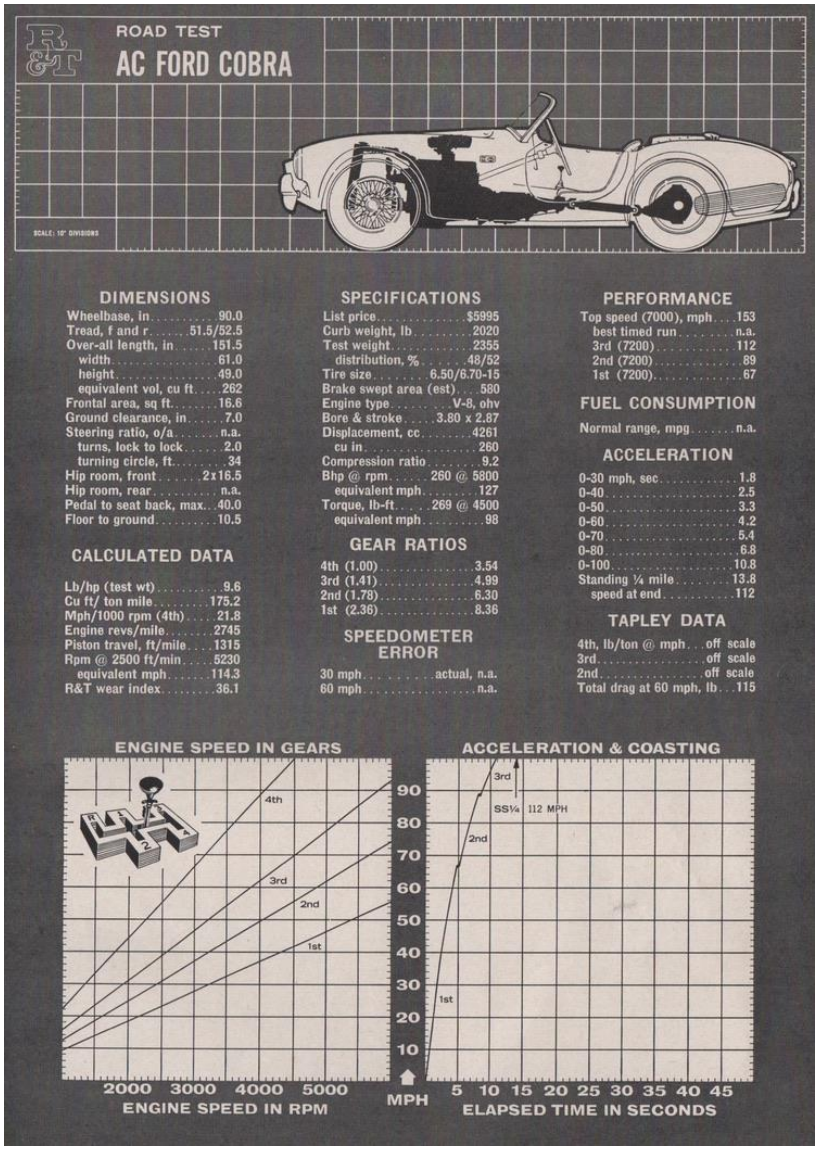
Mentek Build 2448
Factory Five Racing Mk4
1965 Shelby Cobra Replica

18 February 2021

Background

I have been interested in Cobras since the 60's as it fell in the class of many of the muscle cars of the day. Knew a guy that had a Vette and sold it and had to come up with an additional $3k to buy a Cobra. Big bucks for the day. The attached road test sheet shows that the little 289 Cobra performed right there with big block Chevelles, GTOs, Mustangs, etc. I always thought it would be interesting to experience some of the same things that Shelby and his crew went through to build such a car, improve it and turn it into a successful race car, since it was basically a British sports car suffering from many of the same ailments.



ROAD TEST

AC FORD COBRA

SCALE: 10" DIVISIONS

DIMENSIONS

Wheelbase, in	90.0
Tread, f and r	51.5/52.5
Over-all length, in	151.5
width	61.0
height	49.0
equivalent vol, cu ft	262
Frontal area, sq ft	16.6
Ground clearance, in	7.0
Steering ratio, o/a	n.a.
turns, lock to lock	2.0
turning circle, ft	34
Hip room, front	2x16.5
Hip room, rear	n.a.
Pedal to seat back, max	40.0
Floor to ground	10.5

CALCULATED DATA

Lb/hp (test wt)	9.6
Cu ft/ ton mile	175.2
Mph/1000 rpm (4th)	21.8
Engine revs/mile	2745
Piston travel, ft/mile	1315
Rpm @ 2500 ft/min	5230
equivalent mph	114.3
R&T wear index	36.1

SPECIFICATIONS

List price	$5995
Curb weight, lb	2020
Test weight	2355
distribution, %	48/52
Tire size	6.50/6.70-15
Brake swept area (est)	580
Engine type	V-8, ohv
Bore & stroke	3.80 x 2.87
Displacement, cc	4261
cu in	260
Compression ratio	9.2
Bhp @ rpm	260 @ 5800
equivalent mph	127
Torque, lb-ft	269 @ 4500
equivalent mph	98

GEAR RATIOS

4th (1.00)	3.54
3rd (1.41)	4.99
2nd (1.78)	6.30
1st (2.36)	8.36

SPEEDOMETER ERROR

30 mph	actual, n.a.
60 mph	n.a.

PERFORMANCE

Top speed (7000), mph	153
best timed run	n.a.
3rd (7200)	112
2nd (7200)	89
1st (7200)	67

FUEL CONSUMPTION

Normal range, mpg	n.a.

ACCELERATION

0-30 mph, sec	1.8
0-40	2.5
0-50	3.3
0-60	4.2
0-70	5.4
0-80	6.8
0-100	10.8
Standing ¼ mile	13.8
speed at end	112

TAPLEY DATA

4th, lb/ton @ mph	off scale
3rd	off scale
2nd	off scale
Total drag at 60 mph, lb	115

Research and Component Selection

There were a lot of reasons I selected the Factory Five Racing kit. The FFR kit replicates most of the major features of the street version of the 427 Cobra. The frame is basically two 4-inch steel tubes located two feet apart on centers. However, FFR uses a slightly thicker wall tubing. The front and rear suspensions are improvements over the original Shelbys. Many more modern features are also incorporated.

The FFR fiberglass body is the result of a 3d scan of an original 427 owned and raced by Dick Smith. The aluminum Shelby Cobra bodies were not perfect as they were hand hammered out. The Dick Smith car does have some asymmetries so FFR's fiberglass copies also reflect those. Interesting point is that the number on this car (198) reflects the top speed it has seen. Much duct tape was used to close up seams and otherwise improve the aerodynamics. Stock bodied Cobras are not aerodynamic by any means – open bottom, no air dams, spoilers, etc. This is where Peter Brock came in to design the Daytona Coupe to make it competitive in high-speed endurance racing.

FFR sponsors the Factory Five Build School which is a hands-on workshop where students build a Factory Five Mk4 Roadster (Cobra replica) from the bare frame all the way up to the completed car in three days (no paint though). Classes are held at the Mott College Livingstone Center in Howell, Michigan. I opted not to attend the school but did look into the engine/transmission packages the school uses. I found that Roush supplied packages to the Michigan-based school, so I discussed possible choices with them. Budget and street drivability were the main considerations in choosing the package.

I looked at the original transmission/differential ratios used in the original Cobra, per the R&T road test above. This was the major reason for selecting a 3.55 rear axle ratio. Factory Five also recommended this ratio. Roush recommended a Tremec TK600 transmission for durability purposes. Two 5th gear overdrive ratios are available, 0.82 and 0.64. I wanted to be able to go

about 75 mph at 3000 rpm. I chose the 0.82 ratio. With the 0.64 ratio, in 5th gear at 3000 rpm's, speed would have been 100 mph.

Tremec Model

TCET4617	Trans Gear Ratio	Rear Axle Ratio	Driveline Ratio
1	2.87	**3.55**	**10.1885**
2	1.89	**3.55**	**6.7095**
3	1.28	**3.55**	**4.544**
4	1.00	**3.55**	**3.55**
5	0.82	**3.55**	**2.911**
R	2.56	**3.55**	**9.088**

TCET5008			
1	2.87	**3.55**	**10.1885**
2	1.89	**3.55**	**6.7095**
3	1.28	**3.55**	**4.544**
4	1.00	**3.55**	**3.55**
5	0.64	**3.55**	**2.272**
R	2.56	**3.55**	**9.088**

TCET4617 mph @ 1k rpm	mph @ 2k rpm	mph @ 3k rpm	mph @ 4k rpm	mph @ 5k rpm	mph @ 6k rpm	mph @ 6.25k rpm
7.504276509	15.00855302	22.51282953	30.01710604	37.52138254	45.02565905	46.90172818
11.39538285	22.79076569	34.18614854	45.58153139	56.97691423	68.37229708	71.22114279
16.82599498	33.65198997	50.47798495	67.30397994	84.12997492	100.9559699	105.1624687
21.53727358	43.07454716	64.61182074	86.14909432	107.6863679	129.2236415	134.6079599
26.26496778	52.52993556	**78.79490334**	105.0598711	131.3248389	157.5898067	164.1560486
8.412997492	16.82599498	25.23899248	33.65198997	42.06498746	50.47798495	52.58123433

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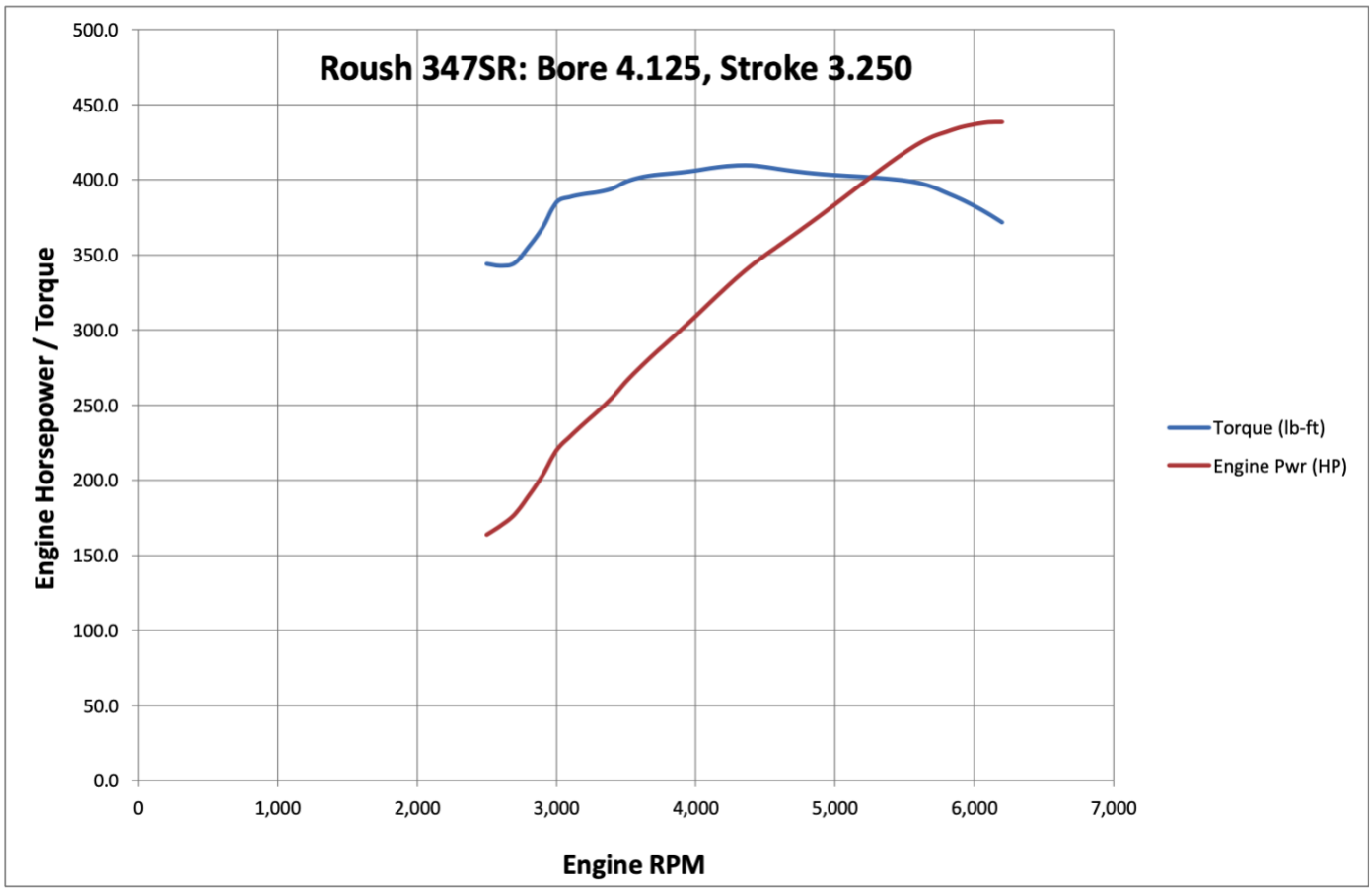
21.53727358	43.07454716	64.61182074	86.14909432	107.6863679	129.2236415	134.6079599
33.65198997	67.30397994	**100.9559699**	134.6079599	168.2599498	201.9119398	210.3249373
8.412997492	16.82599498	25.23899248	33.65198997	42.06498746	50.47798495	52.58123433

Tire Size	Diameter	Width	Tread Depth	Tread Width	Rim Range
315/35ZR17	25.7"	12.3"	10/32"	11.2"	10.5-12.5"
Load Range	**Max Load**	**Max psi**	**Weight**	**Revs/Mile**	
SL	1874 lbs	51 psi	30 lbs	785	

I opted not to go the route of a big block 427 because of the weight and cost. The low end of the Roush engines in terms of price and performance included a 331SRX, a 347SR and a 347R. The 331SRX is basically a 302 seasoned block rebuilt by Roush using standard internals. The 347SR and 347SRX are based on Dart blocks and use all forged internals. The SRX has a lumpier cam and performance is above 4500 rpms. Not too great for street use or even highway driving. Therefore, I chose the 347SR. Power and torque for the 347SR are adequate for normal street and highway driving. Roush does make 427 small blocks, if you have deep enough pockets.



Mk4 and Driveline Order

The FFR kit and Roush engine packages were ordered in early October 2014. FFR offers two options for the roadster kit – a donor car version and a complete kit. The donor version requires that you provide a Fox body Mustang to retrieve things like suspension components, wiring harness, etc. The complete kit replaces all the required donor car parts with aftermarket items such as the coil-over suspension components, polyurethane engine/transmission mounts, etc.

FFR Mk IV Complete Kit w(options below):

- Powder Coating of Chassis
- 302 Headers
- Engine/Trans Mount
- 31 Spline 10.625” driveshaft
- Leather Seat Upgrade
- Front Lower Arms
- 3-Link Deluxe Rear Suspension
- Electric Ultra-Lite Gauges
- 17” 5 lug Halibrand Replica Wheels
- Stainless steel side exhaust
- Wind Wings
- Sun Visors
- Battery Cut-off Switch
- 1.5” Left Hand Chrome Roll Bar
- 1.5” Roll Bar Grommet Set
- Performance 11.65 Rear Brake Set
- 8.8 Rear Axle Housing
- Body Cut Outs
- Roadster Heater/Defroster
- 14” Leather Steering Wheel
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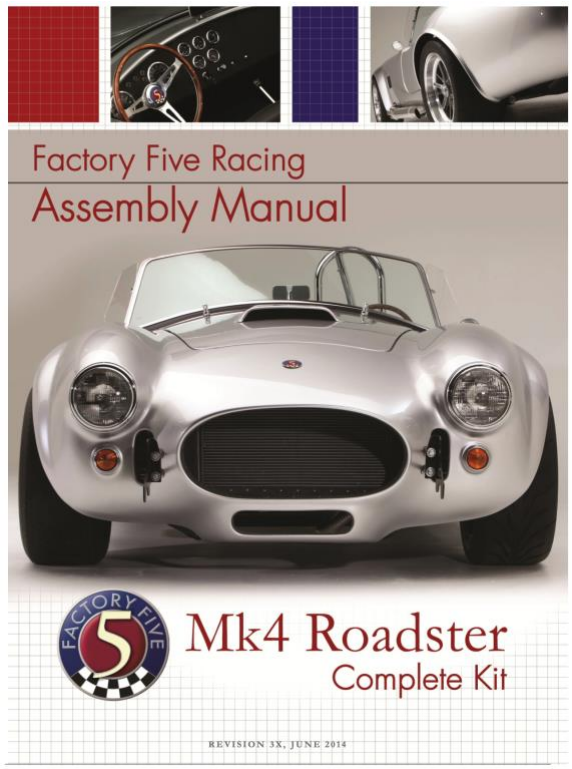
347SR Engine package *(With Front Sump Oil Pan)*

- Dart 4-bolt main Sportsman block
- Roush CNC ported aluminum heads
- Roush logo billet air cleaner
- Holley 770 CFM carburetor
- MSD distributor w/ wires and billet looms
- Standard rotation water pump
- Edelbrock dual plane intake manifold
- Hydraulic roller cam
- Roller rockers
- 4340 forged crankshaft
- 4340 H-beam rods
- Forged pistons
- Starter motor
- Roush logo valve covers
- SFI rated steel flywheel

- 8 qt. "Road Race" front sump oil pan
- Engine is machined, balanced, assembled and dyno tested.
- K&N 2" Air Filter Element
- MKIII Front Drive w/ Alternator, Bracket, Pulleys & Drive Belt
- MSD #6425 Digital 6AL Spark Box & #8202 Blaster II Coil and Bracket
- McLeod Single Disc Clutch & Pressure Plate & Mechanical Release Bearing
- Quicktime #RM-6060 Steel Bellhousing & Clutch Fork
- Tremec TKO-600 #4617 5-Speed Manual Transmission

Also included in the packages is a 475-page assembly manual, a 50 page harness wiring manual and a 40 page inventory for all the boxes of parts.



Delivery

FFR uses a dedicated carrier (Stewart Transport) if you choose to use them. The truck has a trolley mounted crane to lift the body/frame temporary assembly. The remaining boxes are liftable by one person. Delivery was made Thanksgiving weekend, 2014. A small crew of neighbors and friends helped with the unload. A neighbor with a tractor pulled the cart up our driveway with the body/frame and multiple loads of parts boxes. It was interesting that my car was the only delivery being made on the driver's trip. However, there was an original Ford GT40 in the truck which was being delivered somewhere by the owner for restoration. Driver would not provide any information about this car. He was glad that he was driving an unmarked truck though. Some Stewart trucks have FFR logos on them.



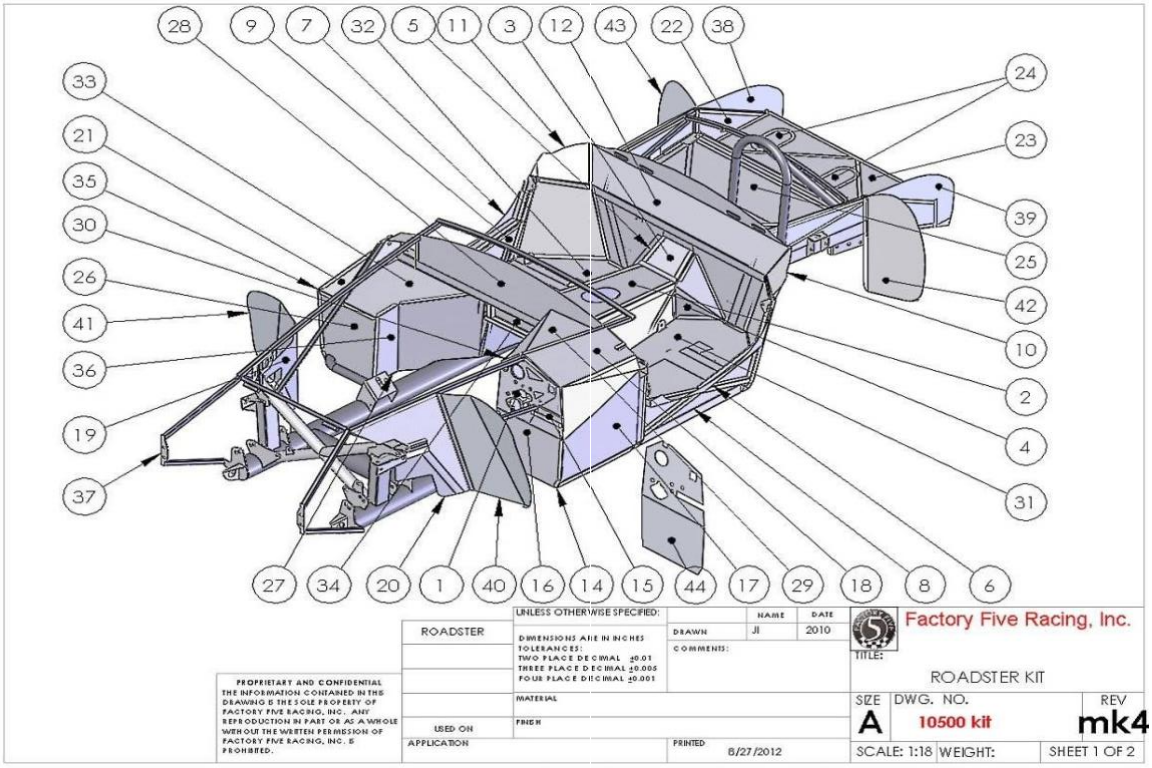



Chassis Build

Not particularly satisfying in terms of fun, but the first step in the build was to perform a complete inventory of all parts since FFR only allows a month to report any missing parts. However, I found that they were very flexible in correcting errors found a later date. The inventory took almost all December 2014. This allowed separation of parts required for the chassis build, engine/trans integration and for the body itself.

Construction of the car can take many paths, depending on personal preferences. There are a few constraints though. The body has to be integrated to the chassis at some point to fit the doors, hood, and trunk with the body correctly mounted to the frame. All the fiberglass parts are provided in an oversize state. The individual pieces must be fitted for proper gaps. Other than that the path is flexible. I had decided to use Tri-Lakes Collision to perform the minimal body work and fitting as well as the paint work. TLC would do the work on an as-available basis since they are not a custom car shop. This meant the body or car possibly had to be in their shop for extended periods. I also decided that I wanted the body painted off the chassis. This meant two periods of in-shop time at TLC 1) perform the component fitting and body mold mark filling with body on chassis and 2) paint the body off the chassis but mounted on a body buck. The body buck is made from plywood to support the body off the frame by providing support point across the body behind the cockpit and across the engine compartment with a wooden support between the dash edge and rear cockpit edge, to keep the body from bowing. This is necessary to keep the body from changing shape since it is freshly molded.

My plan was to 1) build the chassis, 2) install the drivetrain, 3) fit the body to the chassis, 4) install all components to make the car meet requirements for inspection by the CO Highway Patrol. I moved the chassis to my heated shop since that would be the longest period of time, spanning winter months. The chassis shown in the next picture was placed on a comfortable working height on jack stands. Forty plus aluminum panels needed to be installed to form the cockpit, trunk, engine compartment, firewall and dash. These panels are shown in the following figure. Preparation of the panels included drilling 1/16” holes every two inches where they interface with the structure of the chassis frame. In turn, the panels were fitted to the chassis using cleco fasteners to temporarily hold the panels while all remaining holes into the steel were drilled using the drilled panel as a template. When permanently fastening the panels to the chassis, the panels were attached with a non-water-based caulk to insure water tightness. Permanent rivets were installed while the panels were being bonded to the chassis. Some 2000 rivets were installed. Wish I had purchased a pneumatic rivet tool.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TOLERANCES:
TWO PLACE DECIMAL ±0.01
THREE PLACE DECIMAL ±0.005
FOUR PLACE DECIMAL ±0.001
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
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MATERIAL
FINISH
USED ON
APPLICATION
PRINTED
8/27/2012
Factory Five Racing, Inc.
TITLE:
ROADSTER KIT
SIZE
A
DWG. NO.
10500 kit
REV
mk4
SCALE: 1:18
WEIGHT:
SHEET 1 OF 2

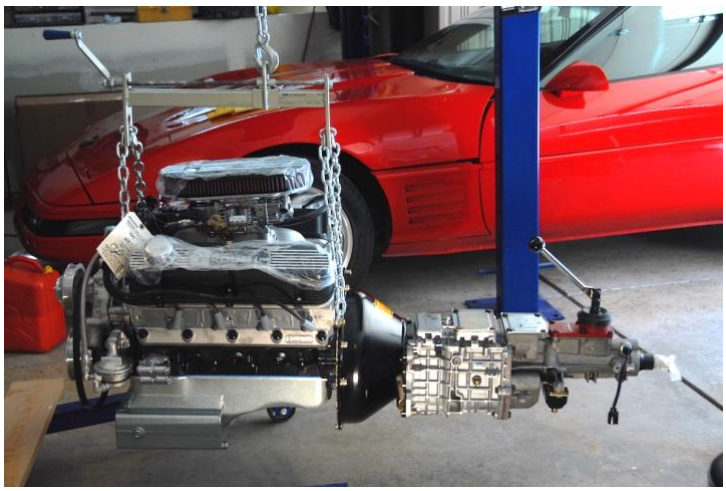
The differential and rear suspension were next installed to the chassis. The differential was shipped without axles installed since axles would interfere with the brake caliper installation. Rear cover was installed with no paper gasket, since a curable liquid gasket was used. The prepped differential is shown below with the three-point suspension components attached. The upper link is provided by FFR and attached to the axle housing and also the pinion flange. The upper link length is adjustable and is used to set the pinion angle. I set the pinion angle ~2 degrees down from driveshaft flange on the transmission, following engine/transmission installation. The following picture shows the differential mounted (with wheels and tires) and fuel tank and filler installed.

Front suspension work was next. First picture shows the passenger side coil over upper and lower control arms. Suspension caster and camber are set using the adjustment screws. Spring rates are 500 lbs/in for front and 600 lbs/in for the rear. Next two figures show completed suspension installation including the steering rack. Note that the heater has been installed through the firewall in the last figure. The large cable penetrating the firewall and hanging over front end is the clutch cable.

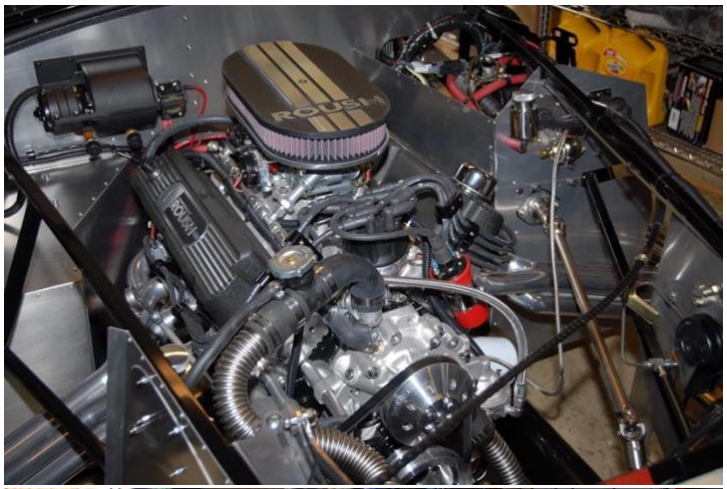
Car is finally rolled out of shop for transfer to garage for driveline installation. At this point the wiring harness has been installed, brakes and emergency brake are operational, gas line is installed. All the wires hanging are ready for connector installation for connection to body – lights, etc. Weather Pack connectors were used throughout.

Driveline Assembly and Engine Installation

While chassis was in my shop, engine was removed from crate and transmission/scattershield were mated. Note in the transmission picture that the rear lug has been removed with a hacksaw in order for transmission to clear a frame crossmember. More forward mounts on the transmission are used. Energy Suspension polyurethane engine and transmission mounts are used. This is close to mounting the engine/trans directly to the chassis. The mounts are so stiff that it was difficult to get the engine transmission to settle into place to match mounting holes in chassis. A lot of persuasion was required. It is difficult to insert the engine/trans into the chassis. The combination basically is hanging from the front two chains. Shelby sometimes jacked the rear of the car up 2-3 feet to alleviate this problem, especially when a carburetor is installed. I did have several problems when installing engine and transmission. The Dart block had to have lugs ground down to accept the engine mounts. Roush had warned about this, but it couldn't be done on the engine stand provided with the engine. After engine and trans were nearly in place, I discovered that one motor mount had a bad weld. Left the engine hanging while that was re-ordered from FFR. After that, I found that a ¾ inch spacer is needed under the transmission mount. The best option was to order raw metal and fabricate my own spacer. Again, the engine hung for awhile longer. The need for this mount was unknown to me but did find out about this known problem on FFR forums. Need for spacer is transmission dependent.



After the installation struggle, engine accessories and transmission sender were installed. The oil pressure sensor was mounted on the foot well via a stainless flexhose to avoid sensor breakage from vibration. Headers were installed, gas line hooked up with no return line. Gambled on not needing one but haven't had any problems with vapor lock. Antifreeze was filled, radiator bled, overflow installed. Heater was not connected. A master breaker was also installed. Was originally going to install an engine oil cooler, but Roush recommended not doing it because it adds restriction to the flow of oil to engine. It's good for racing, but very large lines and gentle bends are required. Engine doesn't need oil cooler for street since it runs cold as it is. Time for first start.



Body Chassis Integration

Following first start, the body, which has had no work performed was fitted to the powered, rolling chassis. The body buck can be seen atop the lift in the background. A few preparations to the chassis are required before body mount. Rubber molding to cushion the body against the hard structure of the frame was the main item requiring installation. Once the body is mounted, with no fasteners installed yet, the quick jacks are installed. This helps position the body correctly side-to-side and somewhat fore and aft. Fore and aft location is dictated by where the firewall and dash line up with the front of the cockpit and where the leading edge of the trunk area of the body line up with the aft edge of the cockpit. The quick jack installation secures the body to the frame. The under edge of the body is also attached to the frame between the front and rear wheels. This allows the body to be pulled in/out a little to help in adjusting the doors and their hinges to be adjusted so the door lines up with the body. Trunk and hood hinges are a trial and error process since the adjustments are inside the mounted body. The hood hinges can be adjusted somewhat by using a long extension socket wrench to reach the hood mount bolts from beneath the chassis.

Fitting the roll bar is done through the trunk and left rear wheel well. Work consists mostly of sizing the holes where the roll bar penetrates to the hard mounts on the frame, but through the body. Roll bar gaskets prevent water and debris from entering the trunk.

The windshield frame penetrates the body in front of the dashboard and mounts to hard structure of the frame. Shims are needed so that the windshield uprights are not flexed as flexing the uprights will cause the windshield to break. In general, the aluminum shims need to be tapered and are handmade from 1/8 inch aluminum sheet. Passenger side bolts for the windshield are relatively easy to install by wrapping one arm through the hood opening and the other arm up from below the dash. Not so straightforward for the driver side post, where there is not enough room for one hand.

Mounting of body accessories such as headlight, turn signals, marker lamps, license frame, windshield wiper system, hood scoop, mirrors, visors, side fender vents, remounting of sidepipes, latches is all that remains. Car is then ready for inspection at the DMV by the State Patrol and application for VIN upon passing inspection. VIN plate delivery to the State Patrol requires about one month following inspection and application. This requires car to be taken to the State Patrol twice. The VIN plate is mounted on the final trip using the special rivets.

Car was licensed at this point but not insured for driving, since the amount of time required at the body shop was not predictable at this point.


U-HAUL


ASSIGNED IDENTIFICATION NUMBER
IDCO 003261 ZZ
STATE OF COLORADO

Body Work

Entire car was delivered to Tri-Lakes Collision for fitting of the doors, hood and trunk to get the gaps to 3/16 inch. Filling and finishing the body mold ridges (not seams, as body is single piece) was the first step in the body work. This required use of a filler specified by FFR to prevent pinholes following painting.


Initial sanding of the red gel coat was also performed with some body filling for low spots, elimination of any waviness and final gapping of the body parts.



Car was now returned to my garage for marking of the centerline of the body for laying out stripes and also for removing all body accessories to include lighting, windshield, rollbar. Marking of the body centerline was accommodated using a home building type laser. V notches were filed to indicate the centerline in inconspicuous places on the body.

Body was removed from the chassis and placed on the body buck with support between the fore and aft edges of the cockpit to prevent body from sagging over the extended time at the body and paint shop.

Paint

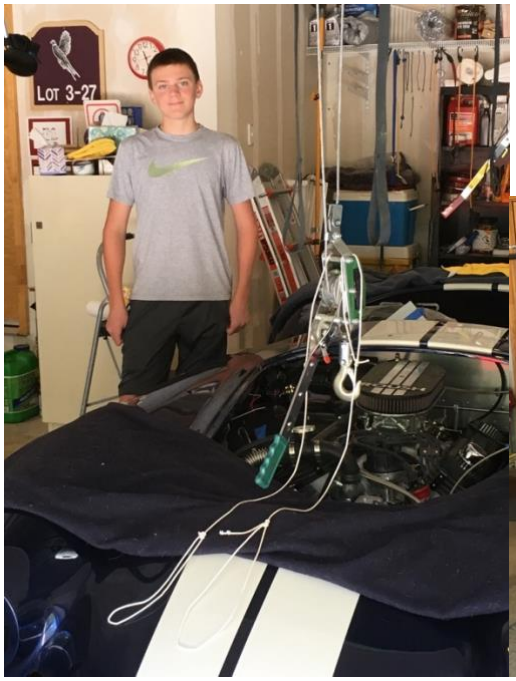
The paint shop now put the finishing touches on the body and other panels prior to priming. While the body was in the paint shop, the interior and trunk carpeting was installed back at my garage, as the chassis was not necessary for paint process at this point.

The first step was the priming of the body followed by a weeklong drying process. (February 2018)

Next the main color coat for the body was applied, stripes were taped and then sprayed over the body color coat.


The color was followed by the clear coat and the buffing and polishing.


With the help of my grandson, Ryan, we re-mounted the body to the chassis for the last time.



Hood, scoop, door, and engine compartment and trunk lids were installed and lined up to make the gaps look correct as possible with a fiberglass body. All the body hardware was remounted.

Finally, finished. (November, 2019)