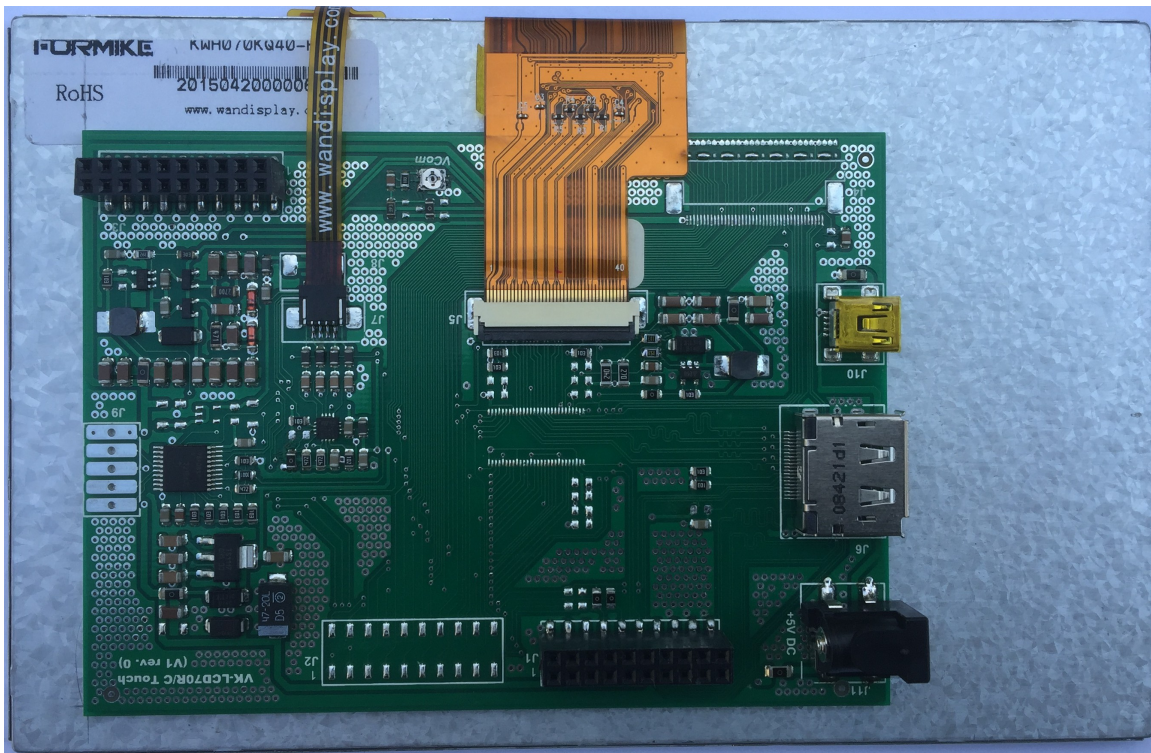


# VK-LCD70RT Display Board

## User manual



Rev. 1.0, Oct.12.2015

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Revision Changelog	
Rev #	Description:
1.0	Initial release
-	-

## INTRODUCTION

VK-LCD70RT is 1024 x 600 resistive touchscreen display board. This board is initially designed to be HMI module for VK-RZ/A1H development board, but can be used as stand-alone display with any LVDS or RGB display source.

Board supports:

- LVDS interface port
- RGB 888 (666) interface port (optional)
- Resistive touch displays
- Capacitive touch displays (optional)
- VK-RZ/A1H header connectors (optional)
- USB B Mini power connector
- DC Power jack connector

All this allow you to connect the board to diversity of development boards, equipped with LVDS or RGB digital output interface (40 pin FFC & FPC connectors), used in a wide range of embedded tasks.

## BOARD FEATURES:

- MCU: 78K0/FA2-L (μPD78F0857)
- Resistive touch controller: (STMPE811)
- 7 inch resistive display (KWH070KQ40-F02)
- LVDS Port connector (In) (Stand-alone display for VK-RZ/A1H development board)
- VK-RZ/A1H header connectors (HMI module for VK-RZ/A1H development board)
- 5 pin Debug/programming Emulator connector (Renesas E1)
- Power connector for DC/DC (In: 5V)
- USB Mini B power connector
- Dimensions: (board only 114.0mm x 82.0mm) ,(board with display: 165.75mm x 105.39mm)

## ELECTROSTATIC WARNING

VK-LCD70RT board is shipped in protective anti-static packaging. The board must not be subject to high electrostatic potentials. General practice for working with static sensitive devices should be applied when working with this board.

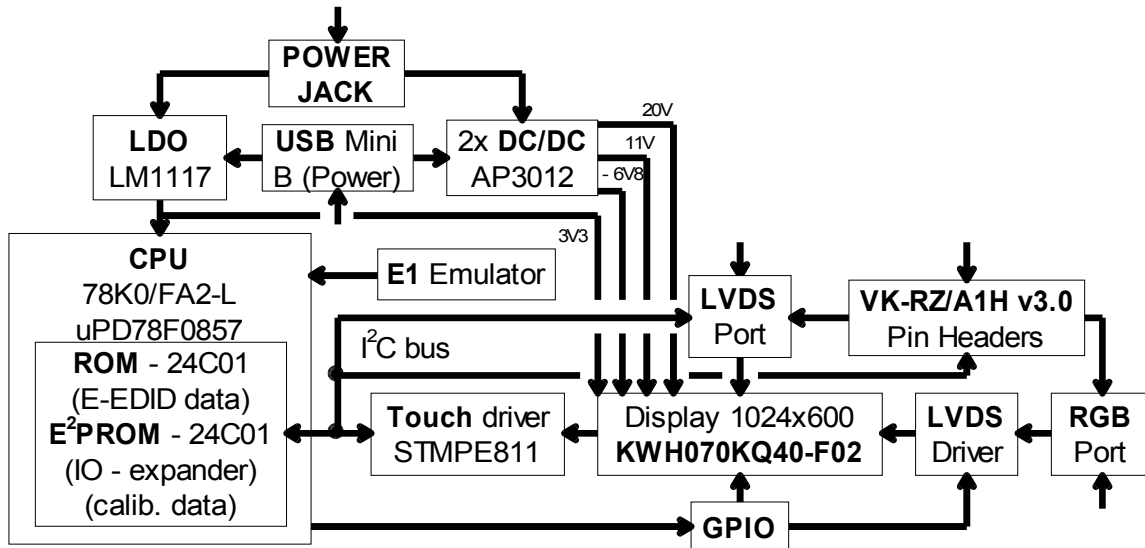
## PROCESSOR FEATURES

The VK-LCD70RT board use MCU μPD78F0857 from RENESAS ELECTRONICS with these features:

- Power supply voltage: VDD = 3.0 to 3.6 V
- Operating ambient temperature: TA = -40 to +85°C
- CPU clock = 20 MHz)

For more information please visit [www.renesas.eu](http://www.renesas.eu)

## BLOCK DIAGRAM



## INTERNAL I<sup>2</sup>C ADDRESS SPACE

I2C Slave device address : **0x4E**

0x00 - 0x7F:	LCD E-EDID Data	(ROM)	(128 Bytes)
0x80 - 0x8F:	IO expander regs	(PROM)	(16 Bytes)
0x90 - 0xC7:	Calibration data	(PROM)	(56 Bytes)
0xC8 - 0xFF:	Free user space data	(PROM)	(56 Bytes)

⚠ I<sup>2</sup>C data is accessed with 1 byte addressing !

## DATA STRUCTURES

*IO expander regs have the following meaning:*

```
typedef union __IOPORT {
    struct __CONTROL_BIT {
        unsigned char RGB_DATA :1; // turn on/off LVDS driver (not used)
        unsigned char M666_888 :1; // LVDS data format (0: 666, 1: 888)
        unsigned char L_R_SCAN :1; // horizontal flip (0: unflipped, 1: flipped)
        unsigned char U_D_SCAN :1; // vertical flip (0: unflipped, 1: flipped)
        unsigned char BL_EN :1; // backlight control (0: off, 1: on)
        unsigned char RESET_CTP :1; // reset the Capacitive tuch driver (not used)
        unsigned char :1; // reserved
        unsigned char :1; // reserved
    };
    unsigned char port; // byte access to the regs
}PORT;

union __IOEXP {
    struct __CONTROL_REG {
        PORT mode; // 1 byte control register type 0: output 1: input
        PORT output; // 1 byte output data
        PORT input; // 1 byte input data
        unsigned char PWM_dc; // 1 byte brightness of the lcd [%] (duty cycle 0-100%)
        unsigned char PWM_div; // 1 byte division ratio
        unsigned char PWM_t; // 1 byte period of the PWM [ticks]
    }regs;
    unsigned char reg[sizeof(struct __CONTROL)]; // 1 byte access to the IO expander regs
};
```

**Period of the PWM signal [Hz] & allowed constants for PWM\_t, PWM\_div**

PWM_t \ PWM_div	0	1	2	3	4
100	20000,00	50000,00	12500,00	3125,00	48,83
101	198019,80	49504,95	12376,24	3094,06	48,34
102	196078,43	49019,61	12254,90	3063,73	47,87
103	194174,76	48543,69	12135,92	3033,98	47,41
104	192307,69	48076,92	12019,23	3004,81	46,95
105	190476,19	47619,05	11904,76	2976,19	46,50
106	188679,25	47169,81	11792,45	2948,11	46,06
107	186915,89	46728,97	11682,24	2920,56	45,63

108	185185,19	46296,30	11574,07	2893,52	45,21
109	183486,24	45871,56	11467,89	2866,97	44,80
110	181818,18	45454,55	11363,64	2840,91	44,39
111	180180,18	45045,05	11261,26	2815,32	43,99
112	178571,43	44642,86	11160,71	2790,18	43,60
113	176991,15	44247,79	11061,95	2765,49	43,21
114	175438,60	43859,65	10964,91	2741,23	42,83
115	173913,04	43478,26	10869,57	2717,39	42,46
116	172413,79	43103,45	10775,86	2693,97	42,09
117	170940,17	42735,04	10683,76	2670,94	41,73
118	169491,53	42372,88	10593,22	2648,31	41,38
119	168067,23	42016,81	10504,20	2626,05	41,03
120	166666,67	41666,67	10416,67	2604,17	40,69
121	165289,26	41322,31	10330,58	2582,64	40,35
122	163934,43	40983,61	10245,90	2561,48	40,02
123	162601,63	40650,41	10162,60	2540,65	39,70
124	161290,32	40322,58	10080,65	2520,16	39,38
125	160000,00	40000,00	10000,00	2500,00	39,06
126	158730,16	39682,54	9920,63	2480,16	38,75
127	157480,31	39370,08	9842,52	2460,63	38,45
128	156250,00	39062,50	9765,63	2441,41	38,15
129	155038,76	38759,69	9689,92	2422,48	37,85
130	153846,15	38461,54	9615,38	2403,85	37,56
131	152671,76	38167,94	9541,98	2385,50	37,27
132	151515,15	37878,79	9469,70	2367,42	36,99
133	150375,94	37593,98	9398,50	2349,62	36,71
134	149253,73	37313,43	9328,36	2332,09	36,44
135	148148,15	37037,04	9259,26	2314,81	36,17
136	147058,82	36764,71	9191,18	2297,79	35,90
137	145985,40	36496,35	9124,09	2281,02	35,64
138	144927,54	36231,88	9057,97	2264,49	35,38
139	143884,89	35971,22	8992,81	2248,20	35,13
140	142857,14	35714,29	8928,57	2232,14	34,88
141	141843,97	35460,99	8865,25	2216,31	34,63
142	140845,07	35211,27	8802,82	2200,70	34,39
143	139860,14	34965,03	8741,26	2185,31	34,15
144	138888,89	34722,22	8680,56	2170,14	33,91
145	137931,03	34482,76	8620,69	2155,17	33,67
146	136986,30	34246,58	8561,64	2140,41	33,44
147	136054,42	34013,61	8503,40	2125,85	33,22
148	135135,14	33783,78	8445,95	2111,49	32,99
149	134228,19	33557,05	8389,26	2097,32	32,77
150	133333,33	33333,33	8333,33	2083,33	32,55
151	132450,33	33112,58	8278,15	2069,54	32,34
152	131578,95	32894,74	8223,68	2055,92	32,12
153	130718,95	32679,74	8169,93	2042,48	31,91
154	129870,13	32467,53	8116,88	2029,22	31,71
155	129032,26	32258,06	8064,52	2016,13	31,50
156	128205,13	32051,28	8012,82	2003,21	31,30
157	127388,54	31847,13	7961,78	1990,45	31,10
158	126582,28	31645,57	7911,39	1977,85	30,90
159	125786,16	31446,54	7861,64	1965,41	30,71
160	125000,00	31250,00	7812,50	1953,13	30,52
161	124223,60	31055,90	7763,98	1940,99	30,33
162	123456,79	30864,20	7716,05	1929,01	30,14
163	122699,39	30674,85	7668,71	1917,18	29,96
164	121951,22	30487,80	7621,95	1905,49	29,77
165	121212,12	30303,03	7575,76	1893,94	29,59
166	120481,93	30120,48	7530,12	1882,53	29,41
167	119760,48	29940,12	7485,03	1871,26	29,24
168	119047,62	29761,90	7440,48	1860,12	29,06
169	118343,20	29585,80	7396,45	1849,11	28,89
170	117647,06	29411,76	7352,94	1838,24	28,72
171	116959,06	29239,77	7309,94	1827,49	28,55
172	116279,07	29069,77	7267,44	1816,86	28,39

<b>173</b>	115606,94	28901,73	7225,43	1806,36	28,22
<b>174</b>	114942,53	28735,63	7183,91	1795,98	28,06
<b>175</b>	114285,71	28571,43	7142,86	1785,71	27,90
<b>176</b>	113636,36	28409,09	7102,27	1775,57	27,74
<b>177</b>	112994,35	28248,59	7062,15	1765,54	27,59
<b>178</b>	112359,55	28089,89	7022,47	1755,62	27,43
<b>179</b>	111731,84	27932,96	6983,24	1745,81	27,28
<b>180</b>	111111,11	27777,78	6944,44	1736,11	27,13
<b>181</b>	110497,24	27624,31	6906,08	1726,52	26,98
<b>182</b>	109890,11	27472,53	6868,13	1717,03	26,83
<b>183</b>	109289,62	27322,40	6830,60	1707,65	26,68
<b>184</b>	108695,65	27173,91	6793,48	1698,37	26,54
<b>185</b>	108108,11	27027,03	6756,76	1689,19	26,39
<b>186</b>	107526,88	26881,72	6720,43	1680,11	26,25
<b>187</b>	106951,87	26737,97	6684,49	1671,12	26,11
<b>188</b>	106382,98	26595,74	6648,94	1662,23	25,97
<b>189</b>	105820,11	26455,03	6613,76	1653,44	25,83
<b>190</b>	105263,16	26315,79	6578,95	1644,74	25,70
<b>191</b>	104712,04	26178,01	6544,50	1636,13	25,56
<b>192</b>	104166,67	26041,67	6510,42	1627,60	25,43
<b>193</b>	103626,94	25906,74	6476,68	1619,17	25,30
<b>194</b>	103092,78	25773,20	6443,30	1610,82	25,17
<b>195</b>	102564,10	25641,03	6410,26	1602,56	25,04
<b>196</b>	102040,82	25510,20	6377,55	1594,39	24,91
<b>197</b>	101522,84	25380,71	6345,18	1586,29	24,79
<b>198</b>	101010,10	25252,53	6313,13	1578,28	24,66
<b>199</b>	100502,51	25125,63	6281,41	1570,35	24,54
<b>200</b>	100000,00	25000,00	6250,00	1562,50	24,41
<b>201</b>	99502,49	24875,62	6218,91	1554,73	24,29
<b>202</b>	99009,90	24752,48	6188,12	1547,03	24,17
<b>203</b>	98522,17	24630,54	6157,64	1539,41	24,05
<b>204</b>	98039,22	24509,80	6127,45	1531,86	23,94
<b>205</b>	97560,98	24390,24	6097,56	1524,39	23,82
<b>206</b>	97087,38	24271,84	6067,96	1516,99	23,70
<b>207</b>	96618,36	24154,59	6038,65	1509,66	23,59
<b>208</b>	96153,85	24038,46	6009,62	1502,40	23,48
<b>209</b>	95693,78	23923,44	5980,86	1495,22	23,36
<b>210</b>	95238,10	23809,52	5952,38	1488,10	23,25
<b>211</b>	94786,73	23696,68	5924,17	1481,04	23,14
<b>212</b>	94339,62	23584,91	5896,23	1474,06	23,03
<b>213</b>	93896,71	23474,18	5868,54	1467,14	22,92
<b>214</b>	93457,94	23364,49	5841,12	1460,28	22,82
<b>215</b>	93023,26	23255,81	5813,95	1453,49	22,71
<b>216</b>	92592,59	23148,15	5787,04	1446,76	22,61
<b>217</b>	92165,90	23041,47	5760,37	1440,09	22,50
<b>218</b>	91743,12	22935,78	5733,94	1433,49	22,40
<b>219</b>	91324,20	22831,05	5707,76	1426,94	22,30
<b>220</b>	90909,09	22727,27	5681,82	1420,45	22,19
<b>221</b>	90497,74	22624,43	5656,11	1414,03	22,09
<b>222</b>	90090,09	22522,52	5630,63	1407,66	21,99
<b>223</b>	89686,10	22421,52	5605,38	1401,35	21,90
<b>224</b>	89285,71	22321,43	5580,36	1395,09	21,80
<b>225</b>	88888,89	22222,22	5555,56	1388,89	21,70
<b>226</b>	88495,58	22123,89	5530,97	1382,74	21,61
<b>227</b>	88105,73	22026,43	5506,61	1376,65	21,51
<b>228</b>	87719,30	21929,82	5482,46	1370,61	21,42
<b>229</b>	87336,24	21834,06	5458,52	1364,63	21,32
<b>230</b>	86956,52	21739,13	5434,78	1358,70	21,23
<b>231</b>	86580,09	21645,02	5411,26	1352,81	21,14
<b>232</b>	86206,90	21551,72	5387,93	1346,98	21,05
<b>233</b>	85836,91	21459,23	5364,81	1341,20	20,96
<b>234</b>	85470,09	21367,52	5341,88	1335,47	20,87
<b>235</b>	85106,38	21276,60	5319,15	1329,79	20,78
<b>236</b>	84745,76	21186,44	5296,61	1324,15	20,69
<b>237</b>	84388,19	21097,05	5274,26	1318,57	20,60



238	84033,61	21008,40	5252,10	1313,03	20,52
239	83682,01	20920,50	5230,13	1307,53	20,43
240	83333,33	20833,33	5208,33	1302,08	20,35
241	82987,55	20746,89	5186,72	1296,68	20,26
242	82644,63	20661,16	5165,29	1291,32	20,18
243	82304,53	20576,13	5144,03	1286,01	20,09
244	81967,21	20491,80	5122,95	1280,74	20,01
245	81632,65	20408,16	5102,04	1275,51	19,93
246	81300,81	20325,20	5081,30	1270,33	19,85
247	80971,66	20242,91	5060,73	1265,18	19,77
248	80645,16	20161,29	5040,32	1260,08	19,69
249	80321,29	20080,32	5020,08	1255,02	19,61
250	80000,00	20000,00	5000,00	1250,00	19,53
251	79681,27	19920,32	4980,08	1245,02	19,45
252	79365,08	19841,27	4960,32	1240,08	19,38
253	79051,38	19762,85	4940,71	1235,18	19,30
254	78740,16	19685,04	4921,26	1230,31	19,22
255	78431,37	19607,84	4901,96	1225,49	19,15

**Calibration data has the following meaning:**

```
union __CALIB {
    struct __DATA {
        unsigned int len; // 4 bytes size of calibration structure [bytes]
        unsigned int flag; //4 bytes validation flag (1: constants are valid, 0: they aren't)
        double KX1, KY1, KX2, KY2, KX3, KY3; // 6 calibration constants [8 bytes each]
    }data;
    unsigned char KX08[sizeof(struct __DATA)]; // 1 byte access to the calibration data
};
```



**Screen coordinates are retrieved by the following equation:**

$$P_x = (KX1 * raw_x) + (KX2 * raw_y) + KX3 + 0,5;$$

$$P_y = (KY1 * raw_x) + (KY2 * raw_y) + KY3 + 0,5;$$

where  $raw_P(raw_x, raw_y)$  is the known raw point from the touch driver and  $P(x, y)$  is the sought screen point.

For more information about the calibration procedure please refer to **AN-1021**  
( <http://www.analog.com/media/en/technical-documentation/application-notes/AN-1021.pdf> )

Of course feel free to modify data in 0x90 – 0xFF, by your own desire, using different calibration algorithms.

## POWER SUPPLY CIRCUIT:

VK-LCD70RT is powered by (5) V DC applied at the power jack.  
VK-LCD70RT could also be powered by USB Mini B connector.  
The consumption of VK-LCD70RT may vary and the maximum (as standalone display) is 600 mA.



**If VK-RZ/A1H development board is connected to VK-LCD70RT the max consumption is 1A.**

## EXTERNAL CONNECTORS DESCRIPTION

### Power jack

PWR J11			
Pin#	Signal Name	Pin#	Signal Name
1	+5V	2,3	GND



The power input should be +(5VDC)

### USB power

USB mini B J10			
Pin#	Signal Name	Pin#	Signal Name
1	+5V	3	-
2	-	5	GND



Pins #2, #3, #4 are disconnected.

### E1 Emulator 5pin connector

E1 J9	
Pin#	Signal Name
1	TOOL C0
2	TOOL D0
3	+3V3
4	RESET
5	GND

### LVDS & RGB ports

LVDS port J6				RGB port J4 (optional)			
Pin#	Signal Name	Pin#	Signal	Pin#	Signal Name	Pin#	Signal Name
1	AUX_CH_-			1	+5V	21	B0
2	GND			2	+5V	22	B1
3	AUX_CH_+			3	R0	23	B2
4	ML_LANE_2_-			4	R1	24	B3
5	GND			5	R2	25	B4
6	ML_LANE_2_+			6	R3	26	B5
7	ML_LANE_1_-			7	R4	27	B6
8	GND			8	R5	28	B7
9	ML_LANE_1_+			9	R6	29	GND
10	ML_LANE_0_-			10	R7	30	Pclk
11	GND			11	GND	31	GND
12	ML_LANE_0_+			12	G0	32	Hsync
13	-			13	G1	33	Vsync
14	-			14	G2	34	DE
15	I2C_SCL			15	G3	35	GND
16	GND			16	G4	36	GND
17	I2C_SDA			17	G5	37	I2C_SDA
18	TP_INT			18	G6	38	I2C_SCL
19	GND			19	G7	39	Reset
20	-			20	GND	40	TP_INT



RGB Connector J4 and LVDS driver (SN75LVDS83B) are optional !



The signals, that are coming in the J6 connector, ARE NOT DISPLAY PORT SIGNALS, regardless of the fact that the connector is the same as Display port.

## CONFIGURABLE REROUTING

There are features that can be enabled or disabled by manually soldering or desoldering a connections, (mostly 0  $\Omega$  resistors). If the user wants to enable given purpose, related designator should be soldered and sometimes some others must be desoldered. Connections with \* are soldered and these are factory default settings.

<b>Optionals: solder at your own risk, double check &amp; comply with the schematic !</b>			
Designator#	Signal	Purpose	Dependence
Jp1 *	SDA3	Access LCD I <sup>2</sup> C Bus from I <sup>2</sup> C3	Remove Jp4
Jp2 *	SCL3	Access LCD I <sup>2</sup> C Bus from I <sup>2</sup> C3	Remove Jp3
Jp3	SCL0	Access LCD I <sup>2</sup> C Bus from I <sup>2</sup> C0	Remove Jp2
Jp4	SDA0	Access LCD I <sup>2</sup> C Bus from I <sup>2</sup> C0	Remove Jp1
Jp5	LVDS driver CLKSEL	Select active front of the clock	-
Jp6	Lcd Reset	Allow reset to go out to RGB port	-
Jp7	+3V3	Power the 78K0 through Display port	-
Jp8 *	A0 Data	Set STMPE811 slave address to 0x82	-
Jp9	AP3012 SH	Turn on/off Avdd ,VGH, VGL with BL_EN	-
Jp10 *	AP3012 SH	Turn on/off backlight with BL_EN	-
Jp11 *	Vcom	Not buffered Vcom voltage	-

## VK-RZ/A1H V3.0 PIN HEADERS

### LCD extension

<b>J9 (RZ/A1H) → J2 (LCD70RT)</b>			
Pin#	Signal Name	Pin#	Signal Name
1	P1_1/RIIC0SDA	2	P3_0/LCDO_CLK
3	P1_0/RIIC0SCL	4	P3_1/LCDO_TCON0 (DE)
5	P3_9/LCDO_DATA1 (B2)	6	P3_8/LCDO_DATA0 (B1)
7	P3_13/LCDO_DATA5 (G0)	8	P3_12/LCDO_DATA4 (B5)
9	P4_2/LCDO_DATA10 (G5)	10	P3_14/LCDO_DATA6 (G1)
11	P3_11/LCDO_DATA3 (B4)	12	P4_1/LCDO_DATA9 (G4)
13	P4_5/LCDO_DATA13 (R3)	14	P4_4/LCDO_DATA12 (R2)
15	P4_7/LCDO_DATA15 (R5)	16	P4_6/LCDO_DATA14 (R4)
17	P4_0/LCDO_DATA8 (G3)	18	P3_10/LCDO_DATA2 (B3)
19	P3_15/LCDO_DATA7 (G2)	20	P4_3/LCDO_DATA11 (R1)

<b>J10 (RZ/A1H) → J1 (LCD70RT)</b>			
Pin#	Signal Name	Pin#	Signal Name
1	+5V	2	GND
3	P1_4/RIIC2SCL ( n.c. LCD70RT)	4	+3V3 ( n.c. to LCD70RT)
5	P1_2/RIIC1SCL ( n.c. LCD70RT)	6	P1_3/RIIC1SDA ( n.c. to LCD70RT)
7	P1_5/RIIC2SDA (n.c. LCD70RT)	8	P1_6/RIIC3SCL
9	P3_2/LCDO_TCON1 (Hsync)	10	P1_7/RIIC3SDA
11	P7_8/IRQ1	12	P3_7/LCDO_TCON6 (Vsync)
13	P5_0/TXCLKOUTP	14	P5_1/TXCLKOUTM
15	P5_2/TXOUT2P	16	P5_3/TXOUT2M
17	P5_4/TXOUT1P	18	P5_5/TXOUT1M
19	P5_6/TXOUT0P	20	P5_7/TXOUT0M

<b>J14 (RZ/A1H) → J3 (LCD70RT)</b>			
Pin#	Signal Name	Pin#	Signal Name
1	n.c	2	Battery ( n.c. to LCD70RT)
3	n.c	4	n.c
5	P8_10 ( n.c. to LCD70RT)	6	P8_8/TxD3 ( n.c. to LCD70RT)
7	P8_11 ( n.c. to LCD70RT)	8	P8_9/RxD3 ( n.c. to LCD70RT)
9	P8_13 ( n.c. to LCD70RT)	10	P8_12 ( n.c. to LCD70RT)
11	P8_15 ( n.c. to LCD70RT)	12	P8_14 ( n.c. to LCD70RT)
13	P9_1 ( n.c. to LCD70RT)	14	P9_0 ( n.c. to LCD70RT)
15	n.c	16	+1V18 ( n.c. to LCD70RT)
17	RESET ( n.c. to LCD70RT)	18	+3V3 ( n.c. to LCD70RT)
19	GND	20	+5V

### SCHEMATICS: