it is driving injectors, as no fault codes were developed from this system.
- Air and water temperature sensors - these were connected to fixed value resistors (2k2 for air temperature, 1k2 for coolant temperature) to sensor GND.
- Ignition outputs - the factory ECU has an input for each ignition output which receives confirmation from the ignitor that the spark has executed correctly. This is "faked" so that the factory ECU believes it has received a confirmation from the ignitor, which is of course under control of the Adaptronic ECU. The circuit for this is shown below:
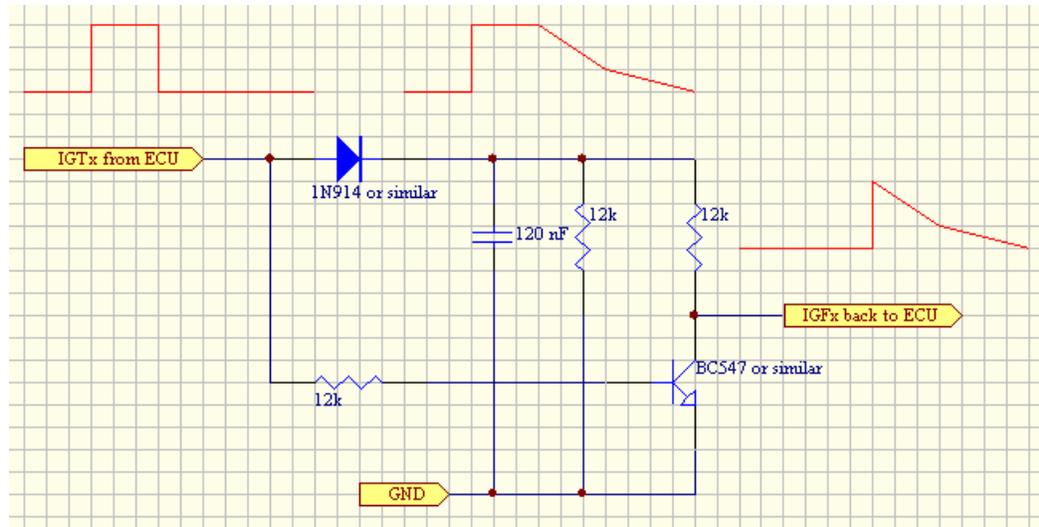
The input from the IGT pin of the factory ECU goes high for the dwell time (about 8 ms at idle, presumably this reduces at higher RPM). This charges the capacitor through the diode. The parallel resistor discharges the capacitor with a time constant of 1.4 ms (12k x 120n). The input being high also holds on the transistor, which pulls the output low. The end result is a 1.4 ms pulse which begins after the ignition pulse generated by the ECU. This causes suppression of EFI faults 15 and 14.

- TPS input - a 4k7 resistor is connected across the 5V and 0V sensor drive to draw the appropriate current. This was in an effort to eliminate EFI fault 41. However in practice, it would appear that after some driving duration, the fault appears. The exact cause is not yet known.
- Airflow meter input - the factory ECU expects to see a 50% duty cycle, variable frequency input on its airflow signal input. The factory ECU has a pull-up to 5V on this signal line. Hence to fool the factory ECU, a PWM output must be generated. This is done by the Adaptronic by setting up a generic output based on air temperature (which does not vary hugely). This allows a duty cycle close to 50%, at a fixed frequency, which seems adequate to suppress EFI fault 31.
- Closed loop - the oxygen sensors are disconnected from the factory ECU to prevent the factory ECU from "learning too far" and "falling over". Whether this is required or not is unclear.

Evaluation

This evaluation follows the installation and dyno tuning of an Adaptronic e420c on the test vehicle. This was performed on the 7th of July, 2006.

Cold starting, warm starting, hot restarting after heat soak - all operate OK on the test vehicle.

Idle speed control works flawlessly.

The following graphs show the performance of the Adaptronic versus the factory
ECU. Note that the factory ECU had been modified to increase the rev limiter.
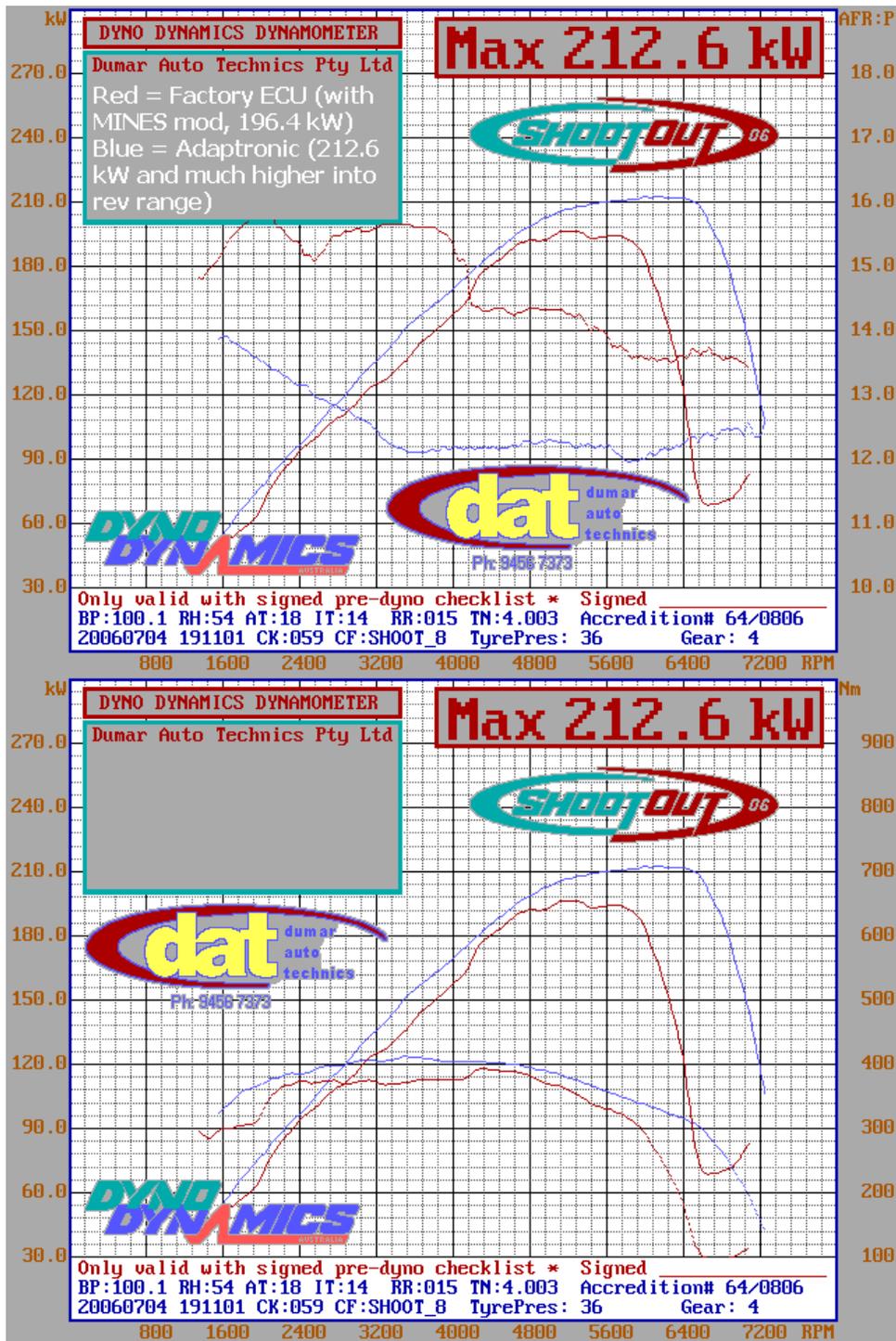
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Factory ECU connector			Function	Adaptronic connector					Connect through to factory?	
Con	Pin	Colour		Con	Pin	Colour	Function			
S	1	Black/Grey	Ignition switch in	Standalone, connect to S24 to bypass ign sw Otherwise, no connection					Yes	for ignition switching
S	2	Pink	VSS	16-pin	14	Brown	MVSS		Yes	for ATX control
S	3	Blue	Kickdown switch	no connection					Yes	for AT control
S	4	Green/White	Stop light	no connection					Yes	May as well
S	5	White/Red	Diagnostic light	6-pin	4	Blue	Aux out 4		No	It'll be on because there'll be a failure
S	6	Blue/Yellow	Warning light	no connection					No	
S	7									
S	8	Red/Yellow	ABS	no connection					Yes	for ABS
S	9									
S	10									
S	11	Grey/Blue	Cruise control	no connection					Yes	for cruise control
S	12									
S	13									
S	14									
S	15									
S	16									
S	17	Green/Red	TT on TDCL	no connection					Yes	for diagnostics
S	18									
S	19	Green/Yellow	TE2 on TDCL	no connection					Yes	for diagnostics
S	20	Light Green	TE1 on diagnosis and TDCL						Yes	for diagnostics
S	21	Pink	DI???? Resistor to GND	no connection					Yes	may as well
S	22	Red/Green	FPC	6-pin	3	Green	Aux out 3		No	We'll drive fuel pump
S	23	White	Aircon clutch control	20-pin	14	White	Dig inp 1		Yes	for aircon control - also to Adaptronic for idle-up

Factory ECU connector			Function	Adaptronic connector				Connect through to factory?	
S	24	Black/Grey	Main relay, active high	no connection				Yes	for ignition switching
S	25	Red/White	Suspension					Yes	for active suspension
S	26	Red	Suspension					Yes	for active suspension
S	27	Pink/Grey	Suspension					Yes	for active suspension
S	28								
S	29	Yellow/Blue	Exhaust temp	no connection				Yes	to save another fault code
S	30	LightGreen/Blue	Exhaust temp	no connection				Yes	to save another fault code
S	31	Black/Red	Main EFI power	no connection				Yes	for power
S	32	Black/Red	Main EFI power	8-pin	1	Red	Ignition +12V	Yes	for power
S	33	Black/Yellow	Battery	no connection				Yes	for power
S	34	Blue/Red	Aircon command	no connection				Yes	for aircon
S	35							Yes	
S	36							Yes	
S	37	Yellow/Red	Traction 2	no connection				Yes	for TC
S	38	Pink/Blue	NEO	no connection				Yes	for TC
S	39	Yellow/Blue	VSH	no connection				Yes	for TC
S	40	Purple/Yellow	VTH	no connection				Yes	for TC
T	1							Yes	
T	2							Yes	
T	3							Yes	
T	4	Brown	Power GND	8-pin	4	Black	PGND	Yes	
T	5	Red	CAS GND	16-pin	4	White	CAS GND	No	Prevent ground loops
T	6	White	CAS GND	16-pin	4	White	CAS GND	No	Prevent ground loops
T	7	Red	CAS GND	16-pin	4	White	CAS GND	No	Prevent ground loops
T	8							Yes	
T	9							Yes	

		Factory ECU connector	Function	Adaptronic connector					Connect through to factory?	
T	10								Yes	
T	11								Yes	
T	12								Yes	
T	13								Yes	
T	14								Yes	
T	15								Yes	
T	16								Yes	
T	17	Black/Red	Inj 3/5	8-pin	6	White	Inj 2		No	We'll do that
T	18	Black	Inj 4/6	8-pin	5	Purple	Inj 1		No	We'll do that
T	19	Black/Yellow	Inj 2/8	8-pin	8	Grey	Inj 4		No	We'll do that
T	20	Yellow	Inj 1/7	8-pin	7	Pink	Inj 3		No	We'll do that
T	21								Yes	
T	22								Yes	
T	23								Yes	
T	24								Yes	
T	25	Green	G2	16-pin	Yellow	10	CAS3		Yes	
T	26	Brown	G1	16-pin	Red	3	CAS2		Yes	
T	27	Yellow	NE	16-pin	Black	11	CAS1		Yes	
T	28	Black/Yellow	VF2 - diag	no connection					Yes	For diagnosis
T	29	Grey/Yellow	VF1 - diag	no connection					Yes	For diagnosis
T	30								Yes	
T	31								Yes	
T	32	Blue/White	Idle 2	16-pin	Red/Brown	8	Aux out 6		No	We'll do that
T	33	Green/Yellow	Idle 1	16-pin	Red/Black	7	Aux out 5		No	We'll do that
T	34	LightGreen/Black	Idle 3	16-pin	Red/Green	16	Aux out 7		No	We'll do that
T	35	Purple/Red	Idle 4	16-pin	Red/Blue	15	Aux out 8		No	We'll do that
T	36								Yes	

Factory ECU connector			Function	Adaptronic connector						Connect through to factory?	
T	37									Yes	
T	38									Yes	
T	39									Yes	
T	40									Yes	
T	41	Blue/Red	Sensor supply	20-pin	Red		19	Sensor +5V		No	We'll supply - connect 4k7 to pin T65
T	42	Blue/Red	Traction TPS	20-pin	Grey		5	Aux in		Yes	Another fault code
T	43	Yellow	TPS signal	20-pin	Green		10	TPS in		Yes	Another fault code
T	44	Green	Water temp	20-pin	Yellow/Black		17	WT		No, connect a fixed 1k2 resistor to GND for factory ECU	
T	45	Yellow/Black	Air temp	20-pin	Blue		7	MAT		No, connect a fixed 2k2 resistor to GND for factory ECU	
T	46									Yes	
T	47	Red/Yellow	Oxygen sensor	20-pin	Yellow/Red		6	EGO		No	So it doesn't learn too far and fall over
T	48	White	Oxygen sensor	20-pin	Yellow/Red		6	EGO		No	So it doesn't learn too far and fall over
T	49	White	Knock sensor	20-pin	Yellow/Green		15	Knock		Yes	So it doesn't learn too far and fall over
T	50	White	Knock sensor	no connection						Yes	So it doesn't learn too far and fall over
T	51									Yes	
T	52									Yes	
T	53									Yes	
T	54									Yes	
T	55									Yes	
T	56	Brown/Yellow	IGNT2	16-pin	Green		9	Ign 2		No, we'll do that	
T	57	White/Red	IGNT1	16-pin	Yellow		2	Ign 1		No, we'll do that	
T	58	Yellow/Green	IGNF1	no connection						No, connect to T57 with IGF defeater circuit	
T	59	Yellow/Black	IGNF2	no connection						No, connect to T58 with IGF defeater circuit	
T	60									Yes	
T	61									Yes	
T	62									Yes	
T	63	Red/Black or Brn	TC closed throttle	no connection						Yes	Another fault code
T	64	Red	Closed throttle	20-pin	Pink		4	Dig in 2		Yes	

		Factory ECU connector	Function	Adaptronic connector					Connect through to factory?	
T	65	Brown	Sensor GND	20-pin	Black	20	Sensor GND		No	Prevent ground loops - connect 4k7 to T41
T	66	Yellow/Green	Airflow/MAP in	20-pin	Orange	18	MAP		No, but connect to Aux out 1 in config below	
T	67								Yes	
T	68								Yes	
T	69	Brown	Power GND	6-pin	5	Black	PGND		Yes	Power
T	70								Yes	
T	71								Yes	
T	72								Yes	
T	73								Yes	
T	74	Green/Black	VSV	no connection					Yes	Get him to do that
T	75								Yes	
T	76	Black/White	Starter (before switch)	no connection					Yes	may as well
T	77	Black	Starter (after inh switch)	no connection					Yes	may as well
T	78								Yes	
T	79	White/Black	Power GND	8-pin	2	Black	PGND		Yes	Power
T	80	White/Black	Power GND	8-pin	3	Black	PGND		Yes	Power

Diagram to wire Adaptronic ECU to standard 1UZFE

Tested on 1UZFE Soarer
Andy Wyatt
2006-07-06

Connection to vehicle
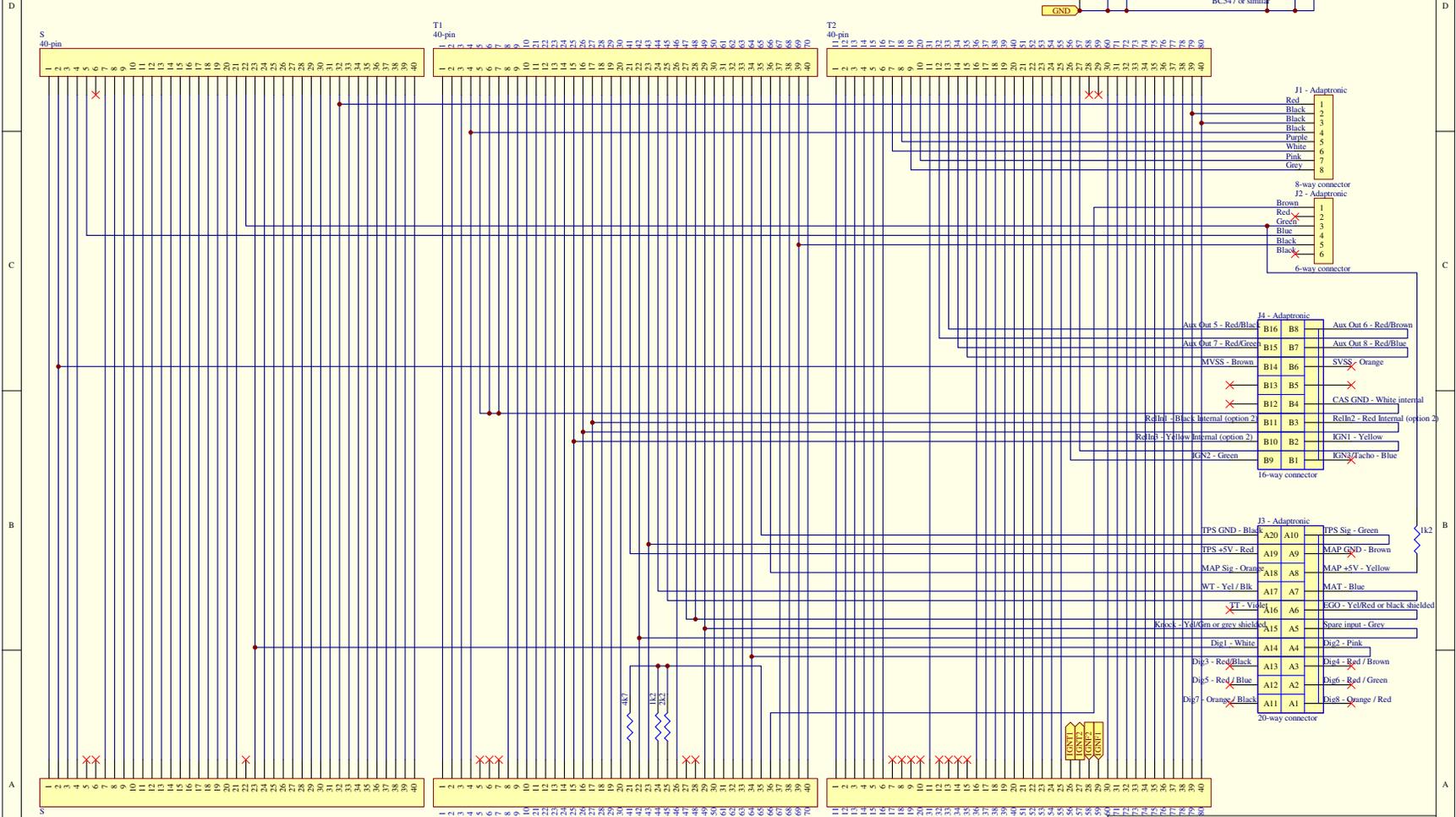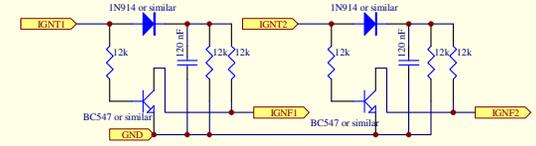
Connection to factory ECU

Size	Number		Revision
A3			

Date: 7-Jul-2006
File: B:\ECUConfigs\091_RushImports_1UZFE\Installation\1UZFE_WiringDiagram.ddb