

**GCE**

**Electronics**

Unit **F615**: Communications Systems

Advanced GCE

**Mark Scheme for June 2017**

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

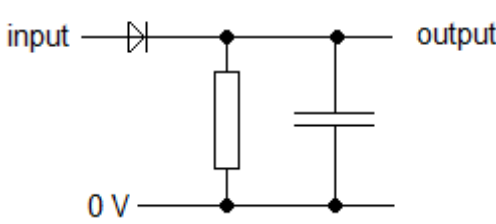
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## Annotations

1		31	BOD	Benefit of doubt
2		21	Cross	Cross
3		241	ECF	Error carried forward
4		191	NBOD	Benefit of doubt not given
5		1841	Not Relevant	Expandable vertical wavy line
6		271	REP	Repeat
7		201	TV	Too vague
8		11	Tick	Tick
9		1741	ZERO	Zero (big)
10				
11				
12				
13				
14				

Question			Answer	Marks	Guidance
1	a	i	need red, green and blue pixels; as any colour can be made by combining these colours;	1 1	Accept 'full colour'
1	a	ii	$2^4 = 16$	1	Accept just 16
1	b	i	0 at beginning of word; 1 at the end; so that display can tell when each six-bit word starts;	1 1 1	accept start and stop bits for [1] Accept low for 0 and high for 1 <b>not</b> starts and ends
1	b	ii	one wire carries line sync pulses; to tell display when to start scanning/refreshing a new row; other wire carries frame sync pulses; to tell display when to start scanning a new frame;	1 1 1 1	Must say 'sync'
1	b	iii	pixels per frame = $768 \times 1380 = 1.06 \times 10^6$ ; words per second = $1.06 \times 10^6 \times 35 = 3.71 \times 10^7$ ; bits per second = $3.71 \times 10^7 \times 6 = 2.22 \times 10^8$ ;	1 1 1	look for words as well as numbers  correct calculation with no explanation [1]
1	b	iv	111 MHz	1	accept 100 MHz
1	c		extra bits are the address information for each word; each display has a different address; $2^5 = 32$ so enough for 24 displays;	1 1 1	

Question			Answer	Marks	Guidance
2	a	i	sinusoidal / sine wave; frequency 117.5 kHz;	1 1	accept 117 or 118
2	a	ii	sinusoidal / sine wave; frequency 5 kHz;	1 1	Between 4.5 and 5.5 kHz
2	a	iii	same a.c. component as <b>A</b> ; but centred on 5 V;	1 1	Accept audio input shifted by 5V
2	b		amplifier; with variable gain; gain determined by voltage at B	1 1 1	Accept input signal, signal at A
2	c	i	<p>input —  — output</p> <p>0 V</p>	5	diode-resistor rectifier [1] resistor-capacitor treble cut filter [1] input, output and 0 V labels [1] RC between 32 $\mu$ s and 16 $\mu$ s [1] justified with $f_0 = \frac{1}{2\pi RC}$ [1]
2	c	ii	the diode (and resistor) rectify the signal; the resistor and capacitor remove carrier / high frequencies;	1 1	

Question			Answer	Marks	Guidance																																										
3	a		(binary) word at outputs; represents voltage at input	1 1																																											
3	b	i	voltage drop across $20\text{ k}\Omega$ is $0.20\text{ V}$ ; so inverting inputs of comparators are $0.10\text{ V}$ apart	1 1																																											
3	b	ii	$0.1\text{ V}$ across $10\text{ k}\Omega$ ; $15 - 0.4 = 14.6\text{ V}$ across $R$ ; so $R$ is $1460\text{ k}\Omega$	1 1 1	Allow use of potential divider equation for full credit.																																										
3	c	i	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>P</th> <th>Q</th> <th>R</th> <th>S</th> <th>C</th> <th>B</th> <th>A</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> </tr> </tbody> </table>	P	Q	R	S	C	B	A	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	1	0	0	1	1	1	0	1	1	1	1	1	1	1	0	0	3	PQRS correct [1] C correct [1] A correct [1]  no ecf from incorrect PQRS
P	Q	R	S	C	B	A																																									
0	0	0	0	0	0	0																																									
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3	c	ii		3	any correct Boolean algebra statement for B [1] any correct NAND gate circuit ( ecf for incorrect expression) [1] use of algebra to justify circuit [1]																																										
3	c	iii		4	correct circuit [1] suitable resistor values for $5\text{ V}$ [1] $0.7\text{ V}$ drop across diode, op-amp saturates at $13\text{ V}$ [1] justification for values using voltage divider, op-amp behaviour and diode behaviour [1]																																										

Question			Answer	Marks	Guidance
4	a		frequency modulation; frequency of carrier/radio wave; determined by voltage of signal;	1 1 1	<b>not</b> amplitude
4	b	i	bandwidth of one station = $5 \times 20 = 100$ kHz; available bandwidth = $107.9 - 87.9 = 20$ MHz; maximum channels = $20 / 0.1 = 200$	1 1 1	200 on its own =[1] no ecf from incorrect bandwidth
4	b	ii	no overlap of signals from adjacent stations; making it easier for receivers to tell them apart;	1 1	
4	c	i	more channels; because AM bandwidth less than FM bandwidth;	1 1	
4	c	ii	more noise; in demodulated signal;/ received signal because limiters/Schmitt triggers can't be used;	1 1 1	Accept argument from FM perspective

Question	Answer	Marks	Guidance
5		7	<p>all clock connections in parallel to CK, Q to D [1]  right-hand Q to SO, left-hand D to +5V [1]  logic systems / multiplexers controlling S and R from PL and a/b/c [1]  SR = 00 when PL = 0 [1]  SR = 10 when PL = 1 and a/b/c = 1 [1]  SR = 01 when PL = 1 and a/b/c = 0 [1]  SO goes low when PL pulsed high [1]  If MUX used signals to D  R must be 0V[1]  S must be 0V[1]  0 into last stage [1]  MUX signal a/b/c/0; Q [1]</p>



Question			Answer	Marks	Guidance
6	a	i	<pre> graph TD     Aerial[aerial] --&gt; TC[tuned circuit]     TC --&gt; RA[rf amplifier]     RA --&gt; D[demodulator]     D --&gt; AA[af amplifier]     AA --&gt; LS[loudspeaker]             </pre>	2	rf amplifier [1] (loud)speaker [1]
6	a	ii	(rf amplifier): increases amplitude; of modulated carrier; (loudspeaker): converts alternating signal into sound;	1 1 1	Just saying amplifier amplifies is insufficient
6	b	i		5	correct circuit ( ignore any input resistor)[1] output and 0 V/earth labels [1] $LC = 1.3 \times 10^{-14} \text{ s}$ [1] C between 100 nF and 1 pF [1] use of $f_0 = \frac{1}{2\pi\sqrt{LC}}$ [1]
6	b	ii	aerial converts radio signals into alternating currents; tuned circuit converts alternating current into voltage; for a narrow range of frequencies; at $1.4 \text{ MHz} \pm 5 \text{ kHz}$ ;	1 1 1 1	

Question		Answer	Marks	Guidance
6	c		8	correct voltage follower [1] correct volume control [1] correct inverting amplifier circuit [1] correct coupling capacitor [1] $R_f / R_{in} = 200$ [1] justified with $G = -\frac{R_f}{R_{in}}$ [1] all resistor values between 1 k $\Omega$ and 10 M $\Omega$ [1] $R_{in}C = 3.2 \times 10^{-3}$ s [1]

Question			Answer	Marks	Guidance
7	a	i	use of summing amplifier formula; $X = 5 \times (4/16) = -1.25 \text{ V}$ ; $-(256/200) \times -1.25 (= 1.6 \text{ V})$ ;	1 1 1	
7	a	ii	EITHER calculation for DCBA = 0001; OR DCBA = 0100 is binary equivalent of 4 THEN resolution = 0.4 V;	1  1	
7	a	iii	DCBA = 0000 gives 0 V; DCBA = 1111 gives $15 \times 0.4 = 6.0 \text{ V}$	1 1	
	b	i	how long it takes output to stabilise; when word at input is changed;	1 1	Accept time taken to convert for [1]
	b	ii	need at least two samples per cycle; so each cycle cannot be shorter than 40 $\mu\text{s}$ ; maximum frequency = $1/40 \times 10^{-6} (= 25 \text{ kHz})$ ;	1 1 1	Accept correct argument from frequencies
	c		allows a number of different signals to (simultaneously) pass down a single link; by allowing each signal in turn on the link; for many short time slots;	1 1 1	

## APPENDIX 1

## Quality of Written Communication

3	The candidate expresses complex ideas extremely clearly and fluently. Sentences and paragraphs follow on from one another smoothly and logically. Arguments are consistently relevant and well structured. There will be few, if any, errors of grammar, punctuation and spelling.
2	The candidate expresses straightforward ideas clearly, if not always fluently. Sentences and paragraphs may not always be well connected. Arguments may sometimes stray from the point or be weakly presented. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.
1	The candidate expresses simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weaknesses in these areas.
0	The language has no rewardable features.

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